THE ROLE OF NEW KEYNESIAN SEMI-STRUCTURAL MACROECONOMIC FORECASTING MODEL IN REALISATION OF SUSTAINABLE DEVELOPMENT GOALS IN UZBEKISTAN

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Abstract New reforms have been adopted in banking system of Uzbekistan since 2017 as monetary policy framework directed from monetary targeting to inflation targeting (IT). Liberalization of the national currency, reaching 5% inflation target on medium-term and operational independence of the Central Bank of Uzbekistan (CBU) have started progress of the reforms. The CBU has set policy rate as the primary tool of monetary policy in the context of inflation targeting regime. According to the experience of countries that implemented inflation targeting regime successfully, it is recommended to use the New-Keynesian semi-structural macroeconomic forecasting model to achieve price stability with the help of policy rate. This paper analyses efficiency of monetary policy by proposing to use New-Keynesian semi-structural macroeconomic forecasting model for Uzbekistan. The model includes 4 main blocks: Demand block (Output gap), Supply block (Philips curve), Exchange rate block (Uncovered Interest Rate Parity (UIP)), Interest rate block (Taylor rule). We expect that this model helps to forecast medium-term macroeconomic scenarios especially reaching inflation target and steady state of the economy.

Keywords:
policy rate,
output gap,
uncovered interest rate parity,
dollarization,
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1 Introduction

Practical monetary policy has greatly improved because of the adoption of inflation targeting. Inflation-targeting central banks can still make significant advancements by being more precise, organized, and open about their operational goals (for example, by using an explicit intertemporal loss function), their forecasts (for example, by selecting the best projections of the instrument rate and the target variables), and their communication (in the form of announcing optimal projections of the instrument rate and target variables) (Svensson, 2007). The president of Uzbekistan signed an official document as a formal strategy to inflation targeting regime in 2017[1]. This decree determined the main guidelines and priorities of moving from money targeting to inflation targeting regime. According to the decree, the CBU is responsible for making inflation 10% in 2021 and 5% inflation target in 2023. Also, coordination of fiscal and monetary policy, preferential loan termination, and keeping fiscal deficit under 1.5 percent to GDP are determined as a smooth transition to IT regime. CBU has developed operational mechanism forecasting and analytical framework since the transition period. As an improvement of operational mechanism, CBU uses repo and swap auction when there is shortage of liquidity in money market, or it uses deposit auctions and repo operations when there is excess liquidity. CBU uses a variety of econometric models to forecast macroeconomic variables such as Bayesian VAR model for forecasting inflation and the Dynamic Factor Model for forecasting GDP[2].

This paper introduces a small macroeconomic quarterly projection model (QPM) for Uzbekistan. We propose to use simple canonical QPM model to analyze interest rate and exchange rate channel of monetary policy. The QPM is a semi-structural model for open economies that help formulate medium-term macroeconomic forecasts.

[1] President decree 5877, "Improving monetary policy by step-by-step transition to inflation targeting regime". https://lex.uz/docs/-4600824

[2] Guidelines of Monetary policy for 2021-2023. https://cbu.uz/en/monetary-policy/trend/

2 Theoretical Background

Tex Norman and Schmidt-Hebbel defined the monetary transmission mechanism as "the process through which changes in monetary policy instruments affect the rest of the economy and, in particular, output and inflation" (Norman & Klaus 2002). Monetary policy impulses transmit through various channels, affecting different variables and different markets, and at various speeds and intensities. The QPM is a tool for cogently organizing ideas and data into baseline assessments, risk comparisons to baseline predictions, and the nature of policy responses to various types of shocks (Berg et al., 2006.a). Research of Al Rasasi and Cabezon showed that the interbank market has seen rapid development since the introduction of inflation targeting regime in Uzbekistan but there are still some signs of market segmentation, as some banks are consistently borrowers or lenders in the market. Another problem with interbank market is underdeveloped government security markets (Al Rasasi & Cabezon, 2022).

There are certain factors that impede the effective conduct of monetary policy for Central Asian Countries (Isakova, 2008). A significant level of dollarization and financial sector underdevelopment can pose a serious obstacle to the functioning of monetary transmission. Additionally, exchange rate pass-through is the strongest channel of monetary transmission in Asian Countries. It is possible to consider QPM as a method which consists of two calibrated models (Cote et al., 2006). The first model is used to study determinants of long-term equilibrium in the economy and the constant impact of economic shocks or policy changes. The second model is made up of a set of dynamic relationships that show paths leading from initial conditions to the implicit steady-state solution, or long-term equilibrium. According to Berg, QPM has four main blocks: aggregate demand block (IS curve), inflation block (Phillips curve), monetary policy rule block (monetary policy reaction function) and exchange rate block (assuming uncovered interest rate parity) (Berg et al., 2006b). The model is structural because each of its equations has an economic interpretation, but the equations are not fully micro-founded. It is perceived as a general equilibrium model because it describes how the equilibrium is established in the economy, and not only in some markets or sectors. It is considered as a stochastic model in that random shocks affect each endogenous variable, and it is possible to use the model to derive measures of uncertainty in the underlying baseline forecasts.

Some applications of the QPM model have been documented in the literature. For example, Nelyubina (2021) researched regional indicators of Russia with the help of QPM model. It allows the policy maker to investigate how shocks in one location spread to others, how various regions react to global shocks, and what the ideal monetary policy should be, according to the author. Another implementation of QPM was used on a study to determine neutral interest rate for Kyrgyzstan. The paper analyzed data from 2000 Q1 to 2019 Q2 and concluded that the real neutral interest rate for Kyrgyzstan was 4% based on various model estimates (Time-Varying Parameter Vector Autoregressions, Dynamic stochastic general equilibrium) and 3.7% based on the QPM model. This figure is higher than from many developing countries due to high public debt, high-risk premiums, low restricted creditors' rights, the rule of law, and low local savings (Teodoru & Toktonalieva, 2020). Drovbishevskiy (2008) conducted research on transmission mechanism to assess the effectiveness of monetary transmission of Russian economy based on data from 1999-2007, by using the method of vector auto regression to compare effectiveness of three channels. His result was that credit channel is the most effective channel compared to the other two ones (i.e. the interest rate channel, and the asset price channel).

Empirical research to analyze monetary policy transmission in Emerging Markets and Developing Economies has been done by IMF researchers (Marques et al., 2020). The results show that interest rate rises are the main sources of reducing economic growth and inflation. In addition, the findings suggest that central banks with modern monetary policy framework such as adapting to inflation targeting, high level of transparency and independence tend to focus more on monetary policy transmission mechanism than financial market development. According to Papadamou, there is a link between central bank transparency and the transmission of monetary policy through interest channel for emerging market economies. It has been shown that when the central bank's monetary policy is more transparent, the monetary transmission is more effective (Papadamou et al., 2014). The main reason for the low efficiency of the monetary transmission is the imperfection of methods for forming the volume and structure of the monetary base (Mishchenko et al., 2021). Banks’ characteristics, such as the capital ratio, exposure to domestic sovereign debt, percentage of non-performing loans and stability of funding structure are the reasons for heterogeneity in the pass- through of conventional monetary policy changes and the location of a bank is irrelevant in this respect

(Altavilla et al., 2020). In small open economies with rigid exchange rates, the effectiveness of domestic monetary policy through the interest rate channel is quite limited (Petrevski & Bogoev, 2012). Iddrisu (2020) and others studied interest rate channel and lending channels of monetary policy transmission for South Africa. The results show that one percent reduction of key policy rate increase bank lending rate to 0.29%. In turn, one percent rise of bank lending rate reduces investment to 0.063%. One percentage decline of investments brings to fall inflation by 0.074%. Musil and Pranovich (2018) made a small structural model by considering economic structure of Belarus. New blocks explain added wage policy, direct lending by government to state-owned enterprises, dollarization in Belarus. Andrle and coauthors (2013) developed a semi-structural new-Keynesian open-economy model for Kenya, a low-income country. The results show that while the imported food price shocks contributed to Kenya's inflation dynamics in 2008 and thereon, it was found that an accommodating monetary policy also played a significant influence. Benes et al. (2017) estimated effectiveness of monetary policy transmission mechanism by using a production version of QPM. The model incorporates specific features of Indian economy such as agricultural sector, food and non-food prices and credibility of Central Bank of India.

3 Methodology

QPM model was developed by IMF economists as a part of forecasting and monetary policy analysis system (Berg et al., 2006b). Based on the literature above, we have made core model structural equations and parameters. The equations are made by considering specific features of economy of Uzbekistan. The core equations are as follows:

Output gap equation

$$l\_y\_gap_t = a_1 l\_y\_gap_{t-1} + a_2 l\_y\_gap_{t+1} - a_3\, rmci_{t-1} + a_4 l\_y\_gapf_t + shock\_l\_y\_gap_t \quad (1)$$

$$l\_y\_gapf_t = a_5 l\_y\_gapf_{t-1} + shock\_l\_y\_gapf_t \quad (2)$$

Output gap equation estimated business cycle. It resembles Euler equation and approximates how monetary conditions index(mci), foreign output gap(l_y_gapf) and demand shock determines output gap ($l\_y\_gap_t$) of the domestic economy. The lag of output gap (l_y_gap) at time (t-1) is added to capture the persistence of the business cycle. This is a structural stochastic equation; therefore, it includes the structural demand shock. Unlike in the domestic part of the model, there is no economic structure (or economic interpretation) in the foreign block. All variables in the foreign or external block follow simple, auto regressive processes (order one) as the second equation above (i.e., the foreign output gap). Monetary conditions index (equation 3) approximates weighted average of two variables: the real interest rate gap (r) and the real exchange rate gap (z). Both variables are determined calculating deviation from the long-term trend or equilibrium level. When both gaps are zero, monetary policy is neutral, which means that there is no stimulating or contracting demand in the economy.

Monetary conditions index (rmci)

$$rmci_t = a_6 r\_gap_t + (1 - a_6)(-z)\_gap_t \quad (3)$$

Philips curve

By considering inflation factors in Uzbekistan, we divided ordinary Philips curve equation into 4 sub-part equations, and then we aggregated all sub-parts.

Philips curve for non-food items

$$dl\_cpi\_nf_t = a_7 dl\_cpi\_nf_{t+1} + (1 - a_7 - a_8) dl\_cpi\_nf_{t-1} + a_8 dl\_cpi\_imp\_nf_t + a_9 rmc\_nf_t + shock\_dl\_cpi\_nf_t \quad (4)$$

The equation (4) shows Philips curve for non-food item. According to the equation, expected value ($dl\_cpi\_nf_{t+1}$) and lag value ($dl\_cpi\_nf_{t-1}$) are the variables that determine non-food inflation equation. Importantly, import of non-food items ($dl\_cpi\_imp\_nf_t$) and real marginal cost index (rmc_nf_t) are the other variables of the non-food inflation equation. We made a separate equation for imported non-food inflation. Imported non-item inflation equation includes lag of its own value, inflation of food items and deviation of nominal exchange rate from its trend value. The QPM has separate equation for real marginal cost index. This index is a weighted average of two gap variables, namely the output gap, and the exchange rate gap. We will show equation of the real marginal cost index later, together with food items.

Philips curve for food items

$$dl\_cpi\_f_t = a_{10}dl\_cpi\_f_{t+1} + (1 - a_{10} - a_{11})dl\_cpi\_f_{t-1} + a_{11}(dl\_cpi\_imp\_f_t) + a_{12}rmc\_f_t + shock\_dl\_cpi\_f_t \quad (5)$$

Variables of food items of Philips curve is almost the same with the non-food items. It covers expected value ($dl\_cpi\_f_{t+1}$) and lag value ($dl\_cpi\_nf_{t-1}$), imported food inflation variable ($dl\_cpi\_imp\_f_t$) and real marginal cost index (rmc_f_t).

Real marginal costs

$$rmc\_nf_t = a_{13}l\_y\_gap_t + (1 - a_{13})(l\_z\_gap_t) \quad (6)$$
$$rmc\_f_t = c_{14}l\_y\_gap_t + (1 - a_{14})(l\_z\_gap_t) \quad (7)$$

As we can see from equation (6) and (7), real marginal cost index for both food and non-food items are determined by output gap which is the pressure by domestic firms to produce one additional unit of output and exchange rate gap which varies with the relative prices of imports.

Philips curve for regulated items and services

$$dl\_cpi\_reg_t = a_{15}dl\_cpi\_reg_{t-1} + (1 - a_{15})d4l\_cpi_t + shock\_dl\_cpi\_reg_t \quad (8)$$

Philips curve for regulated items include the lag value of the regulated items with ($dl\_cpi\_reg_{t-1}$), year on year inflation rate $d4l\_cpi_t$ and the shock to the regulated items.

Finally, we can aggregate all Philips curve subpart equations (equations 4,5,6,7 and 8) to make a single Philips curve. The equation below shows aggregated Philips curve equation for our model.

$$l\_cpi_t = a_{16}l\_cpi\_f_t + a_{17}l\_cpi\_nf_t + (1 - a_{16} - a_{17})l\_cpi\_reg_t + shock\_l\_cpi_t \quad (9)$$

Interest rate – Taylor rule

Next block of our model is the interest rate rule. It bases on the Taylor rule. The model assumes that the central bank reacts to the deviation of inflation and output gap in a structured way. The equation for interest rate rule is as follows:

$$irr_t = a_{18} irr_{t-1} + (1 - a_{18})(irr\_tnd_t + a_{19} dev\_cpi_t + a_{20} l\_y\_gap_t) + shock\_irr_t \quad (10)$$

The lag value of policy rate (irr_{t-1}) signals that the central bank reacts to changes smoothly not abruptly. The equation also has neutral interest rate irr_tnd_t and deviation of inflation dev_cpi_t and output gap $l\_y\_gap_t$. The equation is structural, so it has policy shock that is $shock\_irr_t$.

Exchange rate rule (UIP condition)

The last block of domestic part of our model is the uncovered interest rate parity (sometimes called UIP condition). UIP simply says that the exchange rate at time t is equal to the expected level of the exchange rate in the next period and the differential between foreign and domestic interest rates. Our model takes more sophisticated version of the UIP condition that considers differences in risk and liquidity of domestic and foreign assets. The equation for UIP condition is as follows:

$$l\_s_t = (1 - a_{21}) l\_s\_tar_t + a_{26}(l\_s_{t-1} - (i_t - i\_f_t - prem_t)/4) + shock\_l\_s_t \quad (11)$$

Equation (11) shows that the nominal exchange rate at time t is determined based on the target level of exchange rate ($l\_s\_tar_t$), nominal exchange rate at time t-1 and the interest rate differential between domestic and foreign country that considers the risk premium.

Untill now, we have finished 4 main building blocks of domestic part of our model. Foreign blocks are determined with simple auto regressive processes (AR1). The next step is to choose parameterization before running model simulation. According to the literature (Musil, 2018; Berg et al., 2006b), we may select model parameters by considering Uzbekistan's economic development level and current position. Table 1 shows the parameters that we chose to simulate our model.

Table 1: Model parameters

a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9	a_{10}
0.40	0.30	0.15	0.15	0.80	0.85	0.30	0.05	0.25	0.30

a_{11}	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}	a_{17}	a_{18}	a_{19}	a_{20}	a_{21}
0.05	0.25	0.85	0.85	0.80	0.43	0.35	0.50	1.20	0.50	0.50

Source: Authors' estimations.

The parameters above have been chosen based on the studies of the International Monetary Fund working papers (Benes et al., 2017; Musil and Pranovich, 2018). This parameter is used to evaluate poor and developing countries. Once we have checked different parameter values, reasonable values are chosen for simulation. Based on the simulation results, we checked impulse response of variables with 0.5 shock parameter for demand shock. Once the shock applied, output gap rises dramatically in the first period of analysis and reaches long-term trend in the first quarter of 2026. As the output gap increases, inflation rate also raises in the same quarter and the central banks also decides to increase policy rate. Next, we checked variables by applying non-food supply shock with 1.10 parameter and food supply shock with 1.0. The inflation rate rises in both cases and central bank responds with contractionary monetary policy in the first period. Then, as the demand declines, inflation and interest rates come back to target level in the first quarter of 2026.

4 Discussion and Conclusion

Uzbekistan is one of the post-Soviet countries which have made structural reforms in monetary policy. The country adapted to inflation targeting regime in 2017 and since then CBU changes the monetary policy framework accordingly. In general, inflation targeting central banks use policy rate as a main tool to effect business cycle then the inflation rate. The objective of this paper was to make a model to analyze how effectively interest rate and exchange rate channel work in Uzbekistan. The paper illustrates structural equations of QPM model that is used by IMF and central banks in inflation targeting countries. Implementation of the model can be made by the MATLAB software with the help of IRIS toolbox.

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