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PREFACE BY THE EDITOR-IN-CHIEF

Dear readers,

The current issue of the *Visnyk of the National Bank of Ukraine* assesses the sensitivity of major macroeconomic variables in Ukraine to foreign shocks, highlights the effectiveness of monetary transmission mechanisms following the recent introduction of an inflation targeting regime, and examines the natural level of dollarization for Ukraine, recommending policy actions to reduce dollarization to its natural level.

The first article, *How Trade Composition Affects Sensitivity to Foreign Shocks: Applying a Global VAR Model to Ukraine*, by Oleksandr Faryna and Heli Simola, illustrates the importance of trade linkages in the transmission of foreign shocks to Ukraine's economy. The authors apply a global vector auto regressive model that incorporates time-varying trade and financial weights. The results show that the sensitivity of Ukrainian real economic activity to output shocks in advanced economies (e.g., the United States and euro area) is high, and does not solely depend on Ukraine's trade composition. In contrast, Ukraine's response to output shocks in emerging economies, e.g., CEE, CIS, China, and partly Russia, are explained mainly by the strong bilateral trade links.

In the second article, *The Effectiveness of the Monetary Transmission Mechanism in Ukraine since the Transition to Inflation Targeting*, Oleksandr Zholud, Volodymyr Lepushynskyi and Sergiy Nikolaychuk examine the effectiveness of a range of channels of the monetary transmission since the National Bank of Ukraine switched to a floating exchange rate and an active interest rate policy. The authors conclude that the central bank has sufficient control over short-term interest rates in the interbank market. However, further transmission channels have scope for development in light of the strengthening of lending and the post-crisis recovery of the banking system. A key finding: the leading role of the exchange rate channel is expected to gradually decrease, but will remain important.

The third article, *Estimating a Natural Level Of Financial Dollarization in Ukraine*, by Kostiantyn Khvedchuk, Valentyna Sinichenko and Barry Topf, explores the drivers of financial dollarization in Ukraine using peer comparisons and a minimum variance portfolio model. The authors derive the natural level of dollarization for Ukraine and propose policy measures to reduce dollarization to its estimated natural range.

The Editorial Board encourages researchers and scholars to submit their articles for publication in the Visnyk of the National Bank of Ukraine. Our journal is indexed by RePEc, Index Copernicus International among other databases (Dimensions, SciLit, Lens). In addition, now the journal is included in DOAJ (Directory of Open Access Journals), the online directory, which identifies and provides access to quality open access, peer-reviewed journals.

Best regards,
Dmytro Sologub

HOW TRADE COMPOSITION AFFECTS SENSITIVITY TO FOREIGN SHOCKS: APPLYING A GLOBAL VAR MODEL TO UKRAINE[1]

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Abstract This paper studies the transmission of foreign output shocks to real activity in Ukraine through international trade. We employ a global vector auto regressive (GVAR) model that captures about 80% of the world economy and incorporates time-varying trade and financial weights. According to our estimates, a mild recession in the US of a 1% drop in output generates a substantial recession in Ukraine of about 2.2%. A similar drop of output in the euro area and Russia translates to a drop in output of about 1.7% in Ukraine. Finally, the same drop of output in CEE, China, or the CIS leads to an output decline of about 0.4% in Ukraine. Meanwhile, Ukraine's response to euro area output shock has been steadily increasing over the last couple of decades due to changes in global trade flows. Ukraine's sensitivity to shocks in the US and euro area is notably strengthened by indirect trade effects, while the response to shocks from emerging economies, i.e., China, CEE, the CIS, and partially Russia, is mainly determined by bilateral trade linkages.

JEL Codes C32, F42, F43, E32

Keywords Ukraine, global VAR, foreign shocks, trade compositions

1. INTRODUCTION

Over last few decades, Ukraine has been rapidly integrating with the global economy through trade and financial linkages. Moving from central planning to a market economy and going through a set of internal reforms, Ukraine became a small and very open emerging economy, with about 100% international merchandise trade to GDP.[2] Being an energy importing economy, Ukraine's major export goods are commodities as well – e.g. agricultural goods, metals, etc. This high degree of openness together with considerable dollarization of the economy makes Ukraine particularly sensitive to foreign shocks and vulnerabilities in global markets.

For over 25 years, Ukraine followed a fixed exchange rate regime that was intended to protect the economy from adverse external shocks. However, in 2015 after several dramatic currency crises and recessions, the National Bank of Ukraine gave up fixing the exchange rate and switched its policy framework to an inflation targeting regime, at the same time declaring its commitment to ensure price and financial stability, see Lepushynskyi (2015). A flexible exchange rate, on the one hand, can partially absorb foreign shocks and mitigate their effect on the real economy. On the other hand, the degree of exchange rate pass-through to domestic prices in Ukraine remains high[3] and, hence, foreign factors may play an important role in shaping macroeconomic developments. For this reason, economic stabilization policies require a thorough understanding of the degree and determinants of Ukraine's sensitivity to international shocks.

International trade is one of the most important channels through which external shocks from foreign countries are transmitted to a small open economy. Historically, Ukraine had tight trade linkages with the euro area, Russia, and the countries of Central and Eastern Europe (CEE) and the Commonwealth of Independent States (CIS). Figure 1 shows the trade composition (exports and imports of goods) of Ukraine with major trading partners over the last few

[1] The opinions and conclusions in the paper are strictly those of authors and do not necessarily reflect the views of their affiliated institutions.
[2] According to the World Bank database.
[3] Faryna (2016b) estimates the degree of exchange rate pass-through in Ukraine to be 0.3-0.4, which is relatively high compared to other emerging economies.

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decades. In the early 2000s, Ukraine's major trading partner was Russia, with a trade share of about 40% due to tight linkages in production and common supply chains persisting since the time of the Soviet Union. The euro area was the second largest trading partner of Ukraine, with a trade share of about 30%. These shares had been slightly decreasing ahead of the 2008 global financial crisis (to 30% and 20% for Russia and the euro area, respectively) and Ukraine has since been increasing its trade with other emerging economies. After the global financial crisis, which had a particularly strong effect on Ukraine's economy, Ukraine rapidly increased its trade with Russia in line with the pro-Russian economic policy of the Ukrainian government. Due to the geopolitical conflict with Russia in 2014, Russian trade dropped to about 20%, while Ukraine shifted its trade to the euro area and CEE economies. Meanwhile, China increased its share in Ukraine's trade structure from 3% to more than 10%.

The existing literature provides empirical evidence that Ukraine is sensitive to foreign shocks and that cross-country spillover effects are considerable and significant. Several studies examine the transmission of foreign output shocks to Ukraine within the CIS region. Feldkircher (2015) finds that the US and euro area play a dominant role for the region and for Ukraine in particular. Meanwhile, as argued in Feldkircher & Korhonen (2014), the sensitivity to emerging economies (e.g., China) remains moderate, but is stronger compared to other countries. The importance of the Russian economy for Ukraine is confirmed in Alturki et al. (2009). Faryna & Simola (2018) also report a high sensitivity to US, euro area, Russian, and Chinese output shocks. In addition, several studies provide evidence for the importance of the CIS region in inflation and exchange rate developments, see Comunale & Simola (2018), Faryna (2016a), Beckmann & Fidrmuc (2013), and Dreger & Fidrmuc (2011).

In the new globalized world, where all countries have tight trade linkages, country-specific foreign shocks can amplify the response of an economy through high-order transmission channels. The analysis of the sensitivity of an economy to external shocks, therefore, should take into account the multilateral perspective of the world economy. In this paper, we develop a framework to analyze the sensitivity of Ukraine to foreign shocks from its major trading partners, and how this sensitivity has evolved during the 2000s. In addition, we examine the importance of direct and indirect channels in the propagation of these shocks. We employ a global vector auto regressive (GVAR) model, which includes major macroeconomic variables for 30 economies linked together by trade and financial relationships. The GVAR model in this paper is almost identical to the one in Faryna & Simola (2018), which studies the transmission of international output shocks to the CIS region. Our version of the GVAR model, however, includes a different specification for the Ukrainian individual model, since our focus is a single economy.

First, we develop a GVAR model and evaluate its ability to replicate the propagation of various shocks to the Ukrainian economy. For this purpose, we conduct a bootstrap simulation to test the significance of Ukraine's response to domestic output, foreign output, and oil price shocks. The GVAR model gives reasonable results, although with limited statistical significance. Meanwhile, the response to a global output shock remains statistically significant, indicating that the GVAR model can be a useful tool for exploring the response of the Ukrainian economy to foreign output shocks.

Second, we analyze the sensitivity of Ukrainian economy to country-specific foreign shocks and the evolution of this

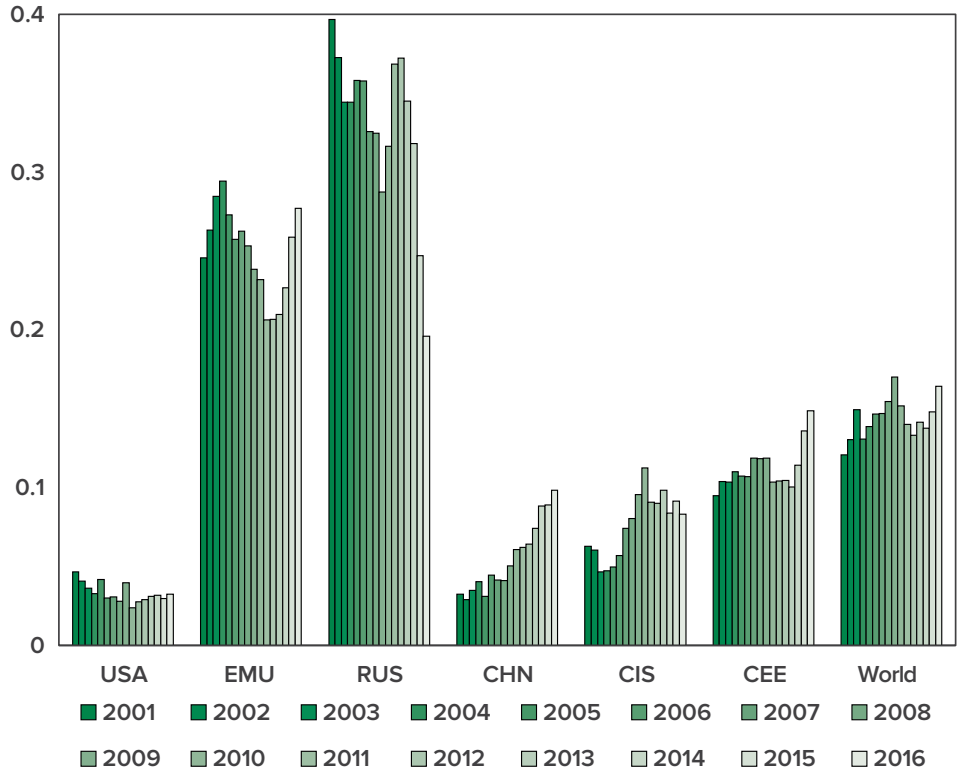

Figure 1. Evolution of Trade Composition in Ukraine.
Note: trade composition is computed using statistics on exports and imports in US dollars from IMF DOTS.

sensitivity over time, as global trade linkages have changed considerably over the last few decades. We compute time-varying responses of Ukrainian output to country-specific output shocks in the US, the euro area, Russia, China, and the CEE and CIS regions to explore how those responses evolve over time. Our general findings suggest that the Ukrainian economy is highly sensitive to foreign shocks, especially in the US, the euro area, and Russia. According to our estimates, a mild recession in the US of a 1% drop in output generates a substantial recession in Ukraine, with a drop in output of about 2.2%. A similar 1% drop in output in the euro area and Russia translates to a drop of output in Ukraine of about 1.7%. Finally, the same drop of output in the CEE area, China, or CIS leads to a decline in output of about 0.4% in Ukraine. The response of the Ukrainian economy to euro area and CEE shocks has been steadily increasing over last couple of decades, whereas it has been slightly decreasing with regard to US and Russian shocks.

Lastly, we analyze how Ukraine's sensitivity to country-specific shocks depends on whether the propagation channels are direct and indirect. In particular, our analysis provides insights on the importance of indirect effects. For this purpose, we solve the model under counterfactual scenarios for Ukraine's trade composition and explore how bilateral trade with a specific country amplifies or counteracts the responses of the Ukrainian economy to foreign shocks. We find that Ukraine's sensitivity to output shocks in the US and in the euro area remains high even if the direct bilateral trade channel is disabled, indicating that even the indirect effects from these shocks are very important for the Ukrainian economy. The response to Russian output shocks also remains strong in counterfactual scenarios due to indirect trade channels, although it is slightly lower than due to the direct trade channel. Foreign shocks to the CEE and CIS regions have a much stronger effect through the direct trade channel. Finally, the propagation of Chinese output shocks through indirect trade channels is weak, indicating that Ukraine's trading partners and the global economy in general remain fairly resistant to macroeconomic developments in China. This is slightly surprising, but similar results have been reported in earlier literature. Thus, Ukraine's sensitivity to shocks in the CEE, CIS, and China are mainly defined by direct bilateral trade linkages.

This paper proceeds as following. In the second section, we briefly describe the global vector auto regressive model used for the analysis, with a particular focus on Ukraine. The third section provides results on i) the sensitivity of major Ukrainian macroeconomic variables to domestic and foreign shocks, ii) the evolution of responses to country-specific foreign shocks over time due to changes in trade composition, and iii) counterfactual scenarios with alternative trade compositions. The fourth section concludes.

2. GLOBAL VECTOR AUTO REGRESSIVE MODEL FOR UKRAINE

In this section, we briefly describe the global vector auto regressive (GVAR) model used to study the transmission of international shocks to major Ukrainian macroeconomic variables. We employ the GVAR model developed in Faryna & Simola (2018), which comprises 30 economies and covers about 80% of world PPP-GDP. However, given that our major focus is a single country, we pay more attention to the specification of the Ukrainian model within the GVAR, while the rest of the model is left unchanged.

Global VAR models have become popular for studying the dynamic transmission of shocks across countries, since they take into account high-order cross-county spillover effects from the multilateral perspective.[4] They incorporate cross-country interdependencies, both static and dynamic, while solving the dimensionality issue.[5] The GVAR model is presented in Pesaran, Schuermann & Weiner (2004) and is further developed in Dees, di Mauro, Pesaran & Smith (2007). Various studies employ GVAR models to explore cross-county spillovers (see, for example, Galesi & Lombardi, 2009; Harahap et al., 2016; Feldkircher, 2015; and Hajek & Horvath, 2018).

The GVAR is a combination of individual country $VARX^*(p_i,q_i)$ models that include domestic variables and weekly exogenous foreign and global variables:

$$\Phi_i(L,p_i)X_{it} = a_{i0} + \Lambda_i(L,q_i)X^*_{it} + \Psi_i(L,q_i)D_t + u_{it}, \qquad (1)$$

where $i=1,2,3,\ldots,N$, N is the number of countries in the panel, X_{it} is a set of country-specific domestic variables; X^*_{it} is a set of country-specific foreign variables; D_t is a set of common global variables; and u_{it} is a vector of structural country-specific shocks. The lag order for domestic variables p_i is assumed to be higher than the lag order for foreign and global variables q_i to ensure the relative importance of domestic variables. Foreign variables are calculated as weighted averages of the corresponding domestic variables in other countries, $X^*_{it} = \sum_{j=1}^{N} \omega_{ij} X_{jt}$, where ω_{ij} is a set of weights such that $\sum_{j=1}^{N} \omega_{ij} = 1$. For example, foreign output for an individual country is calculated as the weighted average domestic output in the rest of the world, while weighting is based on bilateral trade flows between countries. Global variables, in turn, are usually estimated within individual country models (e.g., within the US individual model) or in a separate so-called *dominant unit model* which allows the inclusion of endogenous relationships between global variables and all countries in the panel.[6]

Each individual country model is estimated separately. Thereafter, individual models are combined through weight matrices ω_{ij} so that foreign variables for each country are linked to their domestic counterparts in other countries. After all of the models are linked together, the model is solved to compute Generalized Impulse Response Functions (GIRFs)[7] in order to track how country-specific and variable-specific structural shocks transmit through the world's economies. For example, a shock to a specific variable in one country affects other domestic variables in this country, but also foreign variables in other countries with tight relationships. One of the most important advantages of GIRFs in GVARs is their ability to solve shock identification problems under

[4] The GVAR model is a type of Panel VAR model. Canova & Ciccarelli (2013) provide a comprehensive overview of the empirical applications of Panel VAR models.
[5] Although they have major advantages, Panel VARs usually face several estimation problems. In particular, the large number of endogenous variables in the panel usually exceeds the number of observations in the sample. This problem is crucial for cross-county analysis, since the data availability for most emerging small open economies is limited. On the other side, a large number of cross-section units generates shock identification problems. Global VARs can solve those issues.
[6] See Chudik & Pesaran (2013), Smith & Yamagata (2011) for details.
[7] See Pesaran and Shin (1998) for details.

several conditions. In particular, if cross-country residual correlation and country-specific serial residual correlation is low, GIRFs can be used to evaluate the response to country-specific and variable-specific shocks.

In this paper, we utilize the model developed in Faryna & Simola (2018) which, in turn, follows the approach described in Dees, di Mauro, Pesaran & Smith (2007).[8] The GVAR model includes 30 economies covering about 80% of world PPP-GDP.[9] Each individual country model includes four domestic variables: consumer inflation, real output, the nominal short-term interest rate and real exchange rate for the period 2001Q1 – 2016Q4. The model also incorporates time-varying trade flows[10] and financial linkages[11] to compute foreign output and foreign interest rate variables, respectively. Oil prices are modeled in a dominant unit model, with PPP-adjusted GDP weights for determining the contribution of each country to oil price dynamics. A brief description of the model is presented in Table 1 (apart from the Ukrainian model).

Given that our major focus is a single economy – that of Ukraine – we pay additional attention to the specification of the individual Ukrainian model. Faryna & Simola (2018) restrict the lag order for domestic, foreign, and global variables to unity due to the relatively short sample for a complex GVAR model. In this paper, however, we keep the structure of the global economy unchanged but increase the lag order for Ukrainian variables. We use the standard procedure of minimizing AIC to determine the lag order. Thereafter, we conduct a set of diagnostic tests to check model adequacy. Table 2 reports summary results of tests of the specification of the individual Ukrainian model. The results of the diagnostic tests suggest that the model for Ukraine is stable and well specified.

3. THE RESPONSE OF UKRAINE TO DOMESTIC AND FOREIGN SHOCKS

This section provides results regarding the transmission of domestic and foreign shocks to Ukraine. We calculate GIRFs for Ukraine using several strategies for computing alternative trade-matrices for model solution. First, we analyze the benchmark response of four Ukrainian domestic variables to shocks in domestic output, aggregated global output, and oil prices, using a period-average trade structure as the solution matrix. GIRFs are computed using a bootstrap simulation method that in addition to median GIRF estimates provides information about the statistical significance of responses. Second, we show how the response of Ukrainian output to country-specific foreign shocks has evolved over time as trade linkages have undergone considerable change (see Figure 1). Lastly, in order to understand the importance of indirect propagation channels on Ukraine's sensitivity to foreign shocks, we utilize counterfactual trade matrices for model solution. In particular, we compute GIRFs assuming that Ukraine trades only with a single country or region.

3.1. The Response to Domestic Output, Global Output, and Oil Price Shocks

The GVAR model described in the second section is first used to compute GIRFs to a 1% domestic output and aggregated global output shocks, as well as a 50% oil price shock. The benchmark simulation employs period-average trade and financial compositions for all of the countries in the panel. Benchmark GIRFs are computed using the bootstrap simulation method which allows identification of the confidence level.

The responses given by the model to a 1% domestic output shock are largely in line with expectations, see Figure 2. Real activity increases, which, in turn, drives inflation up. Consequently, the interest rate goes up while the exchange rate appreciates. In the long term, the responses are, however, statistically insignificant. This indicates that the GVAR model has a limited ability to explain internal relationships and dynamics for Ukraine. This might be related to the relatively short time period under consideration, especially as it includes several possible structural breaks.

We further explore whether the GVAR can be useful in analyzing the effect of foreign shocks on Ukraine. We compute the aggregated global output shock for the benchmark solution by assuming that the rest of the world is a single region in terms of shock origin. We calculate the rest of the world region by weighting country-specific variables using PPP-adjusted GDP aggregation. The global output shock here is common for all countries except Ukraine. Figure 3 plots the response of the four Ukrainian domestic variables to an aggregated global output shock. A one-percent increase in global output generates a roughly 2-percent increase in Ukrainian output on impact, and about a 3-percent increase over the long-term. An increase in real activity abroad generates additional demand for Ukrainian goods, which stimulates Ukrainian output and slightly raises inflation. Higher inflation and increased exports may lead to the appreciation of the real exchange rate. Meanwhile, the response of the interest rate is negative, which is somewhat counterintuitive, as both output and inflation go up. However, given that Ukraine has been practicing a fixed exchange rate regime, the negative response of the interest rate to a positive global output shock can be explained by the appreciation of the real exchange rate.

Compared to previous studies on Ukraine and other emerging small open economies, our estimates of the output response are relatively large.[12] This can be explained by the specification of the Ukrainian model, where the lag order for domestic and weekly exogenous variables is not limited to unity. On the one hand, the inclusion of additional lags takes into account delayed macroeconomic effects and provides richer dynamics. On the other hand, the complex structure of the GVAR model can amplify responses via the higher-order transmission channels. Nevertheless, the response of Ukrainian output is statistically significant, with the lower confidence band being higher than 1 percent. The responses of other variables are statistically insignificant, except for

[8] For the technical procedure of model estimation, we use an open source Matlab toolbox for modeling GVAR provided by Smith & Galesi (2014).
[9] According to World Bank database for 2000-2016.
[10] The weights used to construct foreign output variables are based on annual bilateral goods trade flows (i.e. exports plus imports in US dollars). The trade data come from the IMF Direction of Trade Statistics database, which provides data on the geographical distribution of countries' exports and imports.
[11] To incorporate financial exposures of CIS economies, the authors use the IMF's Coordinated Portfolio Investment Survey (CPIS), a dataset on the stock of cross-border holdings of equities and debt securities broken down by issuer residence.
[12] See, for example, Faryna & Simola (2018), Feldkircher (2015), Feldkircher & Korhonen (2014).

the real exchange rate, which appreciates in response to a positive foreign output shock. Our analysis suggests that the GVAR model can be used effectively for studying the response of real activity in Ukraine to foreign output shocks.

Lastly, we compute the GIRFs to a global oil price shock for Ukrainian variables. Given that Ukraine's economy can be characterized as both commodity importing (e.g. energy imports) and commodity exporting (e.g., metals and agriculture exports), the direction of the response to an oil price shock is not straightforward to assess. On the one hand, the increase in energy prices leads to an increase in costs for energy importers and, hence, negatively affects output. On the other hand, oil prices closely correlate with other commodities. Therefore, assuming that the increase in oil prices is associated with increases in prices for other commodities, higher prices should not automatically decrease real output. The aggregated effect, therefore, depends on what channel dominates. In addition, a positive output response of Russia and other trading partners in the CIS region to an oil price shock may generate additional demand for Ukrainian goods which, in turn, drives Ukrainian output up. Figure 4 plots the response of Ukrainian variables to a 50% oil price shock together with 90% confidence bands. The initial response of output is positive (about 4%), while the real exchange rate appreciates (about 9%) with these responses being significant on impact. Long-term responses, however, are insignificant, indicating that the GVAR model is unable to explain the response of Ukraine's economy to commodity price shocks.

Having explored the properties of the benchmark GVAR model with a particular focus on Ukraine, we find that this framework can be useful to understand how foreign output shocks affect Ukrainian real activity. Our estimates can be interpreted in order to measure the response of Ukrainian output to a global recession. In particular, a mild global recession of 1 percent output drop generates a substantial recession of 2% drop in Ukrainian output on impact and 3% drop in the long-run. This indicates that Ukrainian economy is particularly sensitive to global shocks.

However, the cross-country transmission of output shocks heavily depend on trade relationships. Recall that foreign output variables for each individual country model are computed using trade-weighted matrices. Therefore and given that the trade composition in Ukraine has been changing considerably over last decades, we further analyze the response of Ukraine to country-specific foreign output shocks and how it has been changing over time.

3.2. Evolution of Responses to Country-Specific Foreign Output Shocks

We compute GIRFs for Ukraine to 1 percent output shocks in the US, euro area, Russia, China, CEE, and CIS region excluding Russia.[13] All these countries or regions have been important trade partners for Ukraine over the last few decades. The GVAR model in this paper performs fairly well in terms of dealing with cross-country residual correlation which allows us to identify country-specific shocks. However, the relatively high number of individual country models with first order serial correlation limits our ability to identify variable-specific structural shocks. Therefore, in our further analysis we are able to distinguish between shocks to foreign output across countries, while variable-specific structural identification is limited.[14] Given that our model utilizes time-varying trade matrices, we compute GIRFs to output shocks in all the above-mentioned economies for each year starting from 2000 until 2016. Figure 5 shows time-varying long-term responses for Ukraine.[15]

In terms of the degree of sensitivity, Ukraine is highly sensitive to output shocks in the US. A one-percent shock to output in the US increases Ukrainian output by about 2.2%. Although the share of the US in the trade composition in Ukraine is relatively moderate (about 5%), the importance of the US can be explained by its dominance in the global economy in general. It seems that the response to the shocks originating in the US has been slightly declining over the last two decades (2.4% in 2000 compared to 2.1% in 2016).

The high sensitivity of Ukraine to a euro area shock, in turn, is mainly explained by tight trade relationships (about 25% of Ukraine's total trade, see Figure 1). The response to a euro area shock has been steadily increasing from 0.5% in 2000 to 1.7% in 2016. This is partly due to the increased significance of the euro area as a trading partner for Ukraine, but, as argued in Faryna & Simola (2018), is also due to changes in the trade compositions of other countries, which have made the euro area more powerful in terms of the shock transmission.

The response of Ukraine to Russian output shocks is relatively high as well. A one-percent increase in Russian output translates to an increase of about 1.7% in Ukrainian output. Ukraine's sensitivity to Russian shocks has somewhat decreased since the start of the geopolitical conflict between Russia and Ukraine in 2014, but remains relatively high – despite the considerable drop in the trade relationships between the countries. This can be explained by the importance of the Russian economy to other emerging economies (e.g., CIS and CEE) to which Ukraine has shifted its trade recently.

Despite the growing importance of China on the global stage, as well as in the trade composition of Ukraine, the Ukrainian economy's response to Chinese output shocks remains moderate. A one-percent increase of output in China is associated with an increase of about 0.4% in Ukrainian output in 2000, and about 0.5% in 2016. Noteworthy, the sensitivity of Ukraine to Chinese shocks is higher than for several other countries, as shown in Faryna & Simola (2018).

The CEE and CIS economies have always been important trade partners for Ukraine. The trade share of CEE and CIS increased from about 10% in 2000 to 15% for CEE in 2016, and from 6% to 9%, for the CIS. The response to a one-percent shock in the CIS translates to about a 0.5% increase in output in Ukraine, with that response having slightly decreased in recent years. The effect of a one-percent output shock in CEE, in turn, has rapidly increased – from 0.3% to 0.6% – in recent years, which can be explained by increases in trade between Ukraine and CEE.

[13] CEE and CIS variables were computed using PPP-adjusted GDP aggregation. CEE region comprises five countries: Bulgaria, Czech Rep., Hungary, Poland, Romania. CIS region excludes Russia and comprises four countries: Azerbaijan, Belarus, Georgia, Kazakhstan.
[14] For example, we are not able to treat foreign output shocks as demand shocks.
[15] GIRFs here are calculated at the 30th period of response.

To sum up, Ukraine is particularly sensitive to output shocks in the US, the euro area, and Russia, while the response to euro area shocks has been steadily increasing over the last couple of decades. The response to other emerging markets remains moderate and stable, except of the effect from CEE, to which Ukraine has rapidly shifted its trade in recent years.

3.3. Counterfactual Scenarios on Alternative Trade Compositions

In the previous subsection we showed that changes in trade composition have influenced the sensitivity of the Ukrainian economy to foreign output shocks. However, the changes in the Ukrainian responses seem not to be fully explained by changes in the trade structure of Ukraine. Therefore, we further develop a strategy based on counterfactual scenarios of trade composition in order to evaluate the relative importance of direct and indirect trade channels in the Ukrainian economy's sensitivity to foreign shocks.

For this purpose, we assume that Ukraine trades only with a single economy (country or region) while the rest of the world keeps its trade composition unchanged. Technically, we adjust the way foreign-specific variables are calculated for model solution. In particular, in the equation for foreign variables, $X^{*}_{UKRt} = \sum_{j=1}^{N} \omega_{UKRj} X_{jt}$, we change the vector of trade weights for Ukraine ω_{UKRj} so that it contains one element, which equals "1", and other elements which equal "0". If $\omega_{UKR}(j)$=1, Ukraine has full trade linkage with country j. If $\omega_{UKR}(j)=0$, Ukraine has no trade linkage with country j. In addition, we assume that Ukraine has no effect on other countries. We normalize trade and financial weights so that the share of Ukraine equals zero for all countries in the panel. Given that Ukraine's original trade share for the rest of the world is very small, this assumption has almost no effect on the amplification of shocks in the model. Financial linkages remain unchanged for the world economy, as well as for Ukraine.

The analysis can be useful for identifying how foreign output shocks affect Ukraine through direct and indirect trade channels. In particular, a foreign shock to a specific country can affect other countries through their direct trade relationships. A positive shock to a trading-partner economy, e.g. the euro area, creates additional demand for Ukrainian goods, which stimulates exports, and hence raises production and output. In addition, given the complex structure of the GVAR model, which takes into account dynamic and contemporaneous cross-country interdependencies, directly-affected countries can also transmit such shocks further to their trading partners. For example, a positive shock in the euro area creates additional demand for goods not only in Ukraine, but also in other economies linked by bilateral trade, e.g. CEE, the CIS, Russia. These economies, in turn, have an additional effect on Ukraine through the demand channel. Note also that the response to a rise in foreign output is not necessarily positive. If countries gain from bilateral trade, the response of output is expected to be positive. However, if countries face global competition, the response might be negative. Therefore, the general effect of direct and indirect channels depends on the composition of global trade.

A GVAR model can be a useful tool for decomposing direct and indirect channels and illustrating the importance of indirect effects that are not easily identified otherwise. For different counterfactual scenarios, we compute GIRFs for Ukrainian output in response to country-specific output shocks over the long-term, see Figure 6. Each panel corresponds to the response of output in Ukraine to foreign output shocks in the US, the euro area, CEE, China, Russia, and the CIS. Each bar, in turn, shows the response of output in Ukraine in a scenario in which Ukraine trades only with the corresponding economy marked on the x-axis. The baseline response corresponds to the scenario in which trade-weighted solution matrices are computed as period-average trade compositions for each country.

We can note two things from Figure 6, with the example of a shock originating in the US economy in the upper left corner. First, compared to the baseline, the response of the Ukrainian output to a shock in US output is higher when Ukraine trades only with the US. This can be expected, as in this case the weight of the US in the foreign output variable is much higher than in the baseline, exceeding the output effects coming from other countries. Second, we can see that an output shock originating in the US has a relatively strong effect on Ukrainian output, even if Ukraine is not directly trading with the US. If Ukraine is trading, e.g., only with the EMU area, the response of Ukrainian output to a shock originating in the US is nearly as strong as in the baseline, as the US shock increases output and demand in the EMU area, hence supporting Ukrainian exports and output.

Note that our decomposition does not fully distinguish between direct and indirect bilateral trade effects. In particular, even if Ukraine trades only with a shock-originating economy, higher-order spillover channels are enabled. Other affected countries can spill back to a shock-originating economy and have a third-round effect on Ukraine. While the baseline response is the sum of direct and indirect effects given the average trade structure over time, responses under counterfactual scenarios do not measure the direct effect from the baseline response. In contrast, under the counterfactual scenario, we increase the relative weight of the direct effect so that it can be higher than the baseline response if the sensitivity to a shock-originating economy is also relatively higher. Nevertheless, this analysis can indicate whether the difference between responses in various scenarios changes, and whether the sensitivity to country-specific shocks depends on direct bilateral channels, or if it remains stable even if countries have no direct linkages.

This analysis suggests that the sensitivity of Ukraine to output shocks in the US does not solely depend on bilateral trade flows with the US. In particular, even if Ukraine only trades with other countries, the response to shocks in the US does not change considerably. Meanwhile, if Ukraine trades only with the US, the response of Ukrainian output increases from 2.2% (baseline) to 2.6%. This indicates the dominant role of the US in the world and the existence of strong indirect channels for the transmission of its shocks.

We get similar results for sensitivity to output shocks in the euro area. Ukraine's response to a euro area output shock increases form 1.5% (baseline) to 1.9% if Ukraine trades only with the euro area. However, if Ukraine only trades with other countries, the response to a euro area shock does not drop considerably. Similar to the US economy, the euro area can play an important role for other countries and affect Ukraine through indirect trade channels.

Ukraine's sensitivity to the Russian economy seems to depend on both direct and indirect channels. Under full trade linkage with Russia, Ukrainian sensitivity increases from 1.4% (baseline) to 1.8%. Meanwhile, the response decreases to about 1% if Ukraine only trades with other countries. Although the direct trade channel seems to be crucial for the transmission of Russian shocks to Ukraine, the indirect channel should not be ignored: Ukraine also has tight trade relationships with the CIS region and other economies that are sensitive to Russian shocks.

The response of Ukraine to foreign shocks in China, CEE, and the CIS seems to depend mainly on direct bilateral trade linkages. In particular, under full trade linkage with China, CEE, and the CIS, Ukraine's response increases from 0.6%, 0.5%, and 0.4% (baseline) respectively, to 1.2%, 1.6%, and 0.8%. If Ukraine trades with other countries, those responses decrease or remain the same. This suggests that Ukraine's response to shocks from emerging economies are not amplified much through indirect trade channel.

The analysis shows that especially in the case of shocks from the US and the euro area, indirect effects are also very important – even beyond direct bilateral trade linkages. Ukraine's sensitivity to shocks from most emerging economies mainly depends on bilateral trade linkages, but indirect channels can also play a role, although these are more moderate.

4. CONCLUSIONS

Being a small open emerging economy with tight trade linkages to advanced economies and the emerging world, Ukraine is sensitive to foreign shocks. In order to explore the transmission of country-specific foreign shocks to Ukraine, we employ a global vector auto regressive model that consists of 30 economies, including Ukraine and its major trading partners. The estimated individual country models are combined by trade and financial linkages which determine the role of each country in the transmission of international shocks.

We compute Generalized Impulse Response Functions for Ukraine using a bootstrap method and find that the model can be effectively used to assess the Ukrainian economy's response to foreign output shocks. In particular, the results suggest that a 1% shock to aggregated global output translates to about 3% increase in Ukrainian output in the long-term, with that response being statistically significant at 90% confidence level.

We then compute time-varying responses of Ukraine to country-specific shocks to foreign output in the US, the euro area, Russia, China, and the CEE and CIS regions. Our findings indicate that the US plays a dominant role for Ukraine, despite having a relatively low share in Ukrainian trade structure. A mild recession in the US of a 1% drop of output generates a substantial recession in Ukraine of about 2.2%. The sensitivity of Ukraine to output shocks in the euro area and Russia is high as well, which can be explained by the strong trade links between these countries. A similar drop of output in the euro area and Russia translates to a drop of about 1.7% in output in Ukraine. The response to euro area shocks, however, has increased considerably since the early 2000s, which does not tally with changes in Ukraine's trade structure. Meanwhile, the response to shocks in Russia has sharply decreased since the start of the geopolitical conflict in 2014 and the imposition of trade restrictions by both countries. The sensitivity to output shocks in China, the CIS, and CEE remains relatively lower. The same 1% drop of output in CEE, China, and CIS leads to a decline of about 0.4% in output in Ukraine. However, since recessions tend to be much deeper in Russia, CEE, and the CIS, the general effects of a recession in these countries or regions can be painful for Ukraine.

In order to illustrate the importance of indirect trade linkages in the propagation of foreign shocks, we solve the GVAR model under counterfactual scenarios for Ukrainian trade composition. We assume that Ukraine trades only with a single country, and compute impulse responses to output shocks in the above-mentioned economies. We find that output shocks in advanced economies, especially the US, have strong indirect effects on Ukraine, even if direct bilateral trade is small, as they affect other countries that trade more with Ukraine. For emerging-economy shocks, Ukraine's response mainly depends on the direct trade linkages, while indirect effects are not very important. In particular, the response of output in Ukraine decreases considerably if bilateral trade with shock-originating economies is limited.

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APPENDIX A. TABLES

Table 1. Description of the GVAR Model: Main Features and Variables

Time coverage	2001Q1 — 2016Q4
Countries and regions	Ukraine USA China Russia Euro area (block with 12–19 countries): Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain (2001–2006); *plus* Slovenia (2007), Cyprus, Malta (2008), Slovakia (2009), Estonia (2011), Latvia (2014), Lithuania (2015) CIS (4 countries): Azerbaijan, Belarus, Georgia, Kazakhstan. *Note that Georgia left the organization in 2008 but otherwise has tight relations with countries in the region.* CEE (5 countries): Bulgaria, Czech Rep., Hungary, Poland, Romania) Rest of the World (16 separate countries): Australia, Brazil, Canada, Chile, Denmark, Iceland, India, Indonesia, Japan, Korea, Mexico, New Zealand, Norway, Sweden, Turkey, UK
Variables *(Sources: IMF IFS, OECD, National sources)*	*y* = real GDP, index (average of 2010=100), seasonally adjusted, in logs *dp* = consumer price inflation, seasonally adjusted, first log-differences *e* = real exchange rate (nominal exchange rate w.r.t USD deflated by domestic CPI), index (average of 2010=100), in logs, (up – depreciation) *r* = nominal short-term interest rate, typically 3-month or 90-day interbank interest rate *f* = Brent oil price, index (average of 2010=100), seasonally adjusted, in logs
Weights *(Sources: IMF DOTS, IMF CPIS)*	Trade: shares of partner countries in total goods trade (sum of exports and imports) Financial: shares of partner countries in the stock of cross-border holdings of equities and long- and short-term debt securities
Diagnostic test (excluding Ukraine)	
ADF Stationarity	36 out of 202 series — I(0) 176 out of 202 series — I(1)
Lag length	p=1 and q=1 (degrees of freedom considerations)
Cointegration	Trace statistics for rank selection (1 to 3 cointegration equations) LR test for the type of deterministic components (cases II-IV)
Weak exogeneity	69 out of 84 variables (F-test at 5% significance level)
Residual serial correlation	No residual serial correlation for 83 out of 115 equations (F-test at 5% significance level)

Table 2. Diagnostic Tests for Individual VECMX* Model for Ukraine

ADF stationarity test

	y	dp	e	r	y*	r*	f
levels	-1.86	-3.16*	-0.89	-2.99*	-2.35	-1.84	-0.98
(CV)	(-3.45)	(-2.89)	(-3.45)	(-2.89)	(3.45)	(-3.45)	(-3.45)
first differences	-4.16*	-5.67*	-4.52*	-7.20*	-3.29*	-3.61*	-5.59*
(CV)	(-2.89)	(-2.89)	(-2.89)	(-2.89)	(-2.89)	(-2.89)	(-2.89)

Lag order selection (AIC)

q\p	1	2	3	4
1	-287.0	-288.0	-283.2	-300.5*
2	-288.9	-286.4	-280.1	-298.0
3	-281.9	-279.9	-274.1	-295.6
4	-278.5	-277.4	-273.6	-297.9

Trace statistics for cointegration rank order selection

H0: r=0 H1: r≥1	H0: r=1 H1: r≥2	H0: r=2 H1: r≥3	H0: r=3 H1: r≥4	Selected rank
134.10	77.20	43.02	13.81	4

Likelihood ratio test on deterministic components in the cointegration equations

	H0: Case III H1: Case IV	H0: Case II H1: Case III	Selected case
LR	10.54	10.51	IV
(CV)	(-3.84)	(-12.59)	

Final VECMX* specification

Domestic variables	p order	Foreign variables	q order	Cointegration rank	Cointegration case
y, dp, e, r	4	y*, r*, f*	1	1	IV

Note: final rank of cointegration was reduced to ensure stable persistence profile.

Test for Serial correlation of the VECMX* residuals

F crit. 0.05	y	p	e	r
2.61	1.66*	0.43*	2.54*	0.40*

Test for weak exogeneity of foreign-specific variables

F crit. 0.05	y*	r*	f	r
4.03	0.03*	0.14*	2.02*	0.40*

APPENDIX B. FIGURES

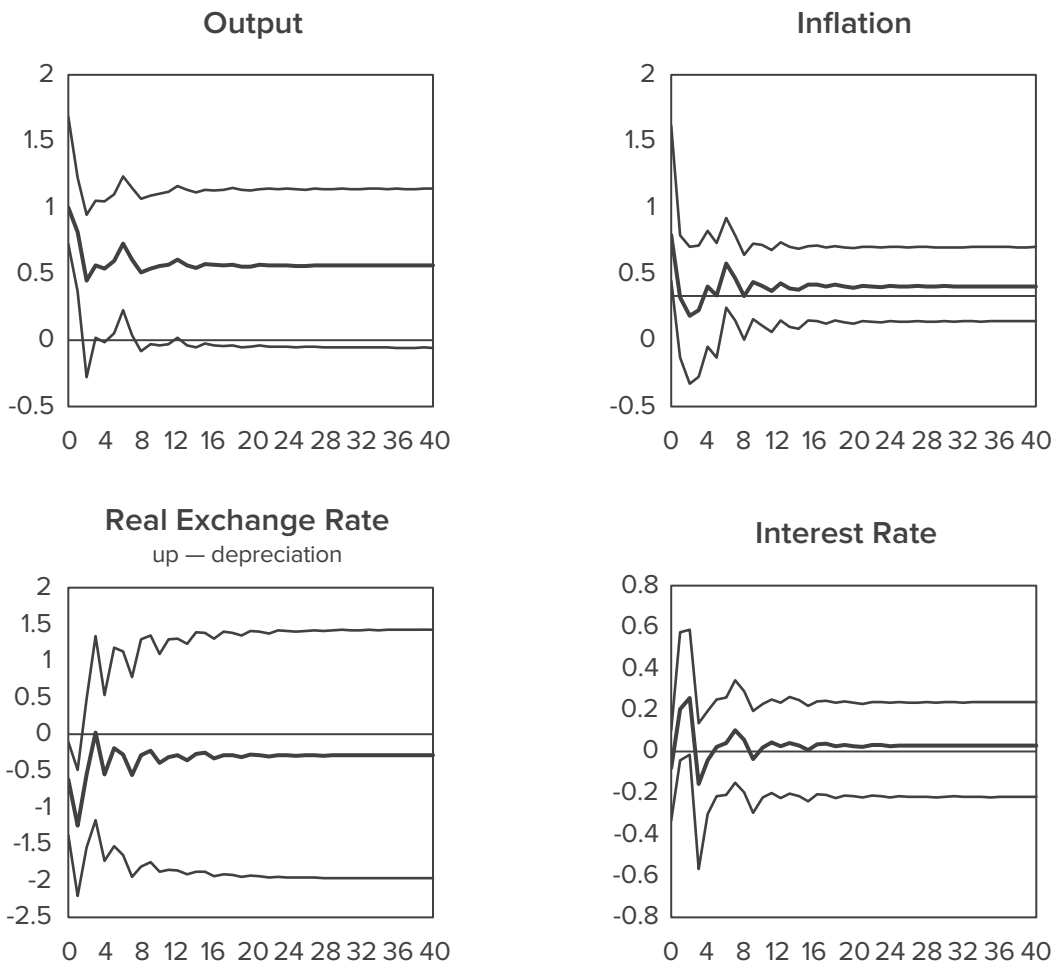

Figure 2. Response of Ukrainian Macroeconomic Variables to 1% Shock to Domestic Output with 90% Confidence Bands (in percent).

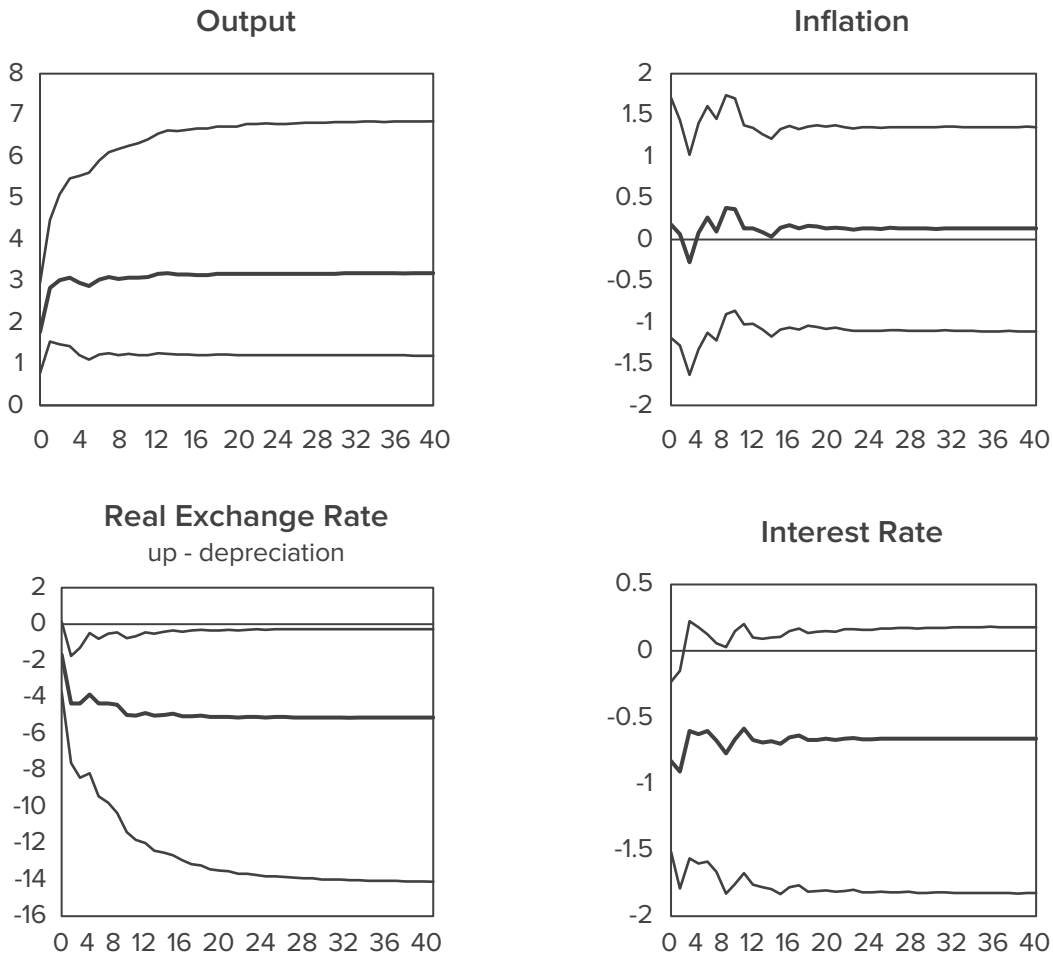

Figure 3. Response of Ukrainian Macroeconomic Variables to 1% Shock to Aggregated Global Output with 90% Confidence Bands (in percent).

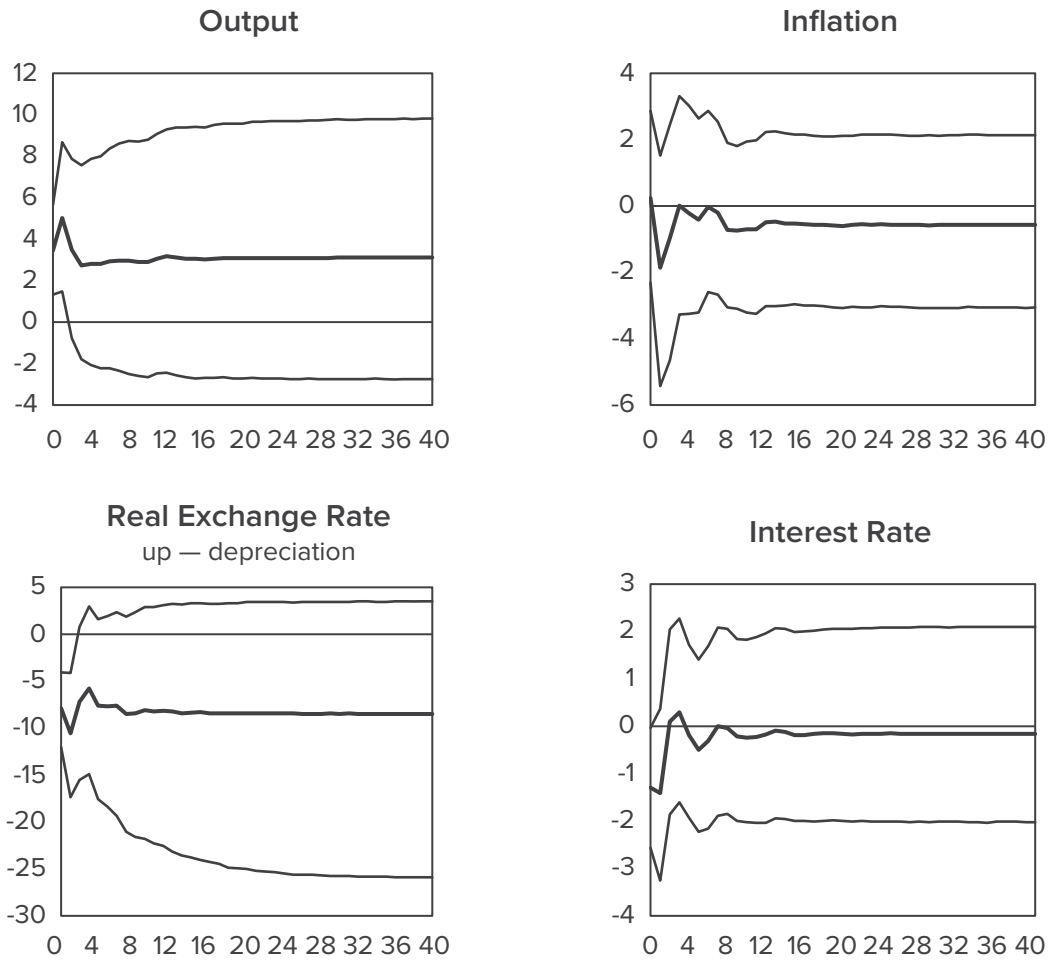

Figure 4. Response of Ukrainian Macroeconomic Variables to 50% Shock to Oil Price with 90% Confidence Bands (in percent)

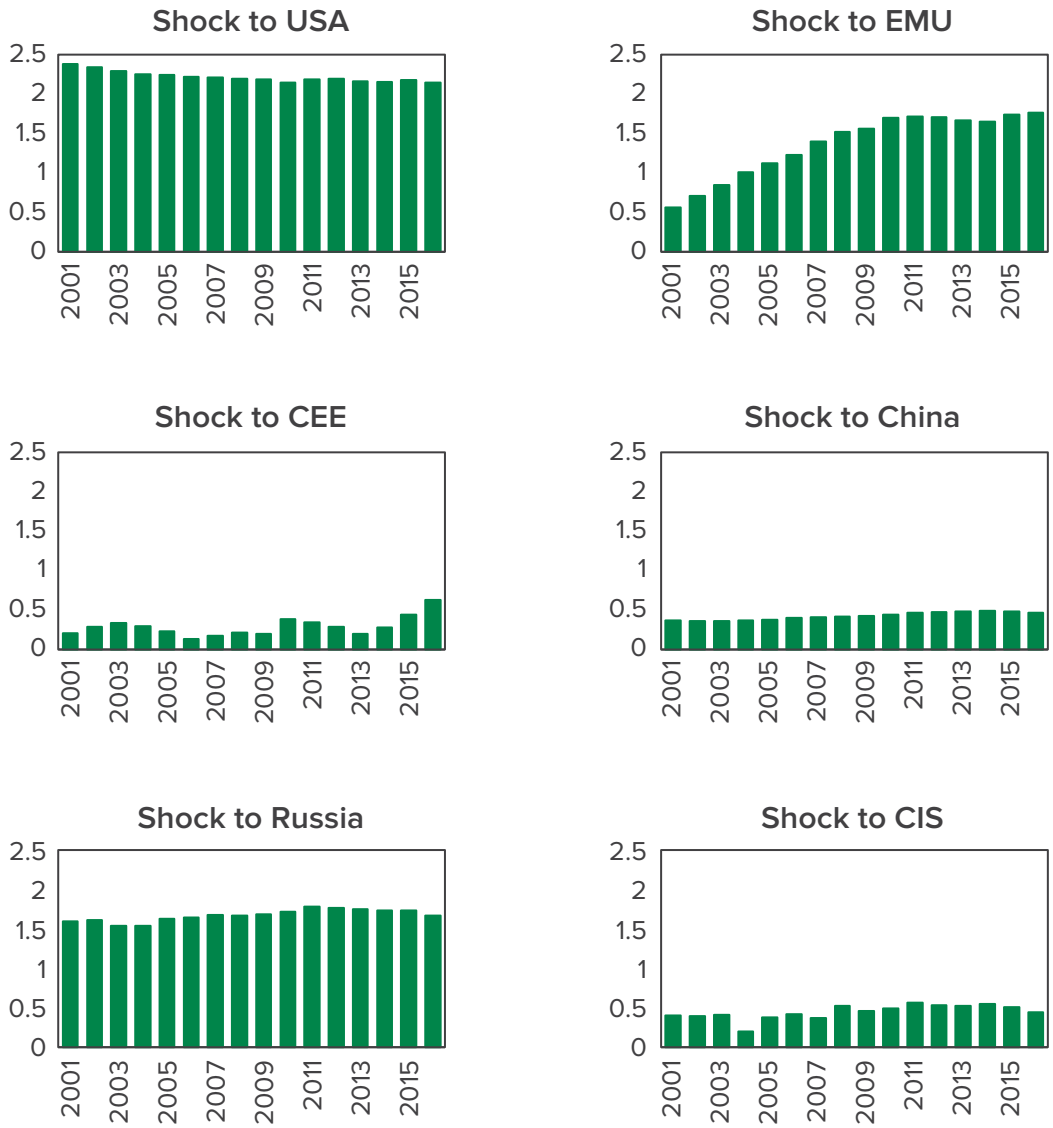

Figure 5. Time-Varying Response of Ukrainian Output to 1% shock to Foreign Output in the USA, EMU, CEE, China, Russia, and CIS (in percent).
Note: time-varying responses are computed using year-specific trade and financial matrices.

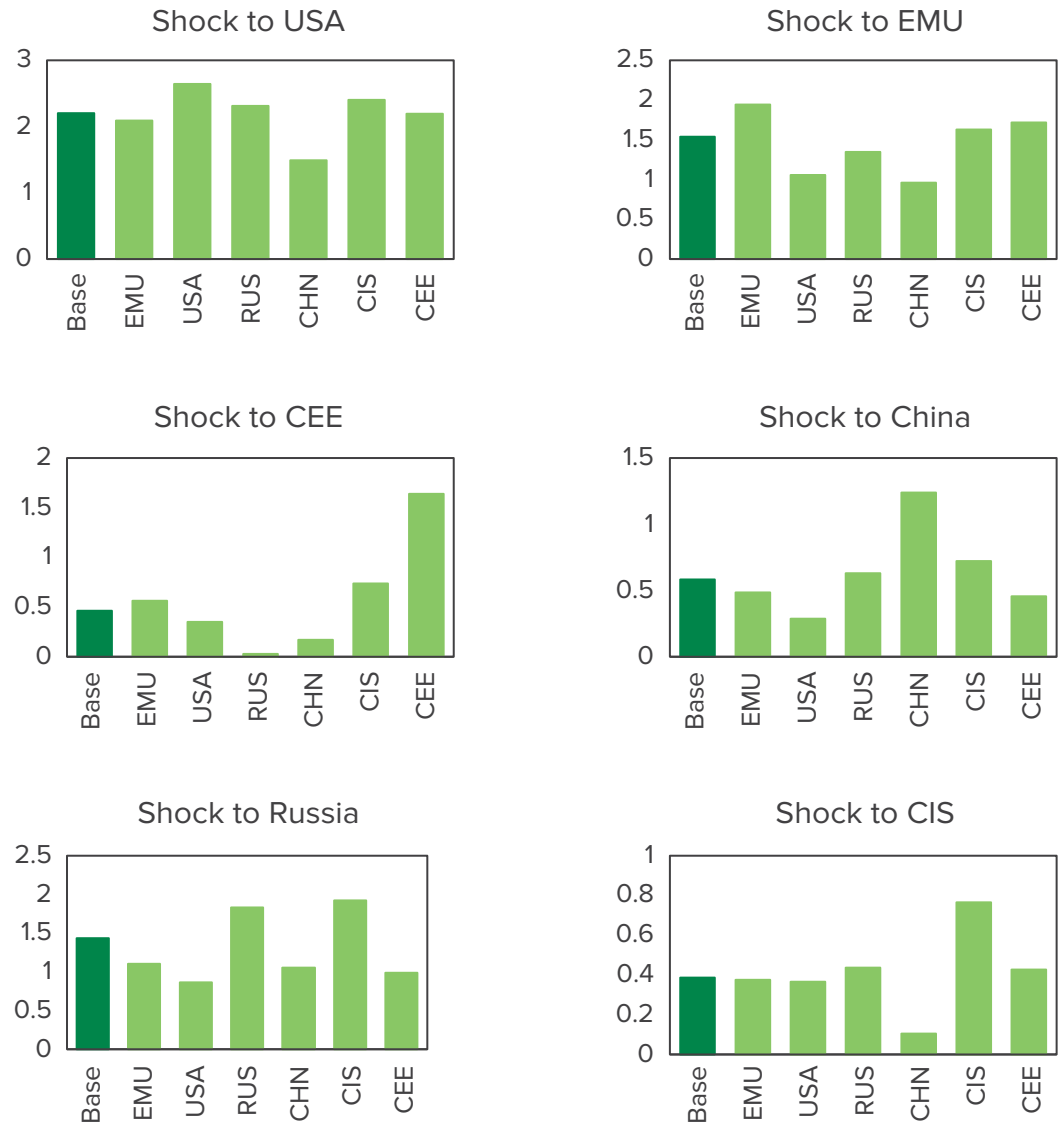

Figure 6. Response of Ukrainian Output to 1% Shock to Foreign Output in the USA, EMU, CEE, China, Russia, and CIS Under Assumption of Full Trade Linkage to Corresponding Economies (in percent).
Note: responses are computed using counterfactual trade matrices where Ukraine trades only with a single country marked on the x-axis.

THE EFFECTIVENESS OF THE MONETARY TRANSMISSION MECHANISM IN UKRAINE SINCE THE TRANSITION TO INFLATION TARGETING

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Abstract This paper analyzes the effectiveness of monetary transmission channels in Ukraine since the National Bank of Ukraine (NBU) transitioned to inflation targeting and after the central bank established its new approach to monetary policy implementation. The authors conclude that the central bank has sufficient control over short-term interest rates in the interbank market and that it uses them to influence other financial market indicators. At the same time, further transmission via the interest rate channel is constrained by weak lending and the banking system's slow post-crisis recovery. The exchange rate channel remains the most powerful avenue of monetary transmission. After the NBU switched to a floating exchange rate and an active interest rate policy, its key rate became a means of influencing exchange rates. The exchange rate channel's leading role is expected to gradually decrease but remain important, as is typical for small open economies.

JEL Codes E31, E42, E52, E58, O11

Keywords monetary transmission mechanism, monetary policy, interest rate channel, exchange rate channel, expectations channel

1. INTRODUCTION

A central bank's key rate has traditionally been the most important instrument of its monetary policy. The central bank uses it to affect the economy, especially to achieve inflation targets. The process of transmitting a signal from the key rate to other interest rates and, in the end, to investment, consumption, and savings decisions is called the "transmission mechanism".

Numerous empirical studies for both developed and developing economies show that the transmission process takes different amounts of time and its effects differ greatly in different countries and in different periods. Bernanke and Gertler (1995) say the monetary transmission is like a black box where the mechanism of step-by-step signal transmission remains hidden and an observer can see only the initial change and the outcome.

The monetary transmission mechanism (MTM) is difficult to study, at least partly because of other factors that affect macroeconomic processes and the endogeneity problem. A central bank's policy represents a response to external challenges and economic agents take into account not only the current policy but also expected actions. For instance, if a change in the key rate is expected to be temporary, banks often opt to not revise interest rates for long-term loans and deposits (e.g., Andries & Billon, 2016). In addition, the response is often asymmetrical; loan rates typically react slower and to a lesser degree to a lowering of the key rate than to an equal rate increase.

In Ukraine, determining the quantitative power of MTM channels is even more difficult owing to the significant structural and institutional transformation of the economy, including changes in the goals and instruments of monetary policy. These changes reflect the way the central bank influences liquidity and financial markets (the first stage of the MTM) and the way monetary conditions affect the economy and inflation (the second stage of the MTM).

In terms of the first stage, since the NBU established its current approach to monetary policy implementation in 2015-16, the relationship between the NBU's key rate (its key monetary policy instrument) and short-term money market rates has been very strong. This was not the case prior to 2015. Additional impacts on financial market indicators are also clearly visible.

However, qualitative assessments of further transmission (the second stage) are challenging. The relationships between financial conditions and indicators of the real sector (economic activity and inflation) are weakened by other factors beyond the central bank's control. These include the consequences of the economic and financial crisis and of the banking system's clean-up in 2014-15, changes in fiscal policy, terms of trade, food supply factors, and more.

The exchange rate also plays an important role in monetary transmission, primarily owing to its substantial effect on economic activity, inflationary processes, finances of households, the corporate and public sectors.[1] This study focuses on both the first transmission stage (the effectiveness of the central bank's influence over exchange rate trends through interest rates and foreign currency interventions) and the second stage (the impact of exchange rates on economic growth and inflation). Both links experienced significant change after the NBU switched from a pegged exchange rate to a floating exchange rate. This study evaluates the effectiveness of monetary transmission channels in Ukraine after the NBU transitioned to inflation targeting, especially through the establishment of a new operational design for monetary policy.

This paper is structured as follows. Section 2 offers an analysis of the key determinants of the MTM in Ukraine, including a description of the latest changes in the NBU's approach to monetary policy and the conditions within which the policy has been executed, with a focus on the characteristics of Ukraine's financial system. Section 3 offers a detailed overview of MTM channels: the interest rate channel, lending channel, exchange rate channel, asset price channel, and expectations channel. This section describes the mechanisms of influence and evaluates the importance of the identified channels. The paper ends with concluding remarks and recommendations on areas of further study.

2. THE DETERMINING FACTORS OF THE MONETARY TRANSMISSION MECHANISM

A well-functioning MTM is an important precondition for the successful implementation of inflation targeting. This monetary policy regime allows central banks to effectively perform their key function of ensuring price stability (Masson et al., 1997; Batini et al., 2005; Airaudo et al., 2016).

Like the majority of central banks in developing market economies, the NBU began implementing inflation targeting when the MTM was in its infancy. To a large degree, that is because the NBU's previous currency peg offered no impetus for the development of the MTM and financial markets. Although the NBU's key rate was a *de jure* "benchmark for the value of money", it *de facto* had no significant impact on other financial indicators. Therefore, a priority objective during the establishment of inflation targeting was to ensure a design that would enable the NBU to control short-term money market rates.

Further transmission occurs primarily via the banking sector as a central piece of Ukraine's financial system. The slow post-crisis recovery of the banking sector and gradual restoration of financial intermediation have determined, to a substantial degree, the characteristics of Ukraine's MTM. At the same time, the government securities market is growing, as is the NBU's ability to influence the economy by regulating short-term yields.

In general, however, the absence of a developed financial market amid the economic crisis and the banking system's clean-up in 2014-2016 seriously constrained the effectiveness of the transmission mechanism. In addition, the NBU's control over inflationary processes using monetary instruments was hindered by powerful factors over which the central bank had no control, including structural economic reforms, fiscal policy, monopolization of certain markets, a significant dependence on global commodity prices, and others.

2.1. Operating Framework of Monetary Policy

After announcing the transition to inflation targeting in 2015, the NBU began to use instruments of interest rate policy. As with most central banks, the NBU's most important instrument is the key rate.

The key rate was *de jure* established when the NBU was created in 1992. However, the rate was a pure formality as the central bank carried out monetary transactions at discrete interest rates with little dependence on the key rate. The first stage of monetary transmission – the management of short-term interest rates in the interbank market – was *de facto* absent and the NBU's key rate only played a signaling role.

After changes in the operational design of monetary policy in April 2016, interest rates for the NBU's main liquidity management instruments became tightly pegged to the key rate.[2] Under conditions of a structural surplus of liquidity, the NBU's market transactions were mostly confined to placing 2-week certificates of deposit at an interest rate equal to the key rate. To dampen short-term interest rate fluctuations in the interbank market, the NBU also carries out overnight transactions at rates pegged to the key rate: the key rate minus 2 p.p. for deposits and the key rate plus 2 p.p. for loans. In addition, the NBU regularly conducts tenders offering refinancing for up to 14 days.[3]

As a result, interest rates in the interbank market are close to the key rate (see Figure 1). Under a liquidity surplus, interbank rates tend to stay closer to the lower part of the range, but they sometimes rise to the upper limit of the range. Money market rates rarely depart the range of interest rates for continuous access instruments (only three times since the beginning of 2016).

Even though the key rate is the decisive factor for short-term interbank interest rates, other factors also affect their behavior. Up to the end of 2016, interbank interest rates were closer to the key rate, whereas between the start of 2017 and mid-2018, they tended to stay closer to overnight deposit rates. That was caused by the nationalization and recapitalization of PrivatBank, which until the end of 2016

[1] Under the inflation targeting regime, the exchange rate is important for countries with developing markets (Nordstrom et al., 2009).
[2] Resolution 277 of 21 April 2016 approving the Regulation on the Principles of Interest Rate Policy of the National Bank of Ukraine https://bank.gov.ua/document/download?docId=30186366
[3] During 2015-2018: key rate plus 2 pp. Effective 11 January 2019, interest rates on 2-week certificates of deposit and on 2-week refinancing loans are set at the NBU's key rate. https://bank.gov.ua/control/uk/publish/article?art_id=83614488

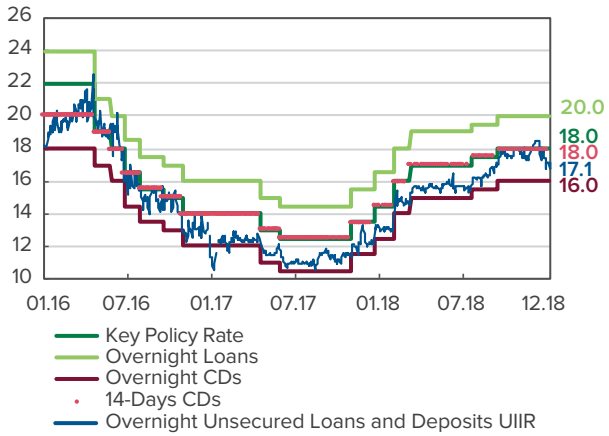


Figure 1. NBU Interest Rates and the Ukrainian Interbank Interest Rate Index, % p.a.
Source: NBU.

had been generating substantial demand for interbank market resources and thus pushing interest rates higher.

More than half of interbank credit market (IBCM) agreements in 2016 were for intermediation services related to financial borrowing by PrivatBank, Ukraine's largest bank by assets. That had a substantial impact on the value of IBCM resources. The reaction of interest rates of its contracts to changes in the NBU's key rate was the longest and the least significant. Since the beginning of 2015, the spread between the cost of PrivatBank's financial borrowings and the average market rate widened gradually to more than 4 p.p. in November 2016.

After PrivatBank was nationalized and halted expensive borrowing, the market's average loan cost has declined by 2 p.p. and the range of interest rate dispersion around the key rate has narrowed significantly (see Figure 2).

Owing to the substantial influence from one large market participant, the study of the deviation of the money market rate from the key rate should be divided into two periods. In the first period (December 2015 – December 2016), the fluctuation of the money market rate was larger and its average value was closer to the key rate (see Table 1).

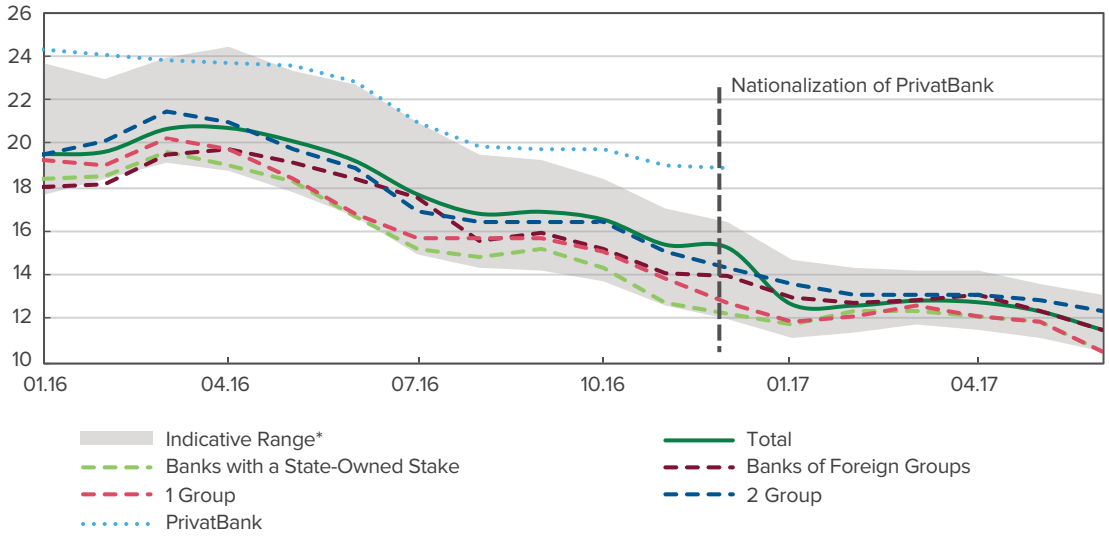
Table 1. The Central Bank Policy Parameters

Period	Average spread	Standard deviation
2015-12-25[4]/2018-12-31	1.131	0.78
2015-12-25/2016-12-18[5]	0.994	1.127
2016-12-18/2018-12-31	1.200	0.519

Source: Own calculations based on NBU data.

The attenuation of fluctuations and the growth of the average spread size are the result of increasing liquidity (and, probably, of growing trust in the banking system after the PrivatBank nationalization). A large standard deviation means the interbank market rate significantly fluctuates while the key rate remains the same, a sign of periods of liquidity deficit and surplus. A positive spread between the key rate and the money market rate indicates a surplus of freely available funds. At present, this spread should not exceed 2 p.p. – the difference between the key rate and the rate on NBU overnight certificates of deposit. The growth in the average spread after 2016 is a sign of the surplus of liquidity in the system. Liquidity declined beginning in August-September 2018, thus reducing the average spread from its level in 2017 to the first half of 2018.

Other countries, even those with developed financial markets and long-standing monetary policy practices, also see a similar effect from certain factors on the dynamics of short-term interbank interest rates. For instance, after the 2007-2008 crisis in developed economies, some rates that typically moved in unison diverged (i.e., the central bank's key rate and LIBOR, EURIBOR, EONIA, and other interbank rates). The spreads widened as bank counterparties lost confidence in banks and banks were forced to charge a risk premium.



*Range of average monthly interest rates on interbank market transactions excluding the highest and lowest 10%.

Figure 2. Loan Interest Rates by Bank Groups, %. Source: NBU.

[4] The date when the Ukrainian Interbank Interest Rate Index was first calculated.
[5] On 18 December 2016, the National Security and Defense Council of Ukraine adopted a resolution on urgent measures to bolster Ukraine's economic security and to protect the interests of depositors, related to the nationalization of PrivatBank.

However, growing uncertainty does not always cause rate spreads to widen. Most banks operating in the interbank money (credit) market have limits on their counterparty banks. Growing uncertainty may result in zero limits (i.e., unavailability of loans) for those counterparties deemed high-risk. In that event, agreements in the money market remain available only to reliable counterparties, for which interest rates are usually lower. A similar situation can sometimes be observed in the Ukrainian interbank market, when agreements between "financially sound" banks (if they have limits on other banks) push interest rates down.

2.2. The Structure and Characteristics of the Financial System

The financial system is important from the viewpoint of both stages of the MTM. Firstly, its structure and characteristics define how monetary policy decisions transform into liquidity and prices in the financial market, and secondly, how the latter affect macroeconomic indicators.

Like in many European countries, Ukraine's financial system is bank-centric (as of the end of 2017, bank assets amounted to 84% of all assets held by financial corporations[6]). That domination by banks is the result of a low level of stock market development. Insurance companies make up the bulk of nonbanking financial companies, while private retirement funds, mutual funds, and other structures are almost nonexistent.

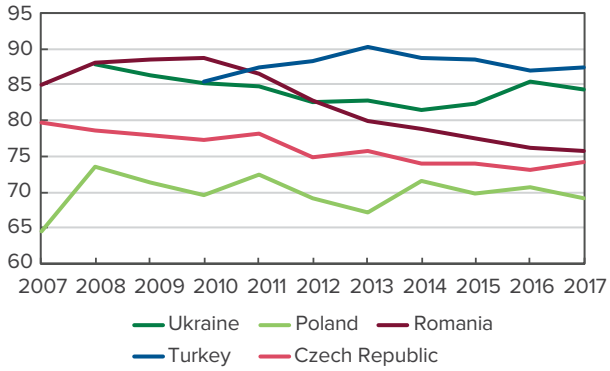


Figure 3. The Banking System's Assets as a Percentage of Financial Assets.
Sources: Central banks of the selected countries, OECD, own calculations.

In Ukraine, markets for stocks, bonds, and some financial derivatives exist on paper, but they are weak. Large Ukrainian companies prefer to issue stocks abroad, both because of the low depth of the local stock market and because of problems with protecting property rights in Ukraine. Since the crash of 2008, trading volumes on Ukraine's largest stock exchanges (PFTS, Perspektiva, Ukrainian Exchange) are negligible and total market capitalization remains lower than at the start of 2008.

Domestic government bonds (DGBs) represent an alternative to deposits for small investors, but attempts to draw these private individuals into buying bonds have largely been unsuccessful. Today, investors can buy hryvnia- and foreign currency-denominated DGBs, but a material return is only possible by investing an amount that is quite large for an ordinary household (starting from UAH 100,000). For comparison: the average amount of bank deposit as of the end of Q1 2019 was UAH 10.63 thousand.

Nevertheless, the current development of the DGB market looks promising. Starting with the 2008 crisis and the monetization of newly issued debt by the NBU to solve budget and quasi-budget problems, the share of DGBs in the NBU's total portfolio grew, reaching 77% of all traded DGBs in 2015. As a result, the government was not motivated to place debt in the market. That motivation appeared only after the NBU committed to avoid fiscal dominance and stop buying up DGBs (through gradual redemption, the NBU's share of DGBs has decreased to 44% as of the end of Q1 2019). This spurred the market development. Today, banks hold the dominant position (48% of all traded DGBs). However, almost 50% of the portfolio held by banks includes those DGBs that were issued to recapitalize the banks. Other participants hold a minimal market share, but their positions are growing. For instance, DGBs held by private individuals account for around 1%, but their total holdings have grown from UAH 42 million in 2015 to UAH 8 billion as of end of Q1 2019. Since individual term deposits total UAH 330 billion, private individuals represent an attractive pool of potential investors. To manage liquidity, the corporate sector also uses DGB; corporates account for 3% of all traded DGBs, with a 6:1 ratio of corporate term deposits to DGBs.

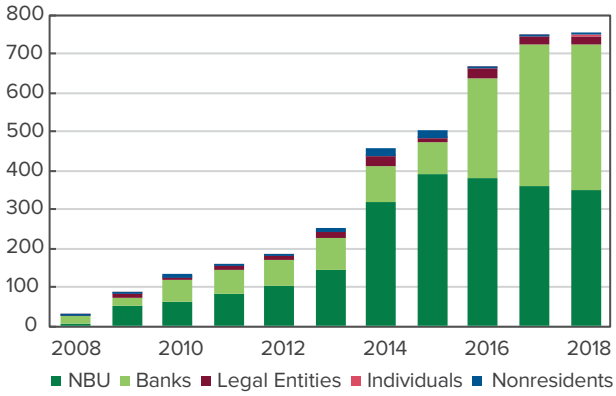


Figure 4. Holders of Domestic Government Bonds, UAH billion, nominal prices.
Source: NBU.

The structure and sophistication of the financial sector help define a country's dominant MTM channel and how fast the macro environment reacts to changes in monetary policy. The asset price channel is more important in countries with a sophisticated stock market, while the interest rate and lending channels are more important in countries with a dominant banking sector.

The depth of the banking sector's effect on the economy is usually measured by the ratio of loans to GDP. The higher this indicator, the greater the impact of changes in monetary policy on the economy. In Ukraine, this ratio was 30% in 2018, one of the lowest indicators in Central and Eastern Europe (see Figure 5). That ratio has decreased over the past four years, driven by the economic recession that limited new lending opportunities amid the significant growth of nominal GDP due to high inflation.

[6] Calculation based on data from the balance sheets of the National Bank of Ukraine, financial corporations (financial assets and liabilities), and deposit corporations (excluding the National Bank of Ukraine)

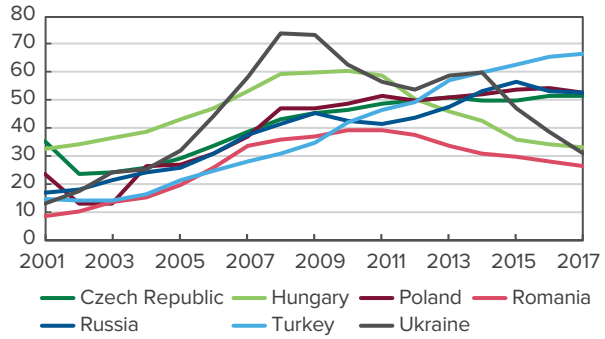


Figure 5. Ratio of Private Sector Loans to GDP, %, 2001-2017.
Source: World Bank.

Moreover, a substantial percentage of total loans in Ukraine were nonperforming loans: 53.2% at 82 solvent banks as of the end of Q1 2019. State banks accounted for 65% of all nonperforming loans, including 82% at the nationalized PrivatBank. On the brighter side, most of these nonperforming loans were reserve-backed. Still, such a substantial percentage of nonperforming loans complicates a bank's normal operation. The low level of financial intermediation translates into a low effect of interest rate changes in the financial sector on the rest of economy.

Before the 2008 crisis, banks in Ukraine were actively lending money, often not overly concerned with borrower's quality. Loans to individuals doubled every year from 2005 to 2007. A substantial percentage of loans were provided in foreign currency (51% of all loans to resident borrowers, including 62% of all loans to households on the eve of the crisis as of the end of Q3 2008). This included loans to individuals and businesses without foreign-currency income (see Figure 6). After the hryvnia depreciated sharply and the economy tanked, instances of nonpayment increased drastically. Many banks were concealing the real quality of their credit portfolios, while the NBU failed to maintain proper control. Therefore, the formal amounts of nonpayment in 2009-2013 were substantially underreported.

Significant structural changes in 2014-15, most importantly the loss of control over part of Ukrainian territory and a sharp devaluation (when the hryvnia lost more than two-thirds of its value against the US dollar), led to serious problems in the banking system. In response, the NBU fundamentally changed its approach to banking supervision, no longer concealing the problems accumulated in the past. As a result, 87 banks which as of the beginning of 2014 held 31% of the banking system's total assets were declared insolvent in 2014-2017. Moreover, to maintain the viability of the banking system, the largest Ukrainian bank, PrivatBank, was nationalized at the end of 2016. This measure led to the fact that state-owned banks hold more than half of total assets in the banking sector (see Figure 7).

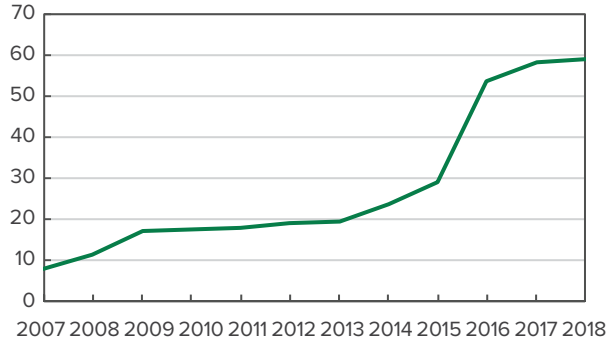
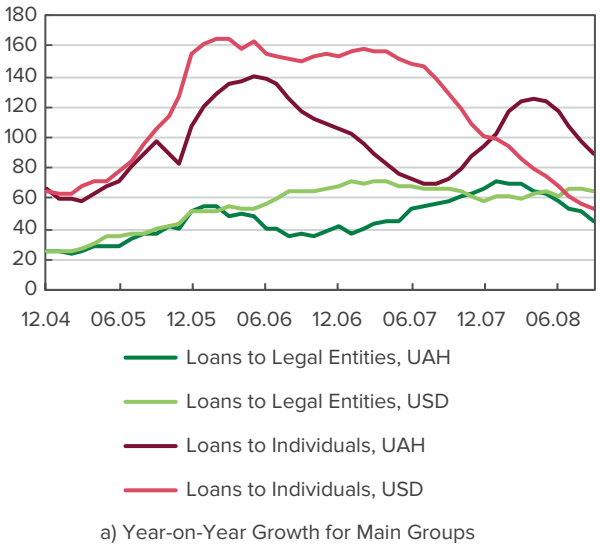


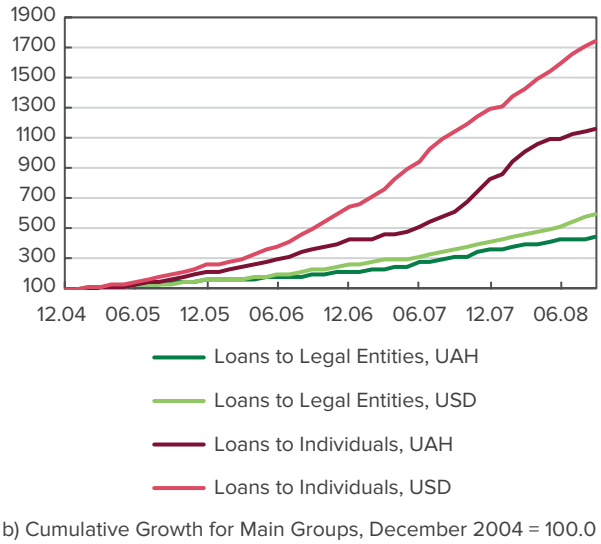
Figure 7. Share of State-Owned Banks in Total Assets of the Banking System as of Year-End, %, 2007-2018.
Source: NBU.

Intense competition between banks during the lending boom of 2004-2008 yielded a situation in which the largest banks did not dominate, as they do in most of the neighboring countries. The crises of 2008-2009 and 2014-2017 drastically changed the situation: as of the end of 2017, the five largest banks held 62% of all assets. As of the end of 2017, the Herfindahl-Hirschman Index for the Ukrainian banking system was 0.12, close to the EU's 0.11 in 2016 (see Figure 8). The higher the number, the more concentrated and less competitive a market.

Another indicator – the banking system's net interest income – can indirectly describe the competitiveness of the banking services market. The more intense the competition, the lower this indicator should be. In Ukraine, it stood at 2.9% of total assets as of the end of 2017, close to that indicator in peer countries (see Figure 9).



a) Year-on-Year Growth for Main Groups



b) Cumulative Growth for Main Groups, December 2004 = 100.0

Figure 6. A Surge in Lending Before the Global Financial Crisis, December 2004 – September 2008.
Source: NBU.

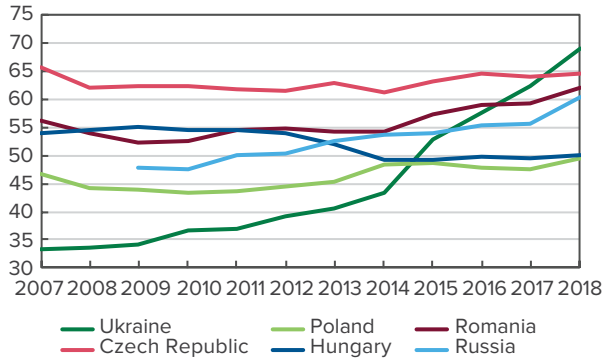


Figure 8. Share of Assets Held by a Banking System's Five Largest Banks, 2007-2018, %.
Sources: NBU, ECB, Central Bank of Russia.

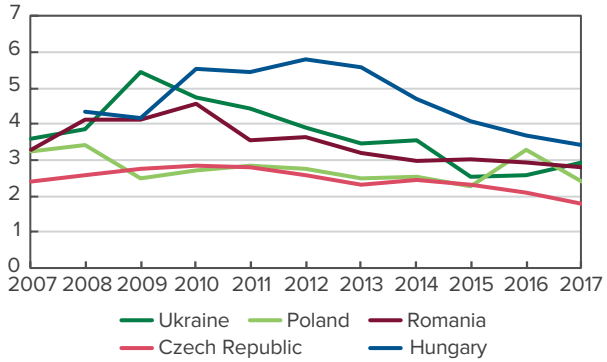


Figure 9. Net Interest Income, % of total assets, 2007-2017.
Source: NBU, ECB.

Lending to the real sector in Ukraine is spread unevenly, with businesses accounting for 82% and households for just 18%. For comparison, in neighboring Poland, businesses accounted for 35% and households for 65% as end-2018; in Romania, this ratio was 42% vs. 58%, respectively.

The level of lending to individuals in Ukraine is extremely low by international standards: only 6% of GDP (with the share of performing loans at just 3% of GDP). These loans can be divided into two groups: (1) the result of past (prior to the 2008 crisis) lending in foreign currency (39% of all individual loans and 97% of non-performing loans), and (2) new hryvnia-denominated consumer loans, mostly short-term. Short-term consumer loans traditionally come at a high interest rate, because the risk of default is higher and the process of recovering loaned funds is costly for banks. Since the main element that determines the loan interest rate is risk, not the cost of funding, consumer loans globally show little reaction to changes in the key rate, which limits the effect of MTM via this channel.

A major contributor to the low level of lending to individuals has been the near-discontinuation of mortgage lending. The mortgage freeze, which began with the 2008 crisis, stems from two factors: the sharp decline of the USD-denominated value of real estate with expectations of a further drop in prices (which reduces the value of real estate as a collateral), and the ban on lending to individuals in foreign currency. Due to the difference in interest rates on mortgage loans, borrowers preferred foreign-currency loans (as in neighboring countries, especially in Russia and Poland).

Almost half of loans to businesses (49% as of the end of Q1 2019) were issued for up to one year. A substantial portion of those were to fund working capital. At the same time, companies have traditionally funded longer-term investment using equity. This has two effects on the MTM. Firstly, since the transmission of the key rate to short-term loan rates takes place faster and to a larger degree than to long-term loan rates, the high percentage of short-term loans enhances the power of the MTM. Secondly, a significant percentage of investments outside the banking system may weaken the effect of the key rate on the economy.

Deposits from individuals and businesses are the main source of funding for the banking system (80% of aggregate liabilities as of the end of Q1 2019). Foreign loans are also substantial and account for another 13% (see Figure 10).

Before the 2008 crisis, the percentage of foreign loans, especially loans taken by banks from western banking groups had been growing rapidly: up to 32% of total liabilities as of the end of 2007. After the 2008 crisis, the share of loans in liabilities increased at first (to 43% as of the end of Q1 2009) because the loans were in foreign currency, but then began to decrease as loans were repaid and/or these funds were converted into bank equity.

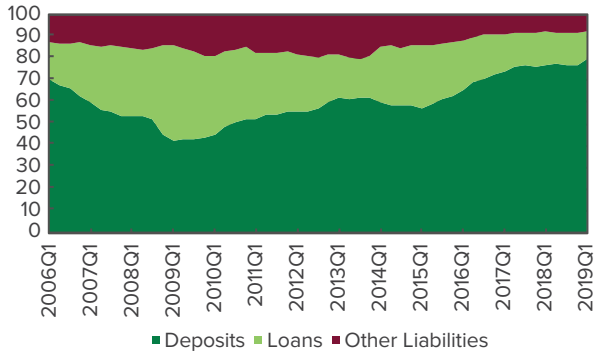


Figure 10. Structure of the Banking System's Liabilities, 2006-2019, %.
Source: balance sheets of NBU deposit corporations.

As of the end of Q1 2019, 58% of all deposits were in hryvnia. That is almost the same level as at the end of 2013 (56%), on the eve of the hryvnia's depreciation. Even with the significant fluctuations of the exchange rate, the share of hryvnia-denominated deposits has been relatively stable over the last 10 years (ranging from 41% to 69% and averaging 56%), so a substantial change in the near future is unlikely. The gap between interest rates on hryvnia and foreign-currency deposits can push depositors towards hryvnia products, but this can be a lengthy process.

A significant dollarization of deposits somewhat limits the effectiveness of the MTM, and de-dollarization can increase its effectiveness. At the same time, the experience of other countries proves that interest rates on deposits by individuals – the basis of funding – react only partially to changes in the key rate. In countries of Central and Eastern Europe, the pass-through is close to 0.7 (Égert & MacDonald, 2008), and in countries of the European Monetary Union, this indicator is close to 0.8 (ECB Monthly Bulletin August 2009). Moreover, this pass-through is much lengthier than in the case of loans (e.g., see: De Bondt et al., 2005).

The Ukrainian banking system is also marked by a prevalence of short-term deposits. As of the end of Q1 2019, 49% of deposits were call deposits and another 35% had a term of up to one year. Deposits with a term greater than two

years held just a 3% share. On the one hand, short maturity allows interest rates to adapt more quickly to changes in market conditions, while on the other hand, they expose the banking system to deposit outflow risk. To control this threat, in March 2018, the NBU introduced[7] a new prudential norm for Ukrainian banks: the Liquidity Coverage Ratio (LCR), which became binding effective 1 December 2018.

3. THE EFFECTIVENESS OF MTM CHANNELS

The significant changes to Ukraine's monetary policy approach and to the country's financial system described in the previous section place constraints on an empirical analysis of the MTM in Ukraine. We therefore focus on an econometric evaluation of the first stage of the MTM: the effect of monetary decisions on financial market indicators. We will analyze the effect of the second stage of the MTM (the impact of changes in financial market indicators on macroeconomic development) using economic theory and the results of empirical studies for other countries, first of all, countries of Central and Eastern Europe (CEE) with transitional economies and similar characteristics to Ukraine's economic and financial system.

After that, we will analyze the effectiveness of the MTM through its five key channels: interest rates, lending, exchange rates, asset prices, and expectations (Mishkin, 1995; Vonnak, 2007).

3.1. Interest Rate Channel

The transmission of a signal from the key rate (via short-term interbank market rates) to long-term interest rates for financial instruments and to interest rates on bank loans and deposits is the key element of a traditional interest rate channel.

With a change in interest rates on bank loans and deposits, the preferences of economic agents for current consumption, investment, and saving should change. Rising interest rates encourage savings as opposed to current consumption and reduce investments. That should result in a slowdown of inflation and/or deflation due to a decrease in aggregate demand.

First Stage: the Effect on Market Interest Rates

In each stage, decisions to change interest rates are affected by not only the key rate (and the central bank's instruments pegged to it, such as certificates of deposit and refinancing loans) but also the economic situation, the structure of the banking system, access to alternate sources of financing, and more.

Another important feature of the money market is the interchangeability of resources, which makes its participants price takers, unlike in the main markets of funding liabilities available to banks: deposits and debt. Therefore, the money market can be seen to be in perfect competition, where interest rates gravitate toward the central bank's key rate. At the same time, interest rates on bank deposits and other liabilities are greatly affected by the business models of banks, the characteristics of the financial system, and other institutional factors.

A telling example is Poland, where spreads between money market rates and interest rates on bank deposits and loans increased after the crisis of 2008. Before the crisis, the transmission of money market rates to deposit and loan interest rates was almost full (Stanisławska, 2014). At the same time, the median ratio of loans to deposits was increasing significantly, which indicated the deposit base was covering a shrinking proportion of the credit portfolio.

After the crisis, banks began to borrow less actively on the money market and more actively on the individual deposit market. This caused a widening of the spread between deposit interest rates and money market rates, while the share of interbank loans in the structure of bank assets decreased (Kapuściński & Stanisławska, 2016). Even in 2014, six years after the crisis, the spread between money market rates and interest rates on individual deposits remains higher than before the crisis.

Recent studies of monetary transmission via the interest rate channel in Poland (Kapuściński et al., 2016; Chmielewski et al., 2018) show that in 2001-2017, the key rate fully transmitted to money market rates in all cases except short-term interbank rates (one-week and one-month WIBOR[8]), which means the transmission is not different from one at 5% statistical significance level. The non-full transmission in the latter two cases is the result of the global financial crisis of 2008-2009, which significantly increased short-term uncertainty. Further transmission of money market rates to interest rates on business and individual deposits indicates full long-term transmission for all except short-term deposits (1 and 3 months for individuals and 1 month for business deposits). The non-full transmission is also related to the crisis: banks were actively taking in short-term deposits during the crisis, and the increasing competition in that segment caused the deviation. According to a more recent study (Chmielewski et al., 2018), there is incomplete transmission to interest rates on property loans for individuals (0.65-0.76), while the transmission to loan interest rates for businesses is statistically higher than one (1.11).

Below we analyze the relationship between money market rates and bank rates in Ukraine. The correlation analysis presented in Table 2 shows a significant dependence between the key rate (directly) and money market rates and loan and deposit rates since 2015. The correlation ratio for the daily raw data series (i.e., without discarding unusually high or low values) varies from -0.12 (key rate and interest rate on short-term household loans) to 0.92 (overnight rate and interest rate on short-term business loans). Even visually, the close relationship is evident between rates on short-term business loans and the overnight and key rates (see Figure 11).

In recent years, Autoregressive-Distributed Lag (ARDL) was the main approach used to assess the effect of overnight rates on other banking system rates. ARDL was used, for example, for Poland by Chmielewski et al. (2018) and for Russia by Nguyen et al. (2017). An important advantage of ARDL models is the possibility to explore time series that are stationary at levels or first differences, i.e. I(0) and I(1),

[7] Resolution 13 of the NBU Board of 15 February 2018 implementing the Liquidity Coverage Ratio (LCR), and Decision 101-rsh of the NBU Board of 15 February 2018 approving the Methodology of Calculating the Liquidity Coverage Ratio (LCR)
[8] WIBOR: Warsaw Interbank Offer Rate

Table 2. Correlation Ratios from January 2015 to December 2018 (daily data).

	Overnight Rate	Key Rate
Overnight rate	1.00	0.96
3-month deposit	0.55	0.76
6-month deposit	0.52	0.73
9-month deposit	0.57	0.75
12-month deposit	0.49	0.70
Short-term individual loans	0.19	-0.12
Long-term individual loans	0.37	0.24
Short-term business loans	0.92	0.87
Long-term business loans	0.27	0.39
Key rate	0.96	1.00

Source: own calculations based on NBU data.

as variables.[9] Since most macroeconomic variables are non-stationary at levels, it significantly increases modeling options.

As shown in Table 3, variables are mostly non-stationary, have a unit root at levels and are stationary at first differences. The table shows the results of two key tests: PP and ADF

The model is as follows:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \cdots + \alpha_n y_{t-n} + \beta_0 x_t + \\ + \beta_1 x_{t-1} + \cdots + \beta_k x_{t-k} + \varepsilon_t, \quad (1)$$

where y is the dependent variable representing a function of its own previous values (autoregression) and of the current and previous values of the independent variable x (distributed lag). An additional advantage of this model for our analysis is the ability to interpret the obtained ratios as short- and long-term effects. Short-term effects are the ratios of direction from the model:

Table 3. Stationarity Tests, Data at Levels and First Differences for Weekly Series for the Period from 25 December 2015 to 14 December 2018.

Variable	Test	Statistics
Overnight rate	PP	-0.90
	ADF	-1.03
Δ Overnight rate	PP	-170.73***
	ADF	-4.66***
Loan rate[+]	PP	-0.67
	ADF	-0.13
Δ Loan rate[+]	PP	-191.49***
	ADF	-4.86***

[+] for short-term business loans.
***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

for example, the effect of an independent variable of the current period is β_0, with a lag of one period is β_1, and so on. For a long-term period, we assume equilibrium, i.e. $y_t = y_{t-1} \ldots = y_{t-n}, x_t = x_{t-1} = \cdots = x_{t-k}$, which allows the formula to be shortened to:

$$y_t = \frac{\alpha_0 + x_t \sum_0^{t-k} \beta_i + \varepsilon_t}{1 - \sum_1^{t-n} \alpha_i}, \quad (2)$$

which gives the following formula for the long-term effect of an independent variable:

$$\gamma = \frac{\sum_0^{t-k} \beta_i}{1 - \sum_1^{t-n} \alpha_i}. \quad (3)$$

Since the transmission mechanism only came into effect recently and, as stated above, transmission make take several months or even years, attempts to assess the effect using this model mostly produce no statistically significant ratios[11]. The exception is the model where interest rates

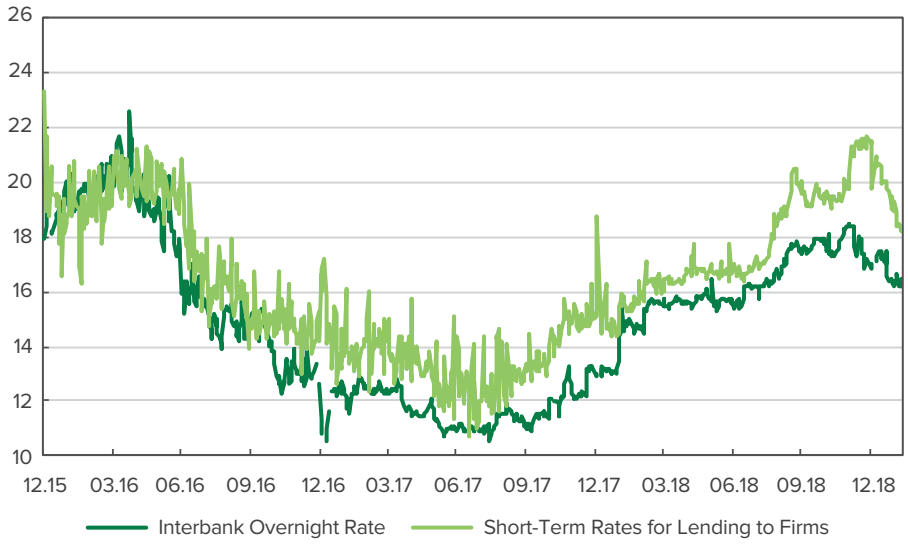


Figure 11. Similarity in Fluctuations between the Overnight Rate and Interest Rate on Short-Term Loans to Businesses. Source: NBU.

[9] For details, see: Pesaran et al. (2001), Pesaran & Shin (1999).
[10] The zero hypothesis for Phillips-Perron (PP), Augmented Dickey–Fuller (ADF) is the existence of a unit root.
[11] Traditionally, these models are based on monthly data. If we assume that inflation targeting began in 2016, we would only have 36 surveys from January 2016 to December 2018, which is insufficient for an in-depth statistical analysis.

on short-term business loans depend on the overnight interbank rate based on weekly data (Table 4).

The model's econometric specification:[12]

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \beta_0 x_{t-1} + \varepsilon_t. \quad (4)$$

Table 4. Results of Assessing the Dependence of Interest Rates on Short-Term Business Loans on the Overnight Rate for Weekly Series for the Period from 25 December 2015 to 14 December 2018.

	Interest Rate
Intercept	0.745**
	(0.318)
Loan-1	-0.391***
	(0.080)
Loan-2	0.174**
	(0.079)
Overnight	0.187***
	(0.048)
F	10.36***
Adj. R^2	0.15
N	155

***, **, * denote significance at the 1%, 5%, and 10% levels, respectively. Standard errors are reported in parentheses.

According to this model, the weekly pass-through level is 19% (for the overnight rate, which in the event of full pass-through must not be statistically different from one). At the same time, the aggregate pass-through level should be 15% (the estimate based on the formula for a long-term effect stated below). The fact that even for such a short period as one week the pass-through level was almost one-fifth of the full transmission shows that interest rates on short-term business loans react quickly enough to changes in the key rate. The fact that the expected long-term transmission is not full indicates that other factors have a substantial effect on the formation of interest rates. In particular, a negative coefficient on the first lag of a dependent variable proves significant interest rate fluctuations even when using weekly data, which in turn is caused by low market volumes, so that even a single loan can decisively influence the interest rate. If we use only data from 2017 (to remove the possible structural shift in money market rates due to the PrivatBank nationalization), the short-term effect would be more significant (about 30%), but the statistical significance of most coefficients would be much lower.

One area for further study is an evaluation of the interest rate channel at the micro level. Kapuściński (2017) evaluates the performance of this channel based on individual rates of Polish banks and on their balance sheets. This approach allows the researcher to check the heterogeneity of the bank's reaction to the key rate change. In particular, Polish banks with worse indicators (such as a higher share of bad loans) respond to a rate hike by cutting lending. Other studies show that the characteristics of a bank like its size, owner type (domestic or foreign, public or private), and others determine to a large degree the bank's market behavior. Therefore, disaggregation can be important for a more accurate assessment of the impact of monetary policy.

The yield curve is an important concept that sits at the junction of the interest rate and expectations channels (i.e. the dependence of risk-free asset rates on their redemption term). In Ukraine, the NBU forms the short part of the yield curve: overnight deposits and 14-day certificates of deposit. The Finance Ministry forms the long end (DGBs with maturity from 6 months to several years[13]). Economic agents can use yield curve data when determining the price of financial assets and derivatives, for risk management purposes or to form expectations about future monetary policy.

Theoretically, the yield on DGBs depends on the current value of money (defined by the key rate), anticipations of possible changes in the value of money, and the term premium. For market agents, the yield on short-term DGBs is the direct continuation of the yield on money market instruments (1- and 14-day certificates of deposit).

Despite the increasing volume and liquidity in recent years, the government securities market remains relatively shallow. Because of that, the transmission of the key interest rate to yields on government securities is fast and full. The low level of engagement leaves room for arbitrage. For instance, there is still a significant gap between the yield on government securities and interest rates on individual deposits. As the DGB market develops, that arbitrage opportunity should disappear.

In 2016-2018, the DGB yield on the primary market followed the movements of the key rate for all maturities. The rise of the key rate starting from the fall of 2017 caused corresponding growth in DGB yields across all terms, with the lowest growth rate observed for publicly placed DGBs with the term of 2 years. That reflects expectations of a decrease in rates during that period, which produced an inverted yield curve.

The yield on government securities reacts not only to changes in the NBU's key rate but also to liquidity conditions. For instance, the increase of DGB yields in late 2018 came amid a shrinking surplus of liquidity and growing interbank credit market rates (see Figure 12).

At the same time, the fast and significant reaction of the yield on government securities (especially longer-term ones) to current monetary decisions is atypical for a developed market. Their change must stem from both the expected future monetary policy and the political and economic events

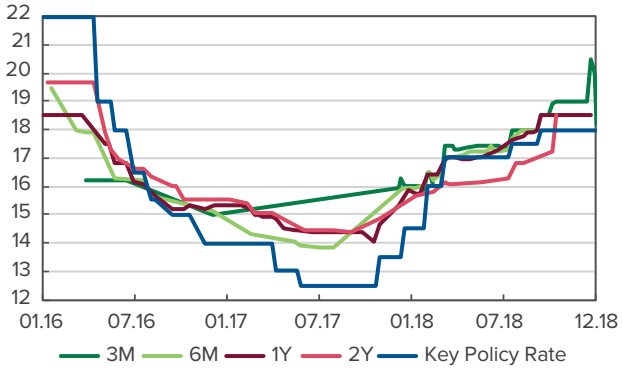
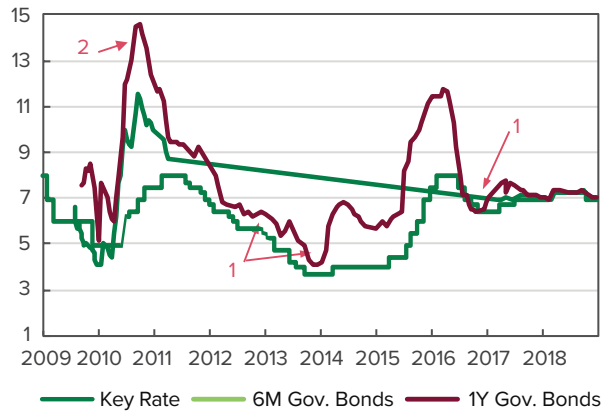


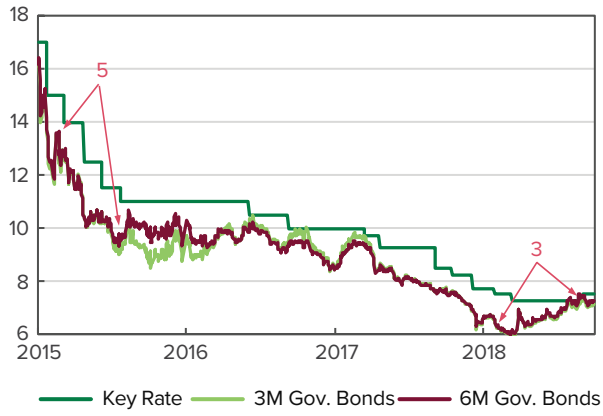
Figure 12. NBU Key Policy Rate and Primary Market DGB Yields, %. Source: NBU.

[12] The change of a dependent variable was used to focus specifically on the change. Since $\Delta y = y_t - y_{t-1}$, the formula can be written in levels, such as: $y_t = \alpha_0 + (\alpha_1 - 1)y_{t-1} + \alpha_2 y_{t-2} + \beta_0 x_{t-1} + \varepsilon_t$

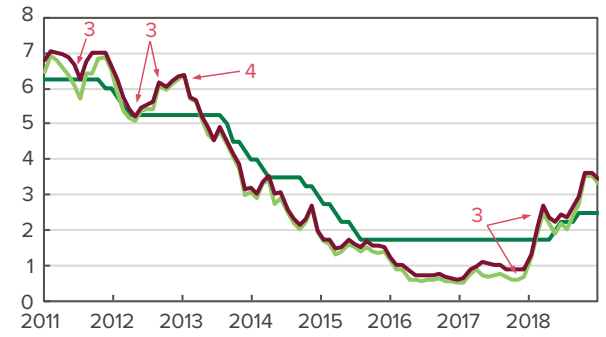
[13] Most DGBs with maturity of over two years were placed off-market, e.g., to cover Naftogaz of Ukraine NJSC's deficit.



a) Government Bonds Yields in Georgia.



c) Government Bonds Yields in Russia.



b) Government Bonds Yields in Romania (bid).

++ Bid, end of month

1 – purchase of government bonds by non-residents;
2 – political instability;
3 – withdrawal of foreign investors from government bonds;
4 – including of government bonds in the JP Morgan/Barclays Indexes;
5 – raise of domestic investors demand on government bonds because of limited access to the International capital market (imposition of sanctions).

Figure 13. Key Rates and Yields on Government Securities in Countries with Inflation Targeting, %.
Source: central banks.

that brought about the change. Below are three examples of how that takes place in regional peer countries that also target inflation (see Figure 13).

As the market for government securities grows and their term increases, developing bond term structure models represents a prospective area of study.

The use of these models allows researchers to study the decomposition of the nominal bond yield on the real interest rate component (the anticipated rate and term premium) and the inflation component (expected inflation and premium for inflation uncertainty), which is important for monetary policy. On this basis, Abrahams et al. (2015) confirm the effectiveness of inflation targeting in the United Kingdom, which allows the Bank of England to offset the premium for inflation uncertainty in the yield on government securities.

A comparison of yields on hryvnia- and foreign currency-denominated DGBs helps evaluate the current premiums for the risk of a change in the exchange rate. A comparison of the distribution of prices for DGBs of the same type in the secondary market may provide information regarding the current level of liquidity (and uncertainty) on different time horizons.

Second Stage: the Effect of Interest Rates on Consumer and Investment Demand

Loan and deposit interest rates affect the decisions of economic agents regarding savings, current consumption, and investments. Higher rates should make savings more attractive and investments less economically beneficial. Therefore, increases in interest rates should reduce aggregate demand and slow the growth of or even cause a decrease in price level.

The experience of developed countries and developing economies corroborates those findings. A study of the MTM in the Czech Republic, Poland, and Hungary (Darvas, 2013) using vector autoregression (VAR) models points out the specifics of transitional economies that switched from a fixed exchange rate to inflation targeting during the period of that study (1993-2011). Therefore, it is proposed to study these economies accounting for well-known 'Lucas critique', i.e. as economies whose reaction modified with a change of their monetary policy regime. Moreover, these economies underwent significant structural transformations, which also changes reaction in time. The EMU was used as the benchmark. Poland proved the closest of the three studied countries in terms of the euro zone's MTM reactions (shocks related to four variables: interest rate, prices, GDP, and exchange rate). This means that the loss of monetary independence (adoption of the euro) will be felt most in Poland if its business cycle does not match the EMU's cycle.

Several methods are used to assess the effect of changes in market rates on the components of aggregate demand (each method has strengths and weaknesses). The National Bank of Poland (Chmielewski et al., 2018) uses various vector autoregression (VAR) models, which have an advantage in their low dependence on theory, as well as semi-structural and structural models based on a deviation of all variables from the trend with the assumption that they will revert to the trend over the long-term.

Most of the aforementioned models show the existence of transmission, with the effect of interest rate changes visible on the exchange rate, GDP growth, price levels, and unemployment rates. At the same time, the quantitative results vary.

Another popular area of study for the interest rate channel involves the use of data from companies' balance sheets to study the effect of changes in market interest rates on their investment decisions. These methods allow researchers to use large data sets to obtain statistically significant conclusions. For example, Kátay and Wolf (2004) use a similar approach for Hungary and find that investments react quickly and significantly to changes in the price of capital.

It is also worth trying to assess the effect of the MTM in Ukraine using several models, as every group of models has its limitations. Assessments should first be done using macro models. Micro analyses of individual transmission chains can be added to them, starting with the pass-through from money market rates to rates at individual banks. In addition, companies' balance sheets can be used to study the effect of interest rate changes on investments.

Since most macroeconomic indicators that are likely to be affected by monetary policy are available only quarterly (i.e., GDP and gross fixed capital formation) or monthly (i.e., price indexes and industrial output), data sample since the country's transition to inflation targeting is rather short. That complicates the use of econometric models (and worsens their analytical and forecasting quality), in particular VAR. For example, the aforementioned studies by the National Bank of Poland had to be confined to five variables (inflation, GDP, money market rates, volume of loans disbursed, and exchange rate) because the addition of another variable (the unemployment rate, for example) significantly reduces the model's quality. The problem of short data sample can be mitigated somewhat with assumptions for how the relationship between some variables had been changing after the launch of inflation targeting.

As of today, market interest rates have a weak impact on aggregate demand and, therefore, on inflation. For example, in 2016-2018 Ukraine had relatively high real interest rates and at the same time high growth rates of private investment and consumption.

Several factors contributed to that situation. First, as we showed in Section 2.3, Ukraine's financial depth is lower than in other countries of Central and Eastern Europe, both in terms of banking intermediation and the volume of government securities held by households and the corporate sector. Second, during a long period of high and volatile inflation, both nominal and real interest rates were very volatile by international standards. That minimized the accommodation by economic agents of interest rate changes in their consumption- and investment-related decisions and, accordingly, minimized the traditional transmission via aggregate demand.

As international experience shows, the establishment of the first stage of monetary transmission and the adoption of inflation targeting both help increase the sensitivity of aggregate demand to interest rate changes. For instance, Kara et al. (2007) used methods of evaluating time-variable parameters to show that the effect of interest rates on the output gap and the effect of the output gap on inflation in Turkey increased significantly after the launch of inflation targeting.

A gradual resumption of lending can also help strengthen the effect of changes in market interest rates on aggregate demand and inflation. Other important factors include a further expansion of the DGB market (along with an increase in bond maturities) and lower dollarization.

3.2. Credit Channel

Bernanke and Gertler (1995) started the discussion of the role of loan supply in strengthening the effects of monetary policy. The basic idea of the credit channel is as follows: tighter monetary policy leads to an increased premium for external financing due to imperfections in the credit market, such as the principal-agent problem and information asymmetry. As a rule, a borrower knows their own situation better than a creditor, allowing the borrower to better assess the chances of success for an investment project. Creditors are less confident in eventual success, and therefore, they demand a risk premium and also affect, to a certain degree, these chances by their own behavior. This asymmetry begets a premium for all types of external financing and leads to a gap between the cost of external and internal funds. That yields problems of adverse selection and moral hazard. As a result, an increase in the key rate by a central bank not only decreases aggregate demand but also reduces loan supply.

Within the overall credit channel, the lending channel and balance sheet channel act differently. In the lending channel, tighter monetary policy reduces credit resources in the banking sector. The balance sheet channel is based on the notion of a financial accelerator. Interest rate changes affect companies' net worth via cash flows and collateral value. Therefore, higher interest rates lead to a lower net worth and higher premium for external financing (loans).

Some evidence shows that the credit channel's contribution to the MTM is insignificant. Firstly, since the economic and financial crisis of 2014-15, commercial banks prefer to finance reliable borrowers regardless of monetary conditions. That is especially true of banks affected by the armed conflict; according to Pham et al. (2018), these banks tend to reduce loan supply, first of all in those regions located farther from their head offices. Secondly, a faster resumption of lending (loan supply) is restrained, especially by institutional factors, including a poor protection of creditor rights. Thirdly, large corporations (especially exporters) have an alternative to bank lending in the form of borrowing from their parent company or selling Eurobonds. Finally, the corporate sector is relatively independent of bank lending: loans financed just 5.3% of investments in 2017.

In future, studies using a large sample of Ukrainian banks and corporations look to be a perspective area. That type of study would be able to identify loan supply factors other than demand for loans.

3.3. Exchange Rate Channel

First Stage: the Effect of Interest Rates on the Exchange Rate

The first stage of the exchange rate channel features a reaction by the exchange rate to interest rate changes. Uncovered interest rate parity is a simple assumption widely used in theoretical models. According to that condition, the

difference between yields on assets in different currencies must compensate the expected change in the exchange rate and the risk premium.

According to theory, a hike in the key rate strengthens the domestic currency, all other conditions being equal. The transmission looks like this: following the key rate, all other rates in the economy grow as well, including the yields on tradable assets like stocks, bonds, and tangible assets. This yield increase makes them more attractive to foreign investment. That increases foreign currency supply locally and, barring interventions from the central bank, currency appreciation pressures.

For developing economies, risk premium shocks can be quite significant owing to changes in risk assessments and preferences by domestic and foreign economic agents.

That significantly complicates the measurement of effects from interest rate changes on the exchange rate. The use of correlations between the interest rate and the exchange rate may lead to incorrect conclusions as one needs to differentiate the effect of two factors on the exchange rate: risk premium shocks exogenous to monetary policy and monetary decisions alone.

In addition, an analysis of the relationship between interest rates and the exchange rate in Ukraine is complicated by the NBU's interventions on foreign exchange market to accumulate international reserves and smooth foreign exchange volatility. Moreover, foreign exchange restrictions constitute an obstacle to the free flow of capital and, therefore, lower the magnitude of the effect produced by interest rate changes on the exchange rate.

No studies have yet been done in Ukraine on the exchange rate effects from changes in interest rates and foreign-currency interventions. However, the latest cycle of key rate hikes suggests there is a strong relationship between monetary decisions and exchange rate trends.

In October 2017, the NBU started a cycle of monetary tightening by raising the key rate after the current and expected inflation rates exceed the targets for 2017 and 2018. The increase in the key rate led to an increase in DGB yields in early 2018. DGBs are perhaps the only liquid asset in Ukraine available to foreigners. In January-November 2017, before the rate increase, the average monthly placement of DGBs with a term of up to one year was less than UAH 600 million. The DGB placement volume increased by more than 10 times in January-February 2018, when the yield rose by approximately 1.6 p.p. The inflows of foreign currency into DGBs strengthened the hryvnia exchange rate from UAH 28.07/USD as on 1 January to UAH 26.95/USD on 28 February. Despite that appreciation, the NBU increased its interventions in the foreign exchange market.

In conclusion, the evidence in Ukraine confirms theoretical expectations. At the same time, the "all else being equal" condition is critical. The start of an election cycle or a serious deterioration in conditions on foreign markets can quickly change the hryvnia's strength trend even when rates are high.

Second Stage: the Effect of the Exchange Rate on Inflation and Economic Activity

The second stage of the exchange rate channel features the effect of its changes on macroeconomic indicators, particularly inflation. The exchange rate affects inflation not only directly via prices for imported goods and the effects on exported goods and production costs, but also via aggregate demand and balance sheet effects.

In Ukraine, the relationship between the exchange rate and inflation has traditionally been the strongest and transmission most rapid.

On one hand, that is a consequence of the high public attention to exchange rates because of the country's history of a hard currency peg. On the other hand, the Ukrainian economy is characterized by a high degree of openness (the ratio of trade turnover to GDP has consistently exceeded 100%) and a high degree of dollarization.

In terms of the transmission to inflation, Faryna (2016) studied the nonlinearity of transmission effects on the basis of a panel autoregressive model with distributed lags. Faryna found that a significant devaluation of the exchange rate (more than 16% per quarter) leads to a high pass-through (0.2-0.3 during 12 months). At the same time, mild exchange rate fluctuations (between 3% and 16%) do not lead to significant shifts in inflationary processes. Meanwhile, under conditions of the exchange rate strengthening the elasticity of inflation revealed to be quite low.

Shevchuk (2017) analyzed the difference in effects from anticipated and unanticipated changes in the exchange rate. His study of the industrial and agricultural sectors showed a lack of a reaction to anticipated changes in the nominal effective exchange rate (NEER) and a negative reaction to unanticipated changes in the NEER. At the same time, unanticipated changes in the exchange rate strengthen if the currency floats as it does currently in Ukraine.

The exchange rate also affects production costs. The same work by Faryna (2016) shows that PPI usually reacts more strongly to exchange rate fluctuations. Then, with a greater time lag it reflects in consumer prices as well.

In addition, according to the NBU's business expectations surveys, firms traditionally mention the exchange rate among the largest contributors to inflation.

However, we expect that the transition to inflation targeting and a floating exchange rate will lower the magnitude of transmission. Taylor (2000) first presented the argument that increased trust in monetary policy, which ensures consistently low inflation rates, reduces the effect from the exchange rate changes as the expectations channel will have already taken care of some of the effect. Taylor's work was followed by many studies based on theoretical models and actual data and concerning the effect of inflation targeting on the magnitude of transmission. The most popular study is by Bailliu and Fujii (2004), in which the authors review 11 developed countries and assess the transmission effect before and after the adoption of inflation targeting. The authors clearly differentiate periods of consistently low inflation with and without inflation targeting. They conclude that the adoption of inflation targeting does decrease the pass-though coefficient.

Another important aspect of the exchange rate channel is the role of foreign currency in the assets and liabilities of economic agents. Exchange rate fluctuations produce significant balance sheet effects, since both households and companies keep a significant portion of assets and

liabilities in foreign currencies, primarily USD and EUR. As of the end of Q1 2019, 41% of resident deposits were in foreign currency.

Historically, the hryvnia's real exchange rate has strengthened during periods of economic growth and weakened during crises. Those trends can be explained, first of all, by capital flows and the use of foreign currency loans to finance capital and production. During periods of capital inflows (usually when the global financial system has a surplus of liquidity) the hryvnia has strengthened in real terms, which has reduced the cost of foreign-currency loans and increased the corporate sector's net assets. Consequently, investments and production activity grew due to balance sheet effects. That was helped by the impact on costs as imported investment goods became cheaper as the hryvnia strengthened. Household purchasing capacity grew as well. On the other hand, the strengthening of the exchange rate reduced price competitiveness and cut into net exports. For that reason, Ukraine's foreign trade deficit has typically widened during periods of economic growth. During crises, the reverse took place through the same channels (balance sheet, costs, trade). Therefore, the effect of exchange rate fluctuations on economic activity in Ukraine is weak because the traditional trade channel is offset by effects from other channels.

3.4. Asset Price Channel

In theory, asset prices decline after a central bank raises its key rate (Mishkin, 1995). That is especially true of bonds (yields increase), as well as stocks and financial derivatives, particularly commodity futures.

Prices for those assets create a foundation for consumer prices and for the appraisal of collateral (especially real estate) and for real estate prices themselves. Then, asset prices influence consumption by households (via the wealth effect) and their liquidity.

This channel works best in countries with developed stock and commodity markets, like the US. In Ukraine, the capacity of the asset price channel is very low. The stock market is in an almost nascent state and stocks play no statistically significant role in the financial assets of households. The same is true of government securities (only UAH 6 billion as of the end of 2018).

Real estate plays a much greater role in household assets. However, considering the near complete lack of activity by commercial banks in mortgage lending, we believe the capacity of the asset price channel via real estate prices is very low.

The asset price channel may manifest itself, to a certain degree, via substantial amounts of foreign currency in cash held by households for savings. Tighter monetary policy that strengthens the hryvnia exchange rate thus reduces the real value of household savings in foreign currency. It may have an effect on long-term consumer and investment decisions by households.

3.5. Expectations Channel

Consistently low inflation creates advantages for economic growth via the anchoring of inflation expectations. In a theoretical model featuring a monetary policy that follows the Taylor rule, long-term inflation rate is defined as a central bank's target. Rational economic agents tie their interest rate anticipations to the central bank's reaction function and their long-term inflation expectations to the central bank's targets. This is based on the confidence that the central bank will carry out the appropriate policy to achieve its declared targets. As a result, such anchoring expectations to targets in itself mitigates the effects from various shocks, makes a strong response from the central bank to these shocks less necessary, and lowers the resulting losses in economic growth. When setting prices and wages, economic agents take into account the central bank's targets rather than short-term deviations of the inflation rate from the target under the effect of particular factors.

As a result, the capacity of this channel is driven by several elements:

1) The existence of central bank clear quantitative inflation target , and the consistency of monetary policy in achieving that target;

2) An efficient strategy of monetary communication, which serves as a connection between policymakers and economic agents;

3) The "rationality" of economic agents' inflation expectations, i.e. their use of all available information to forecast the future, including the central bank's actions taken to achieve inflation targets. The word "rationality" was intentionally placed in quotation marks because economic agents act rationally in any situation, which means their expectations are based on the information available to them. If a central bank has not shown a consistent monetary policy in achieving its declared targets in the past, economic agents will not consider its targets when forming their inflation expectations. On the contrary, if a central bank consistently conducts monetary policy aimed at reaching an inflation target, economic agents will expect the future inflation rate to be close to the target. That is called the "anchoring of expectations".

Therefore, the capacity of this channel is dependent on the degree of trust in the central bank and its monetary policy. The first two elements mentioned above can be quickly established if there is political will.

We focus primarily on the third element, because it defines the degree to which economic agents are capable of taking into account future events, including the central bank's policy, when forming expectations. In the end, this ability of agents to be forward-looking indicates the potential opportunities to anchor inflation expectations at the level of the central bank's target.

At the same time, it is worth reviewing the efforts to establish trust in the central bank and the creation of the new approach to monetary policy in Ukraine.

The transition to inflation targeting with a declaration of clear and, most importantly, irrevocable inflation targets in mid-2015, and the NBU's efforts to achieve those targets, have resulted in a significant and rapid decline of inflation expectations after the crisis (see Figure 14).

However, inflation expectations remained much higher than the NBU's targets, a consequence of the low trust in the NBU owing to historical memory and the experience of the most recent currency crisis of 2014-15. Overall, as

the study by Coibion and Gorodnichenko (2015) shows, inflation expectations significantly depend on the USD-UAH exchange rate.

Moreover, the inflation expectations of various economic agents have been worsening since late 2017 in a large degree due to the consequences of powerful food supply shocks, sharp increases in social standards by the government, and high wage growth, particularly because of intense labor migration.

Notwithstanding a temporary but significant increase in actual inflation, as from mid-2016 to 2017, inflation expectations have remained largely inert. That is a sign of the potential of anchoring them at a lower level, provided the public trust in the NBU's monetary policy.

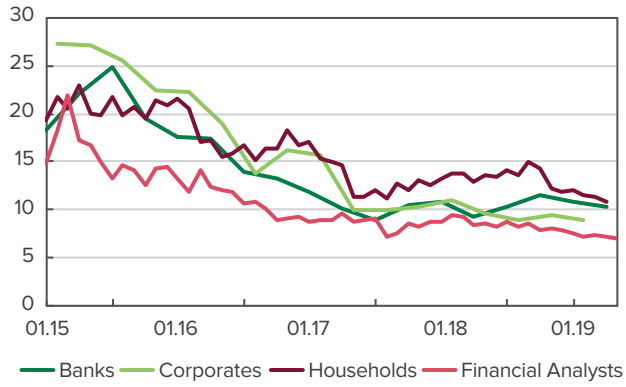


Figure 14. Inflation Expectations for the Next 12 Months by Survey Respondents, %.
Source: NBU.

Although unpopular, the interest rate hikes by the NBU in October 2017 – March 2018 created a foundation for an increase in trust in monetary policy and for an enhancement in the capacity of the expectations channel.

The NBU's implementation of best communication practices regarding monetary policy also contributed. These include the introduction since 2015 of the following elements that are standard for central banks that target inflation: 1) a public schedule of NBU Board meetings on monetary policy (eight annually since 2018); 2) regular press releases and press briefings featuring NBU Board members after every monetary decision; 3) publication of the Inflation Report with the NBU's macroeconomic forecast; 4) publication of Summaries of the Discussion on the Key Policy Rate at the Monetary Policy Committee.

To ascertain the rationality of expectations in Ukraine, we test hypotheses similar to those in studies of New Zealand (Ranchhod, 2003), Poland (Demchuk et al., 2012) and Hungary (Vonnák, 2007). The results of the tests of these hypotheses for Ukraine are just some proximity to reality because the time series are short and the periods they cover include economic crisis and changes in the monetary and foreign exchange regime in 2014-15.

The tested hypotheses include:

H 1. The reaction of long-term forward rates to an unanticipated change of the central bank's key rate are negative (according to Rezessy (2005). If a central bank responds to growing inflation by raising its key rate, the short-term end of the yield curve for government securities increases. In doing so, the central bank is seen to act to tame inflation, which consequently lowers the long-term forward yield.

Because of the limited availability of the data, we can only show that result based on anecdotal evidence. In October 2017 – March 2018, the NBU raised its key rate from 12.5% to 17.0% in four steps. Financials analysts did not anticipate the first two hikes. In other words, the market found out that the NBU is ready to defend its inflation target, even though it did not expect that tight policy in the past (see Figure 15).

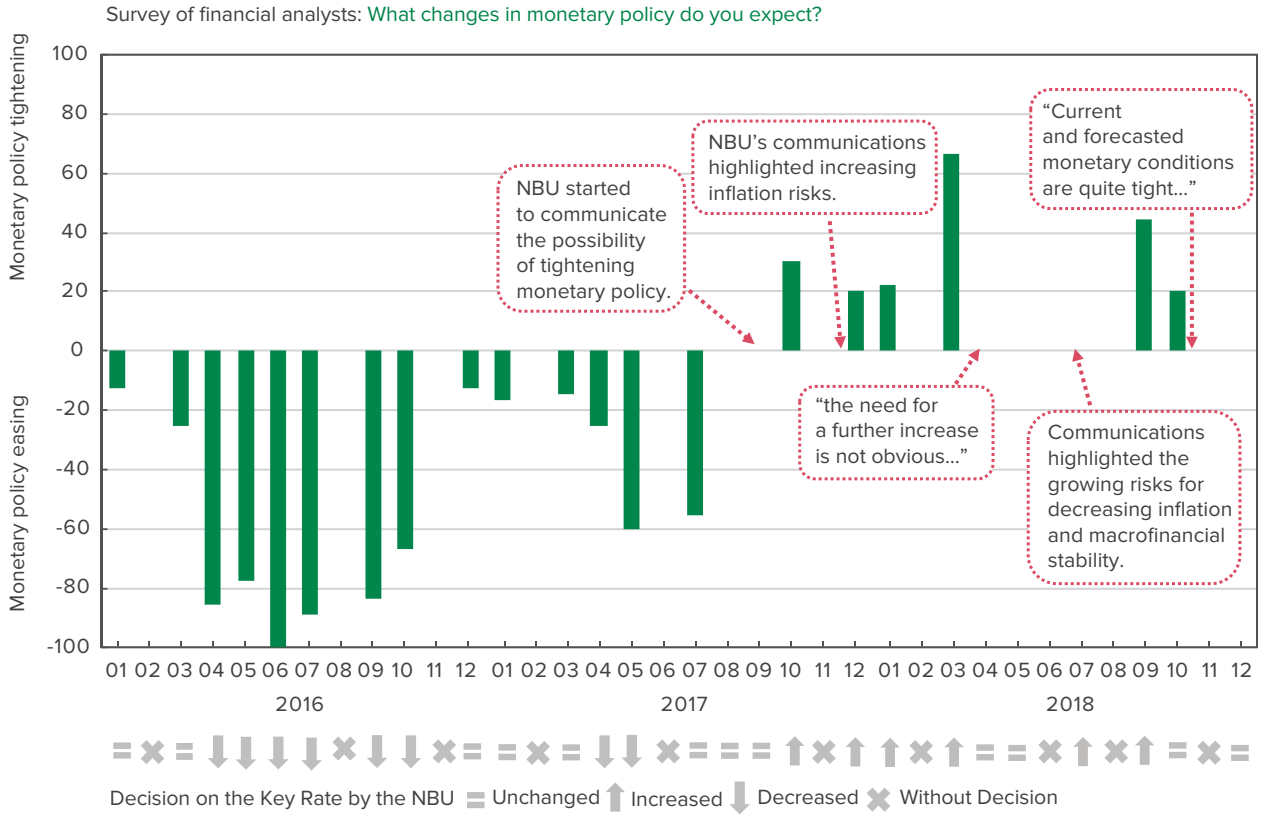


Figure 15. Results of Surveys of Financial Analysts Regarding Changes in the Key Rate, %.
Source: NBU.

As a result, the current yield on DGBs increased, while forward rates were flat or decreased (see Figure 16). In other words, this channel may be effective and the market considers the NBU's behavior.

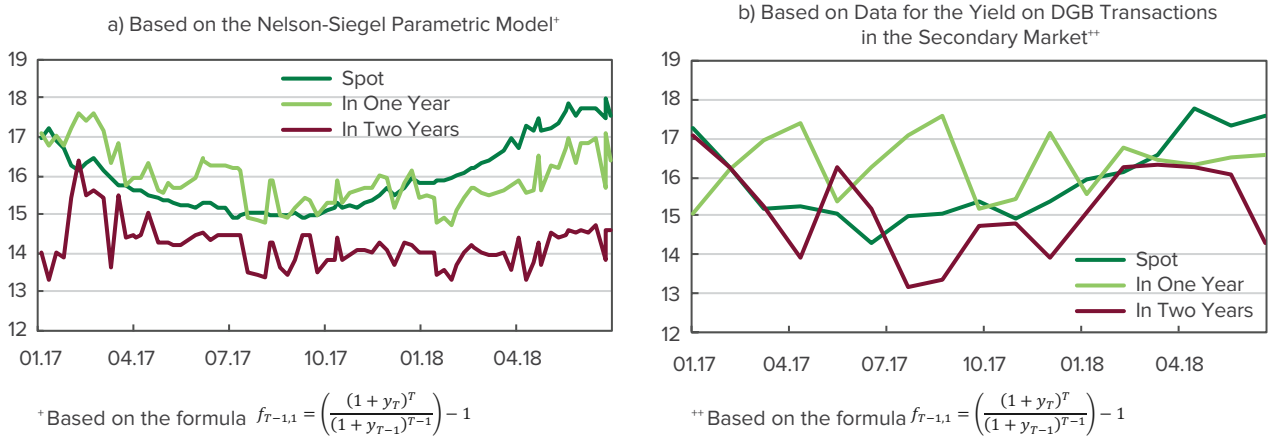


Figure 16. One-Year Forward Interest Rates on DGBs, % p.a. Source: own calculations.

H 2. Inflation expectations are unbiased and/or mostly do not take into account currently observed price trends.

To check these hypotheses, we compare inflation expectations for the next 12 months with actual annual inflation in 12 months.

We assess the mean forecast error (ME), the mean absolute percentage error (MAPE), and the root mean square error (RMSE) for existing expectation series and compare them with a naïve forecast, meaning a forecast built on the assumption that the current value of an indicator will stay the same in the future.

Since different groups are surveyed more or less frequently, we provide separate results for the monthly expectations of households and financial analysts (see Table 5) and the quarterly expectations of firms and banks (see Table 6).

Table 5. Errors in Inflation Expectations of Surveyed Respondents in 12 Months.

Expectation error	ME	RMSE	MAPE (%)
Households	-1.4	15	51
Financial analysts	-6.7	17	39
Naive forecast	6.3	28	146

Source: NBU, State Statistics Committee.
Period: July 2014 – December 2017. Variables: inflation expectations of households and financial analysts for the next 12 months, CPI yoy, actual CPI with a 12-month lag used as a naïve inflation indicator.

Table 6. Errors in Inflation Expectations of Surveyed Respondents in Four Quarters.

Expectation error	ME	RMSE	MAPE (%)
Firms	0.9	14.7	72
Banks	-2.1	15.7	59
Naive forecast	7.4	25.6	166

Source: NBU, State Statistics Committee. Period: Q3 2014 – Q4 2017. Variables: inflation expectations of firms and banks for the next four quarters, CPI yoy as of the last month of a quarter, actual CPI with a 4-quarter lag used as a naïve inflation indicator.

According to Ranchhod (2003), the mean error indicates the existence of bias when forming expectations, because it considers the deviation sign. A negative error indicates an understatement of expectations. In our case, that is what is observed for all respondent groups except firms, where it is positive but close to zero (Tables 4 and 5). This tendency towards an understatement of inflation became a consequence of serious unanticipated shocks that accelerated inflation during the surveyed period. This is especially true of 2015 and, to a lesser degree, 2017.

Nevertheless, the results are promising considering that the expectations have not been anchoring at high levels of actual inflation and have the tendency to decrease. Had expectations been observed at high levels, the error would have been significantly positive, as in the case of the naïve forecast. With more experience in inflation targeting, these expectations can be anchored near the inflation target.

The expectations of all respondent groups for the indicators that take into account the relative value of deviation (but not its sign) are much more accurate than in the case of the naïve forecast (Tables 5 and 6). That shows that the respondents consider factors other than current inflation when forming expectations.

A test of the following hypothesis may help expand on that conclusion.

H 3. Inflation expectations are influenced by future inflation (forward-looking), not past (backward-looking).

Studies of the identification of backward- and forward-looking components of inflation expectations typically have a common flaw: they cannot accommodate the unanticipated shocks that constantly affect an economy. When comparing expectations with actual inflation before and after survey (which was affected by unanticipated shocks), a greater correlation is seen with backward-looking inflation. Therefore, quantitative assessments suggest that inflation expectations are rational neither in developed economies like Sweden (Jonsson & Österholm, 2012) nor in developing economies like India (Sharma & Bicchal, 2018).

Still, a study of whether expectations are correlated with future inflation or if they are "anchored" only to inflation in the past is useful in any case. The degree to which the central bank's monetary policy can potentially influence expectations depends on that understanding.

Table 7. Correlation between Expected and Actual Inflation Indicators (lagged and anticipated)

	Financial analysts		Households	
Months	Backward-looking inflation	Forward-looking inflation	Backward-looking inflation	Forward-looking inflation
0	0.76	0.76	0.77	0.77
1	0.70	0.81	0.73	0.74
2	0.64	0.81	0.70	0.70
3	0.58	0.78	0.66	0.65
4	0.53	0.74	0.61	0.60
5	0.48	0.68	0.57	0.55
6	0.43	0.62	0.51	0.49
7	0.37	0.54	0.46	0.43
8	0.32	0.48	0.43	0.37
9	0.29	0.41	0.39	0.29
10	0.24	0.32	0.36	0.22
11	0.20	0.22	0.30	0.15
12	0.15	0.11	0.26	0.08

Source: NBU, State Statistics Committee. Period: July 2014 – December 2018.
Variables: inflation expectations of households and financial analysts for the next 12 months, yoy changes in CPI.

Table 8. Correlation between Expected and Actual Inflation Indicators (lagged and anticipated)

	Banks		Firms	
Quarters	Backward-looking inflation	Forward-looking inflation	Backward-looking inflation	Forward-looking inflation
0	0.88	0.88	0.88	0.88
1	0.89	0.74	0.83	0.79
2	0.79	0.50	0.69	0.61
3	0.62	0.23	0.51	0.36
4	0.44	-0.02	0.33	0.07

Source: NBU, State Statistics Committee. Period: Q3 2014 – Q4 2018.
Variables: inflation expectations of firms and banks for the next four quarters, yoy change in CPI as of the last month of a quarter.

The cross-correlations presented above are highlighted where it is greater than 50%. The results show that the expectations of all respondent groups have a future-oriented component. It is not surprising that financial analysts are most future-oriented (Table 7); their expectations correlate more with future inflation than with current inflation. They are better at forecasting and they already have a better understanding of the goals and the response function of the NBU's monetary policy. As for other respondent groups, their expectations are largely based on current inflation indicators (Tables 7 and 8).

Unfortunately, in-depth studies of pricing or wage-setting mechanisms in Ukraine and the effect of monetary policy on them, which could have allowed for a thorough study of the expectations channel, are unavailable today. Sufficient survey time periods (especially for the inflation targeting period), which could provide the basis for accurate conclusions for the properties of expectations, are also unavailable.

The adoption of the inflation targeting regime, the macrofinancial stabilization of recent years, and the NBU's interest rate hikes in October 2017 – September 2018 created the basis for a restoration of trust in monetary policy and for an increase in the power of the expectations channel.

An analysis of the available data on inflation expectations indicates that these expectations are influenced not only by current and backward-looking inflation, but also future expected inflation. Economic agents are better placed to forecasts than to simply use naïve forecasts. That is especially true of professional analysts, who already have a better understanding of the goals and the response function of the NBU's monetary policy. The inflation expectations of firms and households are still loosely tied to the NBU's targets. That is natural given the initial low degree of trust, short history of inflation targeting, and significant inflationary shocks of the last years.

The study's results suggest that after more time carrying out a consistent monetary policy aimed at ensuring price stability, inflation expectations can be anchored close to the NBU's inflation target.

This analysis can be expanded, but that would require more data, especially for timeframe during which the NBU has conducted monetary policy based on inflation targeting.

Possible areas of study include:

1) Assessing the persistency of inflation expectations and the degree to which those stay close to the inflation target. This assessment could be based on a sufficient amount of data for the existing inflation targeting period;

2) Evaluation of the period in which inflation expectations return to the target level after a sizable price shock;

3) The effect of changes in the NBU's macroeconomic forecast on inflation expectations.

4. CONCLUDING REMARKS

This work offers our vision of the comprehensive functioning of the MTM and its channels based on the latest studies and the practical experience of implementing monetary policy in Ukraine. Drastic changes in the economic and financial system after the 2014-15 crisis and the recent adoption of the inflation targeting regime make econometric calculations based on the data prior to 2013 irrelevant for an evaluation of monetary transmission channels. However, in cases where high-frequency data is available, an empirical analysis is based on econometric calculations, for example, for the relationship between the key rate and money market rates or commercial bank loan and deposit rates.

The results of this study prove that the MTM channels over which the NBU has a strong influence have been given the opportunity to develop since the adoption of inflation targeting and after the completing of the clean-up of the banking system. In particular, this study finds that the interest rate channel, exchange rate channel, and expectations channel are effective. Other channels are still not influential (the lending channel) or rudimentary (the asset price channel). That is a consequence of the financial system (low stock market development and negligible role of long-term investment institutes like pension funds) and historical factors (high and volatile inflation, low trust in the central bank, structural changes, etc.).

Interest rate channel. Thanks to the implementation of the operational design of monetary policy typical for central banks that pursue inflation targeting, the NBU was able to establish control over short-term interest rates in the interbank market. The magnitude of the pass-through of changes in the key rate to interbank market rates is high and their fluctuations stay within the range for the NBU's overnight standing facilities. These rates quickly and fully affect the short-term end of the yield curve for government securities.

Commercial bank rates on business loans and deposits quickly and fully react to changes in the key rate. The reaction of household deposit rates is slower and weaker. Interest rates on household loans are defined by nonprice factors, since the majority of these loans are short-term consumer loans. Still, the situation may change with the development of mortgage lending. Meanwhile, interest rates on household deposits stopped declining after the NBU began raising its key rate in October 2017. However, the increase has been slow as banks have seen a substantial inflow of hryvnia deposits amid the macroeconomic stabilization, which has reduced competition among banks. At the same time, when the banking system's liquidity declined, competition intensified mostly for corporate funds, which react more quickly to interest rate changes. Nevertheless, we believe the weak effect of the key rate on interest rates for individual deposits is temporary. The arbitrage opportunity between the yield on government securities (not subject to taxation) and interest rates on individual deposits will not remain in the coming years. The announcement by Ukraine's Finance Ministry to simplify access for retail customers to the government securities market should expedite the process.

The effect of interest rate changes on investment and consumption decisions by economic agents is less pronounced in Ukraine than in other countries due to the country's low financial and credit depth. At the same time, considering the limited choice of instruments for household savings where bank deposits play the lead role, commercial bank deposit rates must be a more important element in MTM.

Prospective areas of study. As more data becomes available, the effect of the MTM in Ukraine can be assessed using macro models with added micro analyses of particular transmission chains, first of all, the transition from money market rates to individual banks' interest rates. The effect of interest rate changes on investment and consumption decisions by economic agents remains a topic that has barely been touched in Ukraine, and it deserves an in-depth study.

Credit channel. Some evidence shows that the credit channel's contribution to the MTM is insignificant. The volume of loan supply shows a weak reaction to changes in monetary conditions, because commercial banks are more constrained by other factors in making decisions. Firstly, after the economic and financial crisis of 2014-15, commercial banks have preferred to finance reliable borrowers regardless of monetary conditions. Secondly, the faster resumption of bank lending (loan supply) is restrained by institutional factors, especially the poor protection of creditor rights. Thirdly, large corporations (especially exporters) have an alternative to bank lending in the form of borrowing from their parent company and from the sale of Eurobonds.

After bank balance sheets are cleaned from NPLs and other institutional improvements are implemented, we expect greater lending activity of the banking system. That will increase the availability of data, which will make it possible the quantitative assessment of the lending channel.

Prospective areas of study. A study of Ukrainian banks and corporations using large data sets is a prospective area of study. That would allow us to identify factors that affect loan supply other than demand for loans.

Exchange rate channel. The strengthening of the hryvnia exchange rate that started in January 2018 after a number of interest rate hikes offers convincing evidence of the functioning of uncovered interest rate parity.

The effect of the exchange rate on macroeconomic indicators is one of the main means of influencing inflation due to a substantial pass-through effect. According to existing studies, the pass-through is nonlinear: a substantial devaluation of the exchange rate leads to a high pass-through, whereas mild fluctuations do not produce a serious inflationary response. That justifies the use of foreign currency interventions by the NBU to smoothen exchange rate volatility to help achieve the inflation target.

The effect on economic growth is less pronounced. The negative effect from a stronger exchange rate due to a deterioration of competitiveness is largely offset by positive balance sheet effects because of the high dollarization of the corporate sector's obligations.

Prospective areas of study include the effects of interest rate changes and foreign currency interventions (volumes) on exchange rate changes.

Asset price channel. In Ukraine, the power of the asset price channel is very low. Firstly, the stock market is in a nascent state and stocks play no statistically significant role in the financial assets of households. The same is true of the debt securities market, where only government securities enjoy any true activity. The effectiveness of this channel can strengthen only if (or when) household income and savings increase. Some progress can also be expected once mortgage lending recovers in the future, which would strengthen the power of the asset price channel via the real estate prices.

Expectations channel. An analysis of data on inflation expectations indicates that these expectations are not only influenced by current and backward-looking inflation, but also by forward-looking inflation. Economic agents are better positioned to make forecasts than to simply use naïve forecasts. That is especially true of professional analysts, who already have a better understanding of the goals and the response function of the NBU's monetary policy. The inflation expectations of firms and households are still loosely anchored to the NBU's targets. That is natural given the initial low degree of trust, short history of inflation targeting, and significant inflationary shocks of the last years.

This study offers reasons to believe that inflation expectations can be anchored close to the NBU's inflation target once the NBU gains more experience in executing a consistent monetary policy aimed at ensuring price stability.

Prospective areas of study. With more data available, especially for the period for which the NBU has targeted inflation, the prospective areas of study may include: assessing the persistency of inflation expectations and the degree to which they stay close to the inflation target; evaluating the period when inflation expectations return to the target value after a sizable price shock; analyzing the effect of changes in the NBU's macroeconomic forecast on inflation expectations.

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ESTIMATING A NATURAL LEVEL OF FINANCIAL DOLLARIZATION IN UKRAINE[1]

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Abstract This article overviews the background for financial dollarization in Ukraine. We apply quantitative techniques including both minimum variance portfolio and peer comparison taking into consideration country-specific characteristics to derive an estimated natural dollarization level for Ukraine. The study also discusses potential ways for Ukraine to converge to its natural level, which we estimate at 20%. Additional factors indicate dollarization in the range of 20-30% as realistic medium-term policy goal.

JEL Codes F41, E58, G11

Keywords financial dollarization, natural dollarization, euroization, minimum variance portfolio

1. INTRODUCTION

Dollarization[2] is a common problem for emerging economies, and it is one with no simple solution. As such, the topic is a common one for researchers around the world. Ukraine is an example of such an emerging economy, with the hryvnia serving as legal tender in Ukraine since 1996. After a period of hyperinflation in the 1990s, Ukraine has achieved relative stability by keeping inflation to double digits, and more recently to single-digit levels. Partly owing to the rapid pace of inflation over the past nearly 20 years, dollarization is high in Ukraine. It comes in the form of financial dollarization (financial assets and liabilities in foreign currency), real dollarization (defined as the indexation of prices and wages to foreign currency), and currency substitution (as defined by the use of foreign currency for transactions). Distrust in the government, the memory of rapid devaluations, geopolitical threats, and recurrent banking crises have prompted residents to use and hold savings in foreign currency. Moreover, financial markets are underdeveloped, meaning there are limited opportunities to diversify risk.

Dollarization carries consequences to the domestic economy, and it has few benefits. Aleksić et al. (2008) and Yeyati (2006) show that it weakens the interest rate channel of monetary policy transmission.[3] Excessively dollarized economies have fragile financial sectors because rapid exchange rate movements result in large losses (the so-called balance sheet effect). These economies are therefore prone to banking crises. Their economic growth is also slower and more volatile (Yeyati, 2006). Although financial dollarization promotes financial depth by allowing risk hedging onshore, it has such benefit only in periods of high inflation (De Nicolo et al., 2005). Dollarization promotes investment by lowering interest rates, but it does so at the cost of financial stability. Thus, authorities seek to reduce dollarization to alleviate its mostly negative consequences.

Some degree of dollarization is unavoidable in an open economy, as foreign currency deposits provide a diversification opportunity and can facilitate international trade. Dalgic (2017) views foreign currency deposits as an insurance agreement, where agents who take out foreign currency loans are the insurance providers and the foreign currency depositors insure themselves against devaluation risks.

Nevertheless, excessive dollarization is undesirable. To identify excessive dollarization, we estimate a natural dollarization level. We define it as the dollarization level consistent with the structural characteristics of the Ukrainian economy, assuming a long history of good macroeconomic performance and implementation of appropriate policies. Among structural factors, we consider institutional quality, the geopolitical environment, the high openness of the economy, and the persistence of dollarization due to hysteresis – expectations that become embedded in behavior.

This article aims to estimate the natural dollarization level in Ukraine. That natural level will help to measure excess dollarization and serve as a benchmark for de-dollarization policies. However, further empirical research of the drivers of de-dollarization is needed to develop de-dollarization measures.

[1] The views expressed in this article are solely those of the authors and do not necessarily reflect the view of the institutions that employ the authors.
[2] Throughout this article, "dollarization" refers to the use of any foreign currency (EUR or other widely used currency) instead of the domestic currency, rather than specifically the use of USD.
[3] However, according to Reinhart et al. (2003) and Leiderman et al. (2006), disinflation is still possible in highly dollarized economies. The success of Peru, a highly dollarized country, is an example of this.

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We contribute to the literature by applying a minimum variance portfolio (MVP) model to Ukraine's macroeconomic data. We then use the output of the MVP model to arrive at a natural dollarization level that takes into account country-specific factors.

The article is structured as follows: the next section provides an overview of the literature on the determinants of dollarization and approaches to determining the natural dollarization level. Section 3 discusses the trends in financial dollarization in Ukraine and describes its specific factors. Section 4 provides estimates of the natural dollarization level in Ukraine based on the minimum variance portfolio model, a peer review, and estimates from the literature. Finally, Section 5 concludes and discusses de-dollarization policies.

2. LITERATURE REVIEW

The determinants of deposit and loan dollarization have been studied extensively. They fall largely into three categories: macroeconomic factors, institutional factors, and prudential regulations.

Macroeconomic Factors

Portfolio allocation theory under the assumption of uncovered interest parity (UIP) is the most popular concept for dollarization analysis. Ize and Yeyati (2003) introduce a model that derives the minimum variance portfolio (MVP) allocation between local and foreign currency deposits (and loans, respectively) based on expectations of future inflation and exchange rate behavior. The model suggests that financial dollarization does not depend on the levels of inflation and exchange rate but instead on the expectations of their volatility, which is reflected in the MVP ratio. The greater the expected inflation volatility relative to that of the real exchange rate, the greater the share of foreign currency deposits in the MVP. The MVP ratio approximates actual dollarization in many countries (Della Valle et al., 2018).

According to the MVP model, real dollarization is the lower bound of financial dollarization. Contreras et al. (2016) argue that this is the main reason for the relatively high financial dollarization in Peru despite the country's macroeconomic stabilization and the delivery of stable inflation below 5% for over 15 years. Basso et al. (2010) show that real dollarization, proxied by trade openness, positively affects corporate loan and deposit dollarization.

It follows from the MVP model that the choice of monetary policy and exchange rate regime is key to the dollarization level in the economy. A fixed exchange rate regime aspires to promote macroeconomic stability by stabilizing the exchange rate. Because it lowers exchange rate volatility more efficiently than inflation volatility, the fixed FX regime causes high financial dollarization. As Honig (2009) notes, a fixed FX regime induces borrowers to believe their currency risk is hedged, thus encouraging dollarization.

On the contrary, most countries that target inflation not only aim to bring inflation to the target, but also to keep it in a specified range, thus lowering inflation volatility. Those countries prioritize stabilizing inflation, with exchange rate stabilization a secondary goal. Full-fledged inflation targeting (i.e., one combined with a floating FX regime) should produce the best results in combatting dollarization because it simultaneously lowers inflation volatility and ignores exchange rate volatility. Lin and Ye (2013) have estimated that the introduction of inflation targeting results in, on average, a reduction in financial dollarization of 8 percentage points (pp). Comparing countries with a full-fledged inflation targeting approach to countries with exchange rate targeting offers an even larger estimate of the average treatment effect: 11 pp.

Basso et al. (2010) model expands the MVP model by relaxing the UIP assumption. The model predicts that the interest rate differential (i.e., foreign currency minus the local currency rate) is, along with MVP, an important determinant of dollarization in the short-run when UIP does not hold. Therefore, factors that affect interest rate differentials also affect dollarization. Ample access to foreign bank funding, which widens both loan and deposit interest rate differentials, leads to an increase in loan dollarization and a decrease in deposit dollarization. Empirical analyses have confirmed the theoretical predictions for foreign financing of banks and showed that interest rate differential affects dollarization along with MVP. The impulse response functions show that the effect of the interest rate differential is temporary. Urosevic and Rajkovic (2017) also confirm that interest rate differentials only affect dollarization in the short-run.

Structural Factors

Some authors place government quality on top of their determinants of dollarization. Honig (2009) shows that when controlling for government quality, its effect on dollarization is significant and large while the choice of the exchange rate regime is only marginally important. A hypothetical transition of a country from the bottom to the top of the list in terms of government quality will result in a sizable 35 pp decrease in credit dollarization. De Nicolo et al. (2005) found similar effects stemming from macroeconomic policy credibility and institutional quality.

Adam Honig estimated that the effect of high past inflation is significant and large while the effects of current inflation, depreciation, and MVP are mostly insignificant. This is a sign of the hysteresis of dollarization and explains why many countries have not managed to dampen dollarization even after stabilizing their economies. At first glance, this seems to contradict the MVP model. However, despite a significant decrease in actual inflation variability, the public may still distrust the government's ability to deliver long-run local currency stability, so there may be a systematic gap between expected and actual exchange rate and inflation volatility.

As Basso et al. (2010) note, their model can be used to predict the effect of remittances, although this is not covered in the paper and empirical analysis. Della Valle (2018) shows that remittances positively affect total deposit dollarization.

Prudential Regulations

Prudential measures are also important determinants of dollarization since they affect interest rate differentials. By favoring foreign currency less than local currency, a regulator can promote de-dollarization. Nevertheless, the short-run nature of the interest rate differential effect implies that the effects of these types of prudential regulations are also short-lived.

In particular, Catão and Terrones (2016) show that imposing higher provisions for foreign currency loans decreased both loan and deposit dollarization. At the same time, increases in marginal reserve requirements on foreign currency deposits decrease deposit dollarization only in

some cases and do not affect loan dollarization. Moreover, the introduction of higher capital requirements for foreign currency exposures does not affect dollarization on banks' balance sheets. Kokenyne et al. (2010) find that liquid asset requirements imposed on banks' foreign currency assets reduce deposit dollarization, but the effect reverses soon after the measure is introduced.

Estimation of the Natural Dollarization Level

An MVP model can also be useful for estimating natural dollarization. The MVP approach suggests the optimal currency composition of deposits given the prevailing macroeconomic environment. By assuming that agents expect good macroeconomic conditions in the future, the natural dollarization level can be estimated. However, some factors may induce actual dollarization to depart systematically from the MVP ratio. As discussed in Ize and Yeyati (2003), these include high real dollarization and an imperfectly credible exchange rate targeting regime with episodes of rapid devaluation and high real dollarization. As discussed earlier in this article, actual dollarization may also depart from the MVP due to abundant external bank financing or ample remittances. Lastly, as we discussed previously, low institutional quality and a corrupt government lead agents to disbelieve the government's commitment to deliver macroeconomic stability in the future despite its success in doing so in the past. This will lead to a systemic divergence of the MVP calculated based on actual values of inflation and depreciation from the expectations-based MVP.

Della Valle et al. (2018) are among the pioneers concerned directly with the empirical estimation of the optimal level of foreign currency in an economy. The authors fit a country panel regression of deposit dollarization on a list of dollarization factors, and then compute fitted values using estimated coefficients but replacing actual macroeconomic values with those that reflect a history of good macroeconomic management (i.e., low volatility of inflation and the exchange rate). Using data for 2000-2015, they estimate the natural dollarization level in Ukraine at around 15%.

Geng et al. (2018) found that autonomous euroization for a group of emerging European and Central Asian countries in 2006-2016 was approximately 15-20%. In this case, autonomous euroization refers to the part of deposit euroization which is not explained by the long-term MVP, the maximum level of inflation, and institutional quality. As the authors note, "this may reflect factors like import companies holding FX deposits as a natural hedge". That refers to the share of foreign currency deposits in the economy to be held in the course of trade and doing business, without other factors. This seems to be close to the lower bound of the natural dollarization level.

3. BACKGROUND FOR FINANCIAL DOLLARIZATION IN UKRAINE

Financial dollarization in Ukraine is high but not extreme (Figure 1). In a recent analysis of comparable countries, low-dollarization countries had dollarization levels of 10-20% over 2009-2016, while highly dollarized countries had levels of 40-80% (Della Valle et al., 2018). Ukraine had a dollarization rate of 44%, placing it into the lower end of the highly dollarized range. Moreover, dollarization has decreased over the last three years.

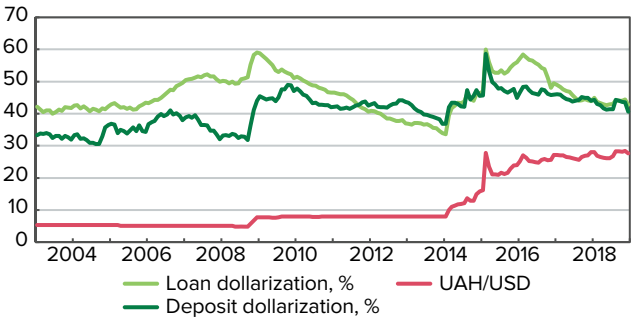


Figure 1. Indicators of Financial Dollarization in Ukraine and the UAH/USD Exchange Rate.
Source: NBU, authors` calculations.

Fundamental factors that contribute to financial dollarization in Ukraine include:

- Macroeconomic instability – Ukraine has experienced repeated episodes of high inflation and sharp depreciations of the domestic currency. Several currency crises accompanied by rapid inflation over the past 20 years have revived the memories of the hyperinflation of the early 1990's. Not only the level of past inflation, but also its high volatility drive uncertainty in the future value of the national currency. This results in a deeply rooted "dollarization psychology" which can be self-reinforcing, resulting in a persistent preference for foreign currency over domestic currency.

- Low governance quality – Ukraine is frequently ranked in the lower half in Worldwide Governance Indicators[4] as measured by control of corruption, rule of law, regulatory quality, and government effectiveness. In recent years, the annexation of Crimea and the military conflict in Eastern Ukraine have increased political instability and raised external threats. This has further eroded trust in the government's economic policy and exacerbated the perception of the instability of the domestic currency. In addition, intrusive and onerous regulation alongside tax avoidance pushes real and financial economic activity abroad, leading to so-called offshorization and subsequent shrinkage of hryvnia funding.

- Monetary policy regime – a *de facto* fixed exchange rate regime until 2014 has distorted risk perception on both sides of the money market. On the one hand, tail risks of exchange rate fluctuations have contributed to a deterioration of the view of the hryvnia's store of value function. On the other hand, prolonged periods of exchange rate stability caused borrowers to be myopic regarding real foreign currency borrowing costs. As a result, depositors invested in foreign currency as a one-sided bet, while low foreign currency interest rates attracted myopic borrowers. The transition to an inflation-targeting regime in 2015 introduced a clear mandate for the central bank to achieve inflation at a specified range alongside a managed floating exchange rate. However, it will take time for the new policy to gain credibility and for the perceptions of economic agents to change, including their inflation and exchange rate expectations.

- Interest rate differential – In conjunction with devaluation expectations and risk aversion, interest rate differentials can stimulate (de)dollarization in the short-run. Empirically,

[4] More detailed information is available on the website of the World Bank.

we observe that interest rate parity holds under stable macroeconomic conditions as both interest rate differentials closely followed devaluation expectations in 2010-2013 (Figure 2). However, devaluation expectations have deviated from the interest rate differential since the 2014 crisis. The systematic excess of households` devaluation expectations over the interest rate differential due to the fresh memory among households of the crisis has set back the reduction of deposit dollarization despite relatively high interest rate differential.

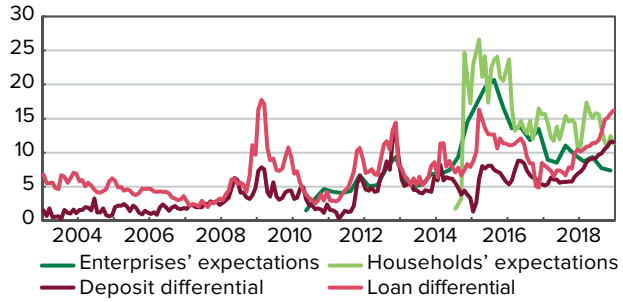


Figure 2. Interest Rate Differentials* and UAH/USD Depreciation Expectations#, % pa.
Source: GFK, NBU, author`s calculations.

* Interest rate differential is a difference between hryvnia and foreign currency interest rates.
# Depreciation expectations is a ratio of 12 month ahead expectation of UAH/USD rate relative to current monthly average rate. Expectation of USD/UAN are based on surveys of households and enterprises.

• External factors – access to foreign funding affects banks' foreign currency positions and their willingness to attract foreign currency deposits. The appetite of Ukrainian banks for foreign funding had been on the rise before the Global Financial Crisis (GFC). The share of foreign liabilities in the total liabilities of deposit-taking corporations (excluding the NBU) surged from 7% in 2002 to 35% in 2008, while foreign assets remained relatively stable. With abundant foreign currency inflows into the banking system from abroad, loan dollarization increased while deposit dollarization declined. The reversal of foreign currency flows since the GFC alongside foreign currency regulations have caused the opposite trend of a decrease in loan dollarization, while deposit dollarization has been relatively stable.

• Real dollarization – although 22 years have passed since the hryvnia became the sole legal tender, the US dollar often serves as a unit of account. Certain goods, such as real estate and vehicles, are de facto indexed to US dollars, whereas *de jure* transactions are made in hryvnia.

• Structural factors – the high openness of the Ukrainian economy alongside shallow financial markets may contribute to dollarization. International trade as a percentage of GDP fluctuates at around 100%. Remittances from labor migrants abroad reached record high USD 11.1 bn in 2018, or 8.5% of GDP. The lack of a market for domestic currency securities is a serious impediment to the development of financial markets and a serious constraint on savers' ability to diversify investments and remain in UAH. Limited access to hedging instruments may force dollarization. However, capital controls are extensive in Ukraine, which holds dollarization back. According to Fernández et al. (2015), Ukraine is part of the "wall" category, meaning it has capital controls for most categories of assets.

4. NATURAL LEVEL OF FINANCIAL DOLLARIZATION IN UKRAINE

Although dollarization is considered a negative phenomenon, some share of foreign currency assets is natural for an economy. In our research, we define natural dollarization as the level consistent with good macroeconomic fundamentals conditional on the implementation of proper government policies, while adjusting for structural characteristics and hysteresis. We assume both deposits and loan dollarization will converge to the natural level in the long-run to exclude the possibility of systemic currency mismatches.

One way to look at financial dollarization is that of a risk-averse investor hedging the portfolio against inflation and currency risks. In this case, MVP dollarization is a reasonable share of foreign currency in an investor's portfolio taking into account expected volatilities of inflation and real exchange rate under conditions of UIP.

According to Ize and Yeyati's (2003) MVP model, the share of foreign currency deposits (and loans) corresponding to the minimum-variance allocation approximately equals:

$$\lambda = \frac{S_{\pi\pi} + S_{\pi s}}{S_{\pi\pi} + S_{ss} + 2S_{\pi s}}, \quad (1)$$

where:

λ represents MVP dollarization,

π is inflation,

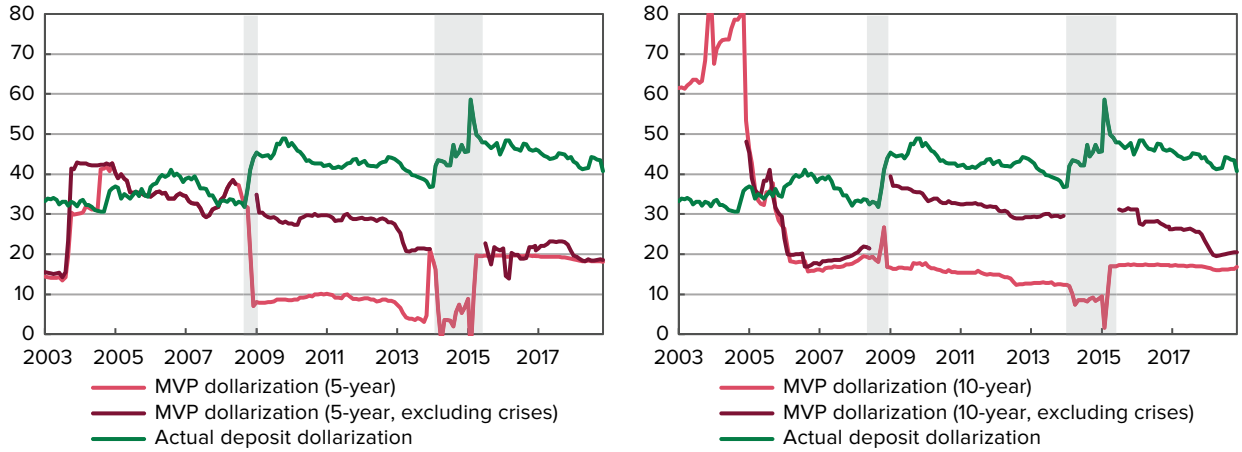
s is the real exchange rate,

S_{xy} is the variance-covariance operator.

We have used historical volatilities of the real exchange rate and inflation as proxies for expected volatilities, which are not observable. In order to compute the variance-covariance matrix for MVP, we tried several options of time series length. The greater the length, the "better" the assumed memory of economic agents. Results for longer time horizons are more persistent. However, the non-linear relationship between exchange rate and prices observed during several crises complicates the interpretation of the results. In the research, we construct two versions of the MVP using rolling periods of 5 and 10 years of data, which respectively suggest 5-year and 10-year MVP dollarization. We exclude crisis periods to obtain more robust results.

The 10-year MVP was in the range of 60-80% in 2003-2004 due to the hyperinflation of the early 1990s (Figure 3 a, b). However, both MVP ratios decline to 30-40% in 2005 and then to 18-22% in 2018. Therefore, the MVP model suggests it is currently optimal to hold 18-22% of the portfolio in foreign currency.

Actual dollarization coincided with the 5-year MVP in 2004-2008. However, since the GFC, actual dollarization is 15-20 pp above the MVP allocation. The regulatory environment is one explanation for the deviation: the high share of *de facto* nonperforming loans in foreign currency has driven banks to hold a high share of foreign currency deposits in order to balance foreign currency positions to



Figures 3a, b. MVP and Actual Dollarization, %. Grey area depict crises periods.
Source: IMF database, SSSU, authors calculations.

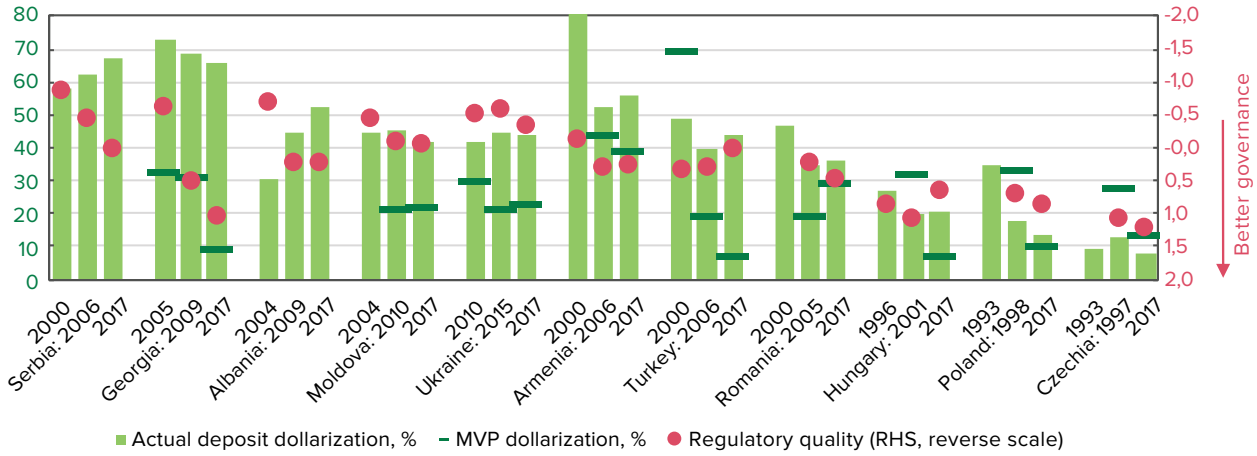
comply with regulations. The devaluation expectations of depositors biased towards downside FX risks, which is not reflected in historical volatilities, are another reason for the deviation of the MVP from actual dollarization.

A peer review is the next step in measuring the level of natural financial dollarization. For comparison, we selected Eastern European countries and countries of the former USSR that have pursued inflation targeting for at least five years (Figure 4). In order to capture the major drivers of dollarization, we show MVP dollarization and regulatory quality alongside deposit dollarization. MVP dollarization is calculated according to (1) based on five years of historical data. As a proxy for regulatory quality, we use the regulatory quality indicator from the Worldwide Governance Database. Regulatory quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.[5]

In most cases, actual dollarization reflects regulatory quality – economies with higher regulatory quality have low dollarization and vice versa. Ukraine falls into the group of countries where high dollarization corresponds to low regulatory quality; the group includes Albania, Moldova, Armenia, Turkey, and Romania. MVP dollarization calculated using historical data fairly well approximates actual dollarization in Armenia, Poland, and the Czech Republic, while actual dollarization is well above its MVP value in other countries. In Georgia and Serbia, dollarization has been persistently high even while regulatory quality has improved significantly.

Although the relatively low value of MVP in Ukraine could motivate investment in domestic currency, de-dollarization is constrained by a distrust of government policies and high real dollarization. Improved governance quality and its perception by the population is crucial for restoring trust in the domestic currency, but that may still not be enough to decrease financial dollarization. As mentioned in the literature review, real dollarization sets a lower bound for financial dollarization. Although real dollarization is not easy to measure, it can be approximated by the pass-through of the exchange rate on prices. Pass-through in Ukraine is estimated at 0.27-0.28 for the nominal effective exchange rate and at 0.40-0.42 for USD/UAH exchange rate (Faryna, 2016).

Summing up the different results for natural dollarization in Ukraine (Table 1), we conclude that dollarization in the long term should fall to 20% given sustainable macroeconomic stability and proper economic policy. As mentioned in the literature review, a recent analysis of panel data indicates 15% as the optimal deposit dollarization rate in Ukraine, while autonomous dollarization for a group of emerging European and Central Asian countries including Ukraine is estimated at



Figures 4. Deposit Dollarization, MVP Dollarization, and Regulatory Quality in Selected Countries that Target Inflation.
Source: World Bank WGI, central banks' websites, authors' calculations.
Note: Three columns for each country represent data as of several years before IT adoption, year of IT adoption and 2017 respectively.

[5] More detailed information is available on the website of the World Bank.

15-20%. Moreover, different measures of MVP dollarization using historical volatilities show almost the same range at 18-22%. Our peer review illustrates that countries that target inflation and have good regulatory quality alongside a long history of macroeconomic stability can reach dollarization levels of 10-20% (Poland, the Czech Republic, Hungary).

Table 1. Summary of Estimates of Natural Dollarization Level in Ukraine.

Source	Estimate
Della Valle et al. (2018)	Benchmark euroization in Ukraine is 15%
Geng et al. (2018)	Autonomous euroization in countries of Europe and Central Asia (including Ukraine) is 15-20%
MVP dollarization	18-22%
Peer review	Actual dollarization in Poland, the Czech Republic, and Hungary is in the range of 10-20%

Source: Della Valle et al. (2018), Geng et al. (2018), NBU, other central banks' websites.

All these measures reflect the natural dollarization concept and provide a robust estimate for Ukraine in the range of 10-20%. However, factors that are unlikely to unwind even after the implementation of proper economic policy and after a macroeconomic stabilization, which include geopolitical risks, governance issues and high openness of the economy raise the natural dollarization level for Ukraine to higher bound – around 20%. In our view, taking into consideration dollarization hysteresis, a range of 20-30% is an achievable medium-term policy goal.

5. CONCLUSIONS AND POLICY DISCUSSION

Some degree of dollarization will always be present in an open economy, but excessive dollarization is undesirable. Authorities seek to lower dollarization to reduce vulnerabilities, improve the effectiveness of monetary policy, and help create an environment that will promote balanced growth.

A reasonable benchmark can aid in evaluating the progress of de-dollarization policies. A review of the recent literature, MVP calculations, and a peer review suggest a range of 10-20%. However, the structural characteristics of the Ukrainian economy suggest a higher level of natural dollarization – around 20%. In our view, due to dollarization hysteresis a realistic medium-term policy goal for Ukraine would be to lower financial dollarization to a range of 20-30%. The current dollarization of deposits and loans is around 40%, which we deem excessive.

Any reduction in dollarization is conditional on macroeconomic stability and the development of financial markets, in addition to the implementation of important structural reforms. Furthermore, Kokenyne et al. (2010), Mecagni et al. (2015) argue that a market-driven approach should be the cornerstone of any long-run de-dollarization policy, while forced measures used in isolation from market-based incentives can lead to capital flight and reduced financial intermediation. Still, some countries suffer from dollarization despite achieving the aforementioned conditions. Therefore, identifying effective de-dollarization drivers remains an open topic for further empirical research.

Based on our analysis of key dollarization factors in Ukraine and a literature review, we propose the following components of a market-driven de-dollarization strategy for Ukraine:

- Strengthening institutions and improving governance: protecting creditor rights, ensuring a strong legal system, including effective and impartial judgement and enforcement, equitable taxation policies and enforcement, and reducing corruption.

- Macroeconomic stability: reducing and stabilizing inflation, pursuing a flexible exchange rate regime with two-way risk and moderate volatility, ensuring a real exchange rate that is consistent with fundamentals, building adequate international reserves, and adopting a sustainable and appropriate fiscal stance.

- Ensuring a stable financial system and strong financial institutions.

- Developing financial markets, especially the government bond market in hryvnia and hedging instruments.

Overcoming excessive financial dollarization is not a quick task. According to Honig (2008), hyperinflation promotes dollarization for at least the next 10 years. Moreover, improvements in government quality take time. Dollarization is the outcome of expectations that build upon both the actual macroeconomic environment and a belief in the government's capacity to keep it stable in the future. Reducing real dollarization by improving the credibility of economic policies and particularly the domestic currency is crucial. The government must continuously confirm its commitment to long-term macroeconomic stability by choosing appropriate policies and regulations, and communicating them effectively.

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