Міністерство освіти і науки України
Національний університет «Києво-Могилянська академія»
Факультет економічних наук
Кафедра фінансів

Магістерська робота

освітній ступінь - магістр

на тему: **«ПРИЧИНИ ТА НАСЛІДКИ ФІНАНСОВОЇ ДОЛАРИЗАЦІЇ: ПРИКЛАД УКРАЇНИ»**

on the topic: **“FINANCIAL DOLLARIZATION CAUSES AND CONSEQUENCES: CASE OF UKRAINE”**

Виконала: студентка 2-го року навчання,
спеціальність 072
«Фінанси, банківська справа та страхування»

Орловська Олександра Сергіївна

Керівник: Лук’яненко І.Г. д-р економ. наук, професор, зав. кафедри, Віт Юніор Іра Девід, професор, PhD

Рецензент Адаменко І.П.
(прізвище та ініціали)

Магістерська робота захищена
з оцінкою «_____»

Секретар ЕК _____ Донкоглова Н.А.
«____» _____ 2023 р.

Київ 2023

Contents

INTRODUCTION

Topic relevance. Financial dollarization, the extensive use of foreign currency in domestic financial transactions, has been a persistent issue in many emerging market economies, including Ukraine. The prevalence of dollarization, in both deposits and loans, has significant implications for monetary policy, financial stability, and economic growth. The causes and consequences of financial dollarization are complex, multifaceted, and context-specific, and thus require careful analysis. The purpose of this thesis is to investigate the factors that drive deposit and loan dollarization in Ukraine and assess its macroeconomic implications. Specifically, the thesis aims to identify the determinants of financial dollarization, evaluate its impact on monetary policy transmission, financial stability, and economic growth, and explore possible policy options to reduce dollarization and promote financial deepening in Ukraine.

Analyzing the level of financial dollarization, both deposit and loan, is highly relevant for Ukraine as it remains one of the most dollarized economies in the world. This dollarization creates significant risks to macroeconomic stability, such as exchange rate fluctuations, increased vulnerability to external shocks, and challenges in implementing monetary policy. Therefore, understanding the drivers of financial dollarization and developing effective de-dollarization policies is crucial for promoting financial stability and sustainable economic growth in Ukraine. The analysis of financial dollarization can provide valuable insights into the dynamics of the country's financial system and inform policymakers about the potential tools and strategies to reduce dollarization in the banking system.

Literature. According to the analysis of the latest research, the focus was shifted rather to deposit dollarization than loan dollarization. The most comprehensive analysis was developed both by Ukrainian and foreign researchers. K. Khvedchuk and V.Sinichenko from NBU economists team developed a thorough analysis on natural level of dollarization in Ukraine, while B.Urosevic and I.Rajkovic focused on empirical analysis for CESE Countries. IMF analysts frequently publish most up-to-date working papers focusing on

emerging markets with high levels of both deposit and loan dollarization and with underdeveloped financial markets. The theoretical framework applied for analysis of the drivers of financial dollarization was developed and studied by N.-K. Kishor, K.-C. Neanidis, P.Honohan, and Levy-Yeyati. The main targeted areas of research concern macroeconomic factors, while prudential regulations, financial market development, institutional strengthening, etc. are still partially not covered especially when analyzing dollarization in Ukraine. There is also little evidence in the literature on the relationship between DD and LD, as well as on drivers and consequences of loan dollarization in Ukrainian context. Taking into account the unique experiences of countries implementing policies aimed at decreasing dollarization, such as the successful Israel, Peru, and Kazakhstan experiences, this research tries to provide both the theoretical framework and empirical evidence on the influence of monetary policies of NBU on dollarization of the banking system. Moreover, most studies analyzed focus on dollarization responses to changes in macroeconomic variables, while no systematic approach is developed to address dollarization from the perspectives of businesses, individuals, banks, and regulator. The flexibility of the applied systems approach would enable to test the hypotheses of Leiderman et al., Urosevic and Rajkovic, and others on the effects of the exchange rate, and inflation volatilities on the dollarization rates and consequent risks associated with it. The paper of Alvarez-Plata and Garcia-Herrero proposes a classification of de-dollarization strategies based on the policy approach used by the central bank. Literature on the combination of both market-based and administrative-based strategies implementation and their efficiencies leaves a significant area to be studied in terms of the Ukrainian context.

Data. The analysis is supported by frequently published official data from NBU, in particular semi-annual Financial Stability Reports, quarterly Inflation Reports, and other methodological materials, publications, and sector reviews.

Objective. The objective of this thesis is to analyze which factors influence both deposit and loan dollarization, to study how financial dollarization can be affected, and which de-dollarization policies are the most relevant for Ukraine both during martial law and in the long run.

Object and subject of research. The object of the research is high financial dollarization – the dollarization of loans and deposits in the Ukrainian banking sector. The subject of the research is the influence of the macroeconomic environment on demand for foreign currency deposits and loans. The key research objectives are the following:

a) to investigate historical context of high dollarization of Ukrainian banking system;

b) to analyze impact of macroeconomic situation on DD and LD;

c) to test hypotheses on behavior of economic agents under high uncertainty on demand for foreign currency loans and deposits;

d) to test hypotheses on banks response to monetary policy and macroprudential regulations in terms of operations with foreign currency instruments;

e) to analyze the future outcome of DD and LD under different scenarios;

f) to define key leverage points in managing dollarization and the following policy options and tools that can be used and are being used by the regulator;

g) to study international practices of concurring dollarization;

h) to develop Ukraine-tailored recommendations for de-dollarization policies.

The methods used for this study are statistical analysis for the banking sector overview, econometrics analysis in part of development of system of simultaneous equations of main macroeconomic indicators and deposit and loan dollarization, and system dynamics approach for analysis of feedback structure and policy implementation. The system's approach includes forecasts and alternative scenarios analysis.

System's analysis based on both theoretical framework and empirical evidence enables to get a **new perspective** on topic of financial dollarization in Ukraine. The econometrics and system dynamics analysis provided Ukraine-tailored practical framework based on empirical evidence. In addition, this research not only investigates the relationships between macroeconomic situation and dollarization, but also defines leverage points that can be targeted to implement de-dollarization policies in the most efficient way. The framework for identifying most effective policies for affecting financial dollarization in Ukraine has been developed to address research objectives. The framework follows P'HAPI approach to analyzing the problem. The first "P" stands for problem description and

identification of the objectives of the paper. “H” stands for hypotheses identification based on conducted literature review, and its Ukraine-specific modifications. “A” stands for statistical analysis of dynamics and structure of the financial sector in Ukraine, development of econometrics and system dynamics empirical models for testing hypotheses on the banking system’s behavior. The second “P” stands for policy options analysis, and determination of leverage points through which dollarization can be addressed and lowered, which include monetary policy, exchange rate policy, prudential regulations, and policies aimed to increase financial education. And last but not least, “I” stands for the implementation of policies, and the development of complex strategy in affecting dollarization, with the incorporation of best-world practices. This thesis aims to develop not separate solutions for a temporary decrease in dollarization but to highlight the importance of the long-term strategy targeted at reducing both deposit and loan dollarization. In addition, conducted scenario analysis allows us to receive different outcomes based on underlying assumptions that are highly relevant during martial law and specific conditions, such as currency restrictions, fixed exchange rate regime, etc. In the recommendations key three areas of policy implementation are defined: inflation targeting, financial market deepening, and administrative measures in periods of martial law, high instability, and other crisis-relevant issues.

The thesis **structure** consists of the introduction, three chapters, conclusions, references, and annexes. This thesis includes 12 Tables, 25 Figures, and 8 Annexes. In Chapter 1 financial dollarization is defined according to various measurement approaches, the literature review part covers both Ukrainian and foreign researchers’ results on the analysis of both loan and deposit dollarization from different perspectives. Chapter 2 based on the theoretical insights received in Chapter 1 analyses the general features and trends of dollarization in Ukraine, forms and tests hypotheses using a system of simultaneous equations, compares different scenarios options using alternative inputs, and compares with the results of simulation for developed system dynamics model. Chapter 3 based on methodological analysis determines key leverage points, reviews different countries’ experiences, and suggests a further strategy for the de-dollarization of the banking system in Ukraine.

CHAPTER 1
GENERAL CONCEPTS OF FINANCIAL DOLLARIZATION AND ITS CAUSES AND CONSEQUENCES

1.1 Definition of financial dollarization, methods of its assessment, and classification

Financial dollarization is a phenomenon in which a foreign currency, most often the US dollar, is used for financial transactions and is held as a store of value in place of the national currency. It can be present in various forms, including deposit dollarization (DD), loan dollarization (LD), and portfolio dollarization. The measurement and classification of financial dollarization have been an ongoing topic of interest for economists and policymakers, as high levels of dollarization can negatively affect the financial system's stability and the monetary policy's effectiveness. Various methods of assessing the degree of financial dollarization include ratio analysis, regression analysis, and portfolio optimization models. Additionally, financial dollarization can be classified based on its source, such as natural or induced dollarization, as well as its duration, whether it is short-term or long-term.

Some common methods of measuring financial dollarization are presented in Table 1.1.

Table 1.1. Methods of assessing financial dollarization

Method	Definition
Currency Composition of Bank Deposits	This measure calculates the proportion of total bank deposits held in foreign currency, typically the US dollar. It indicates the extent to which the public holds foreign currency deposits in the banking system.

Continuation of the table 1.1.

Method	Definition
Currency Composition of Bank Loans	This measure calculates the proportion of total bank loans issued in foreign currency. It indicates the extent to which the banking system is providing foreign currency loans to the public.
Currency Composition of Capital Market Instruments	This measure calculates the proportion of capital market instruments issued in foreign currency, such as bonds and equities. It indicates the extent to which the capital market is denominated in foreign currency.
Currency Composition of Money Supply	This measure calculates the proportion of the money supply that is in foreign currency. It provides an indication of the extent to which the public holds foreign currency in circulation.

Source: developed by the author based on [21], [25]

There are several methods for assessing financial dollarization, which primarily focus on deposit and loan dollarization. One method is the ratio of foreign currency deposits or loans to total deposits or loans, which measures the percentage of foreign currency in the banking system. Another method is the currency mismatch index, which calculates the difference between the share of foreign currency assets and the share of foreign currency liabilities in the banking system. A third method is a Herfindahl-Hirschman index, which measures the degree of concentration of foreign currency deposits or loans in a banking system. Other methods include the exchange rate pass-through index, which measures the sensitivity of prices to exchange rate changes, and the sensitivity of non-performing loans to exchange rate changes.

In addition to the currency composition view, some define currency substitution and dollarization index. Currency substitution is the process of measuring the extent to which individuals and organizations switch between various currencies, such as the national currency and the US dollar, in reaction to fluctuations in exchange rates or interest rates.

The dollarization index is a comprehensive measure that accounts for multiple factors, such as currency composition and currency substitution, in its assessment.

These methods help policymakers and researchers to assess the level of financial dollarization in a country and to design appropriate policies to manage its potential risks.

Financial dollarization can be classified in different ways, depending on the scope and focus of the analysis. One common classification distinguishes between deposit and loan dollarization, as discussed earlier. Another classification distinguishes between external and internal dollarization. External dollarization refers to the use of foreign currencies, particularly the US dollar, for international transactions, trade, and external debt. In contrast, internal dollarization refers to the use of foreign currencies, particularly the US dollar, within the domestic economy, such as for savings, investment, credit, and pricing. Internal dollarization can further be classified into official and unofficial dollarization, depending on whether the use of foreign currencies is legal and recognized by the authorities or not. Another classification distinguishes between financial dollarization and real dollarization, with the former referring to the use of foreign currencies in the financial system, and the latter referring to the use of foreign currencies in the real sector, such as for wages, rents, and consumption. These classifications reflect different aspects and implications of financial dollarization and can be useful for policy analysis and evaluation.

Another way to classify deposit and loan dollarization is to distinguish between retail and wholesale dollarization. Retail dollarization refers to the use of foreign currency by households and small businesses, while wholesale dollarization refers to the use of foreign currency by large corporations and financial institutions. These classifications can be useful for policymakers and researchers in identifying the main drivers of dollarization and designing appropriate policy responses.

1.2 Drivers and risks of deposit and loan dollarization

The majority of the studies reviewed concentrate on the dollarization of deposits rather than loans. When investigating the available literature on financial dollarization in Eastern European countries, deposit dollarization receives the most emphasis due to its

potential correlation with inadequate financial development, a lack of alternative investment options, and an unsteady macroeconomic environment.

Various perspectives exist regarding the factors that drive financial dollarization, including law and finance, monetary credibility, balance sheet, monetary and asset substitution, and portfolio, among others. A study conducted by Levy-Yeyati outlines the primary drivers of deposit dollarization in emerging markets [28]. The research reveals a negative correlation between DD and economic and financial growth, while financial market deregulation, financial stability, and access to international capital markets play significant roles in determining deposit dollarization. Furthermore, the currency substitution perspective posits that prior inflation rates impact DD, as proposed by Savastano [24], [28].

The minimum variance portfolio (MVP) methodology is extensively employed for analyzing dollarization. In 2003, Ize and Yeyati developed a model using portfolio allocation theory, which seeks to establish a local and foreign currency deposit portfolio with minimum variance based on anticipated fluctuations in inflation and exchange rates [12]. The key conclusion is that it is the volatility of major macroeconomic indicators' expectations, rather than their actual values, that primarily determines dollarization. The formula can be presented in a simplified way as follows:

$$\lambda = \frac{S\pi\pi + S\pi s}{S\pi\pi + Sss + 2S\pi s} \tag{1.1}$$

where λ – MVP dollarization;

π – inflation;

s – real exchange rate;

S_{xy} – the variance-covariance operator [13, p. 41].

The institutional theory endeavors to clarify dollarization through institutional factors, such as the regulatory framework, legal system, and the financial sector, as stated by De Nicolo [7]. Additionally, De Nicolo demonstrates that inflation expectations are a crucial determinant of currency substitution. When individuals and businesses anticipate high inflation, they may opt for foreign currency to preserve the value of their savings.

Furthermore, this study reveals that economic instability, which includes currency crises, political uncertainty, and banking crises, may stimulate currency substitution by amplifying the perceived risks of using domestic currency.

Urosevic and Rajkovic examine the dollarization of deposits in five inflation-targeting countries in the CESE region and suggest that the determinants may differ in the short and long term [26]. They utilize a deposit dollarization portfolio optimization model and employ the GARCH methodology to compute inflation and exchange rate volatilities, while the Beveridge-Nelson approach (1981) is used to decompose the permanent and transitory components of DD to differentiate short-term and long-term effects [19]. Interest rate spread, nominal depreciation rate, inflation rate, and MVP rate are among the determinants of DD. The findings indicate that inflation is unlikely to have a significant impact on DD in the short term.

While dollarization is often viewed as a negative phenomenon, a certain amount of foreign currency assets is normal for an economy, as per Khvedchuk et al. [13, p.41]. The concept of financial dollarization can be broadly divided into two types: natural and induced. Natural dollarization refers to the level of currency substitution that would exist in an economy in the absence of any external factors, such as financial market restrictions or macroeconomic instability. On the other hand, induced dollarization is the result of specific policies, events, or external shocks that lead to an increase in the use of foreign currency in the economy. The distinction between natural and induced dollarization is important, as the policies and measures needed to address them can differ significantly. Understanding the drivers of each type of dollarization can help policymakers make informed decisions about monetary policy, financial regulation, and other economic policies. In practice, measuring the natural level of dollarization is challenging and may differ significantly depending on the unique conditions of each country.

In research on financial dollarization, efforts have been made to determine the natural level of dollarization by controlling for the impacts of macroeconomic stability, institutional quality, and other factors that might affect currency choice. Some studies have found that countries with good governance, high macroeconomic stability, and efficient financial markets tend to have lower levels of dollarization, while those with lower levels of these

factors tend to have higher levels of dollarization. The notion of the natural level of financial dollarization holds significance for policymakers and central banks, as it offers a baseline for comprehending the drivers of currency substitution and can influence decisions regarding monetary policy, financial regulation, and other economic policies.

The objective of the research conducted by NBU was to calculate the natural level of financial dollarization in Ukraine. The researchers employed portfolio allocation theory to estimate that the level of FD in Ukraine is approximately 10-20%. They identified various fundamental factors that impact FD, including macroeconomic instability, low quality of governance, interest rate differential, dollarization of the real sector, structural factors, and monetary policy regime.

Financial development in transition economies can lead to dollarization or euroization, which can be driven by three types of factors: the world factor, the regional factor, and the individual country factor [14]. The world factor is generated by financial system development and is common to all countries. The regional factor, such as the EU factor, can be seen in countries joining the EU, leading to convergence processes and affiliation with the union. The individual country factor is a unique set of determinants of financial dollarization in a specific country. This is particularly relevant for countries like Ukraine, which is in the process of becoming an EU member and may experience increased foreign currency dominance due to the liberated market. However, the relationship between financial market development and financial dollarization is a topic of ongoing debate in the literature. On the one hand, it is argued that a well-developed domestic financial market can provide alternative instruments that decrease financial dollarization. For instance, Kishor and Neanidis found that countries with deeper financial markets tend to have lower levels of financial dollarization [14]. On the other hand, the liberalization of financial markets and easier access to foreign instruments may foster financial dollarization. Therefore, the relationship between financial market development and financial dollarization may depend on the specific circumstances of each country, such as the quality of governance, macroeconomic stability, and structural factors. The extent to which the development of the domestic financial market affects financial dollarization is an important question for policymakers, as it can assist in shaping de-dollarization strategies.

Considering periods of the high volatility of exchange rate, geopolitical concerns, a few banking crises, and the ongoing war in Ukraine, the uncertainty of residents in the domestic currency has increased and urged them to hedge their currency risks and hold savings in foreign currency. With low-developed financial markets, diversifying options occur to be very limited.

During the first decade of the 21st century, FD has been the focus of researchers and among the highest policy makers' concerns. Inflation targeting, an increase in institutional credibility, and overall openness of the economy enhanced the decline in the FD rates for most countries, including Ukraine. Successful steps towards market deepening, anchoring expectations, and managing exchange rates helped to decrease dollarization hysteresis and mitigate associated risks.

Deposit dollarization is primarily formed by people's expectations of future inflation and local currency depreciation. High inflation or unstable inflation expectations can lead to a loss of confidence in the national currency, which may drive individuals and businesses to hold more of their wealth in dollars or other foreign currencies. This can increase the level of dollarization in a country's financial system. On the other hand, when inflation is low and stable, it can help to strengthen confidence in the national currency, which may reduce the demand for foreign currencies and decrease dollarization. Central banks can use monetary policy tools, such as adjusting interest rates or implementing inflation targeting, to manage inflation and inflation expectations and reduce the level of dollarization.

Commercial Banks don't have any direct control over people's demand for foreign currency deposits, though they can manage the level of the bank's foreign currency domination by setting deposit rates. Interest rate differential is the spread between local and foreign currency interest rates. It is common to refer to interest rate differential when comparing two different financial instruments or the same financial instrument in two different markets. The interest rate differential can be used as a measure of the relative profitability of investing in one instrument over another – the relative attractiveness of one investment option over another. The higher the interest rate differential, the greater the incentive for investors to move their available funds to the instrument with the higher interest rate. As historically foreign currency interest rates are very low in comparison with

the local currency it would be rational to assume that local currency instruments would be in favor of the investors. Though it's rarely the case as in periods of high inflation interest rates offered by commercial banks hardly cover costs associated with inflation, so investors may prefer to invest in foreign currency with close to zero yields to at least hedge their funds from depreciation and obtain the relatively more stable currency at the end of a deposit period. In times of high macroeconomic uncertainty about future inflation and exchange rates and when there are any restrictions on the flow of foreign currency, FX deposits may be the only investment opportunity that will cover economic agents' risks of funds depreciation, especially when the financial market is not developed or the access to the foreign markets is costly or limited.

Typically financial sector development can be distinguished into two categories: (i) deepening of the financial market, followed by the development of various alternative investment opportunities, such as medium and long-term domestic currency bonds, development of the forward market to mitigate exchange rate risks, indexed instruments to hedge from inflation, etc, (ii) and market liberation, in response to the openness of foreign markets and consequently investments in favor of foreign instruments due to the lower country-specific risks. The former is expected to decrease financial dollarization through a wider range of attractive domestic instruments. The latter instead is expected to increase financial dollarization through investment in foreign markets instruments. Various kinds of research discuss the relationships between the depth of the financial market and financial dollarization. From one point of view, a deeper financial market can provide more opportunities for borrowers and lenders to transact in the local currency, thereby reducing the need for foreign currency borrowing and lending, hence reducing the level of FD. On the other hand, a shallow financial market can limit the availability of local currency financing options, leading to a greater reliance on foreign currency financing. This can increase the level of financial dollarization. In addition, a deeper financial market can offer more risk management instruments, such as derivatives and insurance products, which can help mitigate currency risk and reduce the need for foreign currency borrowing and lending. This can further reduce the level of financial dollarization. Asel examines the relationship between financial sector development and dollarization in the Central Asian economies [2].

Asel finds that financial sector development has a significant negative impact on deposit dollarization, indicating that a more developed financial sector can reduce dollarization. However, the impact on loan dollarization is insignificant, suggesting that further research is needed to better understand the relationship between financial sector development and loan dollarization. In contrast, Bannister's research reveals that financial dollarization, specifically deposit dollarization, has an adverse effect on financial development, which implies that a high level of dollarization slows down the financial deepening. Another finding is that this negative relationship is common for countries with periods of high inflation [4, p.7].

High financial dollarization can have negative consequences for an economy. According to Levy-Yeyati financial dollarization can have several consequences, including increased vulnerability to external shocks, increased interest rate volatility, reduced effectiveness of the monetary policy, reduced ability of the domestic financial system to intermediate savings, and an increased likelihood of financial crises [28]. In addition, Levy-Yeyati notes that dollarization can lead to a higher cost of capital for firms, which can in turn reduce investment and economic growth [28].

Financial dollarization can have a significant impact on a country's economy, particularly on its banking sector. The relationship between exchange rate fluctuations and DD is based on the concept of balance sheet effects. When the domestic currency depreciates, the value of foreign currency-denominated assets and liabilities increases, leading to a rise in FD. On the other hand, when the domestic currency appreciates, the value of foreign currency-denominated assets and liabilities decreases, leading to a decline in FD. As a result, exchange rate volatility can be a major factor in determining FD levels in an economy.

The relationship between FD and exchange rate fluctuations has been explored by various studies, including Leiderman et al., who argue that higher levels of FD can lead to a closer association between exchange rate fluctuations and nonperforming loans. This can have negative implications for the banking sector, which may struggle to collect payments from borrowers who have taken out loans denominated in foreign currency [16]. In this context, the depreciation of the national currency can bring currency exchange gains from

borrowers, but also losses when repaying deposits. As a result, commercial banks often keep interest rates on foreign currency credits at a relatively high level compared to national currency credits, while interest rates on foreign currency deposits remain low compared to domestic deposits. This allows them to hedge against exchange rate fluctuations and minimize their exposure to potential currency exchange losses. However, this can also discourage households and firms from borrowing and depositing in national currency, exacerbating the issue of financial dollarization. Additionally, exchange rate volatility can affect the profitability of banks, especially when they hold a large share of foreign currency-denominated assets and liabilities. Banks may also engage in currency speculation to hedge against exchange rate risk, which can further fuel currency substitution.

Therefore, policymakers and central banks need to carefully consider the effects of interest rate differentials and exchange rate movements on the banking sector and the wider economy when implementing monetary and financial policies.

1.3 De-dollarization policies, central banks' tools, and mechanisms

De-dollarization policies are becoming increasingly important for many countries as they seek to reduce their dependence on foreign currencies and promote economic stability. While the specific strategies for de-dollarization may vary, it is generally recognized that reducing dollarization can help countries avoid financial crises and currency shocks. However, the success of de-dollarization policies can depend on a range of factors, such as the strength of a country's financial institutions, the degree of public trust in the national currency, and the effectiveness of government policies in promoting alternative investment options. Therefore, it is important for policymakers to carefully consider the various approaches to de-dollarization and choose those that are most likely to be successful in their specific economic and political context.

Leiderman et al. analyze inflation targeting in dollarized economies [16]. They state that IT can be more difficult in highly financially dollarized economies, in particular, because it weakens the monetary transmission. They build the VAR model to examine whether higher dollarization should trigger a stronger relationship between exchange rate

movement and non-performing loans. They also conclude that de-dollarization policies in most developing economies typically occur as an endogenous process, in response to keeping inflation close to the target [16, p.18].

The paper of Alvarez-Plata and Garcia-Herrero proposes a classification of de-dollarization strategies based on the policy approach adopted by the central bank [1]. They classify these strategies into two broad categories: market-based and administrative-based. Market-based strategies aim to reduce dollarization through the promotion of alternative financial instruments in local currency, such as government bonds or certificates of deposit. This approach assumes that the market is efficient and that it will respond to incentives provided by the central bank. Administrative-based strategies, on the other hand, involve the imposition of regulatory measures by the central bank to discourage the use of the dollar in the financial system. These measures can include the use of reserve requirements, taxation, or limits on foreign currency lending. The authors note that both market-based and administrative-based strategies have their advantages and disadvantages and that the effectiveness of each strategy depends on the specific economic and institutional context of the country in question. The authors conclude that de-dollarization policies can be successful if they are implemented in a gradual and coordinated way, involve a combination of macroeconomic and financial measures, and are supported by sound monetary and fiscal policies [1, p.24-26].

The transmission mechanism refers to the process by which monetary policy decisions made by a central bank are transmitted to the real economy. In the context of managing dollarization, the strength and effectiveness of the transmission mechanism can play a critical role in reducing deposit and loan dollarization. This is because monetary policy measures, such as changes in interest rates or reserve requirements, can influence the demand for local currency and affect the willingness of banks and individuals to hold foreign currency deposits or loans.

A strong transmission mechanism means that changes in monetary policy are transmitted quickly and effectively to the broader economy, which can help to reduce dollarization by affecting the relative attractiveness of local currency assets. For example, an increase in interest rates on local currency deposits can make them more attractive

relative to foreign currency deposits, while an increase in reserve requirements can limit the availability of foreign currency loans.

However, if the transmission mechanism is weak, monetary policy measures may have a limited impact on deposit and loan dollarization. This can occur if financial markets are underdeveloped if there is a lack of confidence in the stability of the local currency, or if there are regulatory or institutional barriers that limit the effectiveness of monetary policy measures. In such cases, policymakers may need to implement additional measures, such as administrative-based policies, to reduce dollarization.

In his paper, Marco Vega argues that financial dollarization can create agency costs that affect monetary policy transmission and can reduce the effectiveness of monetary policy in achieving its goals [27]. Specifically, he argues that financial dollarization creates a situation where borrowers and lenders have different preferences and objectives, which leads to agency problems. Borrowers may prefer to borrow in dollars because it reduces their exchange rate risk, while lenders may prefer to lend in dollars because it reduces their credit risk. However, if the exchange rate depreciates, borrowers may experience difficulties in repaying their debts, which can lead to increased defaults and non-performing loans. This can result in agency costs, such as adverse selection and moral hazard problems, which can increase the riskiness of the financial system and reduce the effectiveness of the monetary policy. Therefore, Vega suggests that policymakers should carefully consider the role of financial dollarization in creating agency costs and should implement policies that address these costs to improve monetary policy transmission and the stability of the financial system [27].

Central banks have a range of macroprudential policy tools at their disposal to control deposit and loan dollarization. Some of the mechanisms through which central banks' policies can affect FD are presented in table 1.2.

Overall, the effectiveness of these policies depends on a range of factors, including the degree of financial dollarization, the structure of the banking sector, and the broader macroeconomic environment. Therefore, central banks must carefully calibrate their policies to achieve their intended goals.

Table 1.2. Macroprudential policy tools and mechanisms to control dollarization

Policy tool	Mechanism
Reserve requirements	Central banks can set reserve requirements on deposits denominated in foreign currency to make them less attractive for banks. When banks hold a larger percentage of reserves, they have less money available to lend, which can reduce the demand for foreign currency loans.
Loan-to-value (LTV) ratios	Central banks can set loan-to-value (LTV) ratios for foreign currency loans, which limit the amount of foreign currency a borrower can receive as a percentage of the collateral value. This can reduce the demand for foreign currency loans by making them less attractive.
Risk weights	Central banks can assign higher risk weights to foreign currency loans, which means that banks will need to hold more capital against these loans. This can make foreign currency loans less profitable for banks and reduce their supply.
Capital requirements	Central banks can increase capital requirements for banks that hold a high level of foreign currency deposits or loans. This can incentivize banks to reduce their exposure to foreign currency by reducing their foreign currency activities.
FX liquidity management	Central banks can also use foreign exchange liquidity management tools to influence the supply and demand for foreign currency. For example, they can use currency swaps to provide liquidity to banks that need foreign currency, or they can intervene in the foreign exchange market to influence the exchange rate.

Source: developed by the author based on [18], [21]

The National Bank of Ukraine has been using several macroprudential policies to control deposit and loan dollarization, such as reserve requirements, liquidity requirements, and capital adequacy ratios. The NBU has been adjusting these requirements to encourage the shift towards local currency lending and to support the stability of the financial system. The liquidity requirements have also been used to encourage banks to lend in local currency. These requirements ensure that banks maintain a sufficient level of liquidity in their operations, and they are adjusted periodically based on market conditions and the level of dollarization in the banking system. In 2021, the NBU lowered the liquidity ratio from 80% to 70% to support economic recovery and facilitate lending in local currency. Finally, the capital adequacy ratios have been used to ensure that banks maintain sufficient capital to absorb potential losses and maintain their solvency in times of stress. These ratios have been adjusted over time to reflect changes in market conditions and the level of risk in the financial system. In 2020, the NBU introduced a new capital adequacy ratio framework that took into account the specific risks associated with dollarization and required banks to hold higher levels of capital for foreign currency loans and deposits. The new framework is based on the Basel III standards and takes into account the specific features of the Ukrainian banking system. The CAR is a key measure of a bank's financial strength, calculated as the ratio of its capital to its risk-weighted assets. The NBU's new framework includes higher minimum CAR requirements for banks, as well as additional capital buffers to be built up during good times to be drawn down during bad times. The framework also introduces a leverage ratio requirement, which limits a bank's overall exposure to risk. The new CAR framework is intended to enhance the stability of the banking system and ensure that banks have sufficient capital to withstand financial shocks, thereby reducing the risk of bank failures and systemic instability.

De Nicolo discusses the influence of capital controls on shaping currency substitution [7]. Capital controls refer to measures implemented by a government to regulate the flow of capital in and out of a country. The paper argues that capital controls may impact currency substitution by promoting or discouraging foreign currency use. For example, a government or central bank may impose restrictions on foreign currency lending or require certain reserve requirements for foreign currency deposits to discourage dollarization. Capital

controls can also be used to mitigate the risks associated with sudden outflows of capital or exchange rate volatility. However, capital controls can also have negative effects on a country's economy, such as reducing foreign investment or limiting access to international capital markets. Therefore, the use of capital controls as a policy tool for managing financial dollarization should be carefully evaluated and implemented in a way that balances the potential benefits and costs.

Conclusions to Chapter 1

In conclusion, deposit and loan dollarization refers to the phenomenon of individuals and businesses preferring to hold and borrow in foreign currency, typically the US dollar, instead of the domestic currency. This chapter has provided a definition and classification of deposit and loan dollarization, outlining the different types of dollarization and methods of its assessment. The drivers of deposit and loan dollarization have been identified, including financial deepening, market development, fluctuations in inflation and exchange rates, their expectations, and interest rate differentials. On the other hand, the consequences of deposit and loan dollarization can lead to common problems such as increased vulnerability to external shocks and limited monetary policy effectiveness, as well as balance sheet effects such as currency mismatches and credit risks. Policymakers need to understand the drivers and consequences of deposit and loan dollarization to effectively design and implement policies aimed at managing it. Policymakers must carefully consider these drivers and consequences when designing strategies to manage deposit and loan dollarization, considering their country's unique economic and institutional context.

Several policies proved to be efficient in managing dollarization. First, while reducing financial dollarization can promote economic stability, the success of de-dollarization policies depends on a range of factors, including the strength of financial institutions, public trust in the national currency, and the effectiveness of government policies. Second, there are various strategies for reducing dollarization, such as market-based and administrative-based approaches, and policymakers must carefully consider which strategies are most likely to be successful in their specific economic and political context. Third,

macroprudential policies, such as reserve requirements, loan-to-value ratios, and capital adequacy requirements, can effectively control deposit and loan dollarization. Fourth, managing inflation and inflation expectations is crucial for reducing financial dollarization. Finally, the success of de-dollarization policies requires a comprehensive approach that involves a combination of macroeconomic and financial measures, supported by sound monetary and fiscal policies. By taking these factors into account, policymakers can work towards reducing financial dollarization and promoting long-term economic stability.

CHAPTER 2
DATA ANALYSIS AND FINANCIAL DOLLARIZATION MODELLING

2.1 Analysis of the financial dollarization dynamics and structure in Ukraine

The financial sector is a critical component of the economy, and its stability plays a crucial role in the economic development of a country. One of the significant concerns for policymakers is the degree of financial dollarization, particularly in emerging economies. Ukraine is one such economy where the level of dollarization in the banking system has been a persistent issue, impacting its economic stability and growth prospects. Thus, this chapter aims to provide an in-depth analysis of the dynamics of deposit and loan dollarization in Ukraine, examining the structural characteristics of the banking system, and identifying the key factors driving the trends in dollarization. The chapter will also undertake a statistical analysis of the factors affecting deposit and loan dollarization and their relationship with macroeconomic variables, including inflation, exchange rates, and interest rates. By doing so, this chapter aims to provide policymakers with a better understanding of the determinants of financial dollarization in Ukraine and offer insights into potential policy measures that can be implemented to mitigate its impact on the economy.

In Figure 2.1. the dynamics of dollarization of deposits and loans to the residents (except for deposit corporations) are presented. The dynamics of deposit and loan dollarization in Ukraine have been a topic of concern for macroprudential regulators and researchers alike. The extremely high levels of dollarization during the crisis years of 2008-2009, with deposit dollarization (DD) and loan dollarization (LD) reaching 50% and 59.1% respectively, had a significant impact on the financial system of the country. The political and economic situation, the annexation of Crimea by the russian federation, and the war in Eastern Ukraine worsened the macroeconomic situation in 2015, leading to the highest

levels of DD and LD in this century, at 58.8% and 59.8% respectively. However, since then, the financial system has been gradually entering a state of record-low levels of dollarization, due to the implementation of effective inflation-targeting policies and the anchoring of expectations of economic agents. The declining dollarization rate of the banks' balance sheet over the last 6 years can be attributed to the low volatility of the exchange rate and relatively predictable and moderate inflation rates, resulting in lower demand for FX loans and deposits. Also, the experience from the past crisis periods, particularly the high currency risk, made hryvnia-denominated loans more attractive compared to FX loans. As of February, the share of FX loans in the net portfolio dropped to 30%, and the share of FX deposits was 36%. Banks didn't have any incentive for holding FX deposits due to the lower demand for FX loans, hence they set FX deposit rates close to zero.

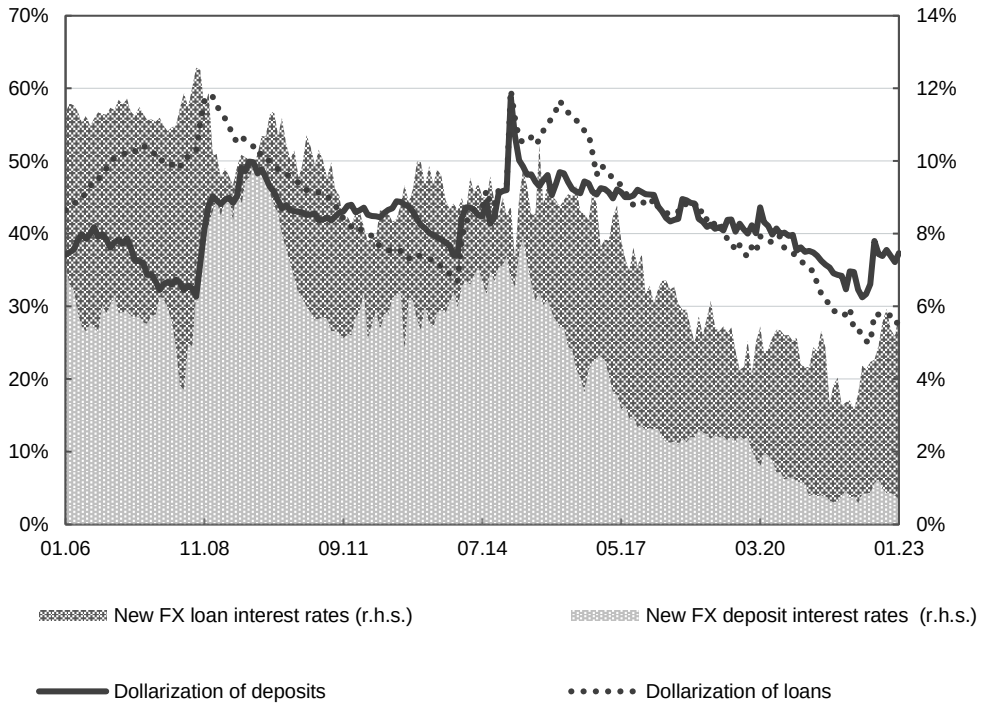


Figure 2.1. Share of FX loans and deposits from 2006 till 2022

Source: developed by the author based on NBU data [9], [21]

Since the beginning of the full-scale invasion, NBU implemented measures that limited the rapid increase of DD and LD, as could have been expected based on the experience of the previous crises. In Figure 2.2. the graph presents the change in the clients' FX deposits dynamics during the first months of the war.

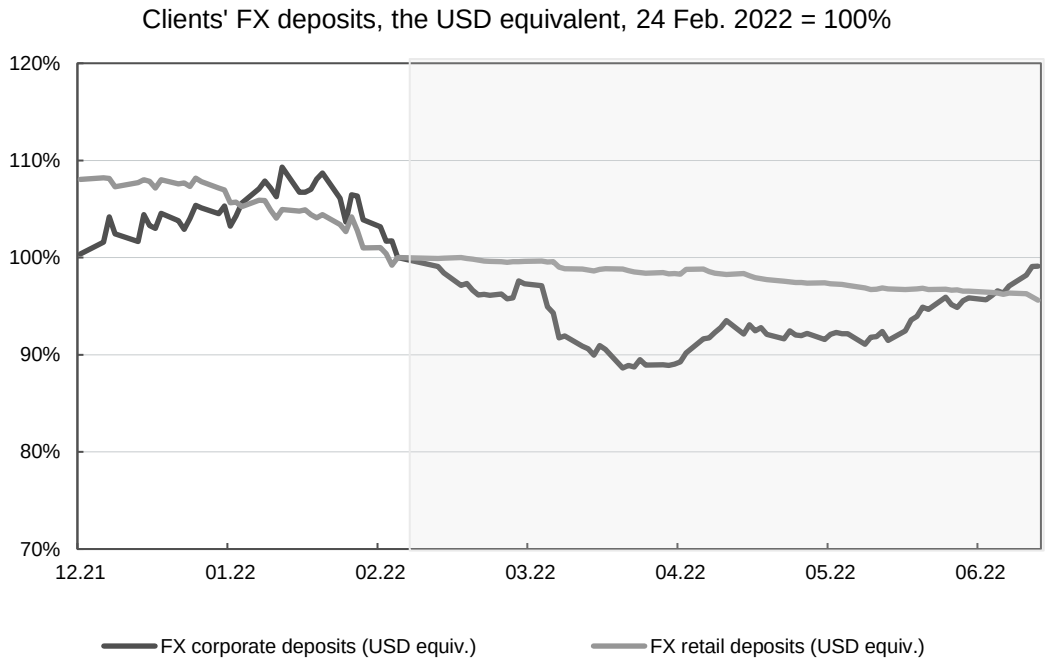


Figure 2.2. Daily Clients' FX deposits from 31 December 2021 till 15 June 2022, the USD equivalent, 24 Feb. 2022=100%

Source: developed by the author based on NBU data [9], [21]

Fixation of the official UAH/USD exchange rate and FX restrictions developed and introduced by the NBU right after the beginning of the full-scale invasion, prevented the national currency depreciation and protected banks from FX deposit outflows. However, these temporary restrictions had limited effect and in the second half of 2022 LD and DD started to grow and reached their prewar levels. Partially such an increase in DD can be explained by hryvnia depreciation, as a response to the corrected fixed exchange rate of UAH to USD.

According to Banking Sector Review, the share of FX retail deposits remained almost unchanged in Q4 2022 (see Figure 2.3) [3]. The dollarization of corporate loans dropped by 3.6 pp in Q4 due to large inflows of hryvnia deposits.

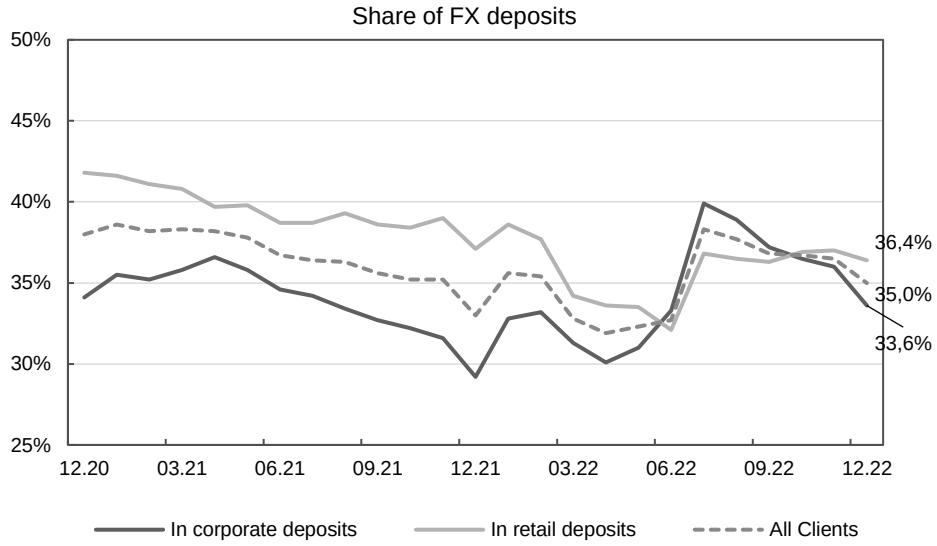


Figure 2.3. Share of FX deposits from 2021 till 2022 as of the end of the month by type of economic agents

Source: developed by the author based on NBU data [3], [21]

In the meantime, over the last quarter of 2022 FX term deposits grew more rapidly than those in the hryvnia (see Figure 2.4).

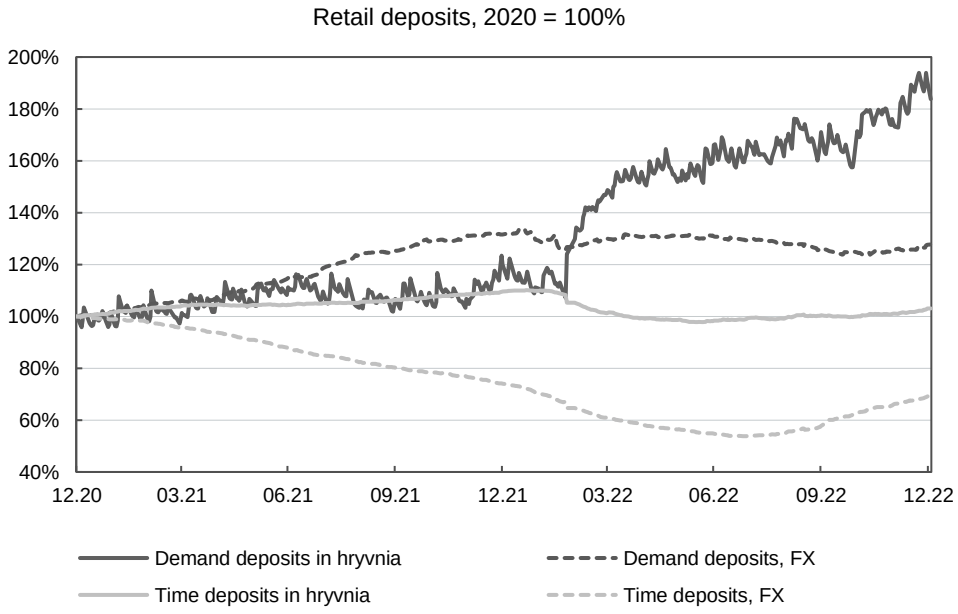


Figure 2.4. Daily retail deposits from 31 December 2020 till 2 January 2023, 2020 = 100%

Source: developed by the author based on NBU data [8], [21]

In the first half of 2022, the volume of hryvnia corporate loans increased due to government credit support programs and the FX corporate lending decreased. Volumes of

FX lending decreased with higher probabilities of non-performing loan repayments due to higher credit and currency risks. In 4Q 2022 hryvnia loans declined by 6,7% qoq, and FX loans by 5,2% qoq in dollar terms (see Figure 2.5). Corporate net loan portfolio in hryvnia decreased among all groups of banks. NBU states that the decline in the volume of the net hryvnia retail loan portfolio in Q4 was primarily in foreign and private banks due to the increase in provisions against credit losses.

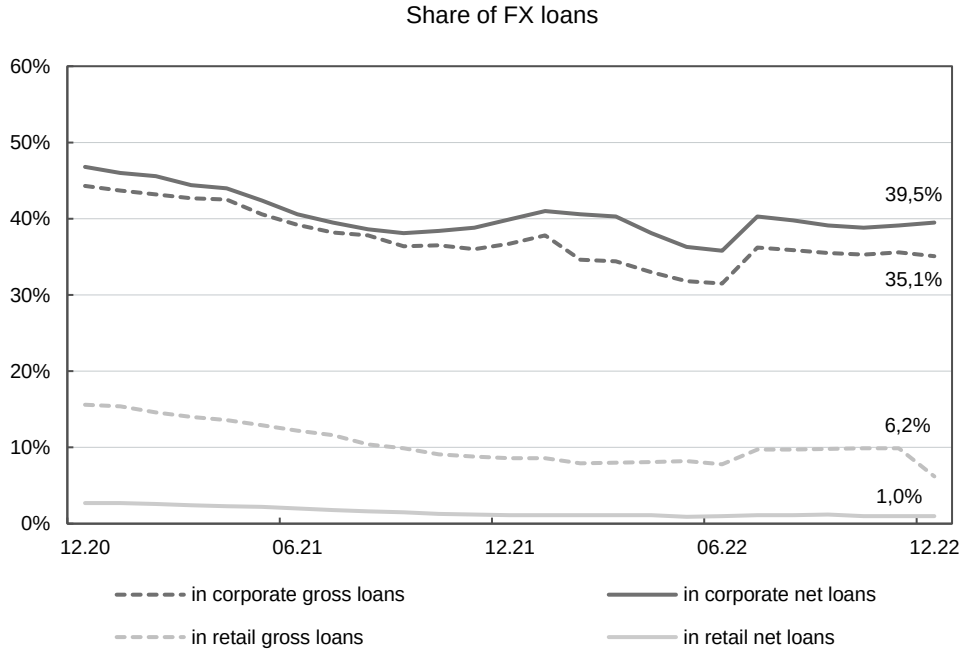


Figure 2.5. Share of FX loans (gross and net) from December 2019 till December 2022 as of the end of the month, by type of borrower

Source: developed by the author based on NBU data [8], [21]

Another finding is that loan dollarization is positively correlated with deposit dollarization and equals 93,16% in Ukraine based on data provided since 2014. On the graph in Figure 2.6 it can be observed that with the increase of DD, the LD increases as well. This result is consistent with the empirical evidence of Neanidis and Savva [23].

In Figure 2.7 the dynamics of the dollarization rate of the net loan portfolio by groups of banks are presented. The highest levels of LD are among state-owned banks (excluding PrivatBank). However, PrivatBank has the lowest fraction of FX in its portfolio since its nationalization in December 2016. Also, foreign banks tend to increase their fraction of FX in the loan portfolio during crisis years more rapidly than other groups of banks.

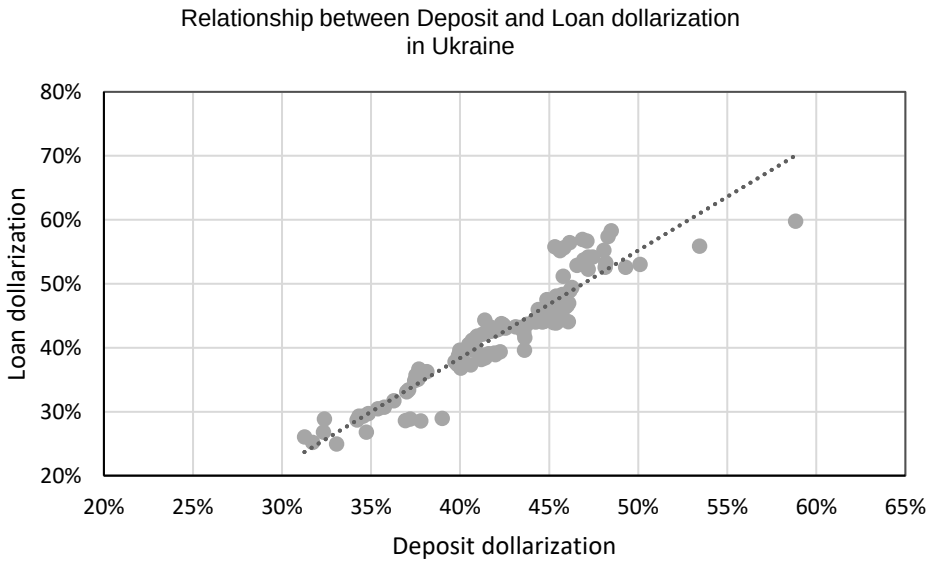


Figure 2.6. Relationship between Deposit and Loan dollarization in Ukraine from January 2014 till October 2022

Source: developed by the author based on NBU data [21]

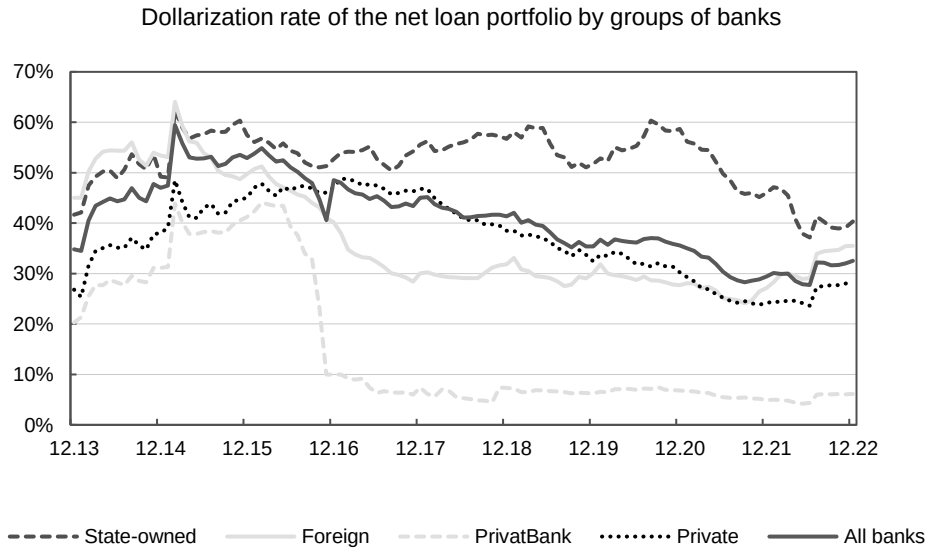


Figure 2.7. Dollarization rate of the net loan portfolio by groups of banks from December 2013 till December 2022 as of the end of the month

Source: developed by the author based on NBU data [9], [21]

Figure 2.8 presents the top 10 banks with the biggest loan portfolios in Ukraine as of 1 January 2023. “Ukreximbank” has both the biggest loan portfolio in the sector and the highest loan dollarization ratio, which can be explained by the business model of the bank – service of foreign economic activities. Typically, banks with foreign capital have high LD

ratios, e.g. “Sens Bank” has the highest level among the biggest lenders in the group and reaches 53%. “Pumb” and “Universal Bank” have the biggest loan portfolios among private capital banks, and their dollarization rate is around 21% and 16% respectively, which is lower than the average among the group – 28%.

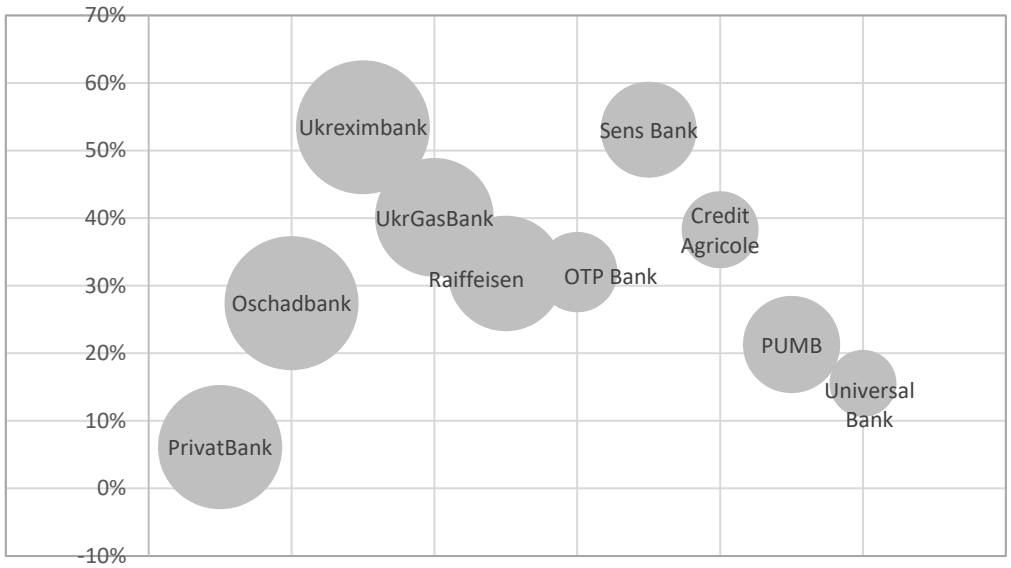


Figure 2.8. Loan dollarization rate of the top 10 banks with the biggest loan portfolios
Source: developed by the author based on NBU data [21]

In conclusion, the statistical analysis conducted revealed the significant impact of high deposit and loan dollarization levels on Ukraine's financial system during crisis years and remains a concern for regulators and researchers. The NBU's measures limited the risks of rapid increases in DD and LD by influencing both clients and banks. The government's credit support programs stimulated hryvnia corporate lending, leading to a decrease in FX lending due to the increase in credit and currency risks. State-owned banks continue to have high dollarization rates, primarily due to their business models. While statistical analysis is useful in analyzing trends, deep empirical analysis using economic and mathematical methods, such as developing systems of simultaneous equations and system dynamics methodology, is necessary to determine and estimate drivers and consequences of dollarization.

2.2 Modelling the system of simultaneous equations for financial dollarization estimation

Financial dollarization, or the use of foreign currency for deposits and loans, is a significant issue for many economies, as it can lead to increased volatility and risks to financial stability. To better understand and analyze the drivers and consequences of dollarization, econometric models are often used. However, due to the interdependence of variables such as deposit and loan dollarization, using separate econometric equations can lead to biased and inconsistent estimates. Therefore, a system of simultaneous equations is more appropriate for analyzing the dynamics of dollarization, as it accounts for the feedback effects and interrelatedness of the variables. To fully understand and estimate the complex interrelationships between the different variables affecting financial dollarization, it is important to utilize the system of simultaneous equations, which is better suited to capture the interdependent nature of the economic system and provide a more accurate and comprehensive analysis of the issue.

A system of simultaneous equations is a powerful tool in econometrics that allows for the analysis of complex economic relationships between multiple variables. One of the key benefits of this approach is that it can provide a more accurate estimation of the relationships between variables, which can lead to more accurate forecasts. Additionally, a system of simultaneous equations can provide insights into the dynamic interactions between variables, which can help policymakers make more informed decisions. Furthermore, this approach can be used to test the robustness of economic theories and models, which can lead to a better understanding of economic behavior. Overall, a system of simultaneous equations can provide valuable insights into the workings of an economy and can help policymakers make better decisions.

Such a system consists of linear regressions, where the dependent variable of one multifactorial regression becomes an independent variable in another regression. Such a systematic view allows for analyzing how both direct and indirect effects influence the system and its outputs. The systematic approach is widely applicable for the analysis of

macroeconomic indicators and specifically the effects on monetary transmission mechanism and provides a framework for policymakers to conduct scenario analysis.

The relationship between consumer price index, exchange rate, key policy rate, deposit dollarization, and loan dollarization has been the subject of much research and analysis in the field of macroeconomics. These variables were chosen because they are important indicators of the stability and health of a country's financial system. CPI is a measure of the average change in prices over time of goods and services consumed by households, and it reflects the level of inflation in an economy. The exchange rate, on the other hand, is the value of one currency in relation to another, and it can have a significant impact on a country's international trade and investment. The key policy rate is set by NBU to influence borrowing costs and money supply in an economy. Finally, DD and LD are important measures of the degree of dollarization in a country's financial system, which is a key indicator of financial stability. By analyzing the relationship between these variables using econometric tools, we can gain a better understanding of the factors that affect financial dollarization and how they interact with each other.

The objective of the empirical analysis was to estimate the effects of monetary policy and macroeconomic stability on the dollarization level in Ukraine.

Following the above mentioned, the system consists of 5 linear regressions of main macroeconomic indicators and dollarization ratios. The observed dependent variables are the consumer price index (CPI), the exchange rate of UAH to USD on the FX market (ER_MARKET), policy rate of NBU (KEY_R), deposit dollarization as a fraction of FX deposits in total deposits of residents (DD), and loan dollarization as a fraction of FX loans in total loans to residents (LD).

The basic underlying assumptions are the following:

a) Deposit dollarization is caused both by banking sector-specific indicators, such as the difference between deposit rates denominated in different currencies, and the volume of corporate lending, and by macroeconomic indicators, such as the exchange rate on the FX market and CPI. This assumption is set based on the theory analysis about what investors take into account when choosing between instruments in different currencies.

b) Loan dollarization is influenced by the level of deposit dollarization as a redistributive function of banks - converting banks' liabilities (deposits) into assets (loans), and is also influenced by the macroeconomic environment presented in the model as the exchange rate and CPI.

c) The policy rate is developed according to Taylor Rule, hence its level is determined by the CPI gap and the output gap, as well as by the neutral interest rate.

d) Taking into account that Ukraine is a small open economy with high dependence on its trading partners, CPI is largely dependent on the levels of CPI of the main trading partners and the exchange rate of UAH to USD. Being an inflation-targeting country, CPI is determined by the monetary policy instrument – the policy rate of NBU.

e) The exchange rate of UAH to USD on the FX market was chosen instead of the official rate because, in periods of different exchange rate regimes, the market level would present a more realistic situation on the market. The exchange rate is affected by the policy rate, debt to GDP, and international reserves level.

The framework of the developed system and its logical relationships are presented as a causal-structure diagram in Figure 2.9.

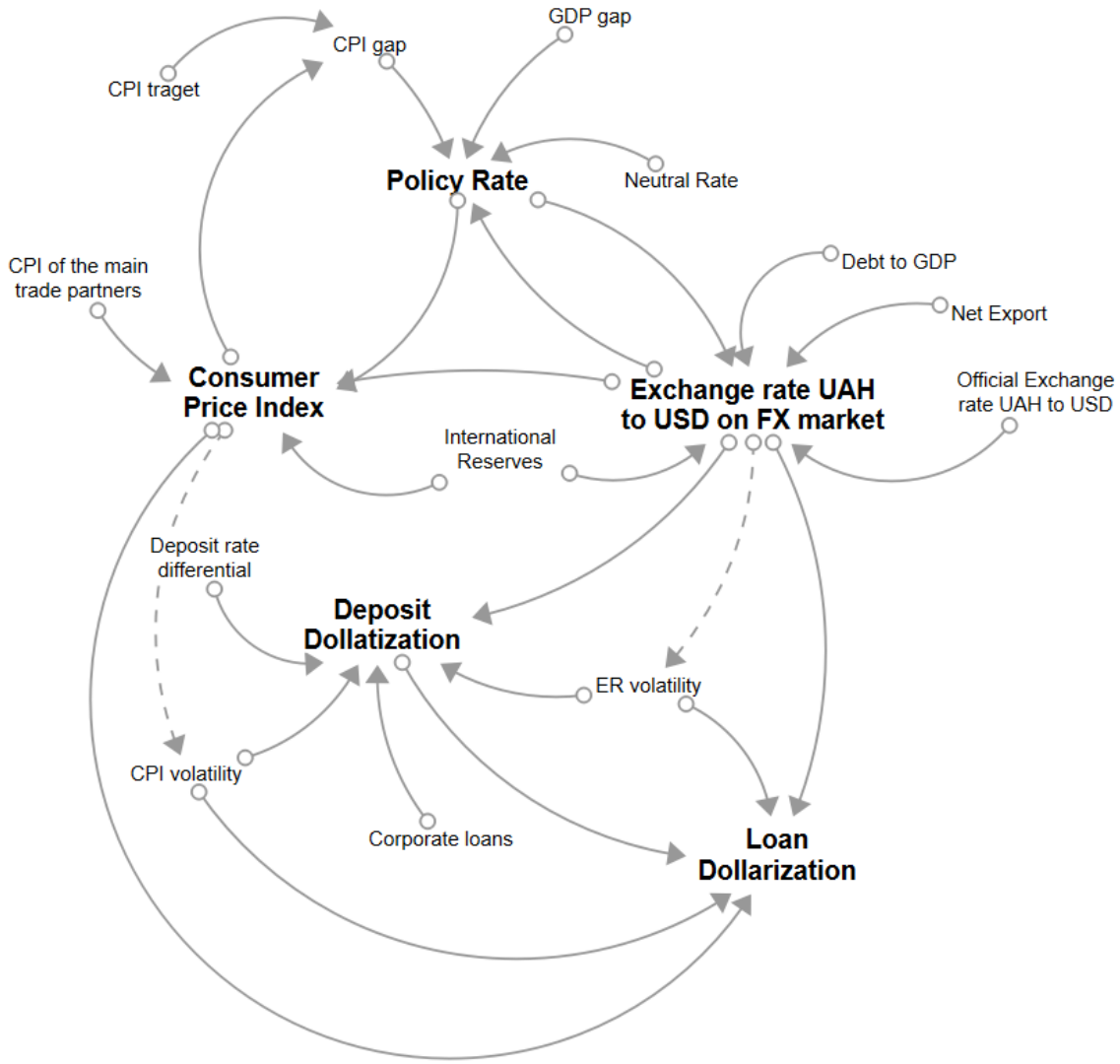


Figure 2.9. Causal diagram of the system of simultaneous equations, where a solid line depicts connections inside the system, while a dotted line presents the estimations outside the system

Source: developed by the author in Stella Architect Software

The general specification of the developed system can be presented as the following:

$$CPI_t = f_1 (KEY\_R_{t-6}, ER\_MARKET_{t-3}, PCPI_{t-1}, CPI_{t-4}, INR\_RESERV_{t-7})$$

$$ER\_MARKET_t = f_2 (KEY\_R_{t-1}, ER\_MARKET_{t-1}, ER\_OFF_{t-1}, INR\_RESERV_{t-6}, DEBT\_TO\_GDP_t, NX_t)$$

$$KEY\_R_t = f_3 (KEY\_R_{t-1}, GDP\_GAP_{t-1}, CPI_t - CPI\_TARGET_t, ER\_MARKET_{t-1}, NR_{t-2})$$
$$DD_t = f_4 (DD_{t-1}, ER\_MARKET_t, ER\_MARKET\_VOL_{t-3}, CPI\_VOL_{t-4}, CREDIT\_TO\_BUSINESS_t, DEPOSIT\_RATE\_DIFFERENTIAL_{t-4})$$
$$LD_t = f_5 (LD_{t-1}, DD_t, ER\_MARKET_t, ER\_MARKET\_VOL_t, CPI\_VOL_{t-2}, CPI_{t-1}) \quad (2.1)$$

where t – time period, CPI – consumer price index to December previous year, %; ER_MARKET – exchange rate of UAH to USD on the FX market, UAH/USD; KEY_R – policy rate of NBU, %; DD – a fraction of deposits of residents in foreign currency; LD – a fraction of loans to residents in foreign currency; PCPI – weighted on volumes of trade CPI of main trading partners; ER_OFF – official exchange rate of UAH to USD, UAH/USD; NX – net export, million USD; INR_RESERV – international reserves, million US dollars; DEBT_TO_GDP – the ratio of debt to real GDP; GDP_GAP – GDP gap, calculated using Kalman filter; CPI_TARGET – inflation target, %; NR – neutral real interest rate, %; CREDIT_TO_BUSINESS – loans to the corporate sector, million UAH; DEPOSIT_RATE_DIFFERENTIAL – spread between deposit rates in UAH and USD, %; ER_MARKET_VOL – volatility of exchange rate of UAH to USD; CPI_VOL – volatility of consumer price index.

For detailed variables overview see Annex A.

Specification of CPI equation:

The main goal of NBU is to keep inflation controlled, stable, and on the targeted level. Since the beginning of the inflation-targeting policy, the key policy rate was the main instrument to stabilize inflation. The effect of the policy rate change is realized through several monetary transmission channels. The policy rate determines the value of money and affects the real sector, hence inflation. Though it takes time for the economy to respond to the changes, and NBU assumes that the average delay time fluctuates from 6 to 18 months. The lagged effect of the previous CPI of a year ago can be explained by the seasonal effect, typically, the Ukrainian economy is highly season-dependent, and producers' behavior patterns from year to year may be repetitive. The exchange rate with a lag of 3 quarters

determines the effect of exchange rate fluctuations passthrough on the internal prices. Being one of the biggest agriculture producers in the world, Ukraine is very subject to fluctuations in prices on the external market, that's why it seems important to include weighted CPI of countries main trade partners: China, Poland, Turkey, Spain, Italy, Netherlands, Egypt, India, Germany, Romania, the USA, Slovakia, Hungary, Austria, and Czech Republic. Also, the volatility of raw materials and energy materials prices in the EU highly affects the situation on the global market and prices in Ukraine as well, as Ukraine imports a big fraction of fuel from Europe. International reserves are included to implement the effect of exchange rate volatility passthrough on the internal prices. According to the above-mentioned, the specification of the consumer price index is the following:

$$CPI_t = \alpha_0 + \alpha_1 * D(KEY\_R_{t-6}) + \alpha_2 * D(LOG(ER\_MARKET_{t-3}) + \quad (2.2)$$
$$+ \alpha_3 * PCPI_{t-1} + \alpha_4 * CPI_{t-4} + \alpha_5 * LOG(INR\_RESERV_{t-7})$$

where CPI_t – consumer price index to December of the previous year, %; ER_MARKET_t – exchange rate of UAH to USD on the FX market, UAH/USD; KEY_R_t – key policy rate of NBU, %; $PCPI_t$ – weighted on volumes of trade CPI of main trading partners; INR_RESERV_t – international reserves, million US dollars.

Specification of exchange rate equation:

The exchange rate is one of the most important variables to determine both inflation and the level of dollarization. In the quarterly projection model (QPM) which is a semi-structural model that NBU uses for its analysis, monetary policy operates through two main transmission channels: the interest rate channel and the exchange rate [10, p.11]. In the initial phase, an increase in interest rates causes the local currency to appreciate due to uncovered interest parity. The economy's openness means that exchange rate changes have an impact on consumer prices in Ukraine through imported inflation, and they also affect economic activity by influencing demand for foreign goods, which in turn affects inflation [10, p.11]. Moreover, the effect of key policy rate change is asymmetrical, meaning that large changes have more effect than small changes. To catch this difference DUMMY1 is introduced in the model, DUMMY1 is a binary variable that represents the volume of change

in the policy rate, where 1 is set when the absolute change of policy rate is bigger than the average absolute change in the time series, and 0 is set when it is smaller. International reserves play a crucial role in maintaining exchange rate stability during economic shocks that may arise from periods of crisis. When the exchange rate is fixed, the NBU intervenes in the foreign exchange market to keep the exchange rate stable. On the other hand, during a floating exchange rate regime, changes in the policy rate have a greater impact on the exchange rate. An increase in the policy rate leads to an appreciation of the currency, while a decrease causes a depreciation. With the history of switching between floating and fixed regimes, the official exchange rate is introduced to represent the limitations of the NBU on the FX market. Net export is included in the specification to reflect the effect of the trade balance on the exchange rate. Additionally, the debt to GDP ratio reflects the impact of changes in external liabilities, as well as the demand and supply of foreign currency, and therefore, affect the exchange rate. According to the above-mentioned, the specification of the exchange rate equation is the following:

$$LOG(ER\_MARKET_t) = \alpha_0 + \alpha_1 * D(KEY\_R_{t-1}) * DUMMY1_t + \\ + \alpha_2 * D(KEY\_R_{t-1}) * (1-DUMMY1_t) + \alpha_3 * LOG(ER\_OFF_{t-1}) + \\ + \alpha_4 * LOG(INR\_RESERV_{t-6}) + \alpha_5 * LOG(DEBT\_TO\_GDP_t) + \alpha_6 * \\ D(NX_t) \quad (2.3)$$

where ER_MARKET_t – exchange rate of UAH to USD on the FX market, UAH/USD; KEY_R_t – policy rate of NBU, %; INR_RESERV_t – international reserves, million US dollars; $DEBT\_TO\_GDP_t$ – the ratio of debt to real GDP; $DUMMY1_t$ – dummy-variable of the volume of change of policy rate; ER_OFF_t – official exchange rate of UAH to USD, UAH/USD; NX_t – net export, million USD.

Specification of policy rate equation:

The key policy rate is the main tool for the inflation-targeting policy of NBU. The most famous rule of monetary policy is the Taylor rule. It has been modified and applied to national models of many central banks, depending on its needs and purposes, and also taking into account specific features of individual economies. To capture the conservative behavior

of a central bank, the policy rate in QPM and its monetary policy rule specification considers its lagged value, which represents persistence in the reaction function [10, p.17-18]. Incorporating both the GDP gap and CPI gap in the model demonstrates the balance or trade-off between stabilizing output and managing inflation, highlighting the flexible nature of the inflation targeting framework [10, p.18].

Over the long run, after all, shocks have dissipated, the policy interest rate reaches its neutral level which indicates an equilibrium value for the interest rate and short-term dynamics, signifying a state of neither being accommodative nor restrictive in monetary policy [10, p.18]. The exchange rate is considered through the indirect impact – it impacts inflation, which in turn can influence the central bank's monetary policy decisions. DUMMY2 is introduced in the model, DUMMY2 is a binary variable that represents the volume of change in the exchange rate, where 1 is set when the absolute change of exchange rate is bigger than the average absolute change in the time series, and 0 is set when it is smaller. According to the above-mentioned, the specification of the policy rate equation is the following:

$$KEY\_R_t = \alpha_0 + \alpha_1 * KEY\_R_{t-1} + \alpha_2 * D(GDP\_GAP_{t-1}) + \quad (2.4)$$
$$+ \alpha_3 * (CPI_t - CPI\_TARGET_t) + \alpha_4 * D(ER\_MARKET_{t-1}) * DUMMY2_t$$
$$+ + \alpha_5 * D(ER\_MARKET_{t-1}) * (1 - DUMMY2_t) + \alpha_6 * D(NR_{t-2})$$

where KEY_R_t – policy rate of NBU, %; CPI_t – consumer price index to December previous year, %; ER_MARKET_t – exchange rate of UAH to USD on the FX market, UAH/USD; GDP_GAP_t – GDP gap, calculated using Kalman filter; CPI_TARGET_t – inflation target, %; NR_t – neutral real interest rate, %; $DUMMY2_t$ – dummy-variable of the volume of change of exchange rate.

Specification of deposit dollarization equation:

Based on the analyzed literature, deposit dollarization is mostly seen as a response to high uncertainty about the macroeconomic situation in the nearest future. The equation includes a lagged deposit dollarization ratio to account for persistence effects. The exchange rate is considered in the model as it falls under the MVP framework: depreciation of the

national currency may increase the incentive for deposit dollarization as individuals and businesses seek to protect the value of their savings from currency fluctuations and invest in a more stable currency. The same incentive applies to inflation: if people experience a relatively low level of inflation, the credibility of the central bank rises as economic agents assume that the central bank keeps inflation under control, and hence their expectations about future inflation become anchored to the central bank's target and forecast. Having stable, moderate inflation, the demand for investing in national currency instruments increases. However, there is evidence from research that in the short term, it is rather inflation volatility that is perceived by households and business entities rather than inflation itself [26, p.8]. During crisis years it becomes more difficult for the central bank to manage inflation, hence economic agents expect bigger inflation deviations and higher depreciation rates. Consequently, inflation volatility and exchange rate volatility have been introduced in the model estimated using the GARCH methodology. The volume of corporate lending is used in the equation as the proxy for the demand for funding in banks. With the increase in demand for corporate lending, banks would try to engage more funding, e.g. they would rise interest rates. Taking into account that the business sector actively engages in trading with foreign companies and customers, they would need funds in foreign currency to conduct their business operations. Volatilities are presented as lagged values because it takes time for the economic agents to perceive the fluctuations in these indicators. The interest rate differential determines the spread between the yield on hryvnia and FX deposits. With the increase of the spread, hryvnia instruments would seem more attractive for investors than FX instruments. According to the above-mentioned, the specification of the deposit dollarization equation is the following:

$$DD_t = \alpha_0 + \alpha_1 * DD_{t-1} + \alpha_2 * DLOG(ER\_MARKET_t) + \quad (2.5)$$
$$+ \alpha_3 * ER\_MARKET\_VOL_{t-3} + \alpha_4 * CPI\_VOL_{t-4} +$$
$$+ \alpha_5 * LOG(CREDIT\_TO\_BUSINESS_t) +$$
$$+ \alpha_6 * DEPOSIT\_RATE\_DIFFERENTIAL_{t-4}$$

where DD_t – a fraction of deposits of residents in foreign currency; ER_MARKET_t – exchange rate of UAH to USD on the FX market, UAH/USD; $CREDIT\_TO\_BUSINESS_t$ –

loans to the corporate sector, million UAH; $DEPOSIT\_RATE\_DIFFERENTIAL_t$ – spread between deposit rates in UAH and USD, %; $ER\_MARKET\_VOL_t$ – volatility of exchange rate of UAH to USD; CPI_VOL_t – volatility of consumer price index.

Specification of loan dollarization equation:

There is significant empirical evidence that a positive relationship between deposit and loan dollarization exists. As deposits are an important lending source, it affects banks' decisions and capacities to provide loans in foreign currency. Moreover, with expected depreciation, banks may receive FX gains from the revaluation of loans denominated in foreign currency, basically shifting currency risk to their borrowers. However, depreciation also increases credit risk, hence, banks have to find an optimal balance for FX lending. Considering currency risk, LD would greatly depend both on the exchange rate and its volatility. When inflation increases, it leads to a decrease in the purchasing power of the domestic currency. This, in turn, increases the cost of borrowing in domestic currency for businesses. As a result, businesses may decide to borrow in foreign currency as it may provide lower borrowing costs due to lower interest rates in foreign currency. However, borrowing in foreign currency also carries the risk of exchange rate fluctuations, which can lead to an increase in the cost of borrowing in domestic currency if the domestic currency depreciates against the foreign currency. Therefore, the decision to borrow in foreign currency is influenced by a trade-off between the potential cost savings from lower interest rates and the risk of exchange rate fluctuations. According to the above-mentioned, the specification of the loan dollarization equation is the following:

$$LD_t = \alpha_0 + \alpha_1 * LD_{t-1} + \alpha_2 * DD_t + \alpha_3 * DLOG(ER\_MARKET_t) + \quad (2.6)$$
$$+ \alpha_4 * ER\_MARKET\_VOL_t + \alpha_5 * CPI_{t-1} + \alpha_6 * CPI\_VOL_{t-2}$$

where , LD_t – a fraction of loans to residents in foreign currency; DD_t – a fraction of deposits of residents in foreign currency; CPI_t – consumer price index to December previous year, %; ER_MARKET_t – exchange rate of UAH to USD on the FX market, UAH/USD; $ER\_MARKET\_VOL_t$ – volatility of exchange rate of UAH to USD; CPI_VOL_t – volatility of consumer price index.

To sum up, the described specification of a system of simultaneous equations includes 5 equations of main macroeconomic and financial variables: consumer price index, exchange rate, key policy rate, and deposit and loan dollarization, which are endogenous variables. It also includes exogenous variables, which are CPI of the main trading partners, official exchange rate, international reserves, debt to GDP ratio, net export, GDP gap, inflation target, neutral interest rate, volatilities of CPI and exchange rate, lending to business, deposit rate differential. Determined (lagged) variables in the system are key policy rate, exchange rate, CPI, international reserves, and deposit and loan dollarization ratios. The developed model allows to include the transmission of macroeconomic variables and monetary instruments' effects on financial dollarization. Including lagged variables enables to account for delays in the system based on the strength of particular monetary transmission channels.

The empirical analysis was performed on the dataset of 34 quarterly observations from 2014 till 1st half of 2022 with short-term forecasting of 4 quarters ahead.

Specifications of the equations of the system estimated on real data and respective determination and Durbin-Watson coefficients are presented in table 2.1.

Table 2.1. System's equations specification

№	Specification of the system's equations	Determination coefficient
1	Consumer price index equation, %	
	CPI = 36.74 - 0.82*D(KEY_R(-6)) + 95.66*D(LOG(ER_MARKET(-3))) + 2.17*PCPI(-1) + 0.16*CPI(-4) - 4.3*LOG(INR_RESERV(-7))	90,33% DW=2.15
2	Exchange rate equation, UAH/USD	
	LOG(ER_MARKET) = -0.09 - 0.015*D(KEY_R(-1))*DUMMY1 - 0.005*D(KEY_R(-1))*(1-DUMMY1) + 0.073*LOG(INR_RESERV(-6)) + 0.162*LOG(DEBT_TO_GDP) + 0.762*LOG(ER_OFF(-1)) - 9.212e-06*D(NX)	85,69% DW=2.14

Continuation of the Table 2.1.

№	Specification of the system's equations	Determination coefficient
3	Key policy rate equation, %	
	KEY_R = 2.26 + 0.76*KEY_R(-1) - 4.76*D(GDP_GAP(-1)) + 0.14*(CPI-CPI_TARGET) + 3.19*(D(ER_MARKET(-1)))*DUMMY2 + 1.06*(D(ER_MARKET(-1)))*(1-DUMMY2) - 1.09*D(NR(-2))	88,72% DW=1.45
4	Deposit dollarization equation	
	DD = -2.77 + 0.66*DD(-1) + 0.14*DLOG(ER_MARKET) + 0.000404*ER_MARKET_VOL(-3) + 9.489e-05*CPI_VOL(-4) + 0.21*LOG(CREDIT_TO_BUSINESS) + 0.0035*DEPOSIT_RATE_DIFFERENTIAL(-4)	91,59% DW=2.2
5	Loan dollarization equation	
	LD = -0.118 + 0.94*LD(-1) + 0.32*DD + 0.11*DLOG(ER_MARKET) – 0.00013*CPI_VOL(-2) - 0.00056*ER_MARKET_VOL + 0.00086*CPI(-1)	98,24% DW=1.82

Source: developed by the author in EViews 12

Every regression is estimated and tested separately for compliance with the classical assumptions of the regression analysis, the best specification is provided after several iterations and modifications. The conclusion on the equations' adequacy is presented in table 2.2-2.6, for more detailed information see Annex B-F.

Table 2.2. Results of testing for compliance with classical assumptions for the consumer price index equation

№	Assumption	Test	Critical value	Conclusion
1	Absence of heteroskedasticity	White Test, H0 – absence of heteroskedasticity	0.9480	Yes
2	Absence of autocorrelation	Breusch-Godfrey LM Test, H0- absence of serial correlation	0.9779	Yes
		Durbin-Watson test	2.15	Yes

Continuation of the Table 2.2.

№	Assumption	Test	Critical value	Conclusion
3	Absence of multicollinearity	Test VIF, H0 – absence of multicollinearity	<10	Yes
4	Residuals normal distribution	Jarque-Bera test, H0 – normal distribution	0.56	Yes
5	Correctness of specification	RESET-test, H0 – correct specification	0.0193	No
		Adjusted R-squared	0.92	Yes
		Fisher F-criteria	p-value < 0.1	Yes

Source: developed by the author in EViews 12

The equation of the consumer price index is consistent with most of the tests, except the RESET-test for the correctness of specification. Hence, additional criteria were taken into account, such as the high explanatory power of the regression (R-squared 92%), and all the independent variables are significant with confidence limits of 10%.

Table 2.3. Results of testing for compliance with classical assumptions for the exchange rate equation

№	Assumption	Test	Critical value	Conclusion
1	Absence of heteroskedasticity	White Test, H0 – absence of heteroskedasticity	0.7278	Yes
2	Absence of autocorrelation	Breusch-Godfrey LM Test, H0- absence of serial correlation	0.8479	Yes
		Durbin-Watson test	2.14	Yes
3	Absence of multicollinearity	Test VIF, H0 – absence of multicollinearity	<10	Yes
4	Residuals normal distribution	Jarque-Bera test, H0 – normal distribution	0.9	Yes

Continuation of the Table 2.3.

№	Assumption	Test	Critical value	Conclusion
5	Correctness of specification	RESET-test, H0 – correct specification	0.7230	Yes
		Adjusted R-squared	0.86	Yes
		Fisher F-criteria	p-value < 0.1	Yes

Source: developed by the author in EViews 12

The equation of the exchange rate is consistent with all of the tests, has high explanatory power of the regression (R-squared 86%), and all the independent variables are significant with confidence limits of 10%.

Table 2.4. Results of testing for compliance with classical assumptions for key policy rate equation

№	Assumption	Test	Critical value	Conclusion
1	Absence of heteroskedasticity	White Test, H0 – absence of heteroskedasticity	0.1279	Yes
2	Absence of autocorrelation	Breusch-Godfrey LM Test, H0- absence of serial correlation	0.3301	Yes
		Durbin-Watson test	1.45	Yes
3	Absence of multicollinearity	Test VIF, H0 – absence of multicollinearity	<10	Yes
4	Residuals normal distribution	Jarque-Bera test, H0 – normal distribution	0.07	Unclear
5	Correctness of specification	RESET-test, H0 – correct specification	0.7160	Yes
		Adjusted R-squared	0.89	Yes
		Fisher F-criteria	p-value < 0.15	Yes

Source: developed by the author in EViews 12

The equation of the key policy rate is consistent with most of the tests, the test of the normal distribution of residuals is unclear, the problem for that can be a very limited number of observations, however taking into account other tests, and the prevalence of the problem of non-normal distribution for small datasets, the equation was developed as best possible to satisfy key tests, it also has high explanatory power of the regression (R-squared 89%), and all the independent variables are significant with confidence limits of 15%.

Table 2.5. Results of testing for compliance with classical assumptions for deposit dollarization equation

№	Assumption	Test	Critical value	Conclusion
1	Absence of heteroskedasticity	White Test, H0 – absence of heteroskedasticity	0.5093	Yes
2	Absence of autocorrelation	Breusch-Godfrey LM Test, H0- absence of serial correlation	0.3337	Yes
		Durbin-Watson test	2.2	Yes
3	Absence of multicollinearity	Test VIF, H0 – absence of multicollinearity	<10	Yes
4	Residuals normal distribution	Jarque-Bera test, H0 – normal distribution	0.87	Yes
5	Correctness of specification	RESET-test, H0 – correct specification	0.1304	Yes
		Adjusted R-squared	0.92	Yes
		Fisher F-criteria	p-value < 0.05	Yes

Source: developed by the author in EViews 12

The equation of the deposit dollarization is consistent with all of the tests, has high explanatory power of the regression (R-squared 92%), and all the independent variables are significant with confidence limits of 5%.

Table 2.6. Results of testing for compliance with classical assumptions for loan dollarization equation

№	Assumption	Test	Critical value	Conclusion
1	Absence of heteroskedasticity	White Test, H0 – absence of heteroskedasticity	0.5085	Yes
2	Absence of autocorrelation	Breusch-Godfrey LM Test, H0- absence of serial correlation	0.7360	Yes
		Durbin-Watson test	1.82	Yes
3	Absence of multicollinearity	Test VIF, H0 – absence of multicollinearity	<10	No
4	Residuals normal distribution	Jarque-Bera test, H0 – normal distribution	0.33	Yes
5	Correctness of specification	RESET-test, H0 – correct specification	0.2014	Yes
		Adjusted R-squared	0.98	Yes
		Fisher F-criteria	p-value < 0.05	Yes

Source: developed by the author in EViews 12

The equation of the loan dollarization is consistent with most of the tests, has high explanatory power of the regression (R-squared 98%), and all the independent variables are significant with confidence limits of 5%.

Previously specified regression equations are then combined and united into one system. To conduct this step, exogenous and determined (lagged endogenous) variables have been defined. This division is needed to test the system for the identity check according to the condition of the order. The condition of the order is defined based on the following formula:

$$(K-k)=(m-1) \quad (2.7)$$

where *K* – the sum of exogenous and determined variables in the system, *k* – the sum of exogenous and determined variables in the equation, and *m* – the number of endogenous variables in the equation.

If (K-k) is lower than (m-1) then the system is underidentified, if it is greater – the system is overidentified. The developed system has 28 exogenous and determined variables and 5 endogenous.

Every equation was tested separately for the identity check (see Table 2.7).

Table 2.7. Results of the system test for the identity check according to the condition of the order

Endogenous variables	Exogenous variables	Determined (lagged endogenous) variables	Condition of the order	Conclusion
Consumer price index equation				
CPI_t	$PCPI_{t-1}$	KEY_R_{t-6}, ER_MARKET_{t-3}, CPI_{t-4}, INR_RESERV_{t-7}	28-5>1-1	Overidentified
Exchange rate equation				
ER_MARKET_t	ER_OFF_{t-1}, INR_RESERV_{t-6}, $DEBT\_TO\_GDP_t$, NX_t, DUMMY1	KEY_R_{t-1}, ER_MARKET_{t-1}	28-7>1-1	Overidentified
Key policy rate equation				
KEY_R_t, CPI_t	GDP_GAP_{t-1}, CPI_TARGET_t, NR_{t-2}, DUMMY2	KEY_R_{t-1}, ER_MARKET_{t-1}	28-6>2-1	Overidentified

Continuation of the Table 2.7.

Endogenous variables	Exogenous variables	Determined (lagged endogenous) variables	Condition of the order	Conclusion
Deposit dollarization equation				
DD_t, ER_MARKET_t	$ER\_MARKET\_VOL_{t-3}$, CPI_VOL_{t-4}, $CREDIT\_TO\_BUSINESS_t$, $DEPOSIT\_RATE\_DIFFERENTIAL_{t-4}$	DD_{t-1}	28-5>2-1	Overidentified
Loan dollarization equation				
LD_t, DD_t, ER_MARKET_t	$ER\_MARKET\_VOL_t$, CPI_VOL_{t-2}	LD_{t-1}, CPI_{t-1}	28-4>3-1	Overidentified

Source: developed by the author based on [17]

The identity test confirmed that every equation is overidentified, consequently, the whole system is overidentified as well. Consequently, the system can be estimated based on a two-stage or three-stage least squares estimation method. The estimated system output from both methods is shown in Annex G.

Based on the decrease of the determinant residual covariance value from 7,19E-11 to 5,95E-11 when switching from the two-stage to three-stage least squares method, the latter was chosen for final system estimation.

The system was therefore tested for the residual autocorrelations using the Portmanteau Autocorrelation test. Results of the test confirm that there are no residual autocorrelations in the system up to lag 12 (see Annex G).

It is crucial to assess the forecast quality of any model as it enables the evaluation of the model's ability to predict outcomes and analyze various scenarios of potential economic events based on different initial conditions and assumptions. By assessing how well the model can forecast future outcomes, we can determine its usefulness for decision-making purposes. If the model consistently produces inaccurate forecasts, it may not be suitable for making reliable predictions, and relying on its results could lead to poor decisions.

Estimating the forecast quality of a model also provides insights into the model's underlying assumptions and parameters and can help identify areas where improvements can be made. Ultimately, by evaluating the forecast quality of a model, we can gain a better understanding of its limitations and potential biases, and make more informed decisions based on its predictions.

The first step to assess forecast quality is to simulate the model and compare it with historical results. Simulated and historical results for endogenous variables are shown in Figure 2.10 and Figure 2.11.

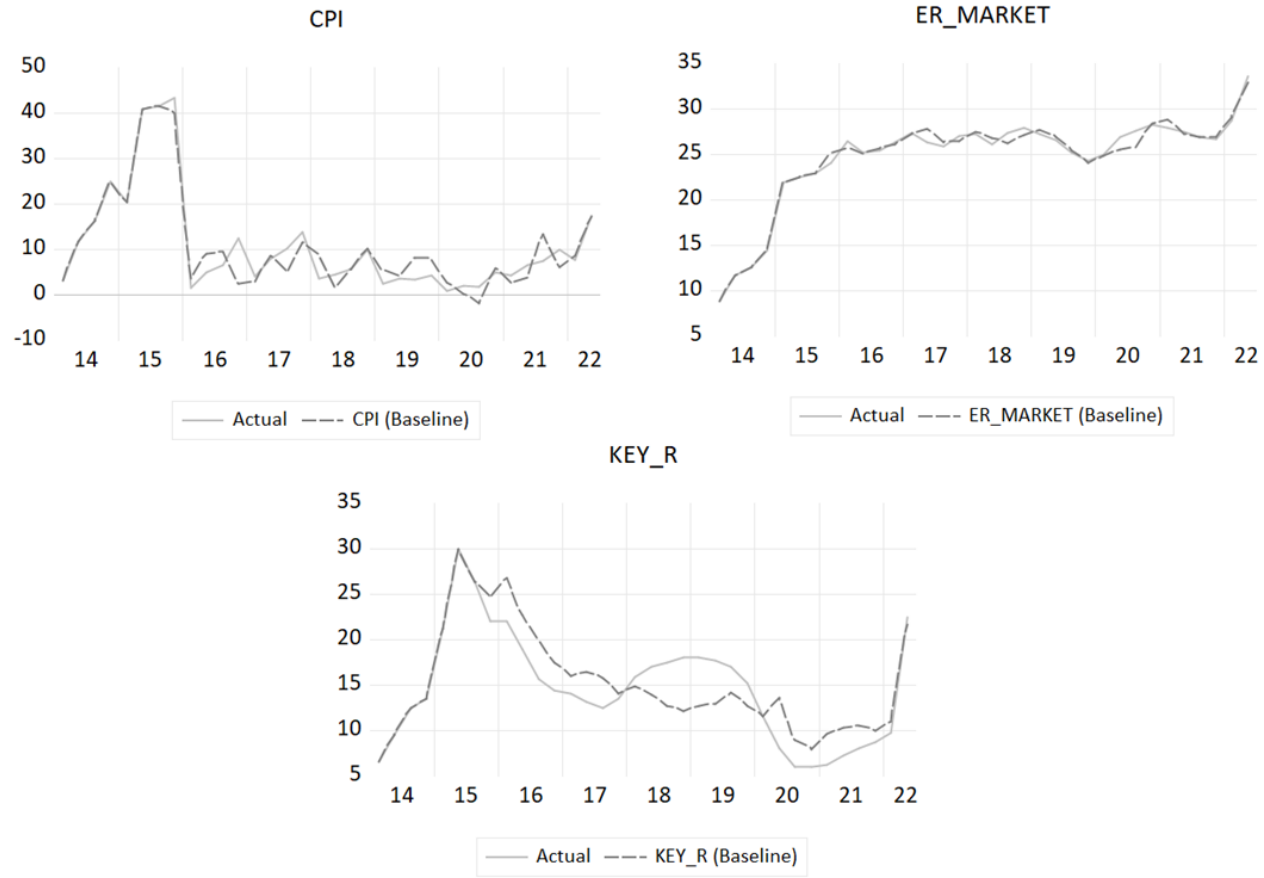


Figure 2.10. Historical and simulated results for consumer price index, exchange rate, and key policy rate

Source: developed by the author in EViews 12

When analyzing results for macroeconomic variables, we can see that the simulated results replicate the actual behavior pretty accurately. What is important in such results is that it manages not only to capture the trend but also to replicate the turning points. The model managed to capture the changes in the economy caused by the russian full-scale invasion, and the consequent actions of the NBU – the increase of the key policy rate,

provoked a sudden increase in the market exchange rate and the increasing trend in inflation. A very accurate forecast for the last periods allows relying on the model for short-term forecasting of future periods.

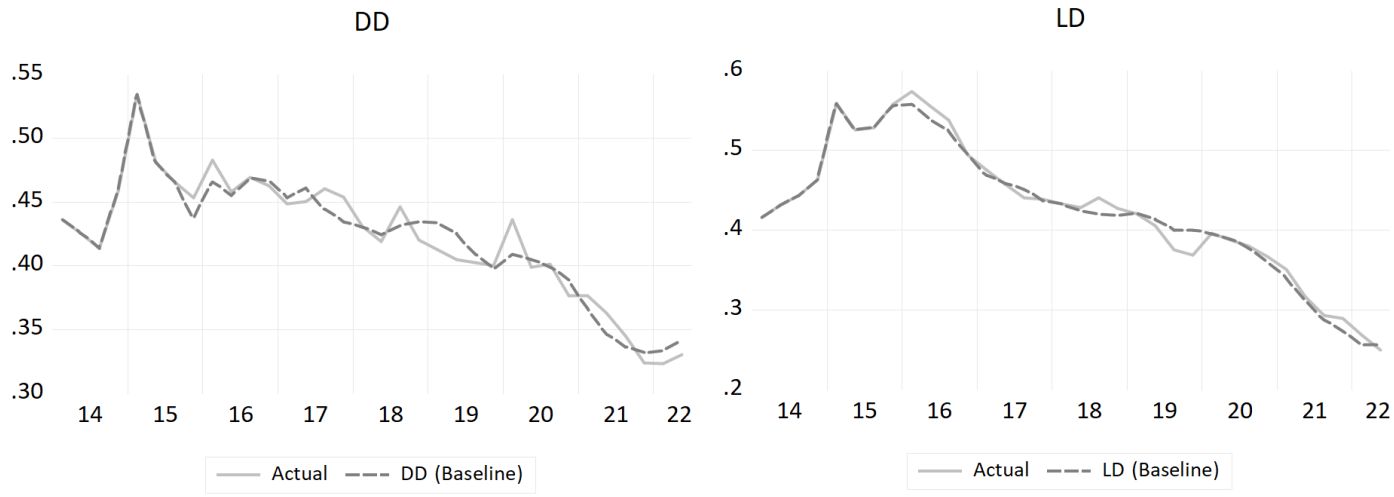


Figure 2.11. Historical and simulated results for deposit and loan dollarization

Source: developed by the author in EViews 12

Deposit and loan dollarization simulated results are also pretty accurate and manage to replicate the turning points, however for the DD, the peaks are rather smoothed by the model. Results of the last periods, therefore, enable to rely on the model for the short-term forecast.

Based on the estimated model, a forecast has been developed for all endogenous variables of the system till the end of 2023.

The baseline forecast for the consumer price index (see Figure 2.12) shows that inflation hasn't reached its peak as of the end of 2022, which supposedly could occur in 1st quarter of 2023. The predicted value for the end of 2022 is consistent with the NBU preliminary forecast of 30%. However, actual inflation in the last quarter of 2022 reached 26,6% and was lower than expected. Since some of the inflationary risks that were assumed to cause pressure on prices haven't been realized, CPI reached its turning point in 4Q 2022 as the rapid increase of the key policy rate to 25% in 2Q 2022 has started affecting the economy with a delay of few quarters. NBU in the meantime forecasts that inflation will slow down to 18,7% in 2023, hence the forecast generated by the model leans toward the lower confidence bound.

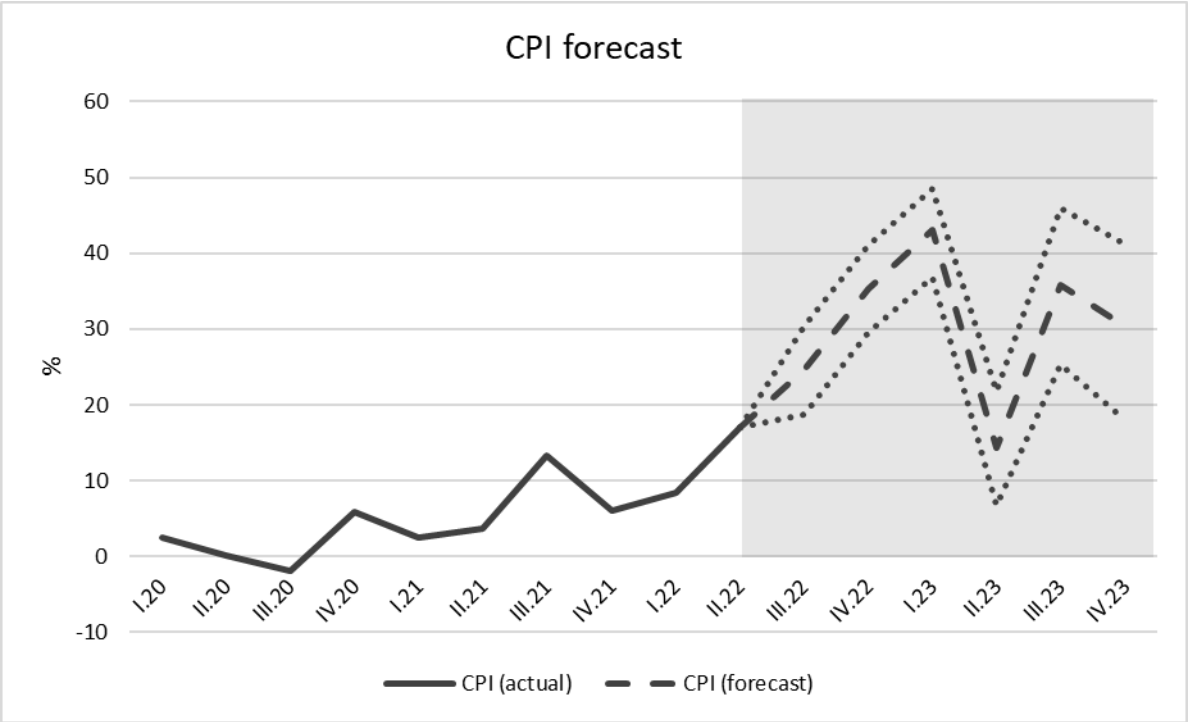


Figure 2.12. Consumer price index forecast

Source: developed by the author

The baseline forecast for the market exchange rate (see Figure 2.13) will stabilize in 2023 and lean toward the official exchange rate. High policy rate and gradual increases in capital requirements of banks will foster monetary transmission and absorption of excess liquidity, which would increase the attractiveness of hryvnia instruments and stabilize the FX market. An increase in macro-financial aid, an increase in export, and stabilization of inflation and its expectations would result in a relatively stable exchange rate in 2023.

According to the baseline forecast for key policy rate (see Figure 2.14), NBU will proceed with tight monetary policy and would keep the rate on the current level till the end of 2023, which is consistent with their claims released in the recent Inflation Report [11]. Hence due to lower inflationary and devaluation risks, a lower confidence bound should rather be considered.

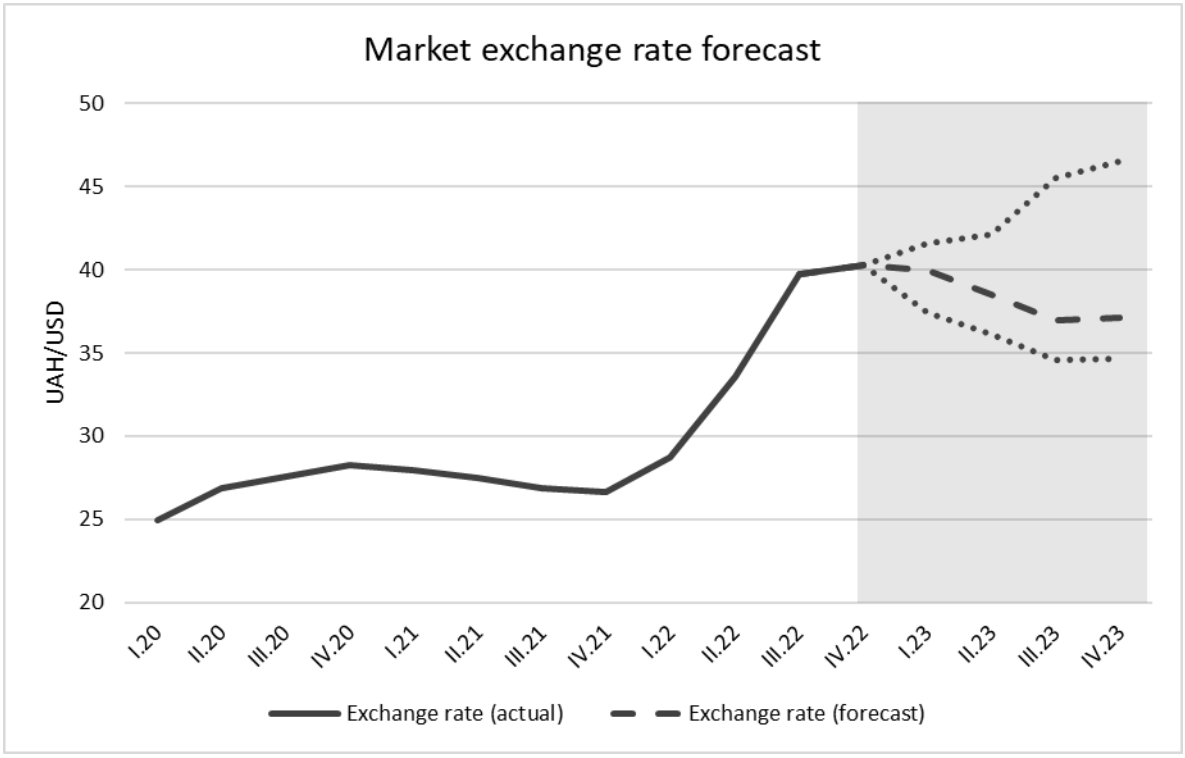


Figure 2.13. Exchange rate of UAH to USD forecast

Source: developed by the author

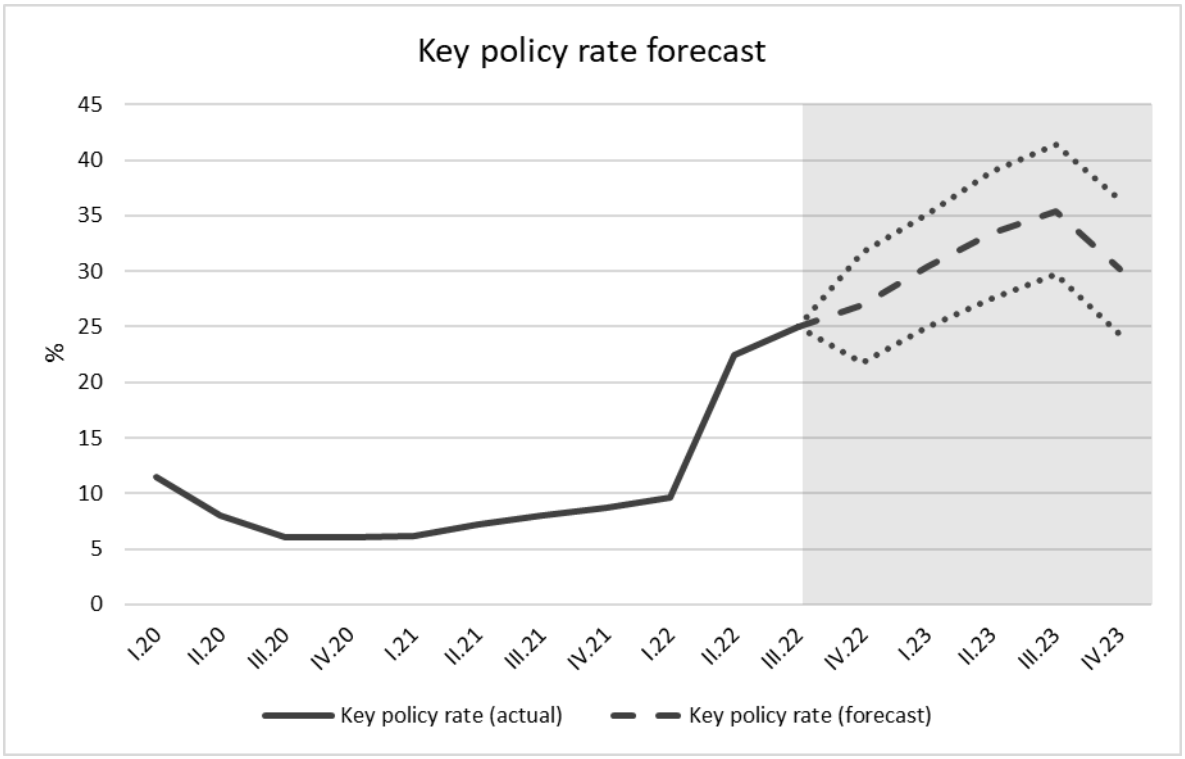


Figure 2.14. Key policy rate forecast

Source: developed by the author

When examining the deposit dollarization forecast (see Figure 2.15), we can observe the effects of the increase of required reserves, and consequently how the decrease in FX

deposit rates managed to keep DD on the pre-war level in the 1st half of 2022. However, with the increase of inflation expectations, uncertainty about the stability of national currency associated with export risks, dependency on foreign macro-financial aid, and FX restrictions, enhanced the increase in the demand for deposits denominated in foreign currency, though the yield is close to zero, meaning that investing in FX would hedge from currency risks. Also, the balance sheet effect from currency depreciation increased banks' FX share. Additionally, NBU allowed individuals to buy FX currency with its further placement on term deposits. With the increase of FX deposits, after its maturity, a high fraction of them would probably stay in the savings accounts due to NBU restrictions on foreign currency cash withdrawals.

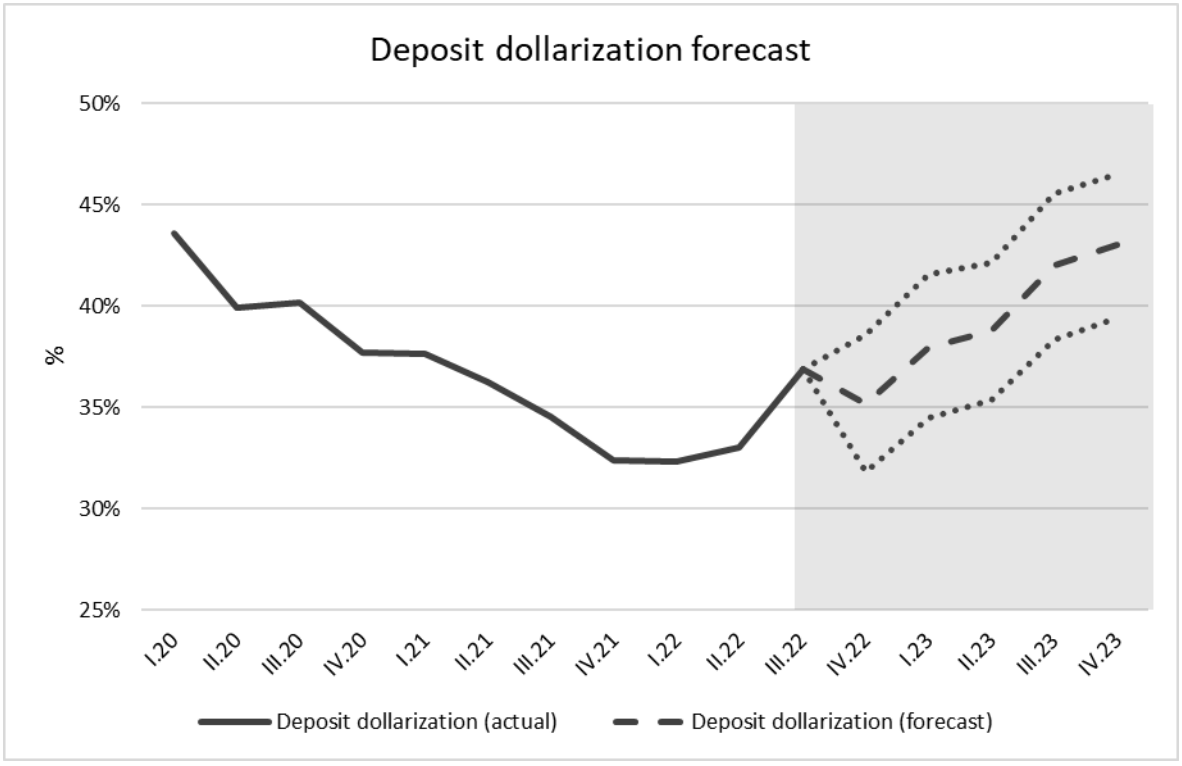


Figure 2.15. Deposit dollarization forecast

Source: developed by the author

An increase in loan dollarization (see Figure 2.16) is largely caused due to balance sheet effects and official exchange rate fixation on the higher level. Currently, FX loans with existing terms are not attractive to both borrowers and banks. Borrowers are not willing to carry currency risks. NPL fraction has been increasing as well, and according to the Financial Stability Report of NBU since the start of the war, 20% of the corporate loan

portfolio in FX currency has been restructured, in comparison with only 9% of the hryvnia corporate loan portfolio [18], [19]. However, with a relatively stable exchange rate in 2023 and lower inflation, loan dollarization is likely to stay at the same level, hence the forecast would lean toward lower confidence bound.

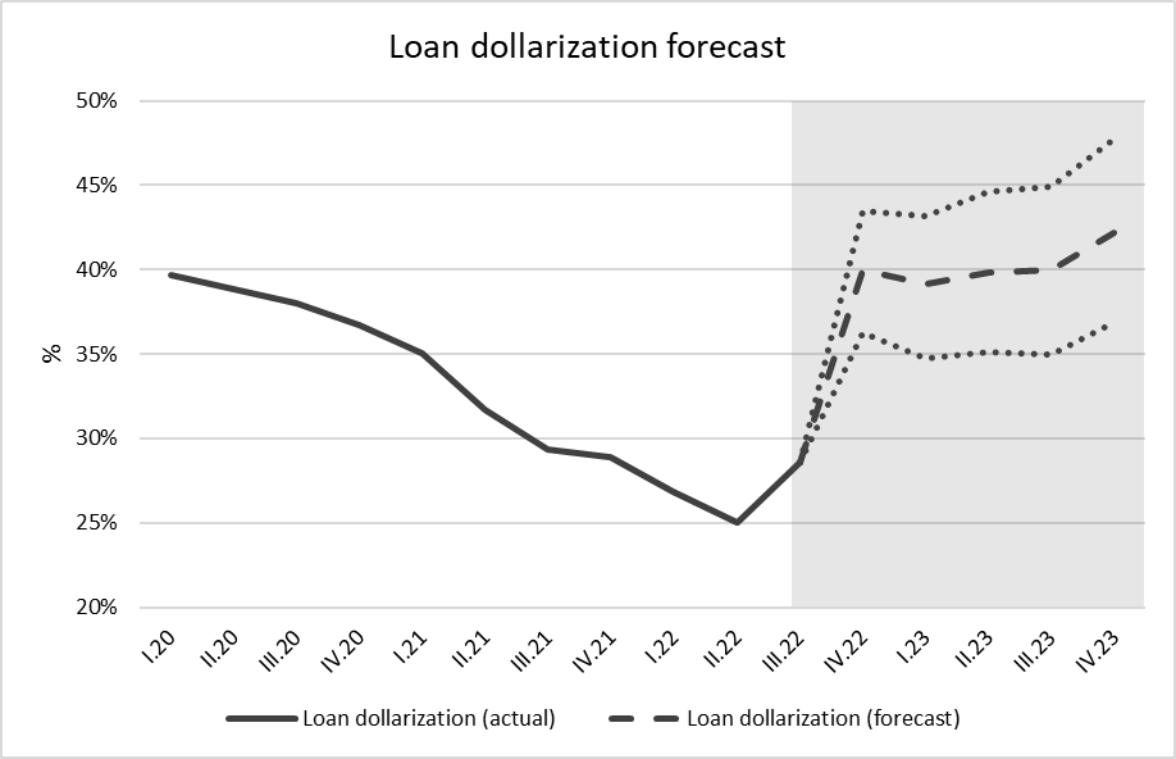


Figure 2.16. Loan dollarization forecast

Source: developed by the author

To sum up, deposit and loan dollarization is going to stay at a relatively high level due to still high inflation risks and exceeding their pre-war level. As the market is highly uncertain and limited, and the transmission mechanism is not as effective as before the war, NBU has to pay attention to macroprudential regulatory tools.

A system of simultaneous equations proved to be a very efficient method to analyze how the macroeconomic situation affects financial dollarization. Deposit dollarization is driven by its previous level, the exchange rate, and its volatility, as well as by consumer price index volatility. It also depends on the demand for corporate lending, reflecting the redistributive function of banks and the difference between national and foreign currency deposit rates. In the meantime, loan dollarization depends on deposit dollarization, exchange rate, inflation, and their volatilities. In the model, only macroeconomic indicators and monetary policy tools are endogenized, which brings to a conclusion that a stable, controlled

macroeconomic environment, increases the confidence of both investors, borrowers, and banks, providing grounds for trust in NBU, the national currency instruments, and consequently for lower levels of financial dollarization.

In addition, as one of the financial stability goals is to ensure low financial dollarization, monetary policies should be followed by relevant macroprudential policies.

Scenario analysis is an essential part of developing a system of simultaneous equations for analyzing complex economic systems such as financial dollarization. This technique involves creating hypothetical scenarios based on different assumptions and modeling the impact of these scenarios on the system under study. Through scenario analysis, we can explore how the system may react to changes in key variables and evaluate the effectiveness of different policy options. This approach can help policymakers and researchers identify potential risks and challenges and develop effective strategies to manage them. By incorporating scenario analysis into the system of simultaneous equations, we can enhance our understanding of complex economic phenomena and improve the accuracy of our forecasting and policymaking.

Assumptions incorporated under the baseline scenario described before were developed using ARIMA methodology and GARCH methodology for volatilities. To perform scenario analysis alternatives optimistic and pessimistic were proposed.

Generally, in an optimistic scenario, both domestic and world inflation will slow down, hence the volatility of CPI will be lower. With the stabilization of the energy situation, businesses will be able to renew their business activity, leading to a decrease in the negative net export and GDP gap. Additionally, Ukraine is expected to continue receiving macro-financial aid, which will help maintain sufficient international reserves and a stable exchange rate.

On the other hand, in a pessimistic scenario, inflation trends will stay relatively high, with massive infrastructure destructions, businesses may not recover, which will lead to a worse trade position and a greater GDP gap. In case Ukraine won’t receive enough macro-financial aid, or will receive them on worse terms, for example, by getting credits instead of grants, it could negatively affect government debt, and international reserves, hence exchange rate will be more volatile than under the baseline scenario.

Assumptions under all the scenarios are depicted in table 2.8.

Table 2.8. Assumptions for scenario analysis

Variable	Baseline	Optimistic	Pessimistic
PCPI	PCPI will increase till the end of 2022 and then gradually decrease by around 2% each quarter.	PCPI will increase till the end of 2022 and then gradually decrease by around 3% each quarter.	PCPI will continue slowly increasing throughout 2023.
INR_RESERV	International reserves will increase from 2.7 billion USD to almost 3 billion USD by the end of 2023	International reserves will increase from 2.7 billion USD to 3.3 billion USD by the end of 2023.	International reserves will decrease throughout the year from 2.7 billion USD to 2.5 billion USD by the end of 2023.
DEBT_TO_ GDP	The average debt-to-GDP ratio will be around 4,69 in 2023.	The average debt-to-GDP ratio will be around 4,69 in 2023.	The average debt-to-GDP ratio will be around 5,18 in 2023.
NX	Net export will be the lowest in the second half of 2022 (-9.1 billion USD in Q3 and -4.9 billion USD in Q4), it will improve to -2.5 billion USD in Q4 2023.	Net export will be the lowest in the second half of 2022 (-9.1 billion USD in Q3 and -4.9 billion USD in Q4), it will improve to -2 billion USD in Q4 2023.	Net export will be the lowest in the second half of 2022 (-9.1 billion USD in Q3 and -5 billion USD in Q4), it will improve to -3 billion USD in Q1 and Q3 2023 but then fall to -3.5 billion USD in Q4.

Continuation of the Table 2.8.

Variable	Baseline	Optimistic	Pessimistic
GDP_GAP	The GDP gap will slowly decrease with gradual business recovery.	The GDP gap will decrease with gradual business recovery, but faster than under the baseline scenario.	The GDP gap will continue to stay at a very high level and will decrease slower than under the baseline scenario.
CPI_VOL	The highest volatility of CPI will be in the second half of 2022, in 2023 CPI will be volatile but the increase in volatility will be moderate.	The highest volatility of CPI will be in the second half of 2022, but lower than under the baseline scenario, it will also slowly decrease to its normal level by the end of 2023.	The highest volatility of CPI will be in the second half of 2022, in 2023 CPI will be volatile and the increase in volatility will be greater than under the baseline scenario.
ER_MARKET_VOL	The highest volatility of the exchange rate will be in the second half of 2022, in 2023 ER will stabilize with the slow increase in volatility.	The highest volatility of the exchange rate will be in the second half of 2022, but lower than under the baseline scenario, in 2023 ER will stabilize with the slow increase in volatility.	The highest volatility of the exchange rate will be in the second half of 2022, but higher than under the baseline scenario, in 2023 ER will stabilize with the slow increase in volatility, which will be higher than under the baseline scenario.

Source: developed by the author

Results from scenario analysis on deposit dollarization are shown in Figure 2.17.

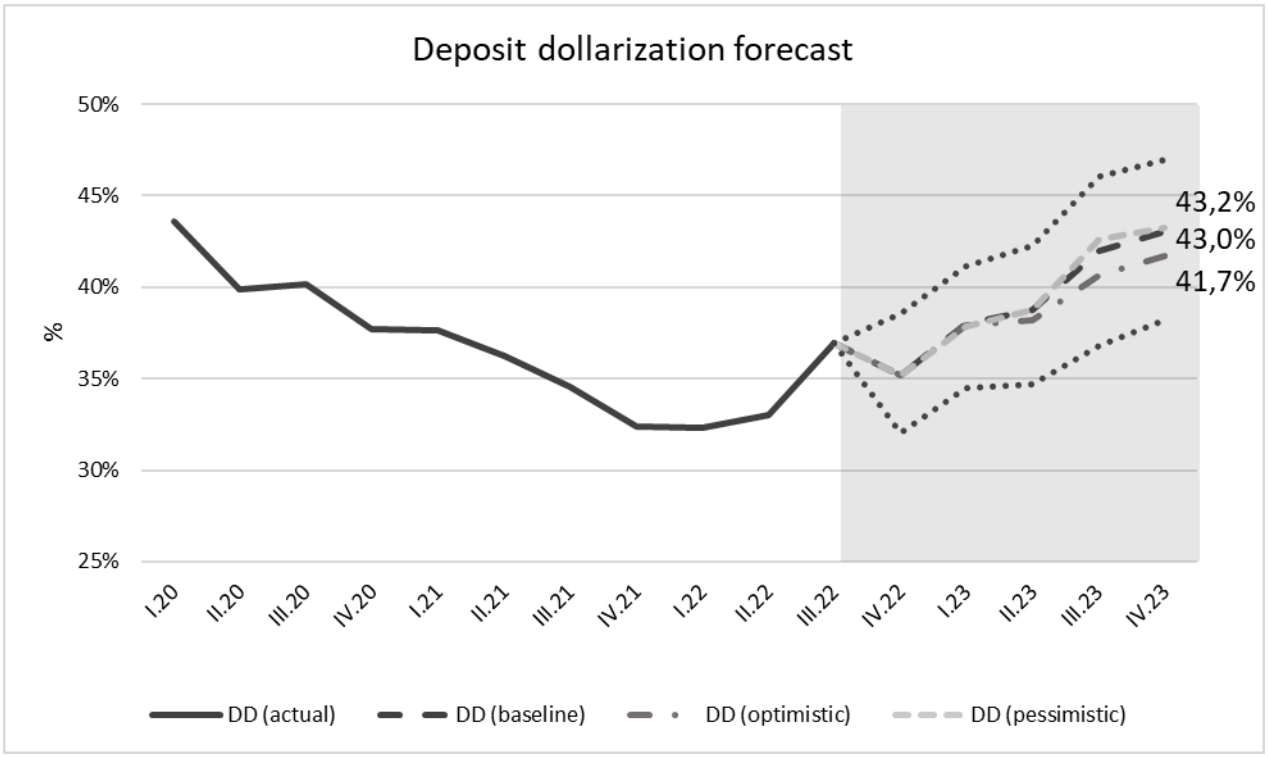


Figure 2.17. Deposit dollarization forecast under baseline and alternative scenarios

Source: developed by the author

Since most assumptions among scenarios are different only for 2023, the difference in results is best seen in the second half of 2023. As mentioned before, the baseline scenario already accounts for major risks and reflects a pretty pessimistic outcome, the difference between negative and baseline scenarios is little, under a pessimistic scenario DD rises faster and reaches 43,2% in Q4 2023, while under baseline it reaches 43%. Under an optimistic scenario, DD is rather smoothed and it reaches 41,7% at the end of 2023. It is important to mention that under all the scenarios macroeconomic situation is rather bad compared to the pre-war levels, hence the change in assumptions about macroeconomic indicators won't affect the system fast enough or in full power. In addition, the changes in deposit rate differential could possibly affect the scenarios, however, the banking system is highly liquid now, and with lower lending trends banks hold no incentive for increasing deposit rates on hryvnia instruments and FX deposit rates are already very low, as a result incorporating such assumption under any of alternative scenarios could produce unrealistic behavior.

Results from scenario analysis on deposit dollarization are shown in Figure 2.18.

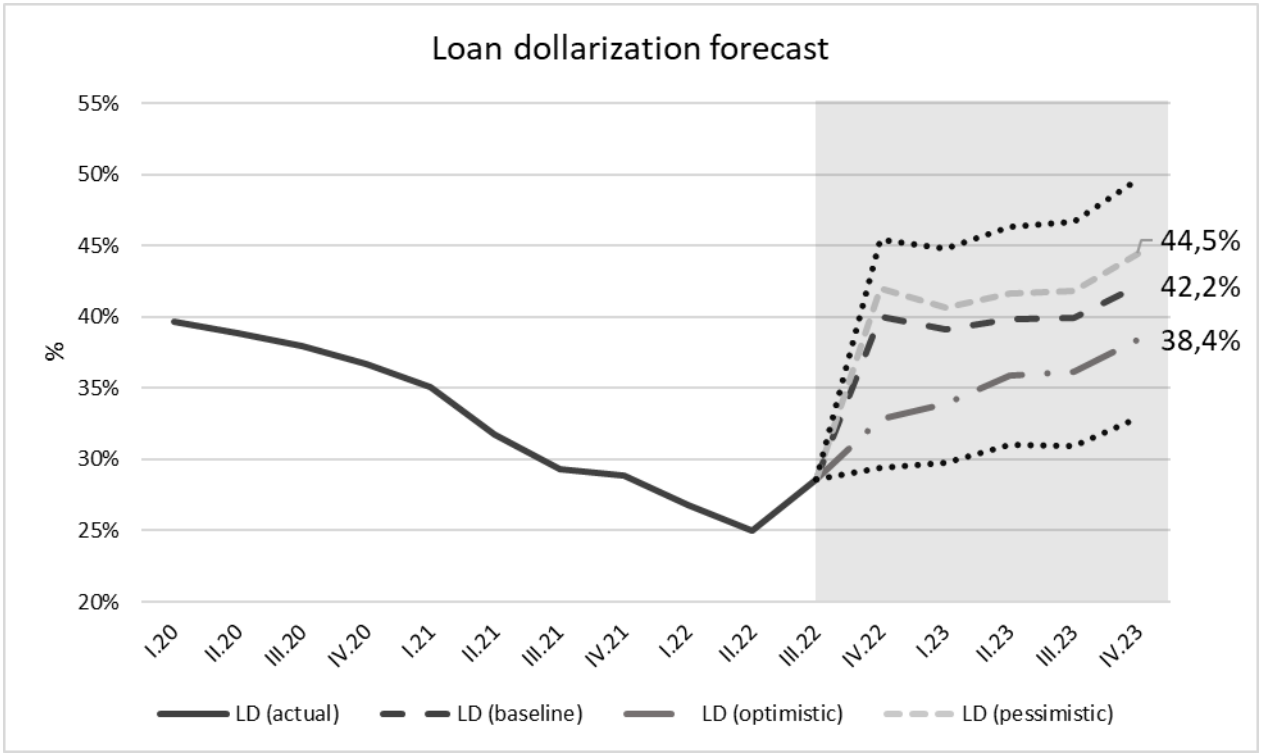


Figure 2.18. Loan dollarization forecast under baseline and alternative scenarios

Source: developed by the author

In contrast to deposit dollarization, loan dollarization appeared to be more sensitive to changes in assumptions and macroeconomic situation. Similar to the DD forecast, the baseline scenario already accounts for unfavorable economic conditions, and it results in the same trend for both baseline and pessimistic scenarios. The greatest increase in LD is observed in 4Q 2022, after that, it slowly increases to 44,5% under pessimistic and to 42,2% under baseline scenarios at the end of 2023. The optimistic scenario doesn't have such a sharp increase at the end of 2022, and it slowly increases throughout the forecast period and reaches 38,4% by the end of 2023.

In conclusion, the scenario analysis conducted using a system of simultaneous equations has provided us with valuable insights into the potential impact of different economic scenarios on deposit and loan dollarization in Ukraine. The findings suggest that even under optimistic assumptions, the macroeconomic situation remains challenging, and deposit and loan dollarization are likely to remain a concern for macroprudential regulators and researchers. While the system of simultaneous equations allowed to capture the interdependent relationships between different macroeconomic variables, future research could potentially benefit from using system dynamics methodology, which would enable to

capture the complex feedback loops and non-linear dynamics that often characterize macroeconomic systems. Overall, the analysis underscores the need for continued vigilance and proactive measures to mitigate the risks associated with high levels of deposit and loan dollarization in Ukraine's banking system.

2.3 System Dynamics framework for policy analysis

The System Dynamics (SD) approach is another method that enables analyzing complex problems, such as the causes and consequences of financial dollarization. It allows modeling relationships and feedback in the system based on incorporated assumptions. When analyzing such systems it appears to be a flexible tool: it is applicable for changing parameters, developing scenarios, and testing hypotheses. While developing the system dynamics model the modeler receives incentives for leverage points in the system. These insights from the developed model can be very valuable for policymakers, and system dynamics software provides opportunities for versatile approach in analyzing the problem and finding possible solutions.

There is little literature on the analysis of financial systems using system dynamics, hence this research aims to provide grounds for the application of SD models in the risk-management practices of banks.

The key part of the model structure is a simplified balance sheet and financial results statement of banks. Assets of the bank consist of hryvnia loans, FX loans, bonds, and reserves. Liabilities consist of hryvnia deposits, FX deposits, and financial capital. The balance sheet structure is important because it allows the calculation of important risk management indicators, such as liquidity ratios, and others, which then can be used by the regulators to analyze the financial health of the banking sector and for the development of macroprudential strategies.

The financial result includes banks’ income and expenses, such as net interest income, net commission income, foreign currency gains or losses, and other income and expenses.

Macroeconomic indicators, such as inflation, policy rate, and exchange rate are taken exogenously, in contrast to the system of simultaneous equations developed in the previous

part, for simplification purposes. These macroeconomic indicators are mostly used in terms of perception, relative changes, and expectations.

The simplified causal-loop diagram is presented in Figure 2.19.

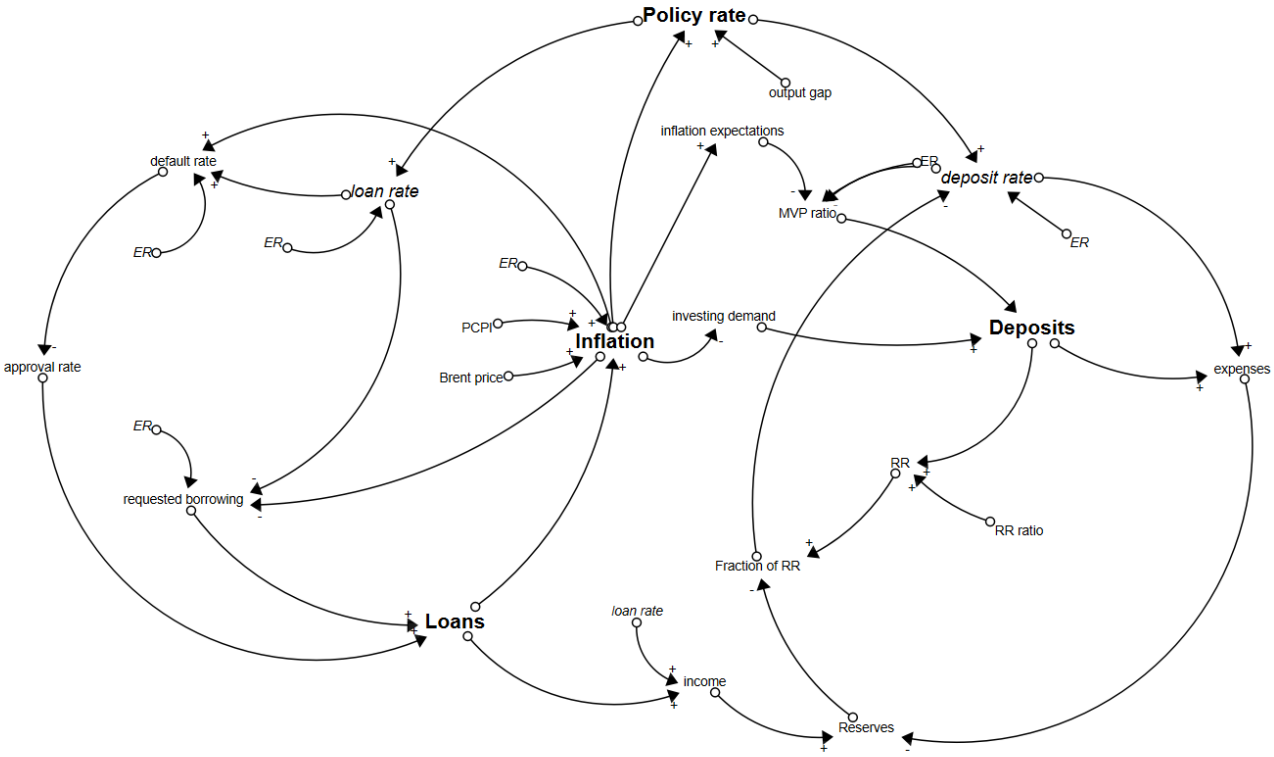


Figure 2.19. Simplified causal-loop diagram of banking sector and monetary policy

Source: developed by the author in Stella Architect

In contrast to the system of simultaneous equations, both hryvnia and FX deposit and loan rates are endogenized. This structure allows tracking of the response of banks to various changes both in the macroeconomic situation and monetary policy. Also exchange rate is taken exogenously, and this part of the model can be developed in further research.

The assumptions developed to describe deposit dollarization are the following:

a) Demand for investing in deposits is driven by its persistent level and changes in inflation – with the increase in inflation, purchasing power of individuals and businesses decreases, hence people invest less, as they have to pay more to maintain their needs.

b) With hryvnia depreciation people tend to invest in foreign currency deposits to hedge from currency risk.

c) With the increase in inflation expectations, people tend to invest in foreign currency deposits due to higher uncertainty and a desire to hedge from inflationary risks.

d) Inflation expectations depend on the monetary credibility and forecast of the NBU. Monetary credibility is adjusted with a delay of 2 years based on the gap between actual inflation and its target. With the decrease of inflation closer to its target, the monetary credibility increases, and consequently inflation expectations will be closer to the forecast communicated by the NBU.

e) If the deposit rate differential that is a difference between hryvnia and FX deposit rates increases it means that hryvnia deposits have higher yields than FX deposits, hence investors would prefer to hold them in their portfolios.

f) Hryvnia deposit rate is positively affected by the change in the policy rate, this assumption is based on the estimated correlation of 0,65.

g) FX deposit rate is also positively affected by policy rate with the estimated correlation of 0,31. It is negatively affected by the change in the exchange rate, as banks don't have the incentive to carry currency risk, the estimated correlation is -0,77. The required reserves ratio set by NBU also affects the willingness of banks to increase the deposit rate on FX deposits: with the increase of the ratio banks will lower their interest rate, and the estimated correlation is -0,3.

The assumptions developed to describe loan dollarization are the following:

a) The demand for loans in hryvnia is driven by the respective interest rate. With the increase of the hryvnia loan rate, customers will be less willing to take loans due to the high costs of its maintenance. The same logic is applied to the effect of inflation on demand for hryvnia loans: higher inflation may reduce the purchasing power of customers, making them more cautious about taking on new debt, also it can reduce demand for credit as businesses and consumers cut back on spending.

b) The demand for FX loans is driven by the respective loan rate: with the increase in the rate, customers will be willing to take fewer loans due to high service costs. It can also be driven by the difference in loan rates in hryvnia and FX: usually, FX rates are lower than the ones nominated in hryvnia. The exchange rate negatively affects FX borrowing demand, as with hryvnia depreciation costs of debt maintenance increase as well.

c) Hryvnia loan rate is positively affected by the policy rate, the estimated correlation is 0,87, and by the hryvnia deposit rate: if banks increase deposit rates, they will

want to increase the spread as well to prevent losing interest income. The estimated correlation between hryvnia deposit and loan rates is 0,85.

d) FX loan rate is positively affected by the policy rate, the estimated correlation is 0,32, and is negatively affected by the exchange rate: with hryvnia depreciation banks will try to manage the risks associated with foreign currency lending, such as exchange rate fluctuations and default risk. The estimated correlation between FX loan rates and the exchange rate is -0,6.

SD model overview is shown in Annex H in regard to separate model structures: Monetary Policy, Deposits, Loans, Interest Rates, Customers demand for savings, Customers demand for borrowings, Balance Sheet, and P&L.

Simulation for deposit dynamics is shown in Figure 2.20. From the graphs, we can see that the simulated results reflect historical data very accurately. Total deposit demand also accounts for the effect of currency restrictions, based on sensitivity analysis estimated multiplier for the increase in demand for deposits in 2022 is 0,4.

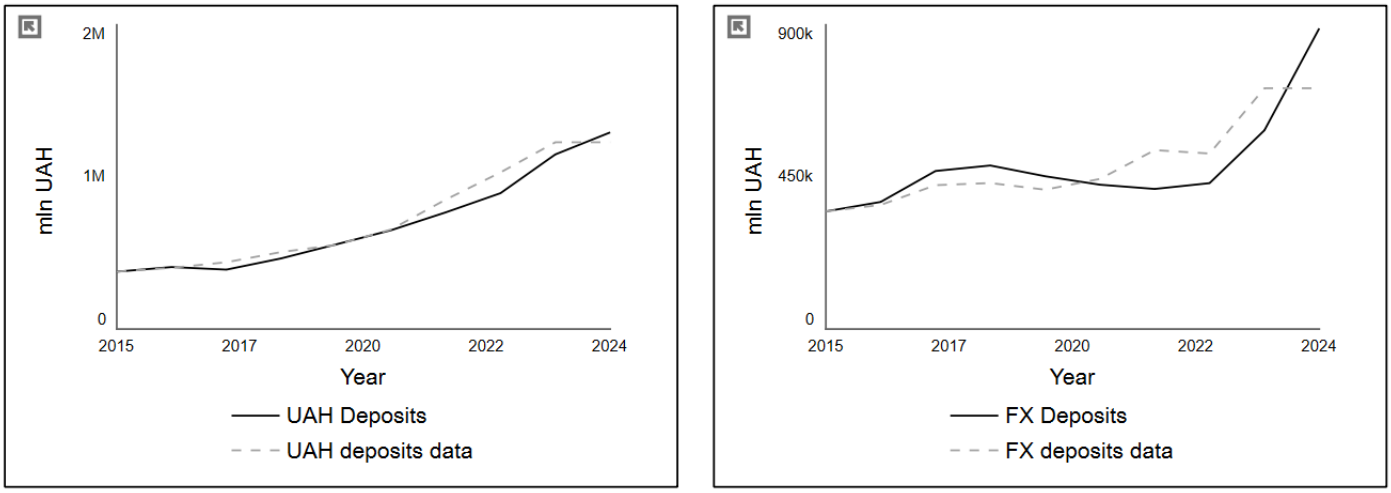


Figure 2.20. Deposits simulation from 2015 till 2024

Source: developed by the author in Stella Architect

Simulated deposit dollarization is also consistent with the historical data (see Figure 2.21). In 2022 even though FX deposits have increased a lot, the overall growth rate of deposits was higher, hence it didn't exceed the pre-war levels. A combination of currency restrictions and an increase in reserve requirements restricted excessive dollarization in

2022. However, the dollarization will continue increasing and as of the end of 2023, it will reach 41%. This result is similar to the one derived from a system of simultaneous equations.

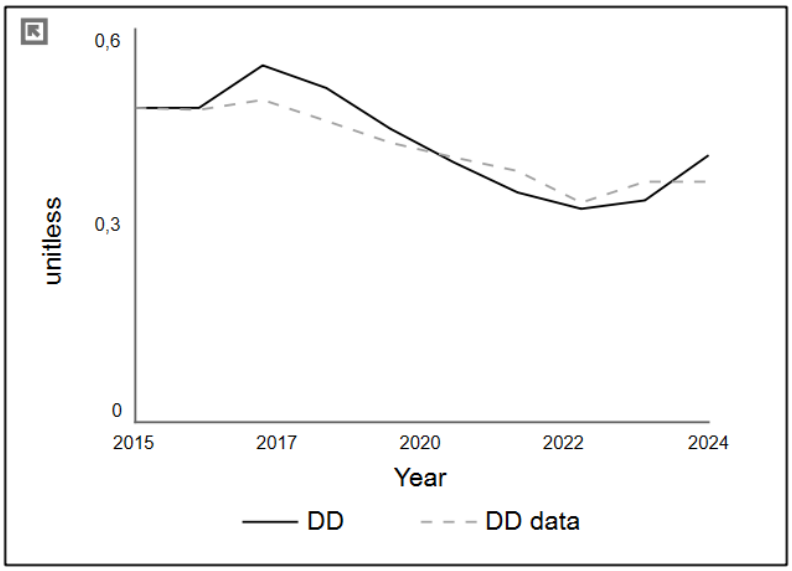


Figure 2.21. Deposits dollarization simulation from 2015 till 2024

Source: developed by the author in Stella Architect

In contrast, loans simulation is more accurate after 2016 and has a gap at the beginning of the simulation, however, this gap between actual and simulated data occurs due to delays in the system, hence the model couldn't account for lagged effects that occurred before 2015 (see Figure 2.22). This problem can be easily solved with the expansion of the analyzed period. Also, foreign currency loan peaks are not reflected by the model. Primarily this can be the result of more sophisticated credit-scoring models and consequently flexible approval rates. The model shows the overall trend in the decrease of loans in the financial system. This result is consistent with the Financial Stability Report of NBU where it is mentioned that having high liquidity banks don't have incentives to provide loans with higher currency and default risk [8], [9].

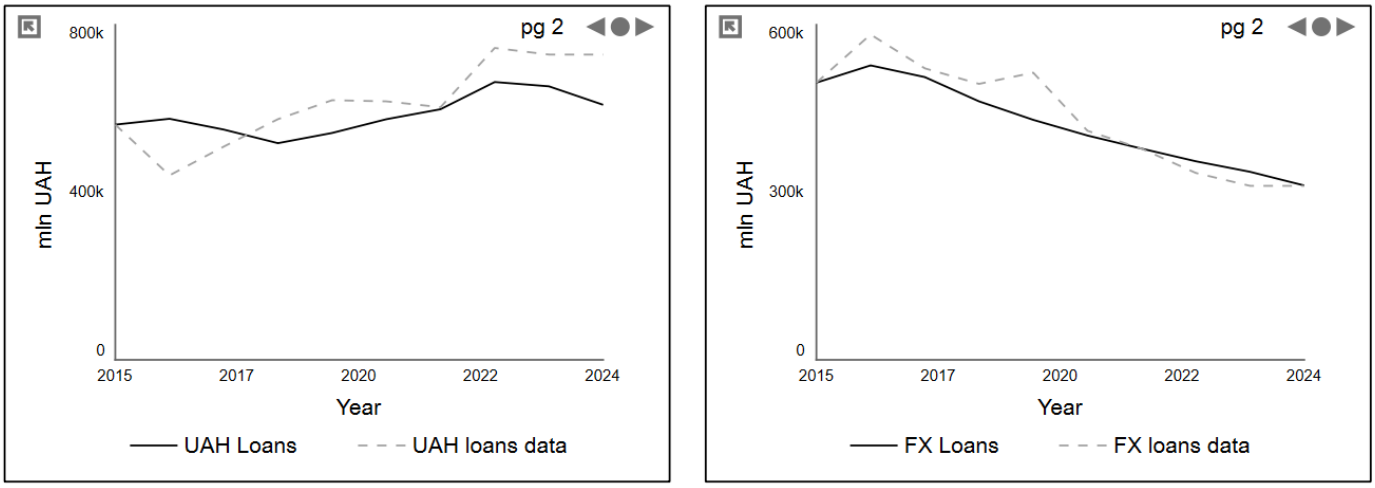


Figure 2.22. Loans simulation from 2015 till 2024

Source: developed by the author in Stella Architect

Loans dollarization, according to Figure 2.23, will stay on the same level. Even though FX loans are decreasing, overall lending is decreasing a bit faster. This outcome can be a result of the decrease in total lending demand from businesses and individuals, due to a decrease in their purchasing power and high uncertainty about their capabilities to fulfill debt obligations. Also, due to the decrease in foreign trade, and the decline in economic activity in general, the demand for foreign currency decreased as well. Hence the low level of loan dollarization would be explained through the overall decrease in demand for borrowings in both hryvnia and foreign currency.

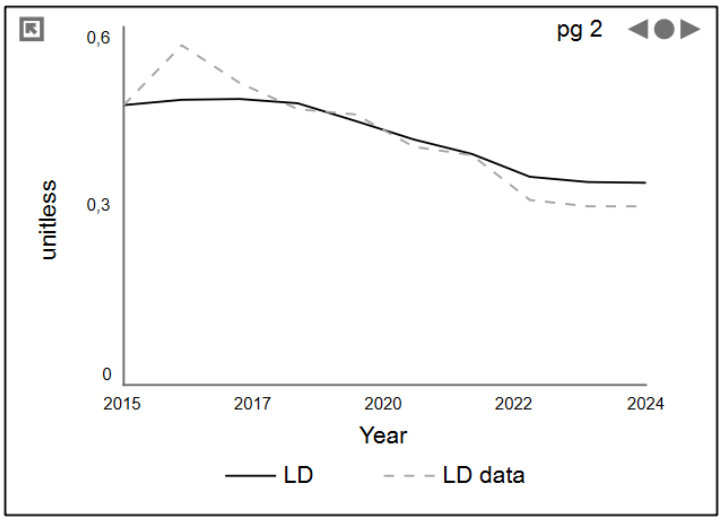


Figure 2.23. Loans dollarization simulation from 2015 till 2024

Source: developed by the author in Stella Architect

To sum up, the system dynamics approach appeared to be a useful tool for analyzing a complex system such as the banking sector. The iterative nature of the modeling process deepened the understanding of the interactions between different variables and feedback loops. The high accuracy of the simulation within the complexity of the system, as well as the possibility to observe both short-term and long-term effects of different policy choices, are the main advantages of the system dynamics approach. According to the results of the SD model, deposit dollarization will continue increasing, however, its growth will be moderate. At the same time loan dollarization will stay on the same level due to both decreases in overall demand for borrowings and banks' unwillingness to take on additional risks during the crisis period.

Conclusions to Chapter 2

In conclusion, the analyses presented in this chapter highlight the significance of deposit and loan dollarization in Ukraine's financial system, particularly during crisis years. The National Bank of Ukraine has implemented measures to address the risks associated with high levels of DD and LD such as the increase in the required reserves ratio [21]. At the same time, policies aimed at stabilizing the macroeconomic situation had an indirect effect on dollarization. Such policies include the increase of policy rate, currency restrictions, allowance to hold 50% of the required reserves in bonds, government credit support programs, etc.

Despite providing valuable insights into trends, statistical analysis should be supplemented by empirical ones using economic and mathematical techniques to fully understand the drivers and consequences of dollarization. A system of simultaneous equations and system dynamics approach were applied to explore the complex system, which is characterized by numerous interdependent relationships between macroeconomic variables, feedback loops, and non-linear dynamics.

The application of a system of simultaneous equations as a more advanced tool for econometric analysis resulted in accurate estimations and high forecast quality. However, such a system is highly dependent on assumptions about the future development of

exogenous variables. It is both an advantage and disadvantage of the model. From one point of view, the outcome of the results will largely depend on the quality of separately estimated models. This process may consume a lot of time and effort, and sometimes in crisis periods or periods with major structural changes, these forecasts may not fully disclose the actual relationships between variables due to the weakening of monetary transmission channels. But on the other hand, it allows for testing different scenarios and hypotheses about future outcomes.

Another approach applied to understand financial dollarization from the perspective of banks was System Dynamics. The model described hypotheses about both formation of demand for investing in deposits and for borrowing funds, how the macroeconomic situation affects economic agents' decisions, and banks' perception of potential risks. It also included the analysis of how banks determine their interest rates and what effect policy rate has on them. It also strived to estimate the effect of currency restrictions implemented in February 2022 on investing demand. Overall, the analysis underscores the need for continued vigilance and proactive measures to mitigate the risks associated with high levels of deposit and loan dollarization in Ukraine's banking system.

CHAPTER 3
RECOMMENDATIONS AND POLICY ANALYSIS FOR DECREASING FINANCIAL DOLLARIZATION IN UKRAINE

3.1 Defining leverage points for de-dollarization policies

As countries around the world seek to reduce their dependence on foreign currencies, de-dollarization has become a popular policy objective. While the benefits of reducing the share of foreign currency deposits and loans are well-known, the process of achieving this goal can be challenging. One of the key questions policymakers face is identifying the most effective leverage points for implementing de-dollarization policies. The term "leverage points" refers to the areas where a small change can have a significant impact on the entire system. In the context of de-dollarization, these are the areas where policy interventions can have the most significant effect on reducing the dollarization level of the economy.

By understanding the various leverage points available to policymakers, effective de-dollarization strategies can be formed to contribute to greater financial stability and sustainable economic growth.

The framework for identifying leverage points and de-dollarization policies in Ukraine is presented in Figure 3.1.

Figure 3.1. Framework for identifying most effective policies for affecting financial dollarization in Ukraine

Source: developed by the author

Regulatory policies aim to influence banks' lending and deposit-taking behavior, while macroeconomic policies impact both banks' and customers' decisions. In addition, interventions aimed at improving financial literacy and education, promoting the use of local currency, and enhancing the availability and quality of financial services can also contribute to reducing dollarization.

In addition, as was shown in the empirical analysis in Chapter 2, these leverage points are interrelated, and a combination of policies may be required to effectively reduce dollarization.

Based on the framework for the analysis of dollarization in Figure 3.1, several leverage points that can be used to affect dollarization are defined in Table 3.1.

Table 3.1. Leverage points to affect dollarization

De-dollarization policy	Description
Monetary policy	Central banks can use monetary policy to affect the demand for foreign currency loans and deposits. By increasing interest rates, the central bank can make local currency deposits and loans more attractive, thereby reducing the demand for foreign currency deposits and loans. As seen from the SD model in the previous chapter, generally hryvnia loans and deposits rates are more sensitive to changes in the policy rate.
Exchange rate policy	Exchange rate policy can affect dollarization by influencing the relative attractiveness of local and foreign currency deposits and loans. If the exchange rate is stable and predictable, it may reduce the demand for foreign currency deposits and loans. A developed system of simultaneous equations has shown the importance of both exchange rate and their volatility for changes in dollarization.
Prudential regulations	Prudential regulations can be used to reduce the risks associated with foreign currency loans and deposits. For example, banks may be required to hold more capital against foreign currency loans, which would make such loans less profitable and reduce the demand for them.
Financial education	Improving financial literacy can reduce the demand for foreign currency loans and deposits by making individuals and businesses more aware of the risks associated with such transactions. This can be done through public education campaigns, financial literacy courses, and other similar initiatives. NBU's communication strategy is very important for anchoring expectations, and increasing the credibility of the institution, and hence its actions.

Source: developed by the author

All of the mentioned above policies and respective leverage points proved to be somewhat successful both in Ukraine and other countries. Now since the potential leverage points for de-dollarization policies have been identified, the next step is to consider how

these policies can be effectively implemented. In this regard, it is useful to draw on the experiences of other countries that have implemented de-dollarization policies in the past. By examining the successes and failures of these policies, valuable insights into what works and what does not can be gained.

3.2 Recommendations for the policymakers with the use of best international practices

In the previous part, the leverage points that policymakers can use to reduce dollarization in the banking system were discussed. Now, it is important to turn the attention to specific recommendations for policymakers based on best international practices. While there is no one-size-fits-all approach to de-dollarization, examining successful experiences from other countries can provide valuable insights for policymakers in Ukraine. This part will explore various policy options and strategies that have been implemented in other countries to reduce dollarization and promote the use of local currency. The strengths and weaknesses of these policies will be examined and lessons that can be applied to the Ukrainian context will be formed. Ultimately, the goal of this part is to provide policymakers with a range of tools and strategies to effectively tackle the issue of dollarization and promote financial stability and development.

Ukraine can take several countries as a reference for successful de-dollarization policies and tools (see Table 3.2).

Table 3.2. Successful de-dollarization practices

Country	Years	Results	Policies and tools
Kazakhstan	2010-now	The fastest rate of credit de-dollarization in the CCA region – from 67% in 2010 to 34% in 2021. LD decreased faster than DD.	Inflation targeting, increase in liquidity coverage ratios for FX obligations, long-term domestic capital market development.

Continuation of the Table 3.2.

Country	Years	Results	Policies and tools
Israel	1990-2004	DD largely and permanently decreased from 50% in the early 1980s to 15% in 2004.	Deepening the market for local currency denominated government bonds, inflation targeting.
Peru	2005-2019	LD decreased from around 80% in 2000 to 27,7% in 2015.	Limitations on the availability of FX deposits, inflation targeting, counter-cyclical reserve requirements.

Source: [1], [5], [20]

Kazakhstan has been implementing de-dollarization policies since 2013 to reduce the share of foreign currency deposits to 30% by 2020. According to the National Bank of Kazakhstan, deposit dollarization dropped from 70% at the end of 2015 to 36% in December 2021 [20]. Similarly to Ukraine, Kazakstan officially adopted inflation targeting as its monetary policy framework in 2016, following a period of floating exchange rates. The National Bank of Kazakhstan has implemented several measures to encourage the use of the national currency, including lowering interest rates on foreign currency deposits, introducing preferential lending rates for borrowers in tenge, and requiring banks to maintain a certain ratio of tenge deposits to foreign currency deposits [20]. The country considers macroeconomic stability as the key factor for de-dollarization.

Another successful example is Israel. The period of dollarization in Israel started around 1990 and it was the first emerging country to have introduced inflation-targeting [1]. Israel is an example of how the provision of alternatives to dollar-denominated assets helped to reduce dollarization by promoting national currency bonds. The Bank of Israel has implemented measures to encourage the use of shekels in international trade and to increase the availability of shekel-denominated financial instruments. These measures have included the establishment of shekel clearing arrangements with other countries, the issuance of government bonds in shekels, and the expansion of the domestic corporate bond market.

The combination of the promotion of government bonds and the period of disinflation reduced investors' uncertainty about local currency assets [1, p.23]. In 2014, the Bank of Israel introduced regulations to limit foreign currency mortgage lending to homebuyers, to reduce the risks associated with exchange rate fluctuations. The regulations required banks to maintain higher capital reserves for foreign currency mortgages and to offer homebuyers the option of taking out a mortgage in shekels instead of dollars.

Peru has also been implementing de-dollarization policies in recent years, including requiring banks to maintain a certain level of local currency reserves and implementing tax breaks for companies that borrow in local currency. The central bank has also been gradually lowering interest rates on local currency deposits and raising interest rates on foreign currency deposits. Its experience can be characterized as the interaction between monetary and macro-prudential policy [6, p.29]. The central banks directly reduced vulnerabilities such as loan dollarization through the use of supplementary reserve requirements to enable traditional monetary policy to effectively fulfill its role [6, p.29].

There are various policies and strategies implemented by different countries to reduce dollarization in their respective banking systems. However, it is difficult to estimate the effectiveness of any particular instrument in isolation since dollarization is a complex issue that needs to be tackled from multiple angles. From the examples discussed above, it is evident that the common denominator for successful de-dollarization is the achievement of economic stability, low inflation, and a stable exchange rate. It is only when these conditions are met that policymakers can effectively implement policies such as reserve requirements, interest rate differentials, and macroeconomic policies to reduce dollarization. Therefore, policymakers need to focus on maintaining a stable economic environment and addressing the root causes of dollarization rather than relying on individual policies in isolation.

The suggested strategy for the de-dollarization of the Ukrainian financial sector can be summed up in the steps presented in Figure 3.2.

IT	Financial market deepening	Administrative measures
• Inflation targeting proved to be effective for de-dollarization both in Ukraine and other countries. • Interest rate, inflation expectations and exchange rate channels are the strongest ones when conducting monetary policy in Ukraine, and have both direct and indirect affects on macroecnomic stability, hence the use of local currency,	• Increase the accessibility of government bonds denominated in hryvnia through technological improvements, simplificartion of investors' experience. • Increase the awareness among the population through marketing campaigns, educationall programs, seminars, and online resources. • Alternative hedging instruments, such as newly introduced instrument of the NBU for the protection of hryvnia savings from exchange rate fluctuations.	• Limitations on operations with foreign currency during martial law. • Higher reserve requirements on FX.

Figure 3.2. De-dollarization strategy for Ukraine

Source: developed by the author

Looking back at the experience of NBU in managing dollarization, inflation targeting played a crucial role in anchoring people’s expectations and maintaining a stable macroeconomic environment. However, maintaining a low level of dollarization during a period of war requires a comprehensive approach that includes a combination of macroeconomic and microeconomic policies. The NBU can take several steps to promote the use of the national currency and reduce dollarization in the banking system. These measures may include implementing monetary policy tools, such as interest rate differentials, reserve requirements, and capital adequacy ratios, to incentivize the use of

local currency. The NBU may also consider introducing measures to reduce foreign currency lending, such as limiting the availability of foreign currency loans or implementing stricter collateral requirements for such loans. Additionally, the NBU can work to improve financial literacy and education, increase public awareness of the risks associated with dollarization, and promote the benefits of using local currency. Finally, the NBU needs to maintain a stable macroeconomic environment characterized by low inflation and a stable exchange rate, which are critical factors in reducing dollarization.

Israel's experience in promoting national currency bonds may be a good reference for how the deepening of the financial market can affect dollarization. Currently, the fraction of bonds in possession of individuals is very low, hence there is potential in attracting Ukrainians into buying bonds.

Ukraine can promote government bonds among individuals through various measures. One effective way is by improving financial literacy and education among the population, particularly regarding investing in government bonds. This can be achieved through public awareness campaigns, educational seminars, and online resources. Another way is by offering attractive interest rates on government bonds compared to other investment options, which can incentivize individuals to invest in bonds. Additionally, the government can simplify the process of buying and selling government bonds, making it easier for individuals to access the market. Since income from bonds is tax-free in contrast to deposits, this tax incentive should be highlighted for investors. Such campaigns like military support bonds appeared to be also effective in attracting people to invest in hryvnia bonds.

Another potential instrument to be used after the crisis period is over is dollar-indexed deposits and inflation-indexed bonds. These instruments have been also adopted in Israel in complex with other prudential rules, that would ensure that banks met the prudential requirements such as open position limits [15, p.16-17]. Dollar-indexed deposits are a type of financial instrument where the interest rate and principal are denominated in local currency but linked to the exchange rate of the US dollar. These deposits can affect dollarization by providing a way for individuals and businesses to obtain exposure to US dollars without actually holding dollars. Dollar-indexed deposits can be seen as a substitute

for holding US dollar deposits, which can contribute to reducing dollarization in the banking system. However, the impact of dollar-indexed deposits on dollarization depends on how they are designed and implemented. If these deposits are not properly regulated, they can potentially increase dollarization by providing a way for individuals and businesses to access US dollars while still avoiding regulatory controls. Therefore, policymakers need to carefully consider the potential benefits and risks of dollar-indexed deposits and design appropriate regulatory frameworks to ensure that they contribute to sustainably reducing dollarization.

A similar logic is applied to the instrument that NBU introduced at the end of 2022 as an additional tool for the protection of hryvnia savings from exchange rate fluctuations while also helping to preserve its international reserves. With this new instrument, individuals can buy US dollars at the official exchange rate, make a term FX deposit with a bank, and withdraw the deposit by selling the dollars back to the bank for hryvnias after it matures. There will be no limits on the number or size of deposits per client. The banks can buy an amount of US dollars equal to the volume of such deposit transactions and deposit the purchased foreign currency into a separate account with the NBU. The NBU will charge interest on the FX balance in the respective separate account with the NBU, to be paid in hryvnias. This tool is expected to reduce demand for FX cash, stabilize expectations, and ease exchange rate pressure in the cash segment of the FX market. It will also incentivize banks to compete for hryvnia deposits and improve the monetary transmission mechanism [22].

To sum up, NBU conducts a very effective monetary and macroprudential policy that allows for managing dollarization. The experience of other countries indicates that macroeconomic stability should be the key objective, without which any additional policies targeted at de-dollarization won’t be fully realized. The deepening of the financial market should be the main strategy to de-dollarize the economy. Easier access and promotion of hryvnia instruments, in particular popularization of hryvnia-denominated deposits and bonds, should be the priority for the NBU and Ministry of Finance. Ensuring macroeconomic stability will keep dollarization on a relatively low level, however, to

decrease its incentives for both banks and individuals and business entities should be provided.

Conclusions to Chapter 3

In conclusion, de-dollarization policies and strategies have been implemented by many countries to reduce dollarization in their banking systems. Identifying and utilizing leverage points such as regulatory policies, macroeconomic policies, financial literacy, and availability of financial services can contribute to reducing dollarization. However, the effectiveness of any particular instrument may depend on the specific circumstances of each country and should be considered in a complex manner. International experience has shown that economic stability, low inflation, and a stable exchange rate are key factors in reducing dollarization. In addition, innovative tools such as dollar-indexed deposits and government bond promotion among individuals can also contribute to reducing dollarization. Policymakers can learn from best international practices to develop effective de-dollarization policies tailored to their specific needs and circumstances. By working to reduce dollarization, countries can improve financial stability, promote the use of local currency, and enhance the effectiveness of the traditional monetary policy.

In addition, the NBU's introduction of a new tool in 2022 to protect hryvnia savings from exchange rate fluctuations and preserve international reserves is a promising step in managing dollarization. However, as seen from the experiences of other countries, achieving macroeconomic stability is key to successful de-dollarization policies. Deepening the financial market, promoting hryvnia-denominated instruments, and providing incentives for both banks and individuals/businesses to use hryvnia are important strategies for reducing dollarization. The NBU's effective implementation of monetary and macroprudential policies will be critical to achieving these goals and maintaining a relatively low level of dollarization in the long run.

CONCLUSIONS

In this thesis analysis on the loan and deposit dollarization in Ukraine was conducted. Chapter 1 introduced different approaches to measure financial dollarization. FD issue is complex and can be analyzed from different perspectives. Main methods of assessing FD are currency composition view, currency substitution view, and dollarization index. The overall dollarization of economy is difficult to measure due to limited control over cash transactions, it can be classified also between financial dollarization and real dollarization, which covers the use of foreign currencies by the real sector in forms of wages nominated in foreign currency, rents, and consumption, etc. Deposit and loan dollarization serves as a pretty accurate proxy for analysis of financial dollarization. Conducted analysis of the available literature revealed high emphasis on deposit dollarization, especially in terms of undeveloped financial markets.

Ize and Yeyati reated the basis for analysis of financial dollarization, introducing portfolio allocation theory [12]. This framework was vastly developed by other scientists such as Urosevic and Rajkovic [26]. The main hypotheses developed under this framework revolves around currency substitution view, meaning that in anticipation of fluctuations in inflation and exchange rates, investors or borrowers would opt for more stable currency.

Using the same framework, Khvedchuk et al. determined natural level of dollarization to be approximately 10-20% [13, p.43].

Many researchers also claim that institutional factors play a vital part in dollarization trends. Economic instability, low credibility to policymakers, and banking crises are viewed as inhibiting factors that limit the effects from conducted monetary policy or implemented administrative regulations.

Another finding is that financial market deepening with broader range of national currency instruments is expected to steadily decrease dollarization to its natural level.

Alvarez-Plata and Garcia-Herrero suggested market-based and administrative-based de-dollarization strategies [1]. Primarily, administrative-based strategy represents macro

and microprudential regulation of the banking system, while market-based strategy is aimed at overall stable economic environment, that would incentivize the usage of national currency.

While analyzing financial dollarization dynamics and structure in Ukraine, the following conclusions have been made:

a) Crisis years have typically been followed by the rapid increase in dollarization;

b) Since the introduction of inflation-targeting, both DD and LD have decreased, mostly due to anchored expectations, interventions of the NBU, moderate inflation rates, and higher credibility to actions of NBU;

c) Since the beginning of full-scale invasion, NBU introduced a series of measures targeted both to preserve financial stability, and record low dollarization ratios;

d) The highest levels of LD are observed among state-owned banks, which can be explained by foreign economic activities services orientation of banks.

System of simultaneous equations has been developed to analyze the influence of macroeconomic indicators on deposit and loan dollarization. The specified system of simultaneous equations comprises five main endogenous variables, including the consumer price index, exchange rate, key policy rate, and deposit and loan dollarization ratios, along with several exogenous variables such as the CPI of the main trading partners, official exchange rate, international reserves, and more. Additionally, the model incorporates lagged variables to account for delays in the system and allows for the inclusion of the transmission of macroeconomic variables and monetary instruments' effects on financial dollarization. By accounting for these factors, the model can provide a comprehensive analysis of the causes and consequences of financial dollarization.

Scenario analysis for alternative optimistic and pessimistic assumptions have been conducted. The baseline scenario forecast appeared to be rather pessimistic, because it already accounts for unfavorable macroeconomic situation and high risks. In the pessimistic scenario, deposit dollarization (DD) increases more rapidly, reaching 43.2% by Q4 2023, whereas under the baseline scenario, it reaches 43%. Conversely, the optimistic scenario portrays a smoother path, with DD reaching 41.7% by the end of 2023. Notably, all scenarios depict a bleak macroeconomic environment compared to pre-war levels, indicating that

altering the assumptions regarding macroeconomic variables may not have an immediate or significant impact on the system. Moreover, changes in deposit rate differentials could potentially influence the scenarios. However, the current banking system exhibits high liquidity, and with reduced lending trends, banks lack an incentive to increase deposit rates on hryvnia instruments, while FX deposit rates are already very low. Thus, incorporating such assumptions in any of the alternative scenarios may lead to unrealistic outcomes. Loan dollarization is found to be more responsive to changes in assumptions and macroeconomic situation, in contrast to deposit dollarization. The baseline scenario already considers unfavorable economic conditions, resulting in a similar trend for both baseline and pessimistic scenarios. The highest increase in LD is observed in 4Q 2022, after which it gradually rises to 44.5% and 42.2% under pessimistic and baseline scenarios, respectively, by the end of 2023. The optimistic scenario shows a gradual increase throughout the forecast period, with no sharp increase observed by the end of 2022, and reaches 38.4% by the end of 2023.

System dynamics approach has been applied to capture the complex feedback loops and non-linear dynamics. The advantage of SD model is that it allows to find leverage points in the system, and to test resilience of the system to different policies. In contrast to system of simultaneous equations, more variables, such as deposit and loan rates have been endogenized. It also includes hypotheses on how investors demand for deposits is formed and how it distributes among foreign currency and hryvnia deposits. Similarly, it covers how the need for borrowings is formed and how banks set the approval rate on loans based on estimated default risk. The results of the simulation indicate that deposit rate will keep increasing in 2023 and will reach around 41% which is consistent with development of DD under system of simultaneous equations. LD in its turn is expected to stay at the same level as a response to overall high credit risk and both reluctance of banks to caring extra risks during crisis period and cautious of borrowers in regards to higher borrowing costs and accordingly debt service.

Chapter 3 concluded findings from Chapter 1 and Chapter 2 into framework for identifying most effective policies for affecting financial dollarization in Ukraine.

International experience indicates that stable macroeconomic environment, successful inflation targeting is the common denominator in persistently decreasing dollarization.

De-dollarization strategy for Ukraine has been developed with the focus on the following three pillars: inflation-targeting, financial market deepening, and administrative measures. In conclusion, the experience of the NBU has demonstrated that maintaining a low level of dollarization during a period of war requires a comprehensive approach that includes macroeconomic and microeconomic policies. The use of inflation targeting has been critical in anchoring people's expectations and maintaining a stable macroeconomic environment. The NBU can take several steps to promote the use of the national currency and reduce dollarization in the banking system, including implementing monetary policy tools, reducing foreign currency lending, improving financial literacy, and promoting the benefits of using local currency. Israel's experience in promoting national currency bonds can serve as a good reference for Ukraine in deepening the financial market and reducing dollarization. Promoting government bonds among individuals through measures such as public awareness campaigns, offering attractive interest rates, and simplifying the process of buying and selling bonds can incentivize individuals to invest in hryvnia bonds. The government can also highlight the tax incentives for investing in bonds compared to deposits. Overall, reducing dollarization requires a concerted effort from the government, the central bank, and the public.

REFERENCES

1. Alvarez-Plata P., Garcia-Herrero A. To Dollarize or De-Dollarize: Consequences for Monetary Policy. *BVA Working Paper*. 2008. № 0921.

2. Asel I. Financial sector development and dollarization in the economies of Central Asia. Final Report for Grant No. PPC IX-69. Global Development Network Regional Research, Global Development Network. Washington, 2010.

3. Banking Sector Review. August 2022. URL: https://bank.gov.ua/en/news/all/oglyad-bankivskogo-sektoru-serpen-2022-roku (accessed on 08.04.2023).

4. Bannister G.J., Gardberg M., Turunen J. Dollarization and Financial Development. *IMF Working Paper*. 2018. № 2018/200.

5. Cakir S., Atamanchuk M., AL-Riyami M., Sharashidze N., Reyes N. Reducing Dollarization in the Caucasus and Central Asia. *IMF Working Paper.* 2022. № 2022/154.

6. Castillo P., Vega H., Serrano E., Burga C. De-dollarization of credit in Peru: the role of unconventional monetary policy tools. *Banco Central de Reserva del Perú*. 2016. № 2016-002.

7. De Nicoló G., Honohan P., Ize A. Dollarization of bank deposits: Causes and consequences. *Journal of banking & finance*. 2005. № 29.7.P. 1697-1727.

8. Financial Stability Report. December 2022. URL: https://bank.gov.ua/en/news/all/zvit-pro-finansovu-stabilnist-gruden-2022-roku (accessed on 08.04.2023).

9. Financial Stability Report. June 2022. URL: https://bank.gov.ua/en/news/all/zvit-pro-finansovu-stabilnist-cherven-2022-roku (accessed on 08.04.2023).

10. Grui A., Vdovychenko A. Quarterly projection model for Ukraine. *NBU Working Papers.* 2019. № 03/2019.

11. Inflation Report. January 2023. URL: https://bank.gov.ua/en/news/all/inflyatsiyniy-zvit-sichen-2023-roku (accessed on 08.04.2023).

12. Ize A., Yeyati E.L. Financial dollarization. *Journal of International Economics*. 2003. № 59.2. P. 323-347.

13. Khvedchuk K., Sinichenko V., Topf B. Estimating a natural level of financial dollarization in Ukraine. *Visnyk of the National Bank of Ukraine*. 2019. № 247. P. 38-44.

14. Kishor N.K., Neanidis K.C. What is driving financial dollarization in transition economies? A dynamic factor analysis. *Macroeconomic Dynamics*. 2015. № 19.4. P. 816-835.

15. Kokenyne A., Ley J., Veyrune R. Dedollarization. *IMF Working Paper*. 2010. № 10/188.

16. Leiderman L., Maino R., Parrado E. Inflation targeting in dollarized economies. *Palgrave Macmillan UK*. 2006. P. 99-114.

17. Lukianenko I.G., Nasachenko M.Y. Stages of building a generalized macroeconomic simulative model of the Ukrainian economy taking into account the level of shading: instructional materials. Kyiv, 2019. 115 p.

18. Macroprudential Policy Strategy of the National Bank of Ukraine. 2020. URL: https://bank.gov.ua/ua/news/all/strategiya-makroprudentsiynoyi-politiki-natsionalnogo-banku-ukrayini (accessed on 08.04.2023).

19. Morley J.C. The two interpretations of the Beveridge–Nelson decomposition. *Macroeconomic Dynamics.* 2011. № 15.3. P. 419-439.

20. National Bank of Kazakhstan. 2023. URL: https://nationalbank.kz/en/news/press-relizy/14758 (accessed on: 08.04.2023).

21. National Bank of Ukraine. 2023. URL: https://bank.gov.ua/ (accessed on: 08.04.2023).

22. NBU Introduces Additional Tool to Protect Households' Hryvnia Savings from Exchange Rate Fluctuations and Safeguard International Reserves. 2022. URL: https://bank.gov.ua/en/news/all/nbu-zaprovadjuye-dodatkoviy-instrument-dlya-zahistu-

grivnevih-zaoschadjen-gromadyan-vid-riziku-kursovih-kolivan-i-dlya-zberejennya-mijnarodnih-rezerviv (accessed on 08.04.2023).

23. Neanidis K.C., Savva C.S. Financial dollarization: Short-run determinants in transition economies. *Journal of Banking & Finance*. 2009. № 33.10. P. 1860-1873.

24. Savastano M.A. Dollarization in Latin America: Recent evidence and some policy issues. *IMF Working Papers.* 1996. № 1996.004.

25. Tufaner M.B. The Determinants of Dollarization in Turkey: An Econometric Analysis. *Econder International Academic Journal*. 2021. № 5.2. P. 108-118.

26. Urosevic B., Rajkovic I. Dollarization of deposits in the short and long run: Evidence from CESE countries. *Panoeconomicus.* 2017. № 64(1). P. 31-44.

27. Vega M. Monetary policy, financial dollarization and agency costs. *Banco Central de Reserva del Perú.* 2015. № 2015-019.

28. Yeyati E.L. Financial dollarization: evaluating the consequences. *economic Policy*. 2006. № 21.45. P. 62-118.

Annex A

Variables description

Table A.1. Model variables detailed information

Variable code	Name	Units	Source
Endogenous variables			
CPI	Consumer price index, to December of previous year	%	NBU
ER_MARKET	Exchange rate UAH to USD on the market	UAH/USD	NBU
KEY_R	Policy rate of NBU	%	NBU
DD	A fraction of deposits of residents in foreign currency		Own calculations based on NBU
LD	A fraction of loans of residents in foreign currency		Own calculations based on NBU
Exogenous variables			
PCPI	Weighted CPI of countries main trade partners: China, Poland, Turkey, Spain, Italy, Netherlands, Egypt, India, Germany, Romania, the USA, Slovakia, Hungary, Austria, Chzech Repuplic	%	inflation.eu, Trading Economics
INR_RESERV	International reserves	mln USD	NBU, ARIMA(5,1,6)
ER_OFF	Official exchange rate of UAH to USD	UAH/USD	NBU
DEBT_TO_GDP	Government debt to real GDP		NBU, Ministry of Finance, ARIMA(4,1,4)
NX	Net export	mln USD	NBU
GDP_GAP	GDP gap		Kalman filter based on NBU data
CPI_TARGET	Inflation target	%	NBU

Continuation of the Table A.1.

Variable code	Name	Units	Source
NR	Neutral real discount rate	%	NBU, ARIMA(7,1,7)
DUMMY1	Generated binary variable, where 1 - absolute change of policy rate >=0.19, and 0 - absolute change of policy rate <0.19		Own estimations
DUMMY2	Generated binary variable, where 1 - absolute change of exchange rate >=0.06, and 0 - absolute change of exchange rate <0.06		Own estimations
CREDIT_TO_ BUSINESS	Loans to the corporate sector	mln UAH	NBU, ARIMA (4,1,7)
DEPOSIT_RATE_ DIFFERENTIAL	Spread between deposit rates in UAH and USD	%	NBU, ARIMA(1,1,6) for FX deposit rates, ARIMA(7,1,6) for hryvnia deposit rates
ER_MARKET_VOL	Volatility of exchange rate of UAH to USD		GARCH(1,1)
CPI_MARKET_VOL	Volatility of consumer price index		GARCH(1,1)

Source: developed by the author

Annex B

Testing equation CPI for compliance with classical assumptions

Table B.1. CPI equation specification

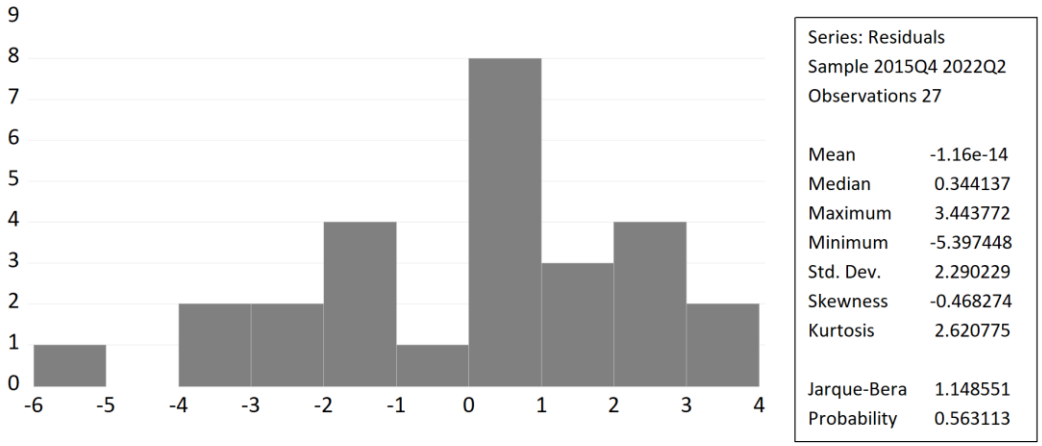
Dependent Variable: CPI
Method: Least Squares
Date: 03/13/23 Time: 17:04
Sample (adjusted): 2015Q4 2022Q2
Included observations: 27 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	36.74307	21.07275	1.743630	0.0958
D(KEY_R(-6))	-0.822357	0.247024	-3.329057	0.0032
D(LOG(ER_MARKET(-3)))	95.65622	6.610097	14.47123	0.0000
PCPI(-1)	2.168830	0.340846	6.363070	0.0000
CPI(-4)	0.160852	0.068382	2.352276	0.0285
LOG(INR_RESERV(-7))	-4.300905	2.209546	-1.946511	0.0651

R-squared	0.921892	Mean dependent var	7.533333
Adjusted R-squared	0.903295	S.D. dependent var	8.194651
S.E. of regression	2.548332	Akaike info criterion	4.901885
Sum squared resid	136.3739	Schwarz criterion	5.189849
Log likelihood	-60.17545	Hannan-Quinn criter.	4.987512
F-statistic	49.57152	Durbin-Watson stat	2.152990
Prob(F-statistic)	0.000000		

Source: estimated by the author in EViews 12

Table B.2. Results on Jarque-Bera test for normal distribution



Source: estimated by the author in EViews 12

Table B.3. Results on White Test for absence of heteroskedasticity

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	0.389051	Prob. F(20,6)	0.9480
Obs*R-squared	15.24470	Prob. Chi-Square(20)	0.7622
Scaled explained SS	7.473479	Prob. Chi-Square(20)	0.9948

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/19/23 Time: 16:51
Sample: 2015Q4 2022Q2
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-7024.276	11702.11	-0.600257	0.5703
D(KEY_R(-6))^2	0.283361	1.027608	0.275748	0.7920
D(KEY_R(-6))*D(LOG(ER_MARKET(-3)))	69.89213	54.72850	1.277070	0.2488
D(KEY_R(-6))*PCPI(-1)	0.521772	2.347902	0.222229	0.8315
D(KEY_R(-6))*CPI(-4)	0.042389	0.439675	0.096410	0.9263
D(KEY_R(-6))*LOG(INR_RESERV(-7))	2.323345	9.838874	0.236139	0.8212
D(KEY_R(-6))	-25.62524	101.0108	-0.253688	0.8082
D(LOG(ER_MARKET(-3)))^2	835.9265	1744.869	0.479077	0.6488
D(LOG(ER_MARKET(-3)))*PCPI(-1)	94.15476	138.6923	0.678875	0.5225
D(LOG(ER_MARKET(-3)))*CPI(-4)	-24.93140	27.09515	-0.920143	0.3930
D(LOG(ER_MARKET(-3)))*LOG(INR_R...	-756.9240	669.8638	-1.129967	0.3016
D(LOG(ER_MARKET(-3)))	7238.335	6677.748	1.083949	0.3200
PCPI(-1)^2	-0.636758	1.747804	-0.364319	0.7281
PCPI(-1)*CPI(-4)	0.350696	1.101559	0.318363	0.7610
PCPI(-1)*LOG(INR_RESERV(-7))	20.06859	32.47239	0.618020	0.5593
PCPI(-1)	-195.9574	312.3154	-0.627434	0.5535
CPI(-4)^2	0.033764	0.073129	0.461702	0.6606
CPI(-4)*LOG(INR_RESERV(-7))	0.696453	4.937724	0.141047	0.8924
CPI(-4)	-8.845690	52.85861	-0.167346	0.8726
LOG(INR_RESERV(-7))^2	-81.33214	136.7310	-0.594833	0.5737
LOG(INR_RESERV(-7))	1515.608	2534.407	0.598013	0.5717

R-squared	0.564619	Mean dependent var	5.050885
Adjusted R-squared	-0.886653	S.D. dependent var	6.552758
S.E. of regression	9.000572	Akaike info criterion	7.283932
Sum squared resid	486.0618	Schwarz criterion	8.291805
Log likelihood	-77.33308	Hannan-Quinn criter.	7.583625
F-statistic	0.389051	Durbin-Watson stat	2.852623
Prob(F-statistic)	0.948043		

Source: estimated by the author in EViews 12

Table B.4. Results on Breusch-Godfrey LM test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 4 lags

F-statistic	0.108433	Prob. F(4,17)	0.9779
Obs*R-squared	0.671730	Prob. Chi-Square(4)	0.9548

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 03/19/23 Time: 16:52
Sample: 2015Q4 2022Q2
Included observations: 27
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.612066	23.56476	-0.068410	0.9463
D(KEY_R(-6))	-0.043373	0.281030	-0.154335	0.8792
D(LOG(ER_MARKET(-3)))	0.528260	7.375319	0.071625	0.9437
PCPI(-1)	-0.036678	0.388531	-0.094401	0.9259
CPI(-4)	0.005555	0.077650	0.071543	0.9438
LOG(INR_RESERV(-7))	0.171831	2.469779	0.069574	0.9453
RESID(-1)	-0.132799	0.253650	-0.523554	0.6073
RESID(-2)	-0.078799	0.252066	-0.312613	0.7584
RESID(-3)	-0.030593	0.269022	-0.113718	0.9108
RESID(-4)	-0.092905	0.270170	-0.343877	0.7352

R-squared	0.024879	Mean dependent var	-1.16E-14
Adjusted R-squared	-0.491362	S.D. dependent var	2.290229
S.E. of regression	2.796858	Akaike info criterion	5.172988
Sum squared resid	132.9811	Schwarz criterion	5.652927
Log likelihood	-59.83533	Hannan-Quinn criter.	5.315699
F-statistic	0.048192	Durbin-Watson stat	1.937236
Prob(F-statistic)	0.999966		

Source: estimated by the author in EViews 12

Table B.5. Results in VIF test for absence of multicollinearity

Variance Inflation Factors
Date: 03/19/23 Time: 16:53
Sample: 2014Q1 2022Q2
Included observations: 27

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	444.0608	1846.266	NA
D(KEY_R(-6))	0.061021	2.377503	2.377416
D(LOG(ER_MARKE...	43.69338	1.451383	1.354809
PCPI(-1)	0.116176	9.329088	1.688321
CPI(-4)	0.004676	5.158487	2.943405
LOG(INR_RESERV(...	4.882094	1916.738	1.871934

Source: estimated by the author in EViews 12

Table B.6. Reset-test results

Ramsey RESET Test
Equation: EQ_CPI4
Omitted Variables: Powers of fitted values from 2 to 5
Specification: CPI C D(KEY_R(-6)) D(LOG(ER_MARKET(-3))) PCPI(-1) CPI(-4) LOG(INR_RESERV(-7))

	Value	df	Probability
F-statistic	3.937497	(4, 17)	0.0193
Likelihood ratio	17.70361	4	0.0014

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	65.58436	4	16.39609
Restricted SSR	136.3739	21	6.493995
Unrestricted SSR	70.78953	17	4.164090

LR test summary:

	Value
Restricted LogL	-60.17545
Unrestricted LogL	-51.32364

Unrestricted Test Equation:
Dependent Variable: CPI
Method: Least Squares
Date: 03/19/23 Time: 16:56
Sample: 2015Q4 2022Q2
Included observations: 27

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	19.55730	26.53061	0.737160	0.4711
D(KEY_R(-6))	-0.531818	0.488374	-1.088956	0.2914
D(LOG(ER_MARKET(-3)))	31.45833	55.19789	0.569919	0.5762
PCPI(-1)	0.895487	1.299304	0.689205	0.5000
CPI(-4)	0.125456	0.105944	1.184170	0.2526
LOG(INR_RESERV(-7))	-2.065215	2.993400	-0.689923	0.4996
FITTED^2	0.015396	0.249620	0.061678	0.9515
FITTED^3	-0.000713	0.036614	-0.019487	0.9847
FITTED^4	0.000193	0.001917	0.100937	0.9208
FITTED^5	-4.32E-06	2.87E-05	-0.150860	0.8819

R-squared	0.959455	Mean dependent var	7.533333
Adjusted R-squared	0.937990	S.D. dependent var	8.194651
S.E. of regression	2.040610	Akaike info criterion	4.542492
Sum squared resid	70.78953	Schwarz criterion	5.022432
Log likelihood	-51.32364	Hannan-Quinn criter.	4.685203
F-statistic	44.69885	Durbin-Watson stat	2.162833
Prob(F-statistic)	0.000000		

Source: estimated by the author in EViews 12

Annex C

Testing equation of exchange rate for compliance with classical assumptions

Table C.1. Exchange rate equation specification

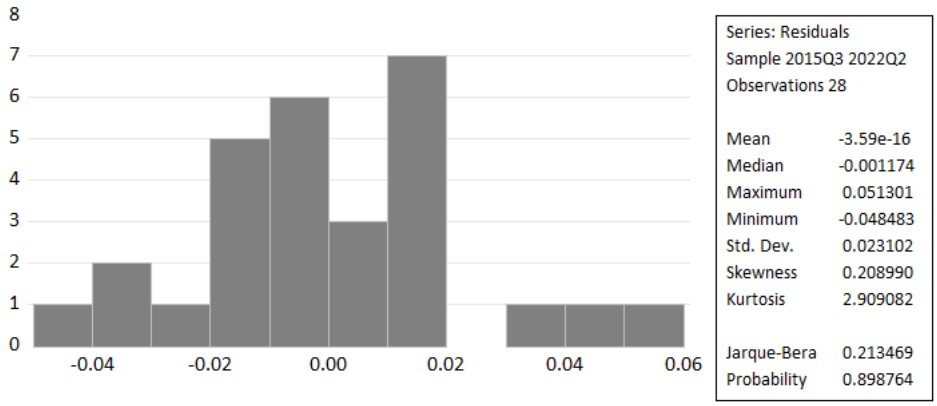
Dependent Variable: LOG(ER_MARKET)
Method: Least Squares
Date: 03/13/23 Time: 17:33
Sample (adjusted): 2015Q3 2022Q2
Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.091650	0.290821	-0.315143	0.7558
D(KEY_R(-1))*DUMMY1	-0.014689	0.005573	-2.635848	0.0155
D(KEY_R(-1))*(1-DUMMY1)	-0.005263	0.002266	-2.322358	0.0303
LOG(INR_RESERV(-6))	0.072960	0.018116	4.027393	0.0006
LOG(DEBT_TO_GDP)	0.162276	0.024130	6.725111	0.0000
LOG(ER_OFF(-1))	0.761703	0.082644	9.216631	0.0000
D(NX)	-9.21E-06	3.40E-06	-2.713236	0.0130

R-squared	0.888717	Mean dependent var	3.282396
Adjusted R-squared	0.856921	S.D. dependent var	0.069251
S.E. of regression	0.026195	Akaike info criterion	-4.234205
Sum squared resid	0.014409	Schwarz criterion	-3.901154
Log likelihood	66.27887	Hannan-Quinn criter.	-4.132388
F-statistic	27.95126	Durbin-Watson stat	2.143888
Prob(F-statistic)	0.000000		

Source: estimated by the author in EViews 12

Table C.2. Results on Jarque-Bera test for normal distribution



Source: estimated by the author in EViews 12

Table C.3. Results on White Test for absence of heteroskedasticity

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	0.725256	Prob. F(23,4)	0.7278
Obs*R-squared	22.58437	Prob. Chi-Square(23)	0.4852
Scaled explained SS	12.12621	Prob. Chi-Square(23)	0.9685

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/19/23 Time: 16:59
Sample: 2015Q3 2022Q2
Included observations: 28
Collinear test regressors dropped from specification

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.997820	2.030862	-0.491328	0.6489
D(KEY_R(-1))*DUMMY1^2	0.665670	2.332001	0.285450	0.7895
D(KEY_R(-1))*DUMMY1*LOG(INR_RE...	-0.242832	0.999885	-0.242860	0.8201
D(KEY_R(-1))*DUMMY1*LOG(DEBT_T...	0.050014	0.237854	0.210273	0.8437
D(KEY_R(-1))*DUMMY1*LOG(ER_OFF(...	0.518670	2.258589	0.229643	0.8296
D(KEY_R(-1))*(1-DUMMY1)^2	0.070419	0.080310	0.876841	0.4301
D(KEY_R(-1))*(1-DUMMY1)*LOG(INR_...	-0.002525	0.002708	-0.932484	0.4039
D(KEY_R(-1))*(1-DUMMY1)*LOG(DEBT...	-0.007373	0.008991	-0.820008	0.4583
D(KEY_R(-1))*(1-DUMMY1)*LOG(ER_...	-0.011779	0.014077	-0.836708	0.4498
D(KEY_R(-1))*(1-DUMMY1)*D(NX)	-1.09E-07	5.40E-07	-0.201186	0.8504
LOG(INR_RESERV(-6))^2	0.013237	0.009568	1.383443	0.2387
LOG(INR_RESERV(-6))*LOG(DEBT_T...	0.011761	0.011177	1.052293	0.3520
LOG(INR_RESERV(-6))*LOG(ER_OFF(-1))	-0.132085	0.080096	-1.649079	0.1745
LOG(INR_RESERV(-6))*D(NX)	1.32E-06	3.29E-06	0.402814	0.7077
LOG(INR_RESERV(-6))	0.159647	0.157546	1.013330	0.3682
LOG(DEBT_TO_GDP)^2	-0.004146	0.020266	-0.204589	0.8479
LOG(DEBT_TO_GDP)*LOG(ER_OFF(-1))	0.012330	0.088727	0.138968	0.8962
LOG(DEBT_TO_GDP)*D(NX)	6.05E-07	6.73E-06	0.089903	0.9327
LOG(DEBT_TO_GDP)	-0.151528	0.277879	-0.545301	0.6145
LOG(ER_OFF(-1))^2	0.170364	0.194556	0.875653	0.4307
LOG(ER_OFF(-1))*D(NX)	-8.45E-06	1.69E-05	-0.501720	0.6422
LOG(ER_OFF(-1))	0.175394	1.010004	0.173656	0.8706
D(NX)^2	1.37E-11	6.20E-10	0.022159	0.9834
D(NX)	1.46E-05	4.74E-05	0.307660	0.7737

R-squared	0.806585	Mean dependent var	0.000515
Adjusted R-squared	-0.305554	S.D. dependent var	0.000724
S.E. of regression	0.000827	Akaike info criterion	-11.58829
Sum squared resid	2.74E-06	Schwarz criterion	-10.44640
Log likelihood	186.2361	Hannan-Quinn criter.	-11.23921
F-statistic	0.725256	Durbin-Watson stat	2.683058
Prob(F-statistic)	0.727788		

Source: estimated by the author in EViews 12

Table C.4. Results on Breusch-Godfrey LM test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 4 lags

F-statistic	0.338930	Prob. F(4,17)	0.8479
Obs*R-squared	2.068030	Prob. Chi-Square(4)	0.7232

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 03/19/23 Time: 16:58
Sample: 2015Q3 2022Q2
Included observations: 28
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.063258	0.345833	-0.182914	0.8570
D(KEY_R(-1))*DUMMY1	0.001285	0.006932	0.185383	0.8551
D(KEY_R(-1))*(1-DUMMY1)	7.39E-05	0.002580	0.028642	0.9775
LOG(INR_RESERV(-6))	0.001469	0.019844	0.074033	0.9418
LOG(DEBT_TO_GDP)	-0.005348	0.031648	-0.168998	0.8678
LOG(ER_OFF(-1))	0.016812	0.101403	0.165789	0.8703
D(NX)	-7.40E-08	3.97E-06	-0.018656	0.9853
RESID(-1)	-0.137820	0.279683	-0.492773	0.6285
RESID(-2)	-0.273624	0.256978	-1.064775	0.3019
RESID(-3)	-0.134410	0.280749	-0.478756	0.6382
RESID(-4)	-0.074642	0.284312	-0.262535	0.7961

R-squared	0.073858	Mean dependent var	-3.59E-16
Adjusted R-squared	-0.470931	S.D. dependent var	0.023102
S.E. of regression	0.028018	Akaike info criterion	-4.025219
Sum squared resid	0.013345	Schwarz criterion	-3.501853
Log likelihood	67.35306	Hannan-Quinn criter.	-3.865220
F-statistic	0.135572	Durbin-Watson stat	2.061712
Prob(F-statistic)	0.998609		

Source: estimated by the author in EViews 12

Table C.5. Results in VIF test for absence of multicollinearity

Variance Inflation Factors
Date: 03/19/23 Time: 16:59
Sample: 2014Q1 2022Q2
Included observations: 28

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	0.084577	3451.314	NA
D(KEY_R(-1))*DUM...	3.11E-05	1.353839	1.248314
D(KEY_R(-1))*(1-D...	5.14E-06	1.110765	1.107638
LOG(INR_RESERV(...	0.000328	1269.284	1.304370
LOG(DEBT_TO_GDP)	0.000582	28.29692	1.387014
LOG(ER_OFF(-1))	0.006830	2966.817	1.381756
D(NX)	1.15E-11	1.158907	1.137278

Source: estimated by the author in EViews 12

Table C.6. Reset-test results

Ramsey RESET Test
Equation: EQ ER3
Omitted Variables: Squares of fitted values
Specification: LOG(ER_MARKET) C D(KEY_R(-1))*DUMMY1
D(KEY R(-1))*(1-DUMMY1) LOG(INR RESERV(-6))
LOG(DEBT_TO_GDP()) LOG(ER_OFF(-1)) D(NX())

	Value	df	Probability
t-statistic	0.359458	20	0.7230
F-statistic	0.129210	(1, 20)	0.7230
Likelihood ratio	0.180312	1	0.6711

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	9.25E-05	1	9.25E-05
Restricted SSR	0.014409	21	0.000686
Unrestricted SSR	0.014317	20	0.000716

LR test summary:

	Value
Restricted LogL	66.27887
Unrestricted LogL	66.36903

Unrestricted Test Equation:
Dependent Variable: LOG(ER_MARKET)
Method: Least Squares
Date: 03/19/23 Time: 17:00
Sample: 2015Q3 2022Q2
Included observations: 28

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.878302	11.04827	0.351033	0.7292
D(KEY_R(-1))*DUMMY1	0.018809	0.093363	0.201463	0.8424
D(KEY_R(-1))*(1-DUMMY1)	0.006230	0.032056	0.194341	0.8479
LOG(INR RESERV(-6))	-0.095875	0.470057	-0.203965	0.8404
LOG(DEBT_TO_GDP)	-0.213943	1.046917	-0.204355	0.8401
LOG(ER_OFF(-1))	-0.967457	4.811209	-0.201084	0.8427
D(NX)	1.28E-05	6.13E-05	0.208651	0.8368
FITTED^2	0.346005	0.962574	0.359458	0.7230

R-squared	0.889431	Mean dependent var	3.282396
Adjusted R-squared	0.850732	S.D. dependent var	0.069251
S.E. of regression	0.026755	Akaike info criterion	-4.169216
Sum squared resid	0.014317	Schwarz criterion	-3.788586
Log likelihood	66.36903	Hannan-Quinn criter.	-4.052854
F-statistic	22.98323	Durbin-Watson stat	2.140482
Prob(F-statistic)	0.000000		

Source: estimated by the author in EViews 12

Annex D

Testing equation of key policy rate for compliance with classical assumptions

Table D.1. Key policy rate equation specification

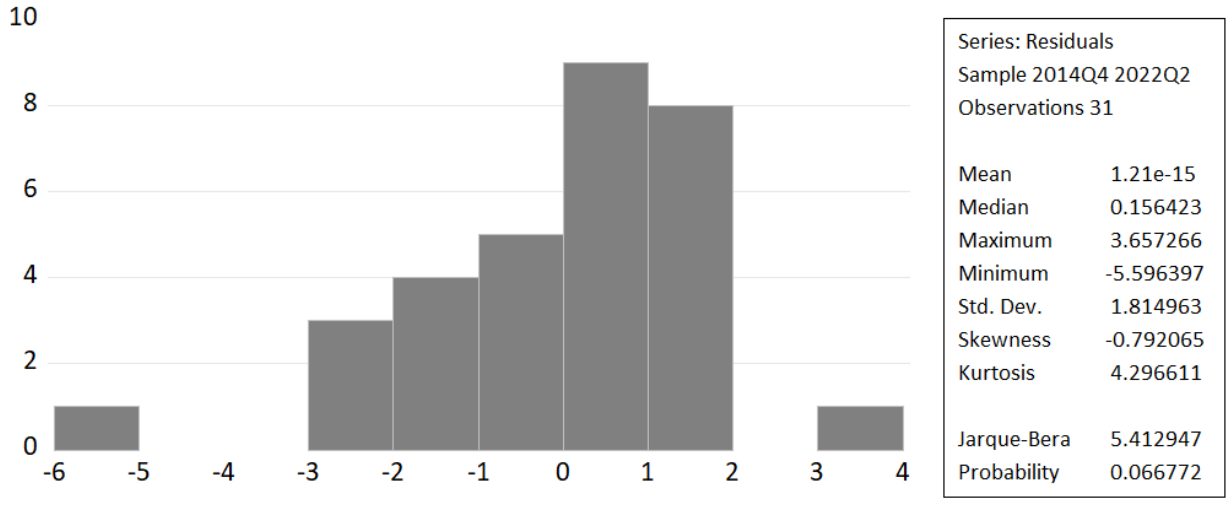
Dependent Variable: KEY_R
Method: Least Squares
Date: 03/13/23 Time: 10:54
Sample (adjusted): 2014Q4 2022Q2
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.265315	1.041962	2.174085	0.0398
KEY_R(-1)	0.762218	0.069595	10.95219	0.0000
D(GDP_GAP(-1))	-4.762721	2.974117	-1.601390	0.1224
CPI-CPI_TARGET	0.135609	0.056655	2.393578	0.0249
(D(ER_MARKET(-1)))*DUMMY2	3.190429	0.929859	3.431088	0.0022
(D(ER_MARKET(-1)))*(1-DUMMY2)	1.058359	0.255021	4.150084	0.0004
D(NR(-2))	-1.085822	0.377326	-2.877675	0.0083

R-squared	0.909809	Mean dependent var	15.06387
Adjusted R-squared	0.887262	S.D. dependent var	6.043477
S.E. of regression	2.029190	Akaike info criterion	4.448830
Sum squared resid	98.82272	Schwarz criterion	4.772634
Log likelihood	-61.95687	Hannan-Quinn criter.	4.554382
F-statistic	40.35046	Durbin-Watson stat	1.445408
Prob(F-statistic)	0.000000		

Source: estimated by the author in EViews 12

Table D.2. Results on Jarque-Bera test for normal distribution



Source: estimated by the author in EViews 12

Table D.3. Results on White Test for absence of heteroskedasticity

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	2.504218	Prob. F(24,6)	0.1279
Obs*R-squared	28.18613	Prob. Chi-Square(24)	0.2523
Scaled explained SS	27.84661	Prob. Chi-Square(24)	0.2666

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/19/23 Time: 17:01
Sample: 2014Q4 2022Q2
Included observations: 31
Collinear test regressors dropped from specification

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.920478	9.073247	-0.542306	0.6071
KEY R(-1)^2	-0.051644	0.074892	-0.689580	0.5162
KEY_R(-1)*D(GDP_GAP(-1))	-0.588811	2.657815	-0.221540	0.8320
KEY_R(-1)*(CPI-CPI_TARGET)	0.006213	0.084080	0.073900	0.9435
KEY R(-1)*(D(ER MARKET(-1)))*DUM...	-6.619206	2.702782	-2.449034	0.0499
KEY_R(-1)*(D(ER_MARKET(-1)))*(1-D...	-0.179753	0.358713	-0.501106	0.6341
KEY_R(-1)*D(NR(-2))	-0.295308	1.447191	-0.204056	0.8451
KEY R(-1)	1.486399	1.659629	0.895621	0.4050
D(GDP_GAP(-1))^2	-61.53470	102.7505	-0.598875	0.5712
D(GDP_GAP(-1))*(CPI-CPI_TARGET)	-6.160807	4.379590	-1.406709	0.2091
D(GDP_GAP(-1))*(D(ER_MARKET(-1)))...	26.80425	47.74420	0.561414	0.5948
D(GDP_GAP(-1))*(D(ER_MARKET(-1)))*...	-6.483572	9.872204	-0.656750	0.5357
D(GDP_GAP(-1))*D(NR(-2))	12.99731	23.24487	0.559148	0.5963
D(GDP_GAP(-1))	6.276632	30.67490	0.204618	0.8446
(CPI-CPI_TARGET)^2	0.081621	0.063169	1.292109	0.2439
(CPI-CPI_TARGET)*(D(ER_MARKET(-1...	-3.456133	1.167739	-2.959678	0.0253
(CPI-CPI_TARGET)*(D(ER_MARKET(-1...	-0.082046	0.292111	-0.280874	0.7882
(CPI-CPI_TARGET)*D(NR(-2))	-0.731042	1.280774	-0.570782	0.5889
CPI-CPI_TARGET	0.312822	1.545851	0.202362	0.8463
(D(ER_MARKET(-1)))*DUMMY2^2	105.5836	47.93058	2.202843	0.0698
(D(ER_MARKET(-1)))*DUMMY2*D(NR(-2))	29.85741	26.75402	1.115997	0.3071
(D(ER_MARKET(-1)))*(1-DUMMY2)^2	1.348662	6.543893	0.206095	0.8435
(D(ER_MARKET(-1)))*(1-DUMMY2)*D(...	-2.385039	2.467123	-0.966729	0.3710
D(NR(-2))^2	4.55E-05	2.645444	1.72E-05	1.0000
D(NR(-2))	3.384973	15.38667	0.219994	0.8332

R-squared	0.909230	Mean dependent var	3.187830
Adjusted R-squared	0.546151	S.D. dependent var	5.883682
S.E. of regression	3.963739	Akaike info criterion	5.562928
Sum squared resid	94.26734	Schwarz criterion	6.719369
Log likelihood	-61.22538	Hannan-Quinn criter.	5.939899
F-statistic	2.504218	Durbin-Watson stat	1.974782
Prob(F-statistic)	0.127933		

Source: estimated by the author in EViews 12

Table D.4. Results on Breusch-Godfrey LM test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 4 lags

F-statistic	1.229114	Prob. F(4,20)	0.3301
Obs*R-squared	6.116847	Prob. Chi-Square(4)	0.1906

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 03/19/23 Time: 17:01
Sample: 2014Q4 2022Q2
Included observations: 31
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.567438	1.234707	0.459573	0.6508
KEY R(-1)	-0.045807	0.086648	-0.528657	0.6029
D(GDP_GAP(-1))	2.980711	3.982475	0.748457	0.4629
CPI-CPI_TARGET	-0.060656	0.073343	-0.827015	0.4180
(D(ER MARKET(-1)))*DUMMY2	0.970399	1.175449	0.825556	0.4188
(D(ER_MARKET(-1)))*(1-DUMMY2)	0.122753	0.324045	0.378816	0.7088
D(NR(-2))	0.069537	0.443692	0.156724	0.8770
RESID(-1)	0.447028	0.278192	1.606904	0.1237
RESID(-2)	-0.006301	0.294105	-0.021423	0.9831
RESID(-3)	0.349711	0.238743	1.464805	0.1585
RESID(-4)	-0.310905	0.274917	-1.130905	0.2715

R-squared	0.197318	Mean dependent var	1.21E-15
Adjusted R-squared	-0.204024	S.D. dependent var	1.814963
S.E. of regression	1.991523	Akaike info criterion	4.487099
Sum squared resid	79.32325	Schwarz criterion	4.995933
Log likelihood	-58.55003	Hannan-Quinn criter.	4.652966
F-statistic	0.491646	Durbin-Watson stat	2.003474
Prob(F-statistic)	0.875859		

Source: estimated by the author in EViews 12

Table D.5. Results in VIF test for absence of multicollinearity

Variance Inflation Factors
Date: 03/19/23 Time: 17:02
Sample: 2014Q1 2022Q2
Included observations: 31

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	1.085685	8.173728	NA
KEY R(-1)	0.004843	9.151748	1.227756
D(GDP_GAP(-1))	8.845371	1.839531	1.832410
CPI-CPI_TARGET	0.003210	1.265866	1.243685
(D(ER MARKET(-1))...	0.864638	2.135760	1.856303
(D(ER_MARKET(-1))...	0.065036	1.284607	1.227489
D(NR(-2))	0.142375	1.328797	1.210465

Source: estimated by the author in EViews 12

Table D.6. Reset-test results

Ramsey RESET Test
Equation: EQ_KEY_R
Omitted Variables: Squares of fitted values
Specification: KEY_R C KEY_R(-1) D(GDP_GAP(-1)) CPI-CPI_TARGET (D(ER_MARKET(-1)))*DUMMY2 (D(ER_MARKET(-1)))*(1 -DUMMY2) D(NR(-2))

	Value	df	Probability
t-statistic	0.368389	23	0.7160
F-statistic	0.135710	(1, 23)	0.7160
Likelihood ratio	0.182376	1	0.6693

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.579678	1	0.579678
Restricted SSR	98.82272	24	4.117613
Unrestricted SSR	98.24304	23	4.271437

LR test summary:

	Value
Restricted LogL	-61.95687
Unrestricted LogL	-61.86568

Unrestricted Test Equation:
Dependent Variable: KEY_R
Method: Least Squares
Date: 03/19/23 Time: 17:04
Sample: 2014Q4 2022Q2
Included observations: 31

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.940677	2.118297	1.388227	0.1784
KEY_R(-1)	0.646490	0.322046	2.007446	0.0566
D(GDP_GAP(-1))	-4.196860	3.396356	-1.235695	0.2290
CPI-CPI_TARGET	0.106695	0.097418	1.095229	0.2848
(D(ER_MARKET(-1)))*DUMMY2	2.753903	1.516927	1.815449	0.0825
(D(ER_MARKET(-1)))*(1-DUMMY2)	0.835867	0.657443	1.271391	0.2163
D(NR(-2))	-0.983477	0.474211	-2.073925	0.0495
FITTED^2	0.004881	0.013250	0.368389	0.7160

R-squared	0.910338	Mean dependent var	15.06387
Adjusted R-squared	0.883050	S.D. dependent var	6.043477
S.E. of regression	2.066745	Akaike info criterion	4.507463
Sum squared resid	98.24304	Schwarz criterion	4.877525
Log likelihood	-61.86568	Hannan-Quinn criter.	4.628094
F-statistic	33.35998	Durbin-Watson stat	1.388113
Prob(F-statistic)	0.000000		

Source: estimated by the author in EViews 12

Annex E

Testing equation of deposit dollarization for compliance with classical assumptions

Table E.1. Deposit dollarization equation specification

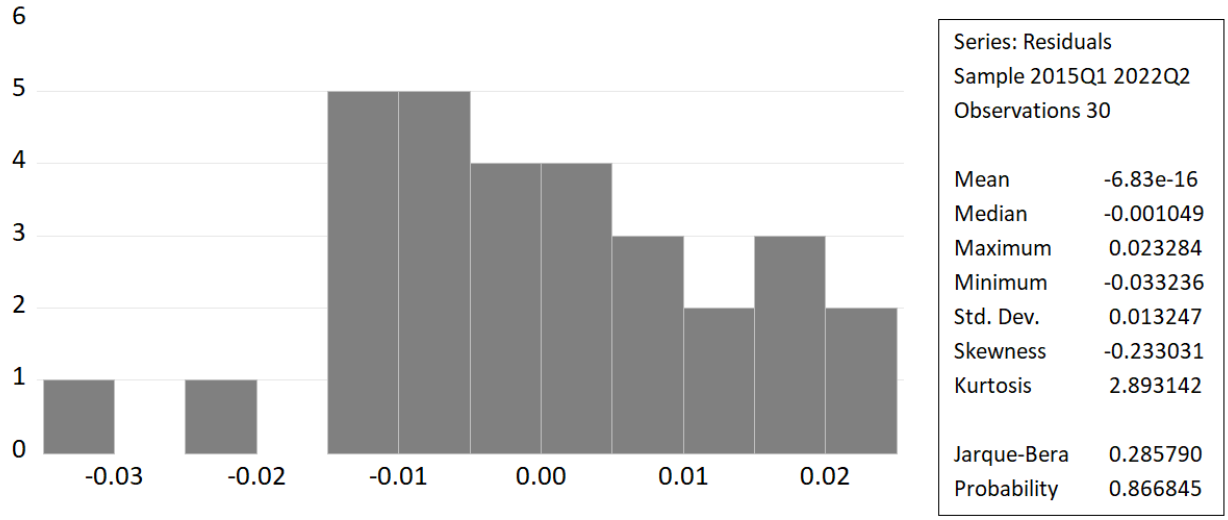
Dependent Variable: DD
Method: Least Squares
Date: 02/18/23 Time: 16:31
Sample (adjusted): 2015Q1 2022Q2
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.774567	0.926116	-2.995919	0.0065
DD(-1)	0.663318	0.079758	8.316616	0.0000
DLOG(ER_MARKET)	0.143207	0.037556	3.813184	0.0009
ER_MARKET_VOL(-3)	0.000404	0.000190	2.129307	0.0442
CPI_VOL(-4)	9.49E-05	3.71E-05	2.555336	0.0177
LOG(CREDIT_TO_BUSINESS)	0.211513	0.069384	3.048425	0.0057
DEPOSIT_RATE_DIFFERENTIAL(-4)	0.003519	0.001222	2.878959	0.0085

R-squared	0.933314	Mean dependent var	0.421111
Adjusted R-squared	0.915918	S.D. dependent var	0.051296
S.E. of regression	0.014874	Akaike info criterion	-5.377398
Sum squared resid	0.005089	Schwarz criterion	-5.050452
Log likelihood	87.66097	Hannan-Quinn criter.	-5.272805
F-statistic	53.65016	Durbin-Watson stat	2.199819
Prob(F-statistic)	0.000000		

Source: estimated by the author in EViews 12

Table E.2. Results on Jarque-Bera test for normal distribution



Source: estimated by the author in EViews 12

Table E.3. Results on White Test for absence of heteroskedasticity

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	1.208278	Prob. F(26,3)	0.5093
Obs*R-squared	27.38488	Prob. Chi-Square(26)	0.3894
Scaled explained SS	15.23622	Prob. Chi-Square(26)	0.9529

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/19/23 Time: 17:06
Sample: 2015Q1 2022Q2
Included observations: 30
Collinear test regressors dropped from specification

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.040927	0.293832	0.139287	0.8980
DD(-1)^2	0.128958	0.203963	0.632260	0.5721
DD(-1)*DLOG(ER_MARKET)	-0.118485	0.093060	-1.273204	0.2926
DD(-1)*ER_MARKET_VOL(-3)	-0.002725	0.002849	-0.956327	0.4095
DD(-1)*CPI_VOL(-4)	-0.000725	0.000696	-1.041371	0.3742
DD(-1)*LOG(CREDIT_TO_BUSINESS)	0.061364	0.128095	0.479051	0.6647
DD(-1)*DEPOSIT_RATE_DIFFERENTIA...	0.001577	0.003486	0.452359	0.6817
DD(-1)	-0.932670	1.782916	-0.523115	0.6371
DLOG(ER_MARKET)^2	0.009271	0.051133	0.181318	0.8677
DLOG(ER_MARKET)*ER_MARKET_VO...	-0.003117	0.003094	-1.007183	0.3880
DLOG(ER_MARKET)*CPI_VOL(-4)	0.000228	0.000356	0.639725	0.5679
DLOG(ER_MARKET)*LOG(CREDIT_T...	0.001450	0.117418	0.012346	0.9909
DLOG(ER_MARKET)*DEPOSIT_RATE...	0.002453	0.002549	0.962212	0.4069
DLOG(ER_MARKET)	0.008973	1.570516	0.005714	0.9958
ER_MARKET_VOL(-3)^2	3.30E-06	3.14E-06	1.051474	0.3703
ER_MARKET_VOL(-3)*CPI_VOL(-4)	2.28E-07	4.20E-07	0.542786	0.6250
ER_MARKET_VOL(-3)*LOG(CREDIT_...	4.58E-05	0.002228	0.020561	0.9849
ER_MARKET_VOL(-3)*DEPOSIT_RAT...	-1.87E-05	3.11E-05	-0.601469	0.5899
ER_MARKET_VOL(-3)	0.000611	0.029582	0.020665	0.9848
CPI_VOL(-4)^2	2.60E-07	1.69E-07	1.531503	0.2232
CPI_VOL(-4)*LOG(CREDIT_TO_BUSIN...	-0.000446	0.000359	-1.242731	0.3022
CPI_VOL(-4)*DEPOSIT_RATE_DIFFER...	-2.09E-05	1.16E-05	-1.808079	0.1683
CPI_VOL(-4)	0.006490	0.005224	1.242172	0.3024
LOG(CREDIT_TO_BUSINESS)^2	-0.000132	0.001644	-0.080303	0.9411
LOG(CREDIT_TO_BUSINESS)*DEPOS...	-0.001749	0.003083	-0.567421	0.6101
DEPOSIT_RATE_DIFFERENTIAL(-4)^2	-1.84E-05	2.16E-05	-0.854348	0.4557
DEPOSIT_RATE_DIFFERENTIAL(-4)	0.023651	0.043270	0.546584	0.6227

R-squared	0.912829	Mean dependent var	0.000170
Adjusted R-squared	0.157350	S.D. dependent var	0.000237
S.E. of regression	0.000218	Akaike info criterion	-14.52766
Sum squared resid	1.42E-07	Schwarz criterion	-13.26658
Log likelihood	244.9148	Hannan-Quinn criter.	-14.12423
F-statistic	1.208278	Durbin-Watson stat	3.140802
Prob(F-statistic)	0.509319		

Source: estimated by the author in EViews 12

Table E.4. Results on Breusch-Godfrey LM test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 4 lags

F-statistic	1.223908	Prob. F(4,19)	0.3337
Obs*R-squared	6.146266	Prob. Chi-Square(4)	0.1885

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 03/19/23 Time: 17:06
Sample: 2015Q1 2022Q2
Included observations: 30
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.163148	0.921005	0.177141	0.8613
DD(-1)	0.023770	0.082296	0.288839	0.7758
DLOG(ER_MARKET)	0.010998	0.038213	0.287819	0.7766
ER_MARKET_VOL(-3)	4.86E-05	0.000205	0.237242	0.8150
CPI_VOL(-4)	-9.94E-08	3.90E-05	-0.002550	0.9980
LOG(CREDIT_TO_BUSINESS)	-0.012434	0.069042	-0.180099	0.8590
DEPOSIT_RATE_DIFFERENTIAL(-4)	-0.000552	0.001255	-0.440222	0.6647
RESID(-1)	-0.315604	0.265295	-1.189635	0.2488
RESID(-2)	-0.162833	0.247993	-0.656603	0.5193
RESID(-3)	-0.465748	0.227285	-2.049177	0.0545
RESID(-4)	-0.239713	0.267492	-0.896152	0.3814

R-squared	0.204876	Mean dependent var	-6.83E-16
Adjusted R-squared	-0.213611	S.D. dependent var	0.013247
S.E. of regression	0.014593	Akaike info criterion	-5.339988
Sum squared resid	0.004046	Schwarz criterion	-4.826215
Log likelihood	91.09982	Hannan-Quinn criter.	-5.175628
F-statistic	0.489563	Durbin-Watson stat	2.092991
Prob(F-statistic)	0.876350		

Source: estimated by the author in EViews 12

Table E.5. Results in VIF test for absence of multicollinearity

Variance Inflation Factors
Date: 03/19/23 Time: 17:07
Sample: 2014Q1 2022Q2
Included observations: 30

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	0.857690	116299.4	NA
DD(-1)	0.006361	158.0670	1.982602
DLOG(ER_MARKET)	0.001410	1.568432	1.416320
ER_MARKET_VOL(-3)	3.60E-08	1.415940	1.187534
CPI_VOL(-4)	1.38E-09	1.933500	1.258855
LOG(CREDIT_TO_...	0.004814	120795.8	2.065829
DEPOSIT_RATE_DI...	1.49E-06	10.46753	1.213636

Source: estimated by the author in EViews 12

Table E.6. Reset-test results

Ramsey RESET Test
Equation: EQ_DD4
Omitted Variables: Powers of fitted values from 2 to 5
Specification: DD C DD(-1) DLOG(ER_MARKET()) ER_MARKET_VOL(-3) (CPI_VOL(-4)) LOG(CREDIT_TO_BUSINESS) (DEPOSIT_RATE_DIFFERENTIAL(-4))

	Value	df	Probability
F-statistic	2.033244	(4, 19)	0.1304
Likelihood ratio	10.68933	4	0.0303

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.001525	4	0.000381
Restricted SSR	0.005089	23	0.000221
Unrestricted SSR	0.003563	19	0.000188

LR test summary:

	Value
Restricted LogL	87.66097
Unrestricted LogL	93.00563

Unrestricted Test Equation:
Dependent Variable: DD
Method: Least Squares
Date: 03/19/23 Time: 17:09
Sample: 2015Q1 2022Q2
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2010.554	4292.562	-0.468381	0.6448
DD(-1)	467.2906	996.4861	0.468938	0.6444
DLOG(ER_MARKET)	100.8163	215.1187	0.468654	0.6446
ER_MARKET_VOL(-3)	0.284838	0.607133	0.469152	0.6443
CPI_VOL(-4)	0.066894	0.142540	0.469303	0.6442
LOG(CREDIT_TO_BUSINESS)	148.9504	317.7660	0.468742	0.6446
DEPOSIT_RATE_DIFFERENTIAL(-4)	2.476152	5.287832	0.468274	0.6449
FITTED^2	-3504.413	7223.496	-0.485141	0.6331
FITTED^3	8751.356	17264.87	0.506888	0.6181
FITTED^4	-10937.79	20514.59	-0.533171	0.6001
FITTED^5	5464.378	9696.383	0.563548	0.5797

R-squared	0.953303	Mean dependent var	0.421111
Adjusted R-squared	0.928726	S.D. dependent var	0.051296
S.E. of regression	0.013695	Akaike info criterion	-5.467042
Sum squared resid	0.003563	Schwarz criterion	-4.953270
Log likelihood	93.00563	Hannan-Quinn criter.	-5.302682
F-statistic	38.78778	Durbin-Watson stat	2.488892
Prob(F-statistic)	0.000000		

Source: estimated by the author in EViews 12

Annex F

Testing equation of loan dollarization for compliance with classical assumptions

Table F.1. Loan dollarization equation specification

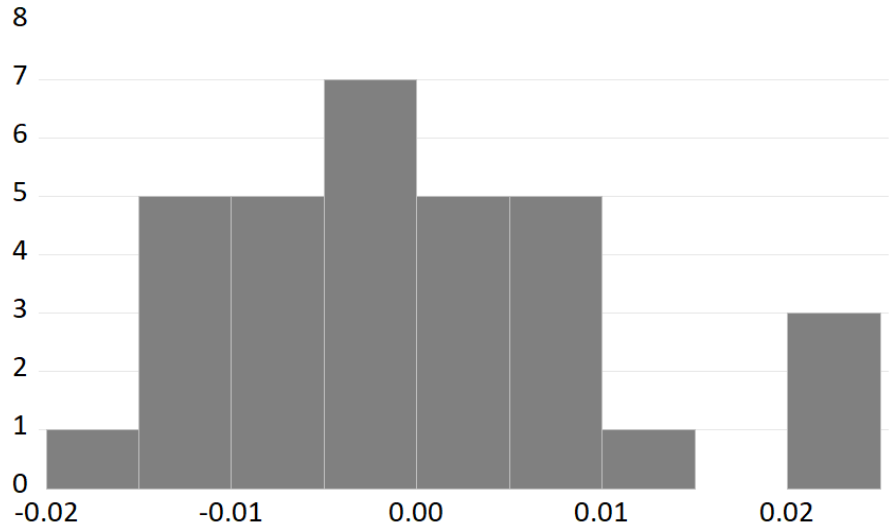
Dependent Variable: LD
Method: Least Squares
Date: 03/19/23 Time: 17:18
Sample (adjusted): 2014Q3 2022Q2
Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.118356	0.023801	-4.972775	0.0000
LD(-1)	0.939887	0.096512	9.738516	0.0000
DD	0.324959	0.126416	2.570551	0.0165
DLOG(ER_MARKET)	0.110758	0.037362	2.964477	0.0066
CPI_VOL(-2)	-0.000134	4.40E-05	-3.049167	0.0054
ER_MARKET_VOL	-0.000562	0.000174	-3.220831	0.0035
CPI(-1)	0.000863	0.000241	3.575402	0.0015

R-squared	0.985793	Mean dependent var	0.426688
Adjusted R-squared	0.982384	S.D. dependent var	0.088290
S.E. of regression	0.011718	Akaike info criterion	-5.864687
Sum squared resid	0.003433	Schwarz criterion	-5.544057
Log likelihood	100.8350	Hannan-Quinn criter.	-5.758407
F-statistic	289.1251	Durbin-Watson stat	1.822760
Prob(F-statistic)	0.000000		

Source: estimated by the author in EViews 12

Table F.2. Results on Jarque-Bera test for normal distribution



Series: Residuals
Sample 2014Q3 2022Q2
Observations 32

Mean	2.06e-18
Median	-0.001467
Maximum	0.024403
Minimum	-0.019332
Std. Dev.	0.010523
Skewness	0.647882
Kurtosis	3.060105
Jarque-Bera	2.243486
Probability	0.325712

Source: estimated by the author in EViews 12

Table F.3. Results on White Test for absence of heteroskedasticity

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	1.142226	Prob. F(27,4)	0.5085
Obs*R-squared	28.32607	Prob. Chi-Square(27)	0.3943
Scaled explained SS	17.80844	Prob. Chi-Square(27)	0.9093

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/19/23 Time: 17:21
Sample: 2014Q3 2022Q2
Included observations: 32

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.029002	0.018569	1.561875	0.1933
LD(-1)^2	0.146340	0.135747	1.078038	0.3417
LD(-1)*DD	-0.424978	0.401873	-1.057492	0.3499
LD(-1)*DLOG(ER_MARKET)	0.163642	0.310720	0.526656	0.6263
LD(-1)*CPI_VOL(-2)	-0.000184	0.000365	-0.504639	0.6403
LD(-1)*ER_MARKET_VOL	-0.002563	0.007230	-0.354561	0.7408
LD(-1)*CPI(-1)	0.001477	0.003356	0.440258	0.6825
LD(-1)	0.055405	0.123424	0.448897	0.6768
DD^2	0.435094	0.394728	1.102264	0.3322
DD*DLOG(ER_MARKET)	-0.269995	0.438266	-0.616052	0.5712
DD*CPI_VOL(-2)	-7.86E-05	0.000360	-0.218682	0.8376
DD*ER_MARKET_VOL	0.005586	0.013093	0.426664	0.6916
DD*CPI(-1)	-0.000229	0.003234	-0.070742	0.9470
DD	-0.191005	0.184986	-1.032540	0.3602
DLOG(ER_MARKET)^2	0.024019	0.048129	0.499058	0.6439
DLOG(ER_MARKET)*CPI_VOL(-2)	-8.54E-06	0.000118	-0.072241	0.9459
DLOG(ER_MARKET)*ER_MARKET_VOL	0.001266	0.002405	0.526229	0.6266
DLOG(ER_MARKET)*CPI(-1)	0.000105	0.000660	0.159276	0.8812
DLOG(ER_MARKET)	0.038319	0.056048	0.683675	0.5317
CPI_VOL(-2)^2	4.55E-08	7.97E-08	0.571137	0.5985
CPI_VOL(-2)*ER_MARKET_VOL	2.50E-06	6.46E-06	0.386952	0.7185
CPI_VOL(-2)*CPI(-1)	-4.52E-07	1.51E-06	-0.299203	0.7797
CPI_VOL(-2)	0.000116	8.37E-05	1.385982	0.2380
ER_MARKET_VOL^2	-8.30E-07	6.71E-06	-0.123605	0.9076
ER_MARKET_VOL*CPI(-1)	-6.43E-06	1.20E-05	-0.535639	0.6206
ER_MARKET_VOL	-0.001237	0.003169	-0.390232	0.7163
CPI(-1)^2	-3.13E-06	5.73E-06	-0.545110	0.6146
CPI(-1)	-0.000472	0.000807	-0.584571	0.5902

R-squared	0.885190	Mean dependent var	0.000107
Adjusted R-squared	0.110221	S.D. dependent var	0.000156
S.E. of regression	0.000148	Akaike info criterion	-15.13397
Sum squared resid	8.71E-08	Schwarz criterion	-13.85145
Log likelihood	270.1435	Hannan-Quinn criter.	-14.70885
F-statistic	1.142226	Durbin-Watson stat	2.701085
Prob(F-statistic)	0.508503		

Source: estimated by the author in EViews 12

Table F.4. Results on Breusch-Godfrey LM test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 4 lags

F-statistic	0.500064	Prob. F(4,21)	0.7360
Obs*R-squared	2.782932	Prob. Chi-Square(4)	0.5948

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 03/19/23 Time: 17:21
Sample: 2014Q3 2022Q2
Included observations: 32
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.014046	0.029849	0.470583	0.6428
LD(-1)	0.025209	0.120556	0.209106	0.8364
DD	-0.060933	0.168222	-0.362216	0.7208
DLOG(ER_MARKET)	0.027310	0.053189	0.513448	0.6130
CPI VOL(-2)	1.80E-05	4.83E-05	0.372387	0.7133
ER_MARKET_VOL	-6.30E-06	0.000184	-0.034303	0.9730
CPI(-1)	-8.80E-05	0.000291	-0.302579	0.7652
RESID(-1)	0.029738	0.257135	0.115651	0.9090
RESID(-2)	-0.367043	0.280306	-1.309437	0.2045
RESID(-3)	0.044110	0.260259	0.169486	0.8670
RESID(-4)	-0.143078	0.245815	-0.582056	0.5667

R-squared	0.086967	Mean dependent var	2.06E-18
Adjusted R-squared	-0.347811	S.D. dependent var	0.010523
S.E. of regression	0.012217	Akaike info criterion	-5.705670
Sum squared resid	0.003134	Schwarz criterion	-5.201823
Log likelihood	102.2907	Hannan-Quinn criter.	-5.538659
F-statistic	0.200025	Durbin-Watson stat	1.928344
Prob(F-statistic)	0.993962		

Source: estimated by the author in EViews 12

Table F.5. Results in VIF test for absence of multicollinearity

Variance Inflation Factors
Date: 03/19/23 Time: 17:21
Sample: 2014Q1 2022Q2
Included observations: 32

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	0.000566	132.0092	NA
LD(-1)	0.009315	419.9413	14.20164
DD	0.015981	672.4162	9.047778
DLOG(ER_MARKET)	0.001396	2.745346	2.391281
CPI_VOL(-2)	1.94E-09	4.382875	2.922376
ER_MARKET_VOL	3.04E-08	1.929866	1.626130
CPI(-1)	5.82E-08	3.295702	1.754501

Source: estimated by the author in EViews 12

Table F.6. Reset-test results

Ramsey RESET Test
Equation: EQ_LD_4
Omitted Variables: Powers of fitted values from 2 to 5
Specification: LD C LD(-1) DD() DLOG(ER_MARKET()) CPI_VOL(-2)
ER_MARKET_VOL CPI(-1)

	Value	df	Probability
F-statistic	1.640588	(4, 21)	0.2014
Likelihood ratio	8.701709	4	0.0690

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000817	4	0.000204
Restricted SSR	0.003433	25	0.000137
Unrestricted SSR	0.002616	21	0.000125

LR test summary:

	Value
Restricted LogL	100.8350
Unrestricted LogL	105.1858

Unrestricted Test Equation:
Dependent Variable: LD
Method: Least Squares
Date: 03/19/23 Time: 17:22
Sample: 2014Q3 2022Q2
Included observations: 32

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	19.64770	17.46346	1.125074	0.2733
LD(-1)	-93.22118	83.41984	-1.117494	0.2764
DD	-32.11205	28.81858	-1.114283	0.2777
DLOG(ER_MARKET)	-11.02050	9.836178	-1.120405	0.2752
CPI_VOL(-2)	0.013297	0.011926	1.114957	0.2775
ER_MARKET_VOL	0.055619	0.049796	1.116948	0.2766
CPI(-1)	-0.085750	0.076431	-1.121926	0.2746
FITTED^2	495.5878	444.4945	1.114947	0.2775
FITTED^3	-1202.026	1095.617	-1.097122	0.2850
FITTED^4	1428.465	1330.384	1.073723	0.2951
FITTED^5	-665.3752	637.3595	-1.043956	0.3084

R-squared	0.989176	Mean dependent var	0.426688
Adjusted R-squared	0.984022	S.D. dependent var	0.088290
S.E. of regression	0.011160	Akaike info criterion	-5.886615
Sum squared resid	0.002616	Schwarz criterion	-5.382768
Log likelihood	105.1858	Hannan-Quinn criter.	-5.719604
F-statistic	191.9115	Durbin-Watson stat	1.888268
Prob(F-statistic)	0.000000		

Source: estimated by the author in EViews 12

Annex G

Testing system of simultaneous equations

Table G.1. Two-stage least squares estimation method

System: SSE8
Estimation Method: Two-Stage Least Squares
Date: 03/19/23 Time: 17:31
Sample: 2015Q4 2022Q2
Included observations: 27
Total system (balanced) observations 135

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-4.154091	0.970271	-4.281372	0.0000
C(2)	-0.815918	0.148122	-5.508404	0.0000
C(3)	92.60416	3.850814	24.04795	0.0000
C(4)	1.847918	0.178898	10.32947	0.0000
C(5)	0.204946	0.038692	5.296921	0.0000
C(33)	-8.94E-06	0.000204	-0.043894	0.9651
C(6)	-0.234080	25.47318	-0.009189	0.9927
C(7)	-0.015231	0.331898	-0.045889	0.9635
C(8)	-0.007201	0.288353	-0.024974	0.9801
C(9)	0.802201	7.218682	0.111128	0.9117
C(10)	0.074020	1.067584	0.069334	0.9449
C(11)	0.160934	1.417627	0.113524	0.9098
C(12)	2.340948	0.869386	2.692645	0.0083
C(13)	0.767366	0.061219	12.53468	0.0000
C(14)	-3.702291	2.399116	-1.543190	0.1259
C(15)	0.138309	0.049480	2.795240	0.0062
C(16)	3.385150	0.895644	3.779570	0.0003
C(17)	0.408324	0.335569	1.216809	0.2265
C(18)	-0.844149	0.298577	-2.827246	0.0057
C(19)	-2.634852	101.1690	-0.026044	0.9793
C(20)	0.633054	11.38985	0.055580	0.9558
C(21)	0.045851	6.775272	0.006767	0.9946
C(22)	0.000511	0.020767	0.024603	0.9804
C(23)	9.86E-05	0.004287	0.023003	0.9817
C(24)	0.202278	7.617781	0.026553	0.9789
C(25)	0.003259	0.141103	0.023098	0.9816
C(26)	-0.112654	3.649669	-0.030867	0.9754
C(27)	0.787783	14.56185	0.054099	0.9570
C(28)	0.445954	18.63743	0.023928	0.9810
C(29)	0.009617	8.084845	0.001190	0.9991
C(30)	-7.62E-05	0.006615	-0.011515	0.9908
C(31)	0.000732	0.038783	0.018874	0.9850
C(32)	0.002219	0.136250	0.016288	0.9870
Determinant residual covariance		7.19E-11		

Source: estimated by the author in EViews 12

Table G.2. Three-stage least squares estimation method

System: SSE8
Estimation Method: Three-Stage Least Squares
Date: 03/19/23 Time: 17:33
Sample: 2015Q4 2022Q2
Included observations: 27
Total system (balanced) observations 135
Linear estimation after one-step weighting matrix

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-4.165846	1.514289	-2.751024	0.0070
C(2)	-0.904671	0.227588	-3.975040	0.0001
C(3)	91.21181	6.039389	15.10282	0.0000
C(4)	1.826626	0.280003	6.523603	0.0000
C(5)	0.216834	0.059858	3.622486	0.0005
C(33)	-8.05E-06	2.88E-06	-2.794303	0.0062
C(6)	-0.193996	0.367475	-0.527916	0.5987
C(7)	-0.016384	0.004769	-3.435629	0.0009
C(8)	-0.009309	0.004077	-2.283167	0.0245
C(9)	0.780609	0.103642	7.531809	0.0000
C(10)	0.077316	0.015503	4.987151	0.0000
C(11)	0.158378	0.020542	7.710105	0.0000
C(12)	2.156365	0.929662	2.319515	0.0224
C(13)	0.784688	0.064967	12.07834	0.0000
C(14)	-4.270203	2.520206	-1.694386	0.0932
C(15)	0.164261	0.052750	3.113972	0.0024
C(16)	3.084925	0.943777	3.268703	0.0015
C(17)	0.477325	0.353069	1.351932	0.1794
C(18)	-0.803648	0.314396	-2.556165	0.0121
C(19)	-2.979338	0.771512	-3.861686	0.0002
C(20)	0.633471	0.086963	7.284347	0.0000
C(21)	0.075885	0.052339	1.449866	0.1502
C(22)	0.000492	0.000158	3.119646	0.0024
C(23)	8.97E-05	3.27E-05	2.739415	0.0073
C(24)	0.227553	0.058089	3.917305	0.0002
C(25)	0.003396	0.001080	3.145266	0.0022
C(26)	-0.119471	0.019980	-5.979550	0.0000
C(27)	0.748079	0.078952	9.475118	0.0000
C(28)	0.499404	0.101194	4.935099	0.0000
C(29)	-0.014925	0.044350	-0.336518	0.7372
C(30)	-6.95E-05	3.59E-05	-1.932065	0.0561
C(31)	0.000812	0.000213	3.817736	0.0002
C(32)	0.002510	0.000741	3.386772	0.0010
Determinant residual covariance		5.95E-11		

Source: estimated by the author in EViews 12

Table G.3. System Residual Portmanteau Tests for Autocorrelations

System Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: no residual autocorrelations up to lag h
Date: 03/19/23 Time: 17:33
Sample: 2015Q4 2022Q2
Included observations: 27

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	40.25742	0.0274	41.80578	0.0189	25
2	61.08003	0.1355	64.29421	0.0842	50
3	89.50491	0.1212	96.27220	0.0496	75
4	119.4984	0.0894	131.4820	0.0190	100
5	141.7683	0.1450	158.8132	0.0221	125
6	166.5389	0.1685	190.6611	0.0139	150
7	188.4166	0.2312	220.1960	0.0116	175
8	205.3860	0.3820	244.3104	0.0177	200
9	222.1669	0.5409	269.4817	0.0226	225
10	237.2407	0.7091	293.4225	0.0308	250
11	252.5445	0.8305	319.2476	0.0342	275
12	264.7845	0.9293	341.2797	0.0504	300

*The test is valid only for lags larger than the System lag order.
df is degrees of freedom for (approximate) chi-square distribution
*df and Prob. may not be valid for models with lagged endogenous ...

Source: estimated by the author in EViews 12

Annex H

System Dynamics model of Banking Sector and Monetary Policy

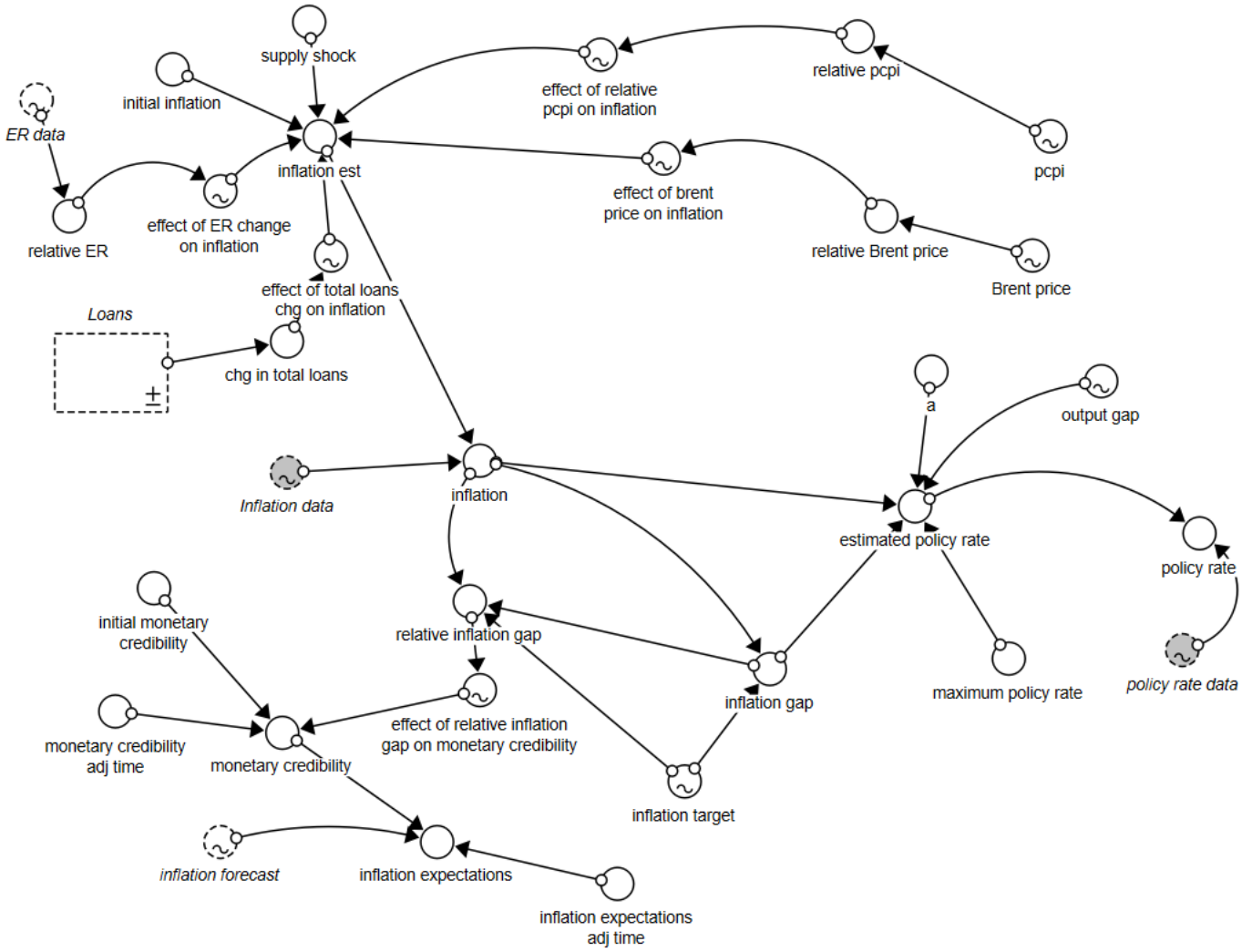


Figure H.1. Monetary Policy module

Source: developed by author in Stella Architect

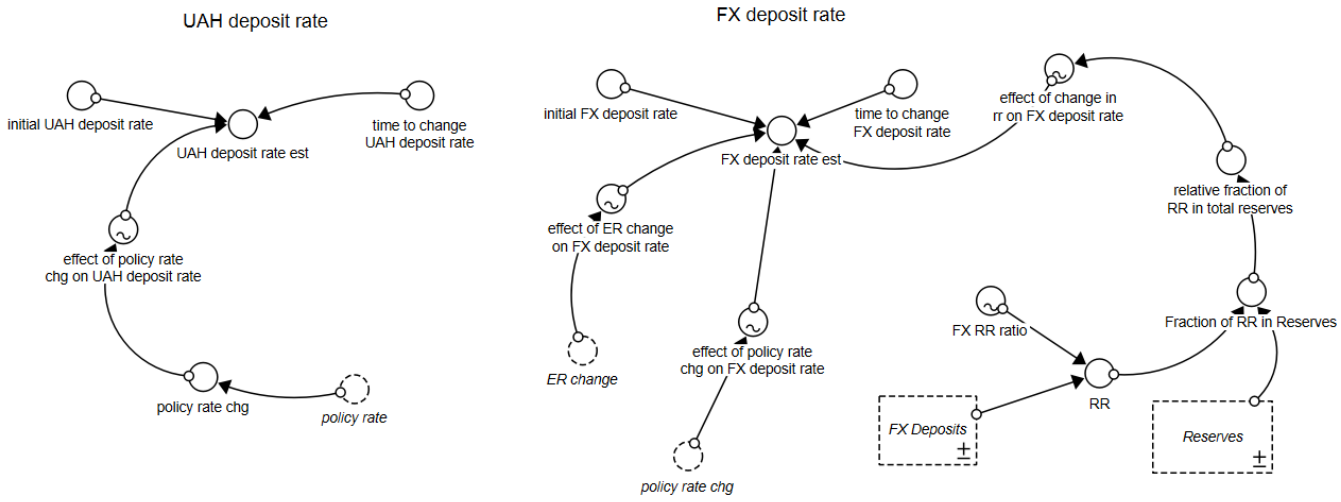


Figure H.2. Deposit rates module

Source: developed by author in Stella Architect

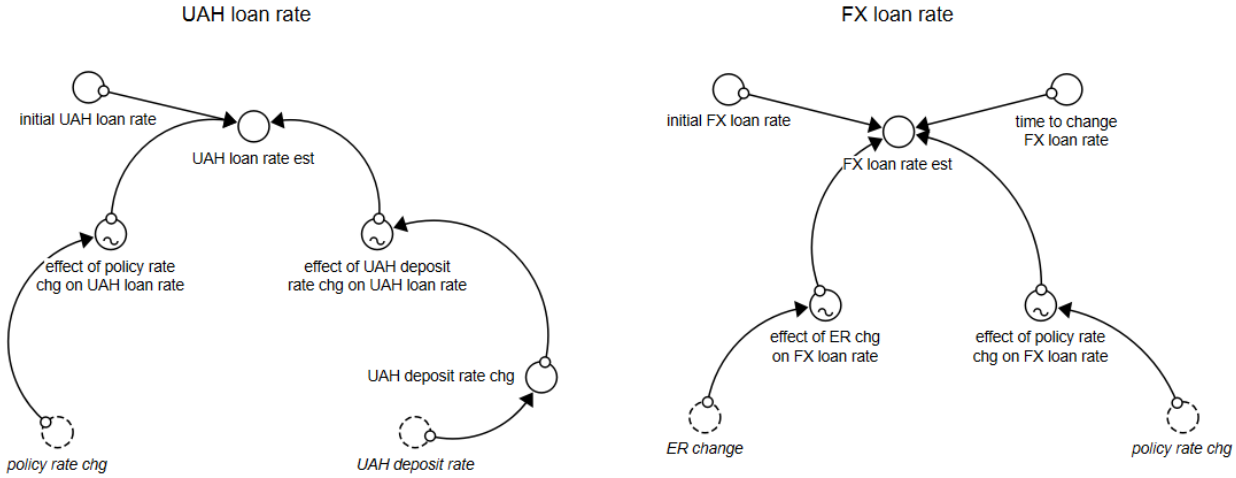


Figure H.3. Loan rates module

Source: developed by author in Stella Architect

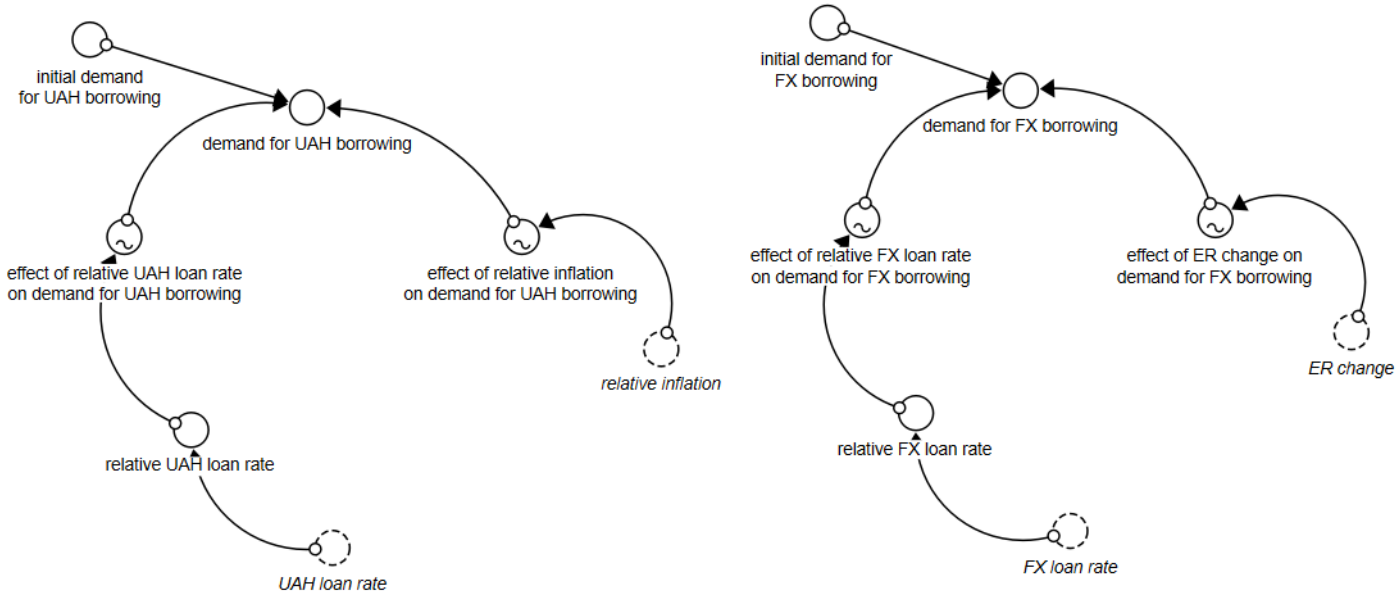


Figure H.4. Customers demand for loans module

Source: developed by author in Stella Architect

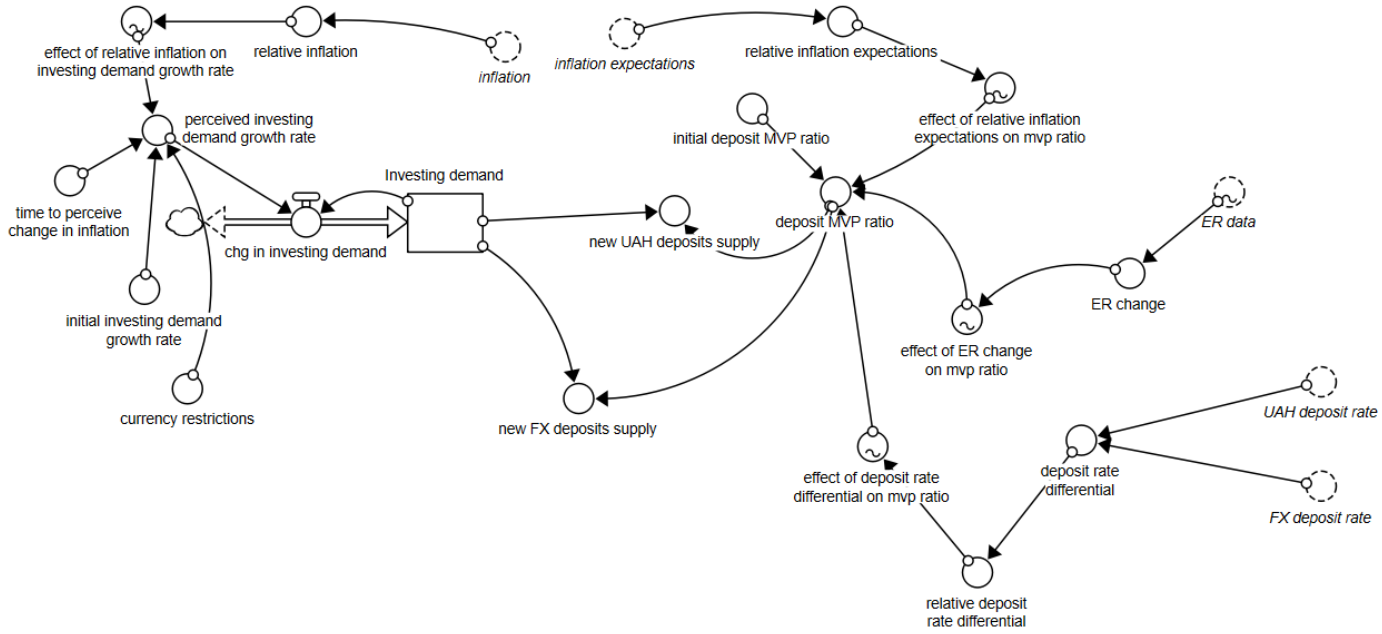


Figure H.5. Customers demand for deposits module

Source: developed by author in Stella Architect

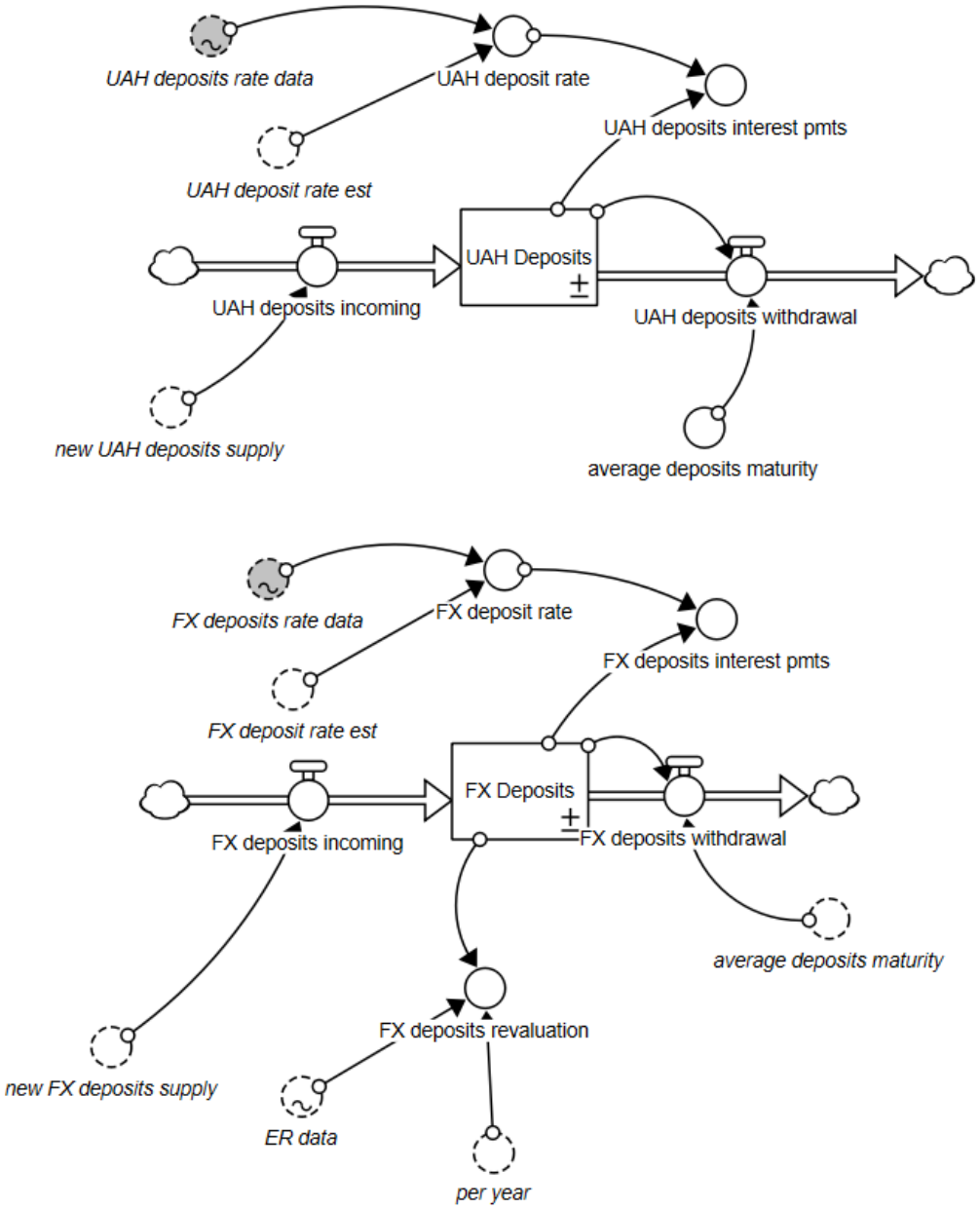


Figure H.6. Deposits module

Source: developed by author in Stella Architect

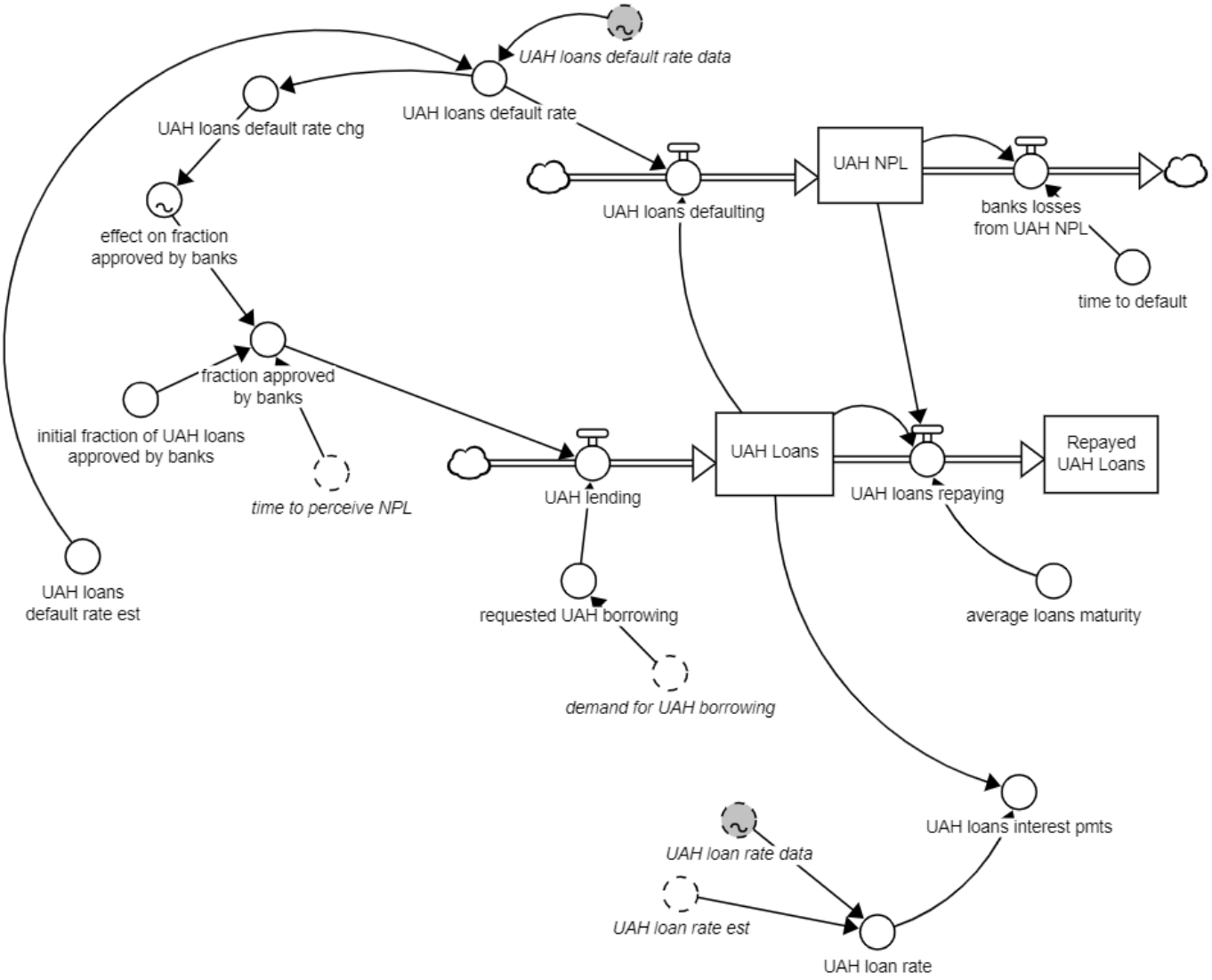


Figure H.7. Hryvnia loans module

Source: developed by author in Stella Architect

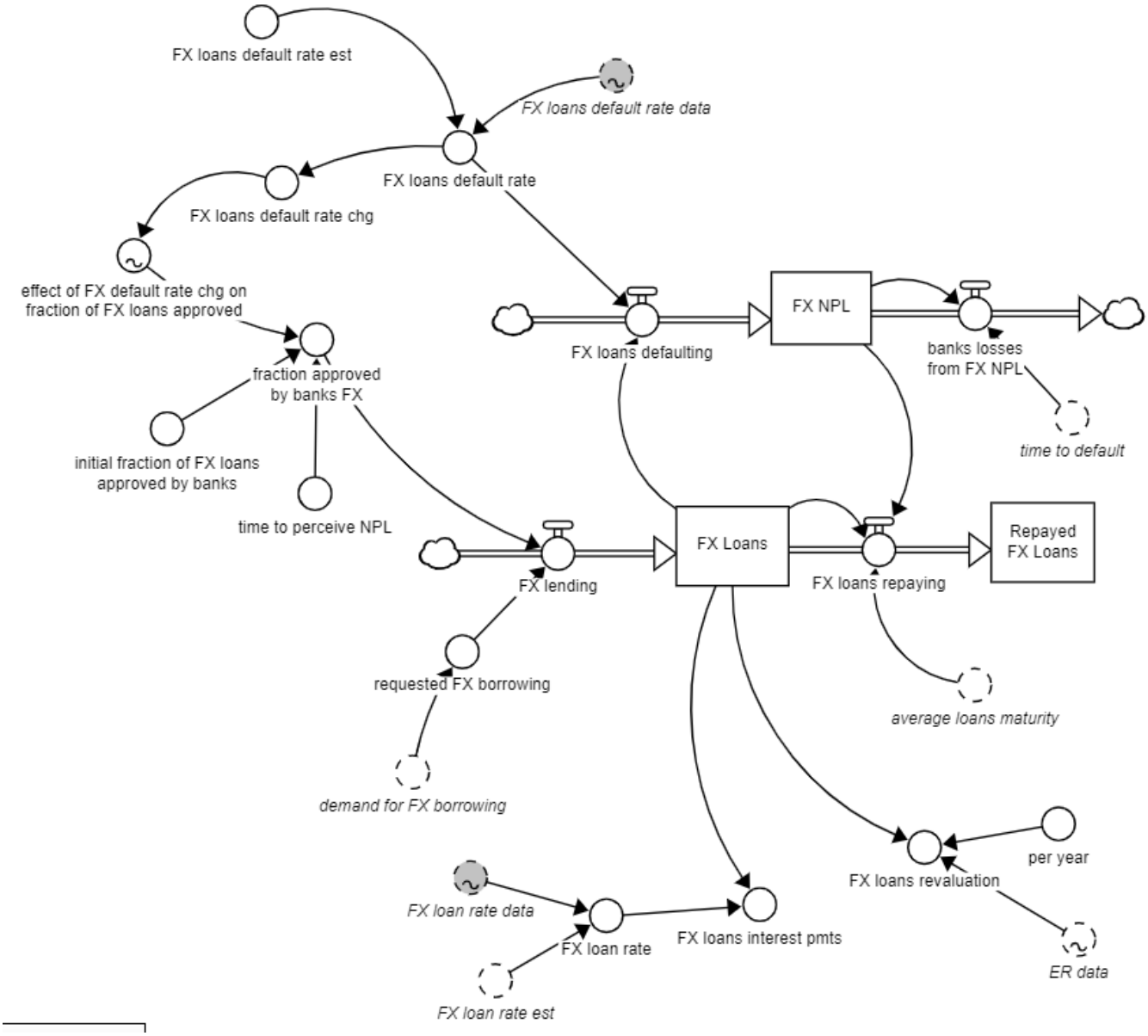


Figure H.8. FX loans module

Source: developed by author in Stella Architect

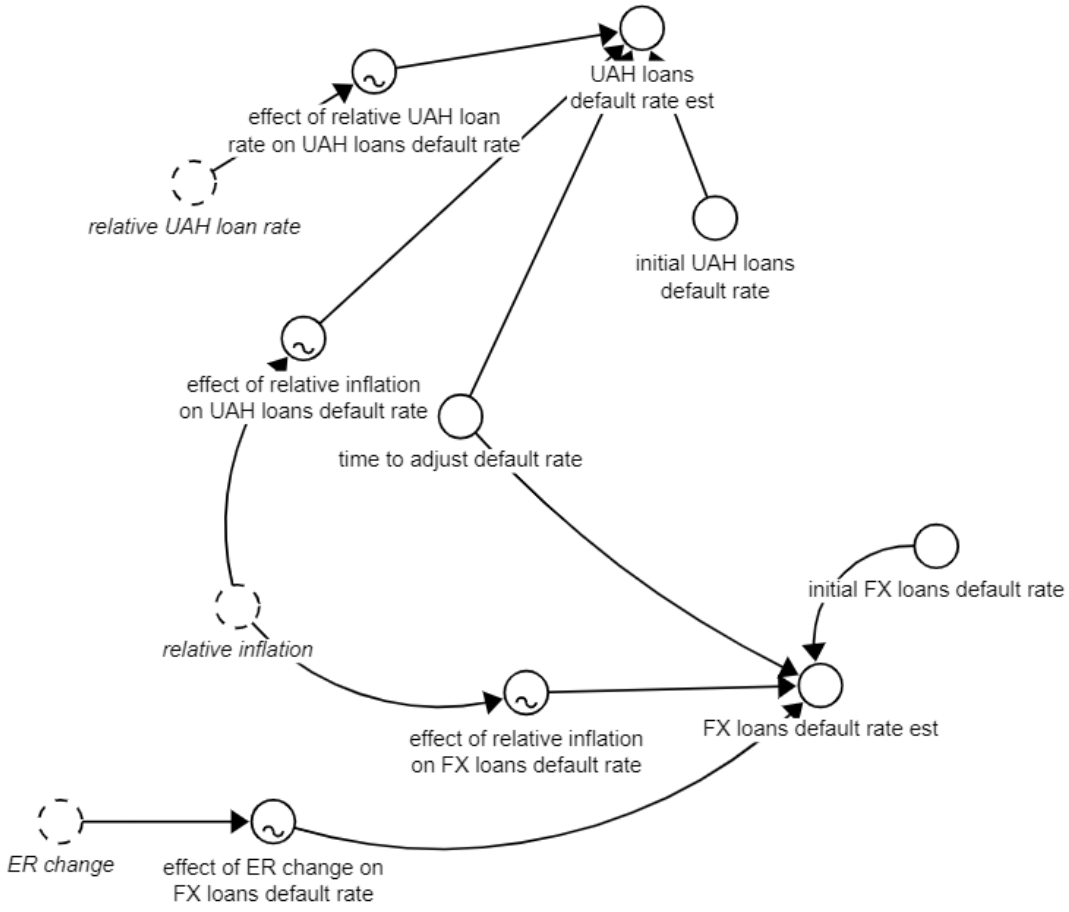


Figure H.9. Non-performing loans module

Source: developed by author in Stella Architect

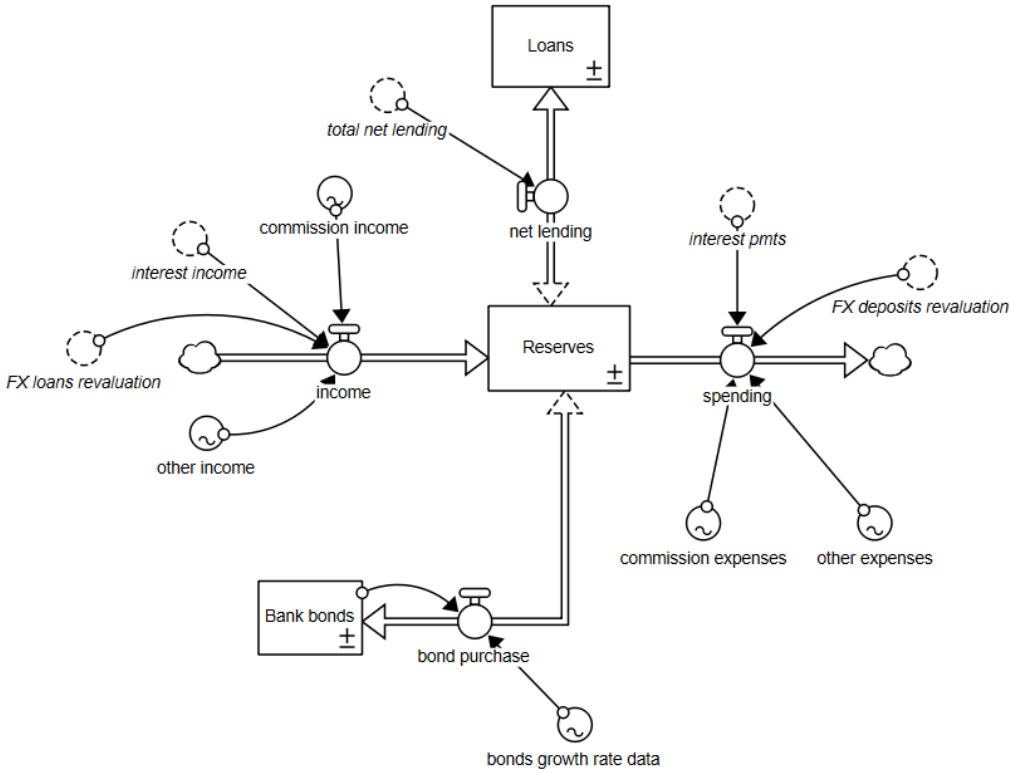


Figure H.10. Banks' Assets module

Source: developed by author in Stella Architect

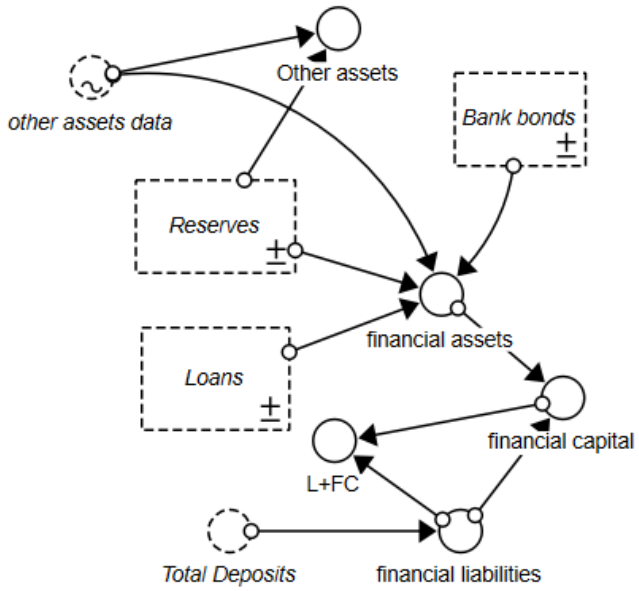


Figure H.11. Balance Sheet module

Source: developed by author in Stella Architect