APPLYING FOREIGN EXCHANGE INTERVENTIONS AS AN ADDITIONAL INSTRUMENT UNDER INFLATION TARGETING: THE CASE OF UKRAINE

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ABSTRACT

This study examines applying foreign exchange interventions under Inflation Targeting regime in an emerging market economy. For this purpose, we employ the Quarterly Projection Model of the National Bank of Ukraine and simulate different policy responses to various macroeconomic shocks. We discuss monetary policy objectives, which are low inflation volatility and accumulation of international reserves, and conclude that monetary policy could benefit from using interventions in addition to the key policy rate. We advise on particular policy reactions (with or without FX intervention) in case of different macroeconomic shocks.

JEL Codes: E17, E52, E58, F31

Keywords: foreign exchange interventions, inflation targeting, monetary policy, macroeconomic models

I. INTRODUCTION

In the 1990s, it was widely believed that a central bank under a "pure" inflation targeting (IT) regime should not have any foreign exchange (FX) interventions in its toolkit. The rationale for this was quite clear: there is a risk that manipulating an exchange rate could undermine credibility to the declared nominal anchor, i.e., an inflation target. In fact, the emergence of IT can be considered as a response to the negative experience of using an exchange rate as a nominal anchor, which in many cases resulted in accumulation of macroeconomic imbalances and loss of credibility.

At the same time, the benefits of using FX interventions were doubtful in developed economies, which were first to adopt IT. The macroeconomic effect of intervention on foreign exchange market was believed to be eliminated because advanced economies used to have open capital accounts and developed financial markets. Thus, any central banks' manipulation with an exchange rate would be offset by capital flows. However, this conventional wisdom has changed after several emerging market economies successfully implemented IT with a specific role for FX interventions.

After the eruption of the global financial crisis in 2008-09, the possibility and even necessity of taking into account exchange rate movements for emerging market economies with IT became obvious. FX interventions could help smooth the devastating effect of excessive exchange rate volatility and speculative capital flows on small open economies. If done prudently, they could enhance the credibility of the IT regime by stabilizing expectations. FX interventions can have prolonged effects on macroeconomic variables given some of their specific features.

The National Bank of Ukraine (NBU) has committed to an IT regime with a floating exchange rate in its monetary policy strategy for 2016-2020 (NBU, 2015). The difference between "floating" and "free floating" exchange rate regimes is that the former presumes a possibility for a central bank to intervene frequently on the FX market (although without having explicit exchange rate targets), IMF (2014).

[1] The views expressed in this paper are those of the authors and do not necessarily represent the position of the National Bank of Ukraine.

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The NBU declares 3 tasks for using FX interventions which are quite common for emerging market economies with IT: 1) FX reserve accumulation; 2) the smooth functioning of the foreign exchange market; and 3) supporting the transmission of the key interest rate as the main policy instrument.

The question of an optimal mix of monetary instruments available for the NBU (a policy interest rate and FX interventions) to achieve price stability and abovementioned tasks is of current importance. The literature on the role of the exchange rate in IT is abundant. However, research on the optimal monetary policy reaction using such a policy mix in response to different types of shocks is scarce.

Thus, the purpose of this paper is to develop an analytical framework that allows advising on the optimal reaction of the NBU using an interest rate and FX interventions in response to different shocks with a view to achieve price stability and other relevant tasks.

The rest of the paper proceeds as follows: a brief overview of the literature on the role of exchange rate and FX interventions under an IT framework is presented in Section 2; Section 3 provides an overview of specific features of Ukraine's economy that motivates having FX interventions in the NBU`s toolkit; Section 4 gives a brief overview of the framework the NBU is applying to perform sterilized FX interventions; methods of analysis, results, and policy implications can be found in Sections 5 and 6; and then followed by conclusions in Section 7.

II. BRIEF LITERATURE SURVEY

Foreign exchange interventions used to be an undoubted instrument for central banks until the early 1970s under the Bretton Woods system of fixed exchange rates, which was an agreement among the United States, Canada, Western Europe, Australia, and Japan. Since that time, there have been major changes in the way they are considered by economists.

After an abandonment of the Bretton Woods system and a move to managed floating, interventions initially increased in scale, but appeared to be successful only temporarily. In the early 1980s, their effectiveness was questioned by both government officials and economists. However, after the Plaza Accord in 1985 and then the Louvre Accord in 1987, the impact of interventions began to be reassessed. The literature until 1993 is devoted to developed countries (namely G-7) and is well examined by Edison (1993).[2] We rely heavily on this paper in our pre-1993 literature review.

Most of the studies consider sterilized interventions and look for economically significant (predictable, sizable, and lasting) effects on the exchange rate. Non-sterilized interventions are not considered. They affect the monetary base, thus generally leading to significant effects on the exchange rate. Hereinafter we regard only sterilized interventions.

The literature measures the effectiveness of interventions through two different channels: portfolio based and signaling. The former arises since the relative supply of foreign and domestic currency assets changes after an intervention occurs. A less abundant asset becomes more pricy. On the other hand, the exchange rate is not affected under perfect capital mobility or in case both assets are perfect substitutes (i.e., uncovered interest parity holds). Advanced economies have massive markets where even huge interventions cannot really change the relative allocation of assets, which creates reasons to be skeptical about the quantitative effect of this channel. Indeed, pre-1993 literature suggests that sterilized interventions do not permanently amend the exchange rate.

From the other perspective, the current exchange rate is affected through the signaling or expectation channel if the market alters its expectations about the future exchange rate. A central bank possesses better information about the fundamentals (at least future monetary policy), thus interventions may become a signal about future exchange rate developments. Some studies suggest that they are a useful tool for signaling official views on foreign-exchange markets, but only effective when supported by the reshaping of other macroeconomic policies. Still, most empirical evidence testifies that interventions are able to influence exchange rates through the signaling channel, though temporarily.

Another important topic in pre-1993 literature is motivation for interventions. The first incentive is the desire to smooth short-term fluctuations in exchange rates. Secondly, sometimes central banks "lean against the wind," not allowing the nominal exchange rate to deviate far from anticipated target level. Moreover, studies of Germany and Japan reveal asymmetry in the countries' reaction rules during the period from 1973 to 1987. The Bank of Japan showed relatively stronger resistance to appreciation of the yen, whilst the Bundesbank exhibited relatively stronger resistance to depreciation of the deutsche mark.

Many studies are concerned about profitability of interventions. However, it is agreed that profitability is not a suitable assessment of effectiveness since both profitable intervention may be non-stabilizing and stabilizing interventions may be unprofitable.

[2] The G-7 (Group of Seven) countries are Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

Edison (1993) concludes that it is possible to explain the motivation for FX interventions, but there is little empirical evidence for sizable and long-lasting effects.

In 1991, the first IT regime was adopted by New Zealand, and now there are about 30 countries that use it, with Ukraine among them. Therefore, the second part of the literature review is devoted to managing the exchange rate under IT.

A central bank under IT commits to an explicit inflation target, which is generally associated with a flexible exchange rate. Masson et al. (1997) indicates the absence of an obligation to any other anchors like an exchange rate to be an important premise for adopting an IT framework. Indeed, a central bank with more than one anchor puts itself at risk of sending conflicting signals about its objectives. Thus, managing exchange rates may disrupt the credibility of a commitment to an inflation target.

However, Ostry et al. (2016) claim that the argument above was used just to prevent countries that are not going to allow for exchange rate flexibility from adopting IT. Furthermore, they reveal that disregarding exchange rate volatility can become costly in countries with mismatches in domestic balance sheets and high exchange rate pass-through. This comes in line with findings by Stone et al. (2009), which investigate the role of the exchange rate in emerging market economies, particularly during the 2008-09 period of financial turmoil, and argue that responding to exchange rate deviations from its medium-term equilibrium produces better economic outcomes. Both studies agree that the exchange rate is a more important policy instrument for emerging markets under IT than for their advanced economy counterparts with massive markets and mobile capital.

The interest rate is a textbook instrument for IT, thus its adjustment might be the first response to exchange rate volatility. In fact, Mohanty and Klau (2005), in their study of Latin America, as well as Ostry et al. (2016) for a wide range of countries, conclude that central banks in emerging economies under IT often implicitly account for exchange rate movements in their interest rate reaction functions (aka the Taylor Rule). Such regimes are often called "Dirty" IT with hybrid policy rules.

Many papers present models with hybrid policy rules, e.g., Roger et al. (2009) or Garcia et al. (2011). Their simulations reveal that advanced economies with broad financial markets do not gain much from including the exchange rate into the interest rate reaction function. On the other hand, more vulnerable emerging economies can benefit in terms of less volatile inflation and output. Yet these studies do not cover the role that interventions can play.

Svensson (1999) suggests no room for an impact from sterilized interventions under uncovered interest parity. However, given not perfectly mobile capital and comparably low stocks of assets, they become a powerful instrument. Thus, along with being in more need for a managed exchange rate, emerging market economies are actually more eligible for possessing FX interventions as an additional policy tool.

Ostry et al. (2016) regard emerging economies as being best characterized by having two targets (inflation and exchange rate) and two instruments (interest rate and FX interventions). They highlight the importance of interventions as a tool against abrupt though temporary changes in capital movements. In contrast, the interest rate is best to deal with persistent shocks. Generally speaking, interventions can act symmetrically against both capital inflows and outflows, though the only crucial difference is that a central bank may eventually run out of reserves in the face of outflows.

The "two targets, two instruments" idea is not rejected by Gersl and Holub (2006), who investigate the Czech Republic's experience since 1998 and find some evidence for the significant effect of interventions on the exchange rate.

Benes et al. (2015) model FX interventions as an additional tool along with the Taylor Rule. They show that such a framework helps to shield the economy against shocks to international financial conditions, but may fail to provide needed exchange rate adjustments, e.g., in response to shocks to terms of trade.

Bayoumi and Saborowski (2014) examine the impact of interventions on the current account and agree on their ineffectiveness for advanced economies. On the other hand, foreign currency buyouts are a source for the current account surplus and undervalued exchange rates in some emerging markets. The study claims controls on capital movements to reconcile these facts. Authors find evidence that, in the absence of capital controls, the potential effect of sterilized interventions on the current account is fully offset by private money movements, thus adjustments in the capital account. For countries with major restrictions, each additional dollar in reserves brings about 50 cents to the current account. The effect is mostly compensated by opposite adjustments in the current account of the United States – the prevailing supplier of reserve currency with the most liquid bond markets.

All in all, sterilized interventions are consistent with an IT framework for emerging market economies. They may be a supplement to the interest rate in reacting to temporary shocks, mitigating abrupt capital movements, and fighting exchange rate volatility. However, as the economy achieves asset substitutability and higher capital mobility, a central bank must rely more and more on the interest rate as an instrument to influence the exchange rate.

III. MOTIVATION BEHIND HAVING FX INTERVENTIONS IN THE NBU`S TOOLKIT

In this framework, sterilized FX interventions could serve as an additional policy instrument to enhance the influence of the key interest rate on the economy and pursue other tasks of monetary policy. Of course such tasks of FX interventions need to be considered only if they enhance the credibility of the IT regime. Here we consider the motivation for FX interventions for the NBU and their consistency with achievement of inflation targets.

International reserves of the NBU are below optimal level

The NBU has the task of international reserves accumulation, which is a part of the Extended Fund Facility (EFF) agreement with the IMF. In the medium-term prospective, this task is reinforcing the IT regime and its credibility. If Ukraine had an adequate level of international reserves, it would be more resistant to external shocks. Thus, both the ability of the NBU to achieve its inflation targets and the overall credibility of the IT regime would increase. However, in the short-term period, achievement of inflation targets and accumulation of reserves could be conflicting. Yet the Law On the NBU gives strict priority to price stability among other tasks. So it resolves possible policy inconsistencies.

Pass-Through from the Exchange Rate to Inflation is nonlinear

The price responsiveness to exchange rate movements of different sizes is nonlinear in Ukraine. Farina (2016) provides evidence that prices are sensitive to small and extremely large changes, but the pass-through effect is insignificant if exchange rate movements are moderate.

That motivates the NBU to smooth the volatility to some optimal levels while avoiding pegging the exchange rate. That is crucial not only for achieving the targets, but for gaining credibility as well. On one hand, some FX volatility stimulates adequate perception of risks related to unhedged FX positions of economic agents. On the other hand, excessively high exchange rate volatility negatively affects both the investment climate and financial stability.

In this regard, the credibility issue needs to be mentioned. The NBU is a beginner in IT and inflation used to be very volatile in the past. In this context, the credibility of the NBU is less than full. Large volatility could undermine efforts to build it.

Among IT countries, the exchange rate volatility is fluctuating in a range of 2-15%, spiking in times of crisis, (Inflation report of the NBU, 2016).

Countries with the experience of using IT and flexible exchange rate usually do not have a need to intervene too frequently on the FX market to smooth volatility. Usually their developed FX markets have a higher potential to find balance by themselves. That reduces the propensity to high volatility. Edwards (2006) noted that volatility under a floating exchange rate is diminishing if IT is applied. That will also be true for Ukraine in the future. However, the FX market is currently shallow and the frequent presence of the NBU is justified with a view to balance it.

Weak transmission of interest rates to prices

Countries with less developed financial systems logically used to have less effective interest rate transmission to the inflation and real variables. But the situation in Ukraine seems to be even more complicated, because financial system has been just rebooted via clean-up reforms. Real sector is overindebted as the loans-to-GDP ratio reached 40% in 2015 and is the highest among peers (Financial stability Report of the NBU, 2016). That hampers the ability of the real sector to receive new loans.

The private securities market is in a rudimentary state. Of course there are positive signs of development as the Ministry of Finance started to place Government bonds on the market in 2016. The yield curve on these instruments is now reacting quite well to changes in the key policy rate. Still, sometimes (especially in time of distress) a change in the interest rate per se could have no appropriate effect on inflation.

Thus, the economic effects of the interest rate could be intensified in some cases through interventions. If short-term fluctuations of the exchange rate are threatening the achievement of the inflation target, monetary policy needs to react. Primarily, such a reaction should be done via interest rate adjustment. But, if the interest rate could not effectively influence the exchange rate in the desired direction, supportive interventions could be justified.

These motives for interventions are considered by the NBU Monetary policy strategy for 2016-2020 as it defines three tasks of using FX interventions: 1) FX reserve accumulation; 2) smooth functioning of the FX market; and 3) supporting the transmission of the key interest rate as the main policy instrument (NBU, 2015).

However, there can be other quite beneficial outcomes of using FX interventions in Ukraine's case.

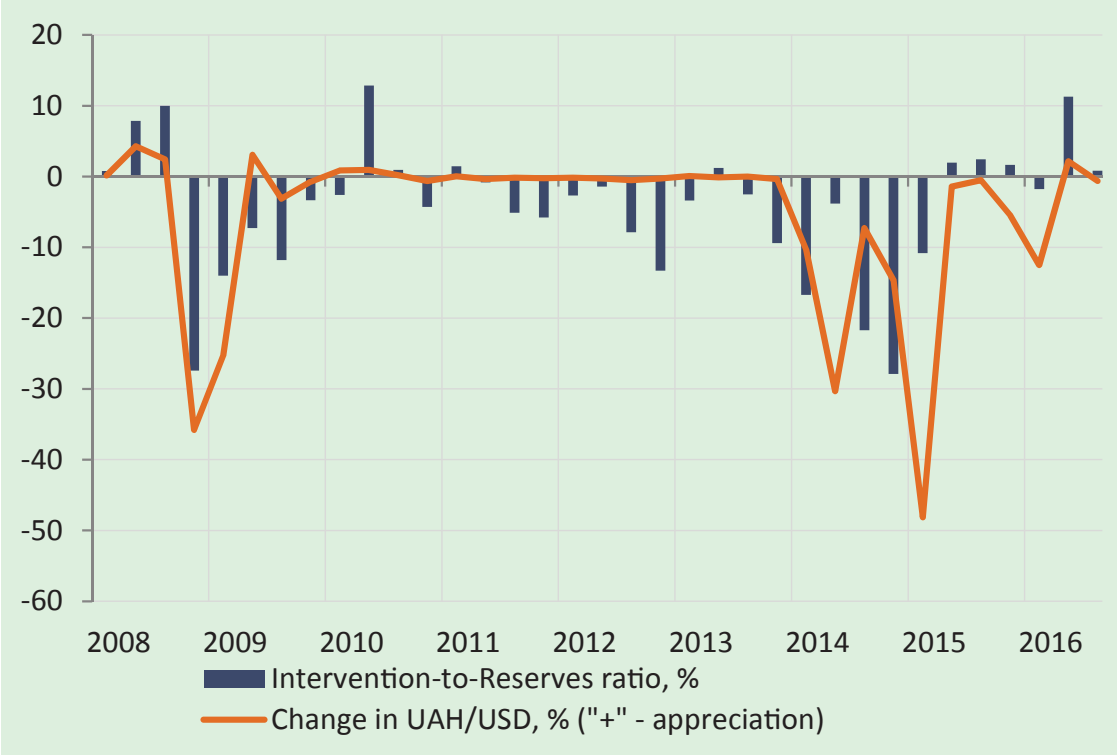
IV. THE NBU`S FRAMEWORK FOR STERILIZED INTERVENTIONS

In the past, the stability of the exchange rate was the central point of the monetary policy in Ukraine. Naturally, FX interventions were intensely used for protecting a certain level of the exchange rate. During the last years of exercising such a pegged regime, the NBU was mostly selling foreign currency, which summed up into a dashing decrease in the FX reserves on the background of an overpriced hryvnia. Thus, in February 2014 when international reserves were depleted to critical levels, the NBU had no other option but to adopt a floating exchange rate, which in turn is a prerequisite for IT.

The NBU declared the interest rate as its main policy tool. A remarkable step was made in April 2016 when new monetary policy implementation framework was adopted, which is common for IT central banks. The NBU determines a single policy rate for its main liquidity-injecting or liquidity-absorbing operations. From that time, decisions on the key policy rate have had a significant effect on market rates and actually define the policy stance.

The design of monetary policy instruments allows the NBU to steer interbank market interest rates as well as perform special tasks of FX interventions. The NBU performs both buyer and seller roles in order to smooth the volatility of the exchange rate. Given that there is the task of accumulation of international reserves, the NBU is a net buyer on the FX market. Because of this task on international reserves accumulation, since mid-2015 the NBU reacts with FX interventions only gradually when the exchange rate is depreciating but more actively when it is appreciating (Figure 1).

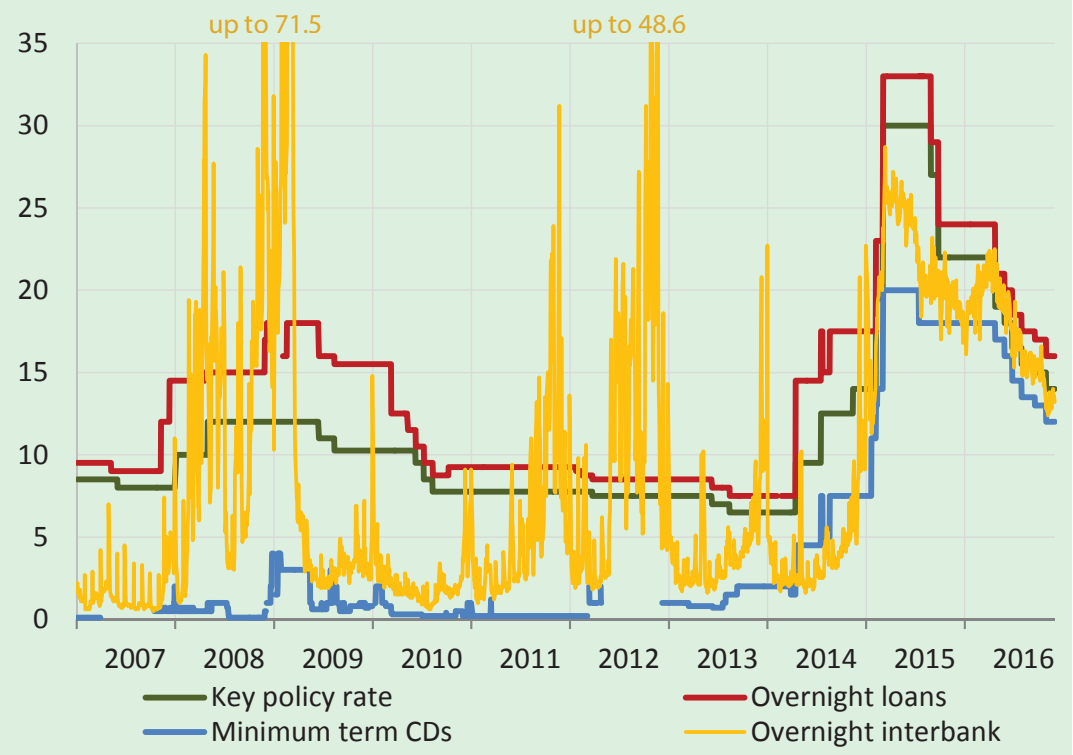
Figure 1. NBU`s FX interventions and UAH/USD exchange rate



These operations create a surplus of liquidity in the banking system. In such conditions, central banks can implement independent monetary policy through sterilization operations. Benes et al. (2015) defines sterilized interventions as FX interventions that 1) keep market interest rates unchanged or 2) do not change the level of reserve money.

The NBU defines the key interest rate as its main instrument, so the first definition is applicable in this case. Ukrainian banks use excess liquidity to buy NBU's certificates of deposits with remuneration equal to the key interest rate. The NBU is performing the role of a debtor of last resort and, hence, manages to steer interbank interest rates close to its key policy rate. The NBU started to perform such active interest rate policy in 2015 with some updates that increased its efficiency in 2016 (Figure 2).

Figure 2. NBU's Policy Rates and interbank market rates , % pa



Actually, this setup gives the NBU two separate instruments: the key interest rate for achieving inflation targets and FX interventions for smoothing exchange rate volatility and accumulation of FX reserves.

It is worth noting that such practice dramatically differs from the past experience of the NBU (up to 2014). Under a fixed exchange rate, negative shocks had been absorbed through FX sales and liquidity shortages with interbank interest rate hikes (Figures 1 and 2). The volumes of FX sales reflected not only attempts to prevent the exchange rate from depreciating, but also direct operations with state energy company Naftogaz for gas imports. These operations were discontinued in mid-2015 when reforms in the energy sector allowed Naftogaz to settle its contracts by itself.

For the purposes of this research, we ignore operations of the NBU with the Government related to exchanging its funds into foreign currency or vice versa. Such operations do not have direct implications for the markets. One could argue that without having the ability to exchange funds with the NBU, the Government would be pushed to enter the market for those purposes. Given that the FX market in Ukraine is shallow and there is the need to accumulate international reserves, the NBU would have to react with interventions. Thus, the overall impact on the FX market and economy would be eliminated.

V. MODEL AND METHOD

We dedicate this section to presenting the main features of the NBU's Quarterly Projection Model (QPM), which is conventionally used for analysis of the core macroeconomic dynamics in the Ukrainian economy. In this paper, we use it to simulate macroeconomic responses (so-called Impulse Response Functions) to different shocks, including policy ones. Ideally no policy decision must be implemented without modeling its anticipated outcomes. Hypothetically, such a decision could be done on a judgmental basis, but only modeling can provide consistent and comprehensive views on how a set of variables in policy focus react to a particular action or shock. Moreover, Impulse Response Functions (IRF) reveal the possible reactions to risks and are therefore able to help in dealing with uncertainty.

The QPM by no means is able to produce any short-term forecasts, which is a job reserved for other approaches. Instead, it investigates key macroeconomic linkages, "tells the story behind them," provides a framework for policymaking, and analyzes the way it influences the economy and inflation.

The QPM is a "gaps" model. It captures the general dynamic equilibrium of the economy and estimates deviations from it. The latter are called gaps. Their developments are explained, particularly what are the contributors and how they fade out with time.

Glossary

y_t	GDP in logs*100
$\overline{y}_t$	Potential GDP, a sustainable long run level that generates no inflationary pressure
$\hat{y}_t$	GDP gap, scale is built so that it is measured in percent deviations from the potential
s_t	UAH per USD exchange rate, growth means depreciation in domestic currency
s_{t+1}^{exp}	Expectations about the future exchange rate
$\overline{z}_t$	REER trend, accounts for inflation in main trading partners, growth means depreciation
$\hat{z}_t$	Real effective exchange rate (REER) gap
$\overline{r}_t$	Real interest rate trend, aka real natural interest rate
$\hat{r}_t$	Real interest rate gap
$\widehat{w}_t$	Real wage gap
$\hat{y}_t^W$	World output gap, weighted GDP gap of main trading partners
$\widehat{tot}_t$	Terms of trade gap, weighted ratio of main export and import prices
f_t	Fiscal impulse
π_t^{core}	Core inflation, i.e. headline except regulated prices as well as prices for fuel and raw foods
π_t^{food}	Price changes in foods, annualized quarter-over-quarter percent changes
π_{t+1}^{exp}	One quarter ahead inflation expectations
$\pi 4_t$	Year-over-year inflation
π_t^T	Targeted inflation
π_t^W	Weighted average for main trade partners (world) inflation
π_t^{WT}	World inflation target
i_t^T	Key interest rate
i_t	Interbank interest rate
i_t^W	World interest rate
$prem_t$	Sovereign risk premium for Ukraine
tb_t	Trade balance, % of GDP
$\varepsilon_{i,t}$	Different kinds of shocks

Main equations

$$y_t = \overline{y}_t + \hat{y}_t \quad (1)$$

$$\hat{y}_t = \alpha_1 \hat{y}_{t-1} + \beta_1 \hat{y}_{t+1} + \gamma_1 \hat{z}_{t-1} - \delta_1 \hat{r}_{t-1} + \theta_1 \hat{w}_t + \vartheta_1 \hat{y}_t^W + \mu_1 \widehat{tot}_t + \rho_1 f_t + \varepsilon_{1,t} \quad (2)$$

$$\pi_t^{core} = \alpha_2 \pi_{t-1}^{core} + \beta_2 \pi_{t+1} + \gamma_2 (\pi_{t-1}^W + \Delta s_{t-1} - \Delta \overline{z}_{t-1}) + \delta_2 \hat{y}_t + \theta_2 \hat{z}_{t-1} + \vartheta_2 \hat{w}_t + \mu_2 (\pi_t^{food} - \pi_t^T) + \varepsilon_{2,t} \quad (3)$$

$$i_t^T = \alpha_3 i_{t-1}^T + (1-\alpha_3)(\overline{r}_t + \pi_{t+1}^T + \beta_3 (\pi 4_{t+3}^{exp} - \pi_{t+3}^T) + \gamma_3 \hat{y}_t) + \varepsilon_{3,t} \quad (4)$$

$$s_t = \alpha_4 s_{t+1}^{exp} + (1-\alpha_4)\left(s_{t-1} + 2(\Delta \overline{z}_t + \pi_t^T - \pi_t^{WT})/4\right) + (i_t^W - i_t + prem_t)/4 + \varepsilon_{4,t} \quad (5)$$

$$tb_t = \alpha_5 tb_{t-1} - \beta_5 \hat{y}_t + \gamma_5 \hat{y}_t^W + \delta_5 \hat{z}_t + \theta_5 \widehat{tot}_t + \varepsilon_{5,t} \quad (6)$$

Equation (1) is a simple identity. It reveals the relationship between the GDP level, its potential, and gap. We think of gap as a cyclical deviation from potential output. In economic terms it stands for a measure of relative demand. Negative numbers indicate depressed demand, while positive ones evidence in favor of an "overheated" economy. The concept is defined and equations are constructed so that the GDP gap typically gravitates to zero on the medium-term horizon of a simulation. The output in turn approaches its potential.

Equation (2) models the developments of the GDP gap. Its behavior is quite complex and depends on many factors. Among them in order as they appear in the equation are expectations about future economic activity and the effects from the real effective exchange rate and the real interest rate that both contribute to the monetary policy stance, world demand, terms of trade, wages, and fiscal impulse.

Foremost, expectations about future economic activity are constructed as a weighted sum of model forecast and lagged value. This is the way to model adaptive expectations. Next we introduce several additional gap terms. A positive REER gap, which means that the real exchange rate is depreciated against its equilibrium trend, makes exports relatively cheaper and contributes positively to the GDP gap. A real interest rate above its trend stimulates savings, but depresses domestic demand. A gap in real wages represents slack in the labor market.

Ukraine is a small open economy, thus its output depends on external conditions. They are modeled with the world output gap, i.e., relative demand from main trade partners, and the terms of trade deviation from its long-term level.

Last but not least is fiscal impulse. Both budget expenditures and revenues react to the economy's business cycles. The fiscal impulse distills fiscal policy from these cyclical movements and reveals whether it is truly expansionary or contractionary.

Equation (3) models the behavior of core CPI, though other inflation components are modeled in a similar fashion. The core component has the highest weight. Moreover, its example is the most illustrative since core inflation is deeply linked with domestic demand, unlike other CPI parts that depend highly on exogenous factors. Headline inflation is a weighted sum of its components. We must mention that headline inflation is targeted by the NBU.

The equation utilizes an expectations-augmented version of the Phillips curve. Expectations are again adaptive, however, now the lagged value of core inflation is combined with a model forecast of the headline one. This is to provide a link with administratively regulated and other goods in the consumer basket, thus capturing the bargaining power of workers.

The second term represents imported inflation. It considers both changes in prices of main trade partner countries and changes in the exchange rate. Changes in REER equilibrium trend allow accounting for contributions from different price movements in tradable and non-tradable goods according to the Balassa-Samuelson effect. Later we describe the effect in depth. Imported inflation is assumed to impact with a one quarter delay.

Core inflation is modeled to depend on real marginal costs, thus having a pro-cyclical reaction to a combination of GDP gap and real wage gap, i.e., general economic activity and the labor market in particular. Moreover, REER deviation from its equilibrium is modeled to be at least partially compensated for by change in prices.

Finally, the equation incorporates what we call "fried potatoes effect." It suggests that movements in costs for raw foods should be reflected in core inflation, since it comprises prices for processed foods.

Equation (4) models a key interest rate reaction function in the form of a modified Taylor Rule. The lagged value represents persistence in the decision-making of the NBU, while the second term gives some glance to its active rule. In a steady state, the rate approaches its neutral level, which is the sum of the real natural interest rate and targeted inflation. From a policy point of view, neutrality means that GDP will grow at its potential rate and inflation will be stable.

The key interest rate actively reacts if y-o-y inflation projected three quarters ahead deviates from its target. Similarly, it reacts to the stance of the economy. In particular, it rises in response to a positive GDP gap, which means an "overheated" economy and is a clear inflationary prerequisite.

There is no exchange rate in the Taylor Rule, thus we do not expect the NBU to adjust the key interest rate in response to exchange rate movements per se.

Notice that the interest rate in equation (5) is not the key policy rate. Instead, it is the interbank rate, which fluctuates around the key policy one in autoregressive fashion.

Equation (5) is based around the Uncovered Interest Parity (UIP) condition. This is embodied in the last term of the equation, while the first and the second terms represent the expected movements in the exchange rate and the effect from NBU interventions on the currency market (we discuss them in the next paragraph). Indeed, in the absence of interventions and stable expected exchange rate, the world interest rate and the domestic one will differ only on the value of the sovereign risk premium. For example, this premium surged for Ukraine both in 2009 and 2015. Generally, international investors act to equalize returns on their investments in different currencies with amendments for anticipated risks.

The first term in equation (5) is the model forecast of the exchange rate one-quarter ahead. The second term represents interventions in the following way. The lagged value of the exchange rate is complemented with a double change in its medium-term target, thus summing up in a targeted value. The relative weight between the model forecast and targeted value defines how heavily the NBU intervenes, mitigates exchange rate volatility, and anchors market expectations.

We consider such a framework as the best way to model sterilized FX interventions for the NBU. Under sterilization, we mean that the interest rate is set independently of exchange rate movements. The interest rate is defined in equation (4) in the Taylor Rule without special reference to the exchange rate. But, of course, there is indirect influence from FX interventions on the interest rate through responses of inflation and an output gap to the exchange rate dynamic. But by those effects, we actually want to track the combined use of both instruments: the interest rate and FX interventions.

The medium-term target is not a real target per se, but rather reflects the idea behind the Balassa-Samuelson effect. It states that the difference in domestic and world inflation targets does not strictly lead to exchange rate re-evaluation, but instead is compensated for by productivity growth, which is well proxied by changes in the real effective exchange rate (REER) trend. Due to this effect, inflation rates in developing countries can be higher as long as they come along with higher productivity growth. The exchange rate is modeled to be stable in the long-run equilibrium for Ukraine.

Equation (6) explores the developments of the trade balance. Firstly, the lagged term represents overlapping contracts. Next, the trade balance depends on both domestic and external demand. The former increases a deficit, while the latter contributes to a surplus. Further, the trade balance gets improved with depreciated REER, which stimulates foreign demand for domestic goods, as well as favorable terms of trade that make exported goods relatively more valuable.

The trade balance is essentially the net export that is a part of GDP. Thus, it is modeled similarly to the GDP gap with a bit of a loop, since increased domestic demand worsens the trade balance.

Calibration

The mechanism that transforms the set of equations into a model of the Ukrainian economy is the parameter values, which are presented in the following tables. The parameters were not statistically estimated, but rather calibrated, with a view to comply with economic theory and provide sound model properties. We also evaluated how well the model performs on the historical horizon, while accounting for macroeconomic structural breaks as well.[3]

Equation (1)

α_1	β_1	γ_1	δ_1	θ_1	ϑ_1	μ_1	ρ_1
0.30	0.20	0.06	0.04	0.07	0.5	0.07	0.2

[3] For more discussion on calibration, one may refer to Benes et al. (2003).

Equation (2)

α_2	β_2	γ_2	δ_2	θ_2	ϑ_2	μ_2
0.40	0.50	0.10	0.30	0.10	0.10	0.09

Equation (3)

α_3	β_3	γ_3
0.70	1.20	0.40

Equation (4)

α_2	
0.20	with interventions
0.70	without interventions

Equation (5)

α_5	β_5	γ_5	δ_5	θ_5
0.50	0.25	0.25	0.30	0.20

VI. RESULTS OF ANALYSIS AND POLICY IMPLICATIONS

To illustrate how FX intervention can be beneficial in achieving the NBU`s goals, we considered several cases with different shocks:

1. Aggregate demand shock;
2. Aggregate supply shock;
3. Risk premium shock;
4. Foreign interest rate shock – inflow of "hot" capital;
5. Terms of trade shock.

In all cases, shocks lead to a deviation of the inflation from the targeted level. The task here is to choose the optimal combination of the NBU`s instruments as a reaction to a each shock. Such combinations include: reaction with policy interest rate only or interest rate supplemented by FX interventions. In case of exchange rate shock (inflow of "hot" capital), a capital control tool is considered in addition.

IT is a flexible regime that needs to take into account not only stabilization of inflation (thus limiting its volatility), but stabilization of the real economy, Svensson (2009). Therefore, the NBU has flexibility in the timing of bringing inflation to the target in order to minimize output losses.

Additionally, policy reaction needs to take into account the limited amount of international reserves and the task of the NBU to accumulate them.

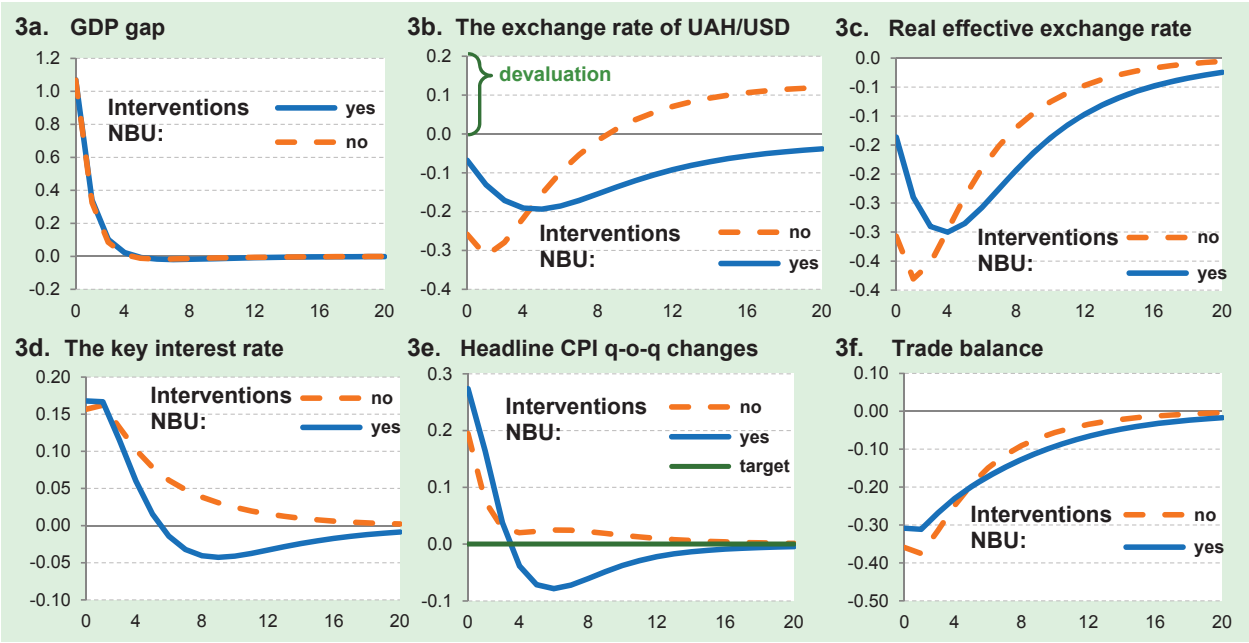
Aggregate demand shock

The cause of a shock can vary, e.g., fiscal expansion or expectations driven by a rush in the consumer market. It is designed as a positive change in output gap that lasts for one quarter and then gradually dies out back to potential (Figure 3a).

Exceeding demand causes acceleration of inflation, so the NBU needs to react using its policy rate in both scenarios. An increased interest rate appreciates both nominal and real exchange rates in the short-run. However, the NBU introduces FX interventions in scenario 2 and restrains the exchange rate from excessive appreciation (blue line, Figures 3b, 3c). Appreciated REER generates additional demand for imports. It depresses trade balance, which leads to exchange rate depreciation in the medium-run. In scenario 2, the NBU intervenes again. This time the purpose is to reduce depreciation.

In scenario 1, the NBU does not use FX interventions, and a more long lasting reaction with the policy rate is needed to mitigate the inflation outbreak (Figure 3d). Inflation reaches its target without excessive volatility (orange dashed line, Figure 3e).

Figure 3. Aggregate demand shock under different policy responses



Policy implications. Monetary policy after an aggregate demand shock is a bit tricky and has to account for a trade-off between more volatile inflation and a more volatile exchange rate. The NBU probably needs to react to domestic demand shocks using only the key policy rate. The advantages of such an approach are less volatile inflation, a slightly faster narrowing of the trade deficit (Figure 3f), and saving international reserves. In scenario when interventions are used together with the policy rate, inflation is more volatile, which could negatively affect the IT regime's credibility while international reserves are just being "eaten up."

Aggregate supply shock

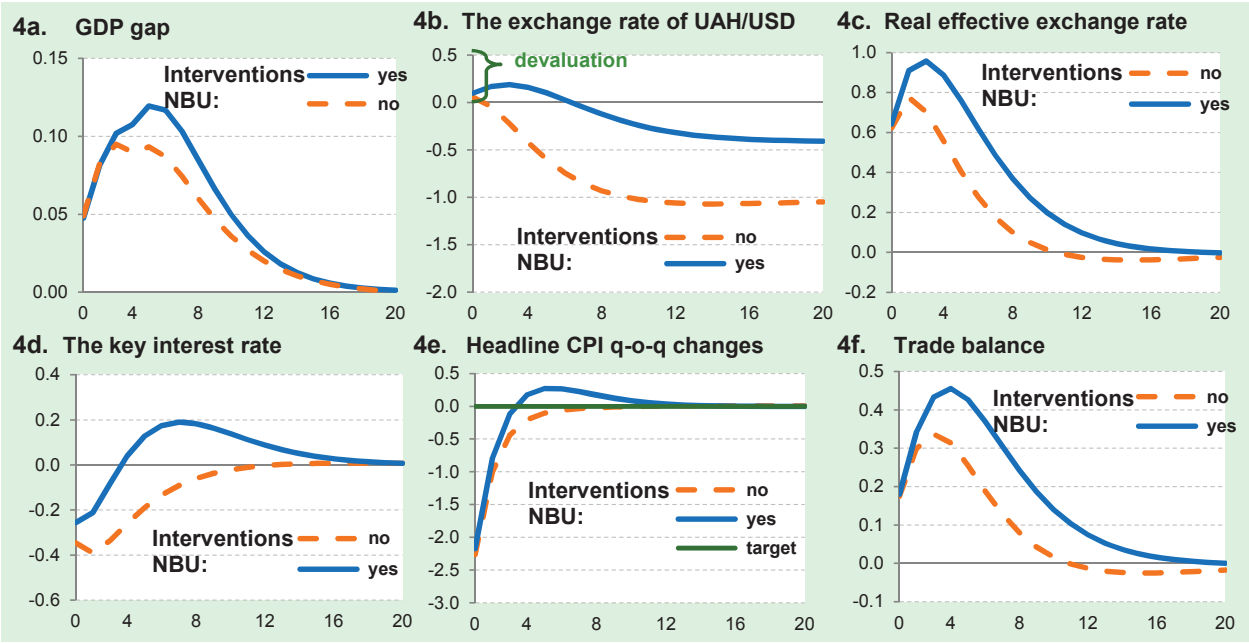
This kind of indignation is commonly modeled as a drop in prices, which takes the form of a negative shock to residual in the Phillips curve. A decrease in prices leads to depreciation in REER (Figure 4c), thus improving the competitiveness of domestic producers, stimulating net exports, and leading to medium-term nominal exchange rate appreciation (Figure 4b). An improved trade balance (Figure 4f) also contributes to higher aggregate demand and "overheats" the economy (Figure 4a).

However, reactions of all the variables differ in two policy scenarios. In scenario 1 (orange dashed line) the NBU does not intervene on the FX market, thus allowing nominal exchange rate to appreciate swiftly. In scenario 2 (blue line) the NBU purchases foreign currency from the market and constrains appreciation.

Both scenarios make the NBU react to deflationary pressure with a lowered policy rate (Figure 4d). But in scenario 2, the initial decrease is less significant and the NBU even needs to increase the policy rate after some time because of an "overheated" economy.

In scenario 2, the output gap is larger on the simulation horizon because of a more pronounced REER undervaluation, which stimulates external demand. Inflation quickly returns to its target and even slightly overshoots it (Figure 4e). Finally it approaches the target as a result of increased policy rate. In contrast, inflation approaches its target more gradually in the first scenario.

Figure 4. Aggregate supply shock under different policy responses



Policy implications. All in all, FX interventions after a favorable supply shock may restrict exchange rate appreciation and contribute to a trade balance improvement. Taking into account the need to accumulate international reserves, the NBU might consider such a scenario as an opportunity to take advantage and buy FX from the market. An additional benefit of such a policy is higher GDP growth. Given the open Ukrainian economy, slowing the pace of nominal exchange rate appreciation provides more significant stimulus for GDP growth in comparison with a decreased policy rate. However, the policy rate can be effective in counteracting some inflation pressure, which could arise due to an "overheated" economy.

Risk premium shock

Ukraine is an emerging market economy with low credit ratings. Moreover, its international reserves are below the composite metric of reserve adequacy, IMF (2016). Thus, investor's sentiments can change very quickly as a reaction to domestic developments or global shifts in risk attitudes.

This kind of shock models an abrupt, albeit temporary, increase in sovereign risk premium, which indicates a lack of credibility in the country, e.g., during crises. In particular, Ukraine's risk premium peaked in both years 2008 and 2014.

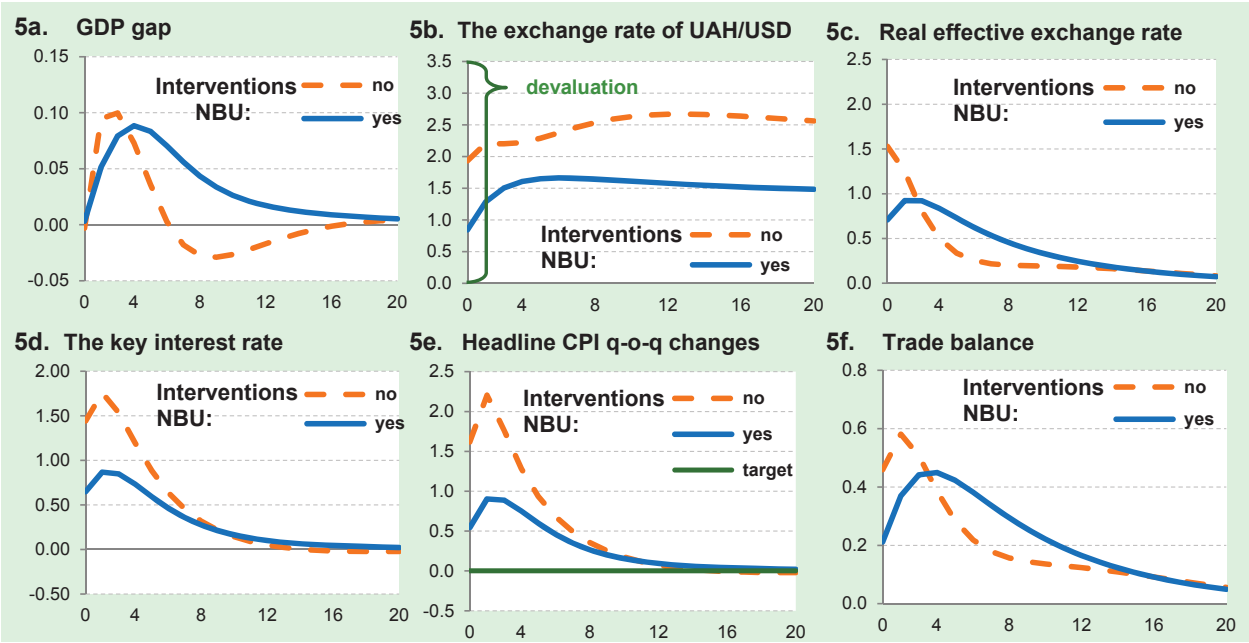
A higher risk premium leads to sharp capital outflows and consequently devalued domestic currency (Figure 5b). In scenario 1 (orange dashed line), the NBU doesn't intervene on the FX market and allows the exchange rate to depreciate significantly. In scenario 2, the NBU intervenes on the FX market, which allows a smooth depreciation (blue line). As we discussed in Section III, the pass-through from the exchange rate to inflation depends on the scale of exchange rate changes. In scenario 1, a sharp depreciation of the exchange rate leads to a significant inflation hike (Figure 5e), though it declines quickly as a result of the temporary nature of the increase in the risk premium as well as the surged policy rate (Figure 5d). In scenarios with FX interventions, smoother devaluation leads to more modest increases in inflation.

Due to the stickiness in price responses, disturbances in the nominal exchange rate are to a high extent transferred into the real exchange rate (Figure 5c). Devalued REER in turn stimulates external demand for domestic goods, improving both the trade balance and contributing to a positive output gap (Figures 5a, 5f). With interventions, the stimulus is less abrupt but more lasting. Moreover, the cumulative effects are higher.

The shock in risk premium creates two sources of inflationary pressure. The first acts through a positive output gap. The second comes along with a devalued REER and increased prices for imported goods.

The NBU immediately increases the key interest rate with a view to resist an inflationary outbreak. This helps to restrain aggregate demand and attract more foreign capital. The need for tight monetary policy lasts a bit longer with interventions since inflationary pressure is more enduring.

Figure 5. Risk premium shock under different policy responses



Policy implications. In case of risk premium shocks related to investors' sentiments, the NBU needs to react with a policy rate hike combined with FX interventions with an aim to mitigate the pace of depreciation. A smooth adjustment of the exchange rate helps to preserve confidence and limit the pass-through to prices. As a result, the increase in inflation is less dramatic and less volatile. Among the other positive outcomes of such a policy are longer benefits for the economy and trade balance because of a slower REER appreciation after the shock.

Foreign interest rate shock – inflow of "hot" capital

Here we consider a situation with conflicting policy goals that arrive after short-term capital inflows. The latter are caused by deviations from the UIP condition in terms of increased differences between domestic and foreign interest rates or expectations of exchange rate appreciation. The shock is modeled as a drop in foreign interest rates.

Such inflows force the exchange rate to appreciate and put pressure on interest rates to decline. However, they are unstable and are thus able to quickly reverse and cause undesirable volatility of the exchange rate, interest rates, and inflation.

In a "classical" case, an IT central bank could lower interest rates while allowing the exchange rate to appreciate. That would demotivate further capital inflows and prevent disinflationary pressure. But if inflation is already high for whatever reason (e.g., fiscal expansion, global environment), the central bank could be unable to lower interest rates. At the same time appreciation caused by "hot" speculative inflows could have a damaging effect on the domestic real sector.

Cases when central banks in emerging economies were facing these described challenges are not rare. In Ukraine's case, such episodes happened several times, e.g., in 2005 when the NBU needed to adjust the fixed exchange rate to a new revalued level.

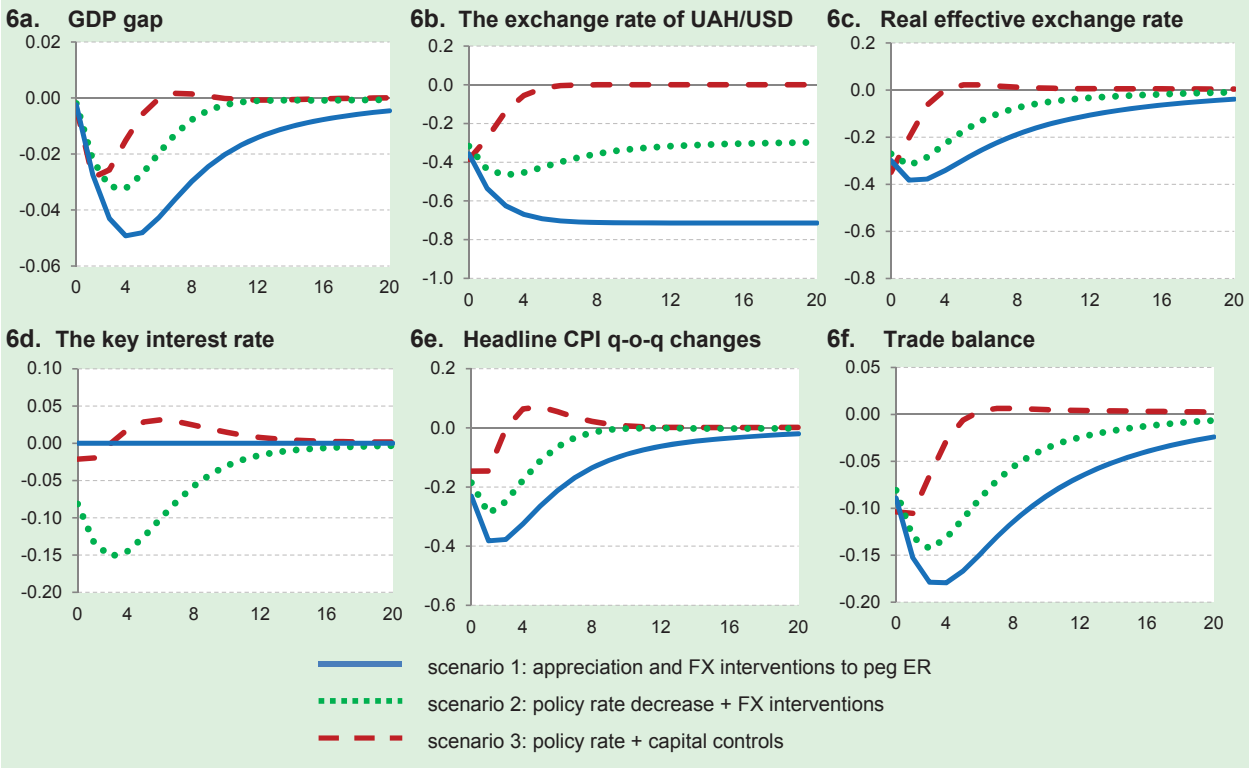
Such policy is replicated in scenario 1 when, after abrupt revaluation, the exchange rate remains stable due to FX interventions (blue line, Figure 6b). The NBU is not lowering the policy rate (Figure 6d).

In the scenario 2, the NBU lowers the policy rate (green dotted line, Figure 6d) and allows moderate appreciation of the exchange rate using FX interventions (Figure 6b). A lower interest rate demotivates capital inflow, thus appreciation pressure is less significant.

In scenario 3, the NBU uses a capital control tool as well as two other instruments with the intention of containing short-term capital inflows. The effect of a capital control tool is modeled as an increase in the risk premium. International experience suggests a variety of such tools that allows managing composition of capital flows: reserve requirements, taxation, special licensing requirements, and outright limits or bans (Ostry et al., 2016).

In this case and after initial appreciation, the exchange rate depreciates to the previous level (red dashed line, Figure 6b). The initially lowered policy rate needs to be increased (Figure 6d) as depreciation of the exchange rate creates some inflationary pressure (Figure 6e).

Figure 6. Foreign interest rate shock under different policy responses



In scenario 1 (Figure 6e), deflation is the most significant and prolonged as the effect from appreciation intensifies due to an increase in the real interest rate as the nominal rate remains stable.

In scenario 2 (Figure 6e), lowering the policy rate by the NBU helps to bring inflation back to its target faster in comparison with scenario 1.

Loss of real growth is the most significant in scenario 1 (Figure 6a) because of appreciation of the exchange rate and tight monetary policy. This policy mix is the most harmful for the trade balance (Figure 6f) as well.

Scenario 3 is optimal from the position of GDP loss minimization. The negative effect on trade balance also vanishes quickly in this scenario.

Policy implications. In the case of "hot" capital inflows, the most appropriate monetary policy needs to include a combination of policy rate reaction, interventions, and application of capital control tools. Such a policy mix allows for avoiding a damaging effect on the real sector and limits excessive volatility of output, the exchange rate, and inflation.

However, monetary policy is a short-term solution to a problem. The conflict of goals in this case emerges because of existing imbalances in fiscal or financial sectors. For the persistent reduction of risks related to speculative capital, other policies (e.g., fiscal, macroprudential) need to react.

Terms of trade shock

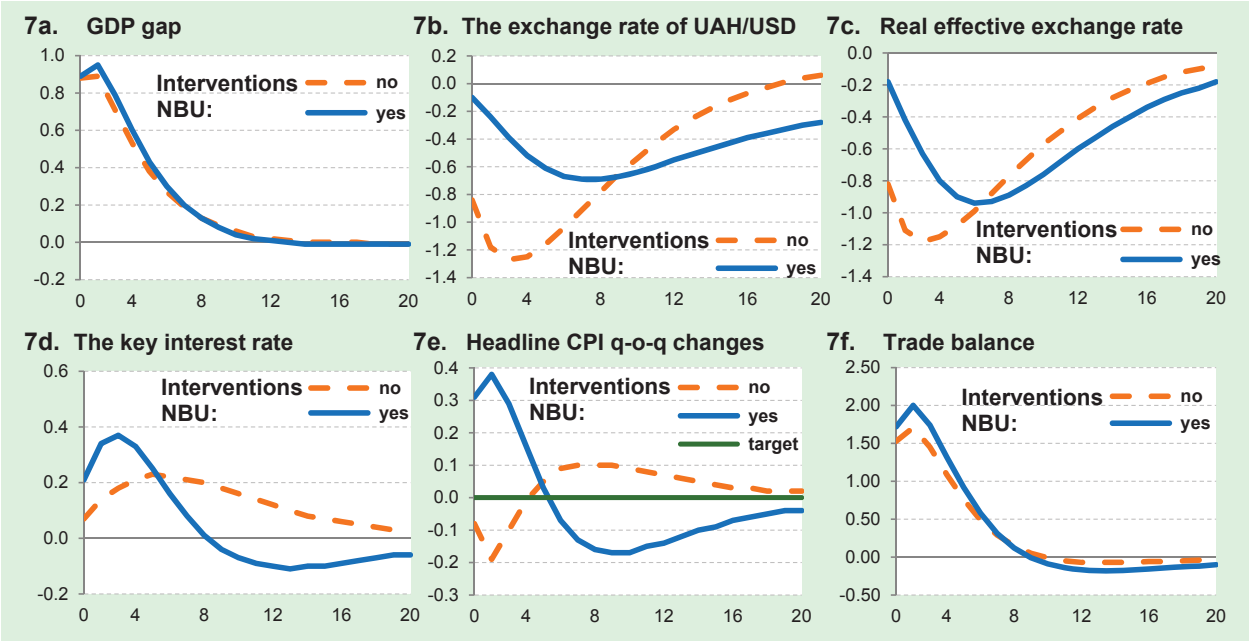
As an open price taking economy with a lot of trade in raw commodities, Ukraine is exposed to the impact from developments on commodity markets. We model terms of trade shock as a 10 percent increase in the ratio of an export deflator over an import deflator. This may come through a surge in world prices for wheat or some ferrous metals, which are the main exported goods.

This kind of shock immediately improves trade balance (Figure 7f), thus leading to both nominal exchange rate appreciation (Figure 7b) and opening a positive GDP gap (Figure 7a). The NBU reacts to the economy "overheating" with an interest rate increase (Figure 7d), though the reaction is delayed under the scenario without FX interventions (orange dashed line).

The reason for the mentioned delay lies in a disinflation hike (Figure 7d) caused by appreciation of the exchange rate. If the NBU applies interventions and conducts FX buy-outs (blue line), the appreciation is less pronounced and outweighed by the inflationary pressure from excessive demand. Increased inflation enforces a sharper interest rate response, which may end up being over-reactionary against the background of prolonged currency appreciation.

It is important to notice that the shock is modeled as a temporary one. Moreover, appreciated currency stimulates domestic demand, which in turn reverses trade balance into deficit. These movements eventually return the exchange rate to its pre-shock level. However, interventions might reduce exchange rate volatility.

Figure 7. Terms of trade shock under different policy responses



Policy implications. In the event of a favorable shock to terms of trade, the monetary policy response must consider the overall macroeconomic context. If inflation is suppressed (e.g., due to low domestic demand), the NBU is able to replenish its international reserves and permit some inflation. In the contrasting case of an already "overheated" economy, the right decision is probably to allow exchange rate appreciation with a view to mitigate inflation.

If inflation is close to the target, FX interventions are yet advised. They might mitigate exchange rate volatility, which is also beneficial for the anchoring of inflation expectations.

Volatility under different policy responses

Simulations showed that different shocks require different policy responses. The main reasoning behind FX interventions was that they help to smooth exchange rate volatility. However, under IT it is more important to mitigate volatility of inflation and, under a flexible version of IT, the volatility of the GDP gap. Sometimes it is not the case with application of FX interventions as an additional tool. We formalize that finding by construction of unconditional standard deviations of the model variables, which arise in response to each particular shock.[4] Table 1 summarizes.

[4] For more discussion on unconditional standard deviations, one may refer to Benes et al. (2015).

Table 1. Macroeconomic volatility under different policy responses

	GDP gap	*ΔER UAH/USD*	*REER gap*	*Key interest rate*	*CPI q-o-q changes*	*Trade balance*
Aggregate demand shock						
Without Interventions	1	1	1	1	1	1
With Interventions	1.0	0.4	1.0	0.9	1.6	0.9
Aggregate supply shock						
With Interventions	1.2	0.5	1.5	0.8	0.9	1.5
Risk premium shock						
With Interventions	0.5	0.4	0.6	1.1	0.7	0.7
Foreign interest rate shock						
With Interventions	0.7	0.5	0.7	1.8	0.9	0.8
Terms of trade shock						
With Interventions	1.1	0.3	0.9	1.2	2.1	1.2

Similarly to IRF, we examine one shock at time. Each column represents how big the standard deviation will be of a variable should the shock in heading be the only source of volatility in the economy. For comparison purposes, we normalize the results with respect to the case without interventions. Thus, a lower than unity number indicates that interventions are able to mitigate volatility.

Indeed, the exchange rate enjoys sufficiently lower volatility for all kinds of shocks under interventions. However, inflation volatility is mitigated only for three of them: aggregate supply, risk premium, and foreign interest rate. Applying interventions after these shocks would strictly come in line with IT. Moreover, in cases of the latter two, more stable GDP growth would be ensured as well.

Applying FX interventions after aggregate demand or terms of trade shocks could surge inflation volatility and does not create benefits for bringing down the volatility of output. From this prospective, FX interventions are not recommended in case of such shocks. However, this volatility analysis does not take into account the importance of international reserve accumulation, which is crucial for price stability in the medium- to long-term perspective. Thus, as mentioned before, the final decision needs to be based on an assessment of the situation before a shock hit the economy.

VII. CONCLUSIONS

A central bank operating under an IT regime in a developed economy often relies solely on the policy interest rate as a monetary instrument. However, research and experience in recent years shows that flexible IT can benefit from using FX interventions as a supplementary tool in emerging economies. Here we consider using FX interventions in the context of a floating exchange regime, so the central bank does not seek any particular level for the exchange rate or oppose the dominant trend on the FX market.

In this research, we show the cases when the monetary policy of the NBU can benefit from using FX interventions in combination with the policy interest rate.

For the purposes of our analysis, we simulate macroeconomic responses to different shocks in the NBU's QPM. Different monetary policy scenarios are considered as a reaction to a shock. The optimal scenario is advised on the basis of achieving goals that can enhance the credibility of the IT regime. They are inflation stabilization, accumulation of international reserves, safeguarding competitiveness of the real sector, and smoothing undue volatility of the exchange rate.

On the basis of the analysis, we discovered that there is no universal policy advice. Sometimes trade-offs emerge. The use of FX interventions needs to be considered on the basis of the nature of the specific shock. Such an approach allows the avoidance of conflict among monetary policy goals and enhances the credibility of the IT.

In the case of shocks to supply, the risk premium, and "hot" capital flows, the monetary policy could definitely benefit from using FX interventions in addition to the key policy rate. This policy-mix brings down the volatility of inflation in addition to smoother volatility of the exchange rate, which is essential for expectations in dollarized countries. In that way, the IT regime could gain greater credibility.

Moreover, if such shocks are leading to currency appreciation pressure, the NBU needs to use the opportunity and accumulate international reserves. A decrease in the policy interest rate needs to be moderate while easing of monetary policy can be achieved by slowing the pace of exchange rate appreciation. That supports the exporting sector and economic growth in the best way for a small open economy like the Ukrainian one.

In case of shocks related to credibility issues (e.g., risk premium) the NBU needs to react more harshly using both its policy interest rate and FX interventions that are needed to smooth depreciation, but not avoid it.

In the case of a shock related to "hot" capital inflows, some kind of capital control tool needs to be implemented in addition to the interest rate and FX interventions. Such a combination allows for minimizing volatility of inflation and output losses.

In case of aggregate demand or terms of trade shocks, the trade-off for policy choice arises as using FX interventions is accompanied by a higher volatility of inflation. However, there is no doubt that in case of depreciation pressure on the national currency the NBU needs to refrain from using FX interventions (except marginal use for smoothing the functioning the FX market), allow the exchange rate to play the role of shock absorber, and save international reserves, which are a scarce resource.

If there is an appreciation pressure, the NBU has to make a policy decision between less volatile inflation and output or accumulation of international reserves and a temporary increase of output. In this case, the overall macroeconomic situation needs to be taken into account.

If inflation is already suppressed when the shock happens (e.g., due to low domestic demand), the NBU is able to replenish its international reserves and permit some inflation. In the contrasting case of an already "overheated" economy, the right decision is probably to allow exchange rate appreciation with a view to mitigate inflation.

References

- Bayoumi T., Saborowski C. (2014). Accounting for Reserves. Journal of International Money and Finance, Vol. 41, Issue C, pp. 1-29.
- Beneš J., Berg A., Portillo R., Vávra D. (2015). Modeling Sterilized Interventions and Balance Sheet Eeffects of Monetary Policy in a New-Keynesian Framework. Open Economies Review, Vol. 26, No. 1, pp. 81-108. https://doi.org/10.1007/s11079-014-9320-1
- Beneš J., Hlédik T., Vávra D., Vlek J. (2003). The Quarterly Projection Model and its Properties. The Czech National Bank's Forecasting and Policy Analysis System, pp. 63-98.
- Blanchard O., Dell'Ariccia G., Mauro P. (2010). Rethinking Macroeconomic Policy. Journal of Money, Credit and Banking, Vol. 42, Issue s1, pp. 199-215. https://doi.org/10.1111/j.1538-4616.2010.00334.x
- Edison H.J. (1993). The Effectiveness of Central-Bank Intervention: A Survey of the Literature After 1982. Special Papers in Internationals Econimics, No. 18, International Finance Section, Department of Economics, Princeton University.
- Edwards S. (2006). The Relationship Between Exchange Rates and Inflation Targeting Revisited. Working paper, No. 12163, NBER. https://doi.org/10.3386/w12163
- Faryna O. (2016). Nonlinear Exchange Rate Pass-Through to Domestic Prices in Ukraine. Visnyk of the National Bank of Ukraine, No. 236, pp. 30-42. https://doi.org/10.26531/vnbu2016.236.030
- Garcia C.J., Restrepo J.E., Roger S. (2011). How much should inflation targeters care about the exchange rate? Journal of International Money and Finance, Vol. 30, No.7, pp. 1590-1617.
- International Monetary Fund (2014). Annual Report on Exchange Arrangements and Exchange Restrictions.
- International Monetary Fund (2016). Country Report, No. 16-319, IMF.

- Mohanty M.S., Klau M. (2005). Monetary Policy Rules in Emerging Market Economies: Issues and Evidence, Monetary Policy and Macroeconomic Stabilization in Latin America. Springer Berlin Heidelberg, pp. 205-245.
- National Bank of Ukraine (2016). Financial Stability Report, June 2016. Available at: https://bank.gov.ua/doccatalog/document?id=32247009
- National Bank of Ukraine (2016). Inflation Report. July 2016. Available at https://bank.gov.ua/doccatalog/document?id=34754670
- Ostry J.D. (2012). Managing Capital Flows: What Tools to Use? Asian Development Review, Vol. 29, No. 1, p. 82.
- Ostry J.D., Ghosh A.R., Chamon M. (2016). Two targets, two instruments: Monetary and exchange rate policies in emerging market economies. Journal of International Money and Finance, Vol. 60, pp. 172-196.
- Roger S., Restrepo J.E., Garcia C. (2009). Hybrid inflation targeting regimes. Working Papers, No. 09-234, pp. 1-57, IMF. https://doi.org/10.1596/1813-9450-4847
- Savastano M.M.A., Masson M.P.R., Sharma M.S. (1997). The Scope for Inflation Targeting in Developing Countries. Working Paper, No. 97-130, IMF, pp. 1-53. https://doi.org/10.5089/9781451855159.001
- Stone M., Walker W.C., Yasui Y. (2009). From Lombard Street to Avenida Paulista: foreign exchange liquidity easing in Brazil in response to the global shock of 2008-09. Working Paper, No. 09-259, IMF, pp. 1-35. https://doi.org/10.5089/9781451874051.001
- Svensson L.E. (1999). Inflation targeting as a monetary policy rule. Journal of monetary economics, Vol. 43, No. 3, pp. 607-654. https://doi.org/10.1016/S0304-3932(99)00007-0
- Svensson L.E. (2000). Open-economy inflation targeting. Journal of international economics, Vol. 50, No. 1, pp. 155-183. https://doi.org/10.3386/w6545
- Svensson L.E. (2009). Flexible inflation targeting: lessons from the financial crisis. Speech by Mr. Lars E O Svensson, Deputy Governor of the Sveriges Riksbank, at the workshop Towards a new framework for monetary policy? Lessons from the crisis.