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Authors:

Tural Yusifzada Nazrin Ramazanova Ramiz Rahmanov Vugar Ahmadov

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QUARTERLY PROJECTION MODEL OF AZERBAIJAN (AzIM 1.0)¹

Tural Yusifzada, Nazrin Ramazanova², Ramiz Rahmanov, and Vugar Ahmadov

The Central Bank of the Republic of Azerbaijan

Abstract

This paper presents the first version of the Azerbaijan Quarterly Projection Model (QPM), a forward-looking, open-economy gap model. The model is designed for forecasting, simulations, and monetary policy analysis. It consists of five main building blocks: (i) aggregate demand block consisting of output gap, (ii) a Phillips curve (inflation forecasting) block modeling inflation and inflation expectations, (iii) a risk adjusted uncovered interest rate parity block serving as the nominal anchor; (iv) Taylor rule (short-term interest rate) block that defines the monetary policy reaction function; and (v) an external sector block. AzIM 1.0 is based on a semi-structural New Keynesian QPM framework, which has been adapted to reflect the specific characteristics of the Azerbaijani economy, particularly the transmission mechanisms and formulation of the monetary policy. The model calibration is informed by econometric estimations for Azerbaijan, insights from international literature and comparable country experiences, as well as historical trends. To assess the model's robustness and adequacy, we conduct impulse response analysis, equation decomposition, and in-sample simulations.

Keywords: Quarterly Projection Model, the Azerbaijani economy, forecasting and policy analysis, monetary policy

JEL classification: E32, E37, E47, E52

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² Corresponding author: Nazrin Ramazanova (Nazrin_Ramazanova@cbar.az)

Introduction

Generally, the models used by central banks with objectives of forecasting and policy analysis range from various time series models for short-term assessment to calibrated theoretical models and estimated structural models. This study discusses the structural macro-econometric model of the Central Bank of the Republic of Azerbaijan, which is the Quarterly Projection Model or AzIM (Azərbaycan İqtisadiyyatının Modeli). It is a so-called gap model that enables central banks to forecast macro-economic fundamentals, especially inflation over the medium term (up to 24 months). The QPM is a general equilibrium model that holds foundations in New Keynesian theory, allowing better analysis of the different types of real and nominal shocks on Azerbaijan economy.

The Azerbaijani economy has experienced a dynamic trajectory of the development, characterized by distinct patterns.

The QPM has some unique characteristics, one of which is that Azerbaijan economy evolves around its well-defined equilibrium path, and different variety of shocks cause deviations from the equilibrium. These shocks depending on the degrees of continuity produce usually persistent impacts on gaps due to the presence of real and nominal rigidities. The role of the monetary in this regard is fundamental as it closes those gaps and brings the economy back to its equilibrium path.

By incorporating the specificities of the Azerbaijani economy, the model allows to analyze the impact of monetary policy on pushing economy to target level of inflation and long-term output level. We calibrated the model to enhance its accuracy and relevance in capturing the evolving dynamics of the Azerbaijani economy.

To further illuminate the properties of the model, this study employs an extensive impulse response analysis, showing the dynamic responses of the economy to various internal and external shocks. Specifically, a thorough analysis of various macroeconomic variables such as the inflation and GDP is conducted, employing a decomposition approach to discern the historical drivers that have shaped their trajectories over time. The model is developed on the key assumption that the monetary policy cannot influence the long-term equilibrium of the economy, and it will only affect the cyclical dynamics of

Furthermore, this paper conducted detailed in-sample simulations to provide a comprehensive assessment of the model's predictive performance and its capacity to capture the complex dynamics of the Azerbaijani economy. These simulations demonstrate the model's robustness and effectiveness in forecasting key macroeconomic variables, thereby underscoring its practical relevance for policy analysis and decision-making.

The structure of the paper is as follows. Section 2 outlines the key stylized facts about the Azerbaijani economy and show its development trajectory since 2003. Section 3 describes the model's transmission mechanism, details its core blocks, and presents the calibration results. Section 4 investigates the model properties using impulse-response analysis, decomposition, and in-sample simulation. Finally, Section 5 summarizes the main findings and discusses directions for future research.

Stylized facts of the Azerbaijani economy

Azerbaijan's economy has demonstrated strong growth performance over the past two decades. The external balance has generally remained in surplus, contributing to accumulation of foreign

reserves that have served as a buffer against potential external shocks. In 2015, the economy faced with a significant terms-of-trade shock resulting from a sharp decline in oil prices, which had substantial implications for macroeconomic stability. While efforts to diversify the economy away from hydrocarbon have been initiated. Notable progressed have already been achieved. In recent years, the exchange rate has remained relatively stable, supported by a de facto peg to the U.S. dollar. The following section presents an analysis of Azerbaijan's economic performance across distinct periods, with particular attention to the effects of major external and domestic shocks, the 2008 global financial crises, the 2015 currency devaluations, and the COVID-19 pandemic.

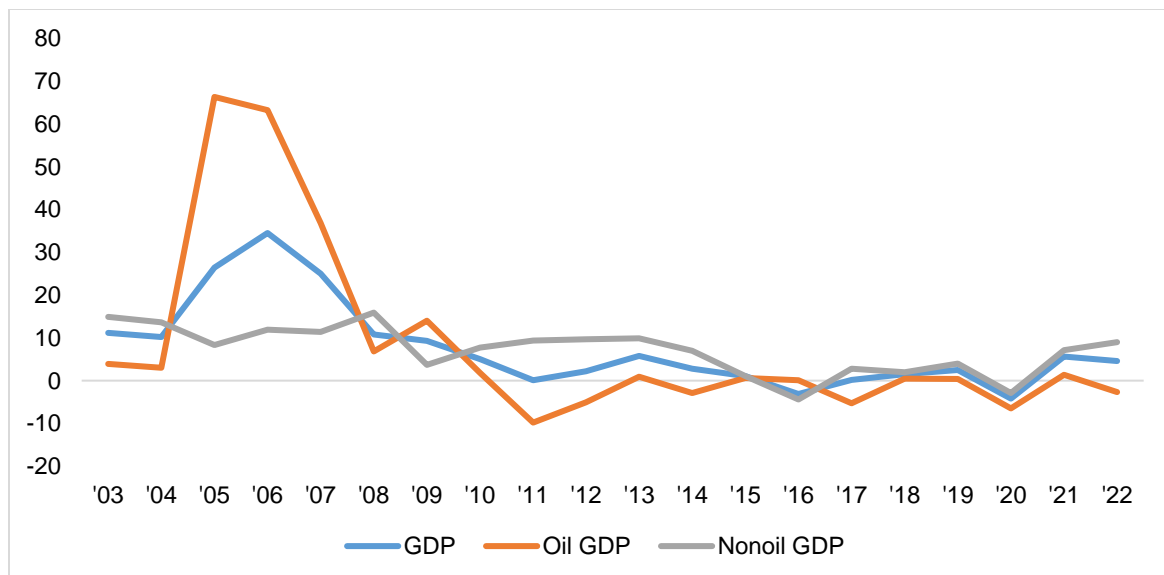
Period 1: Pre-2008 Global Financial Crisis (2003-2007)

During this period, Azerbaijan experienced robust economic growth, largely driven by the oil and gas sector. GDP growth averaged over 20%, positioning the country as one of fastest-growing economies globally (Figure 1). The trade balance was heavily skewed towards energy exports, particularly oil and gas (Figure 2). The surge in oil exports led to a notable increase in foreign reserves, and the state budget received the transfers from the State Oil Fund (SOFAZ) (Figure 3). This fiscal expansion and spectacular economic growth were accompanied by a rise in domestic prices (Figure 4).

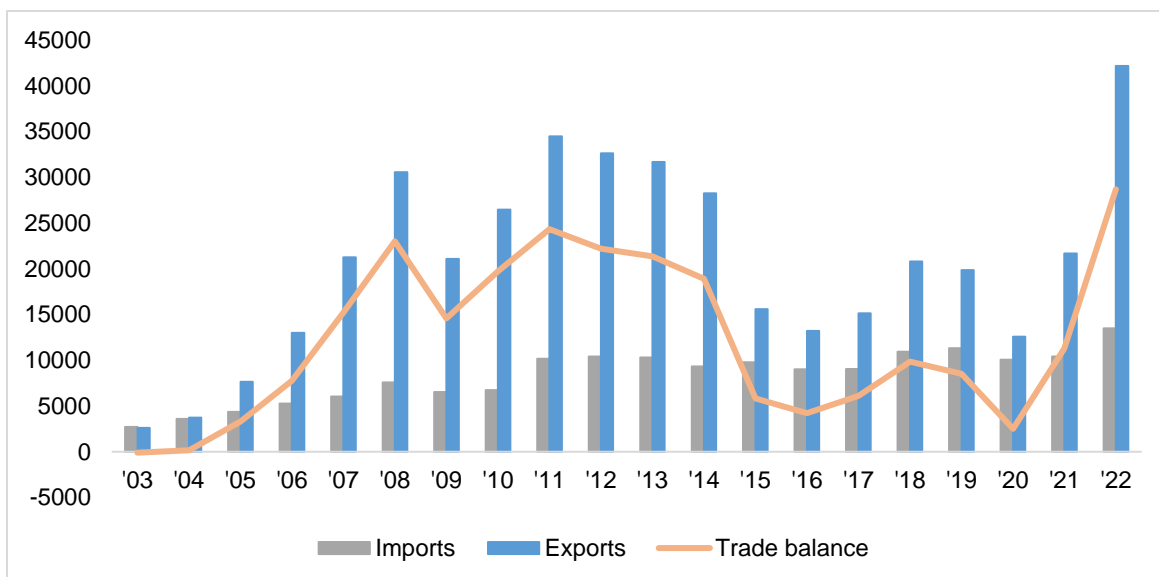
Period 2: The 2008 Global Financial Crisis and Its Aftermath (2008-2014)

The global financial crisis of 2008 had a significant adverse impact on Azerbaijan's economy, as falling oil prices led to a contraction in oil gas exports (Figure 2). Despite the weakening of the trade balance, the national currency, withstood the external shocks and avoided depreciation (Figure 5). Inflationary pressures eased, with inflation falling to 1.5% in 2009. However, starting in 2011, GDP growth began to slow, primarily due to a decline in oil production. Although the non-oil sector showed strong performance, it was insufficient to offset the downturn in the oil sector. Despite this, the decline in oil production did not result in the fiscal austerity, as the transfers from SOFAZ remained one of the financing sources for the state budget (Figure 3). Post-crisis, inflation remained relatively subdued.

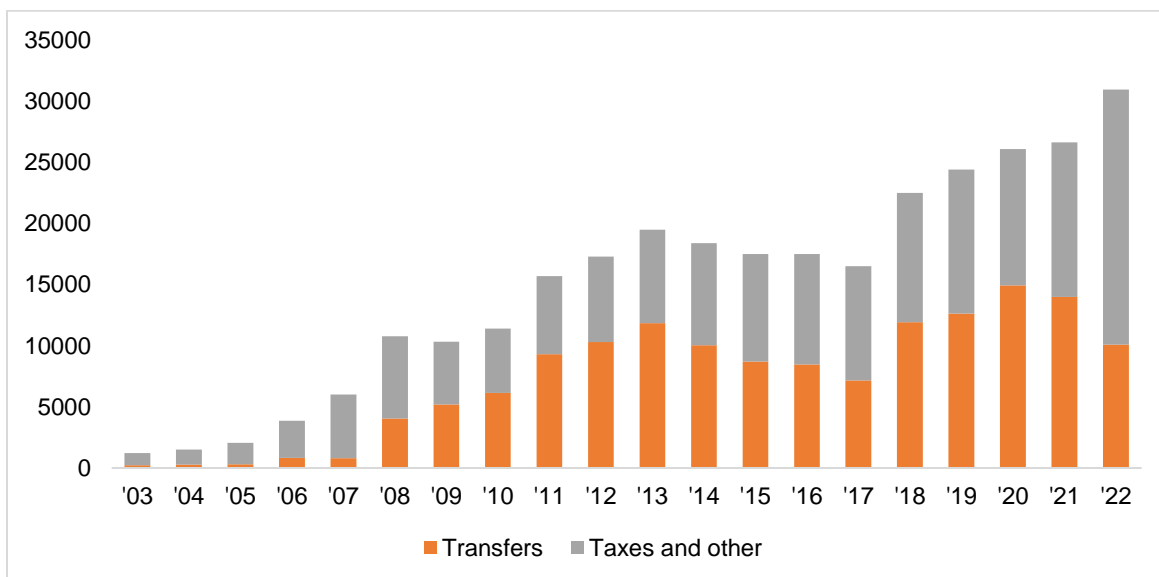
Figure 1. GDP, %



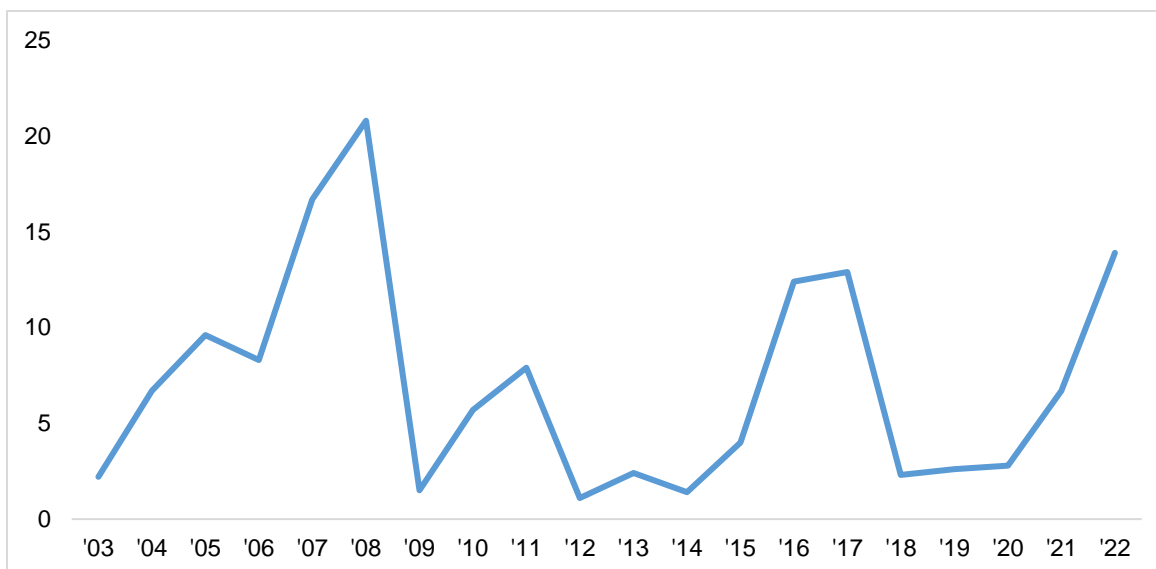
Source: The State Statistical Committee of the Republic of Azerbaijan

Figure 2. Trade Balance, million. USD

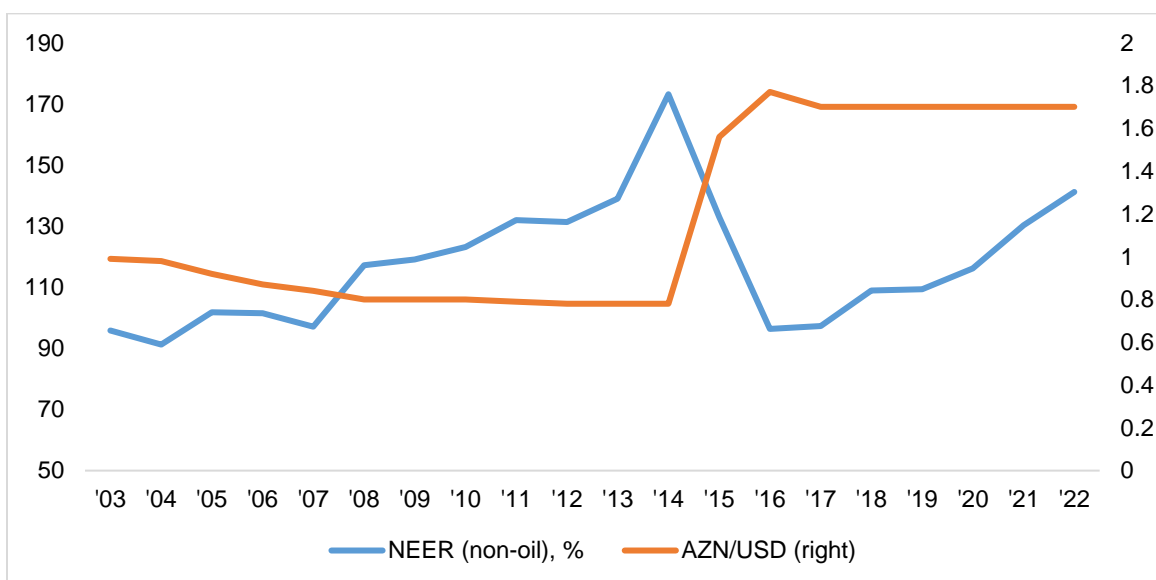
Source: The Central Bank of the Republic of Azerbaijan

Figure 3. Government budget revenues, mln. manat

Source: The State Statistical Committee of the Republic of Azerbaijan

Figure 4. Inflation, %

Source: The State Statistical Committee of the Republic of Azerbaijan

Figure 5. Exchange rates

Source: The Central Bank of the Republic of Azerbaijan

Period 3: The terms-of-trade shock: oil price drop (2015-2019)

From mid-2014 to early 2016, the global economy witnessed a sharp decline in oil prices, one of the most significant drops in recent history. This 70% decrease ranked among the top three largest oil price declines since World War II, rivaled only by the supply-driven collapse of 1986. The prolonged downturn in oil prices led to a substantial reduction in oil revenues, exacerbating pessimistic

expectations. These expectations placed unprecedented pressures on the national currency, resulting in devaluation by 46%.

This triggered an immediate economic contraction. The non-oil sector dropped by 4.4% in 2016 (Figure 1). A key factor in this contraction was a decline in the budget expenditure, driven by reduced revenues. Additionally, the depreciation of the nominal effective exchange rate caused a surge in inflation, primarily due to the increased import costs. Despite government interventions to curb inflation, it remained elevated, exceeding 10% in both 2016 and 2017 (Figure 4).

The economy began to recover in 2018 and the fiscal spending increased with increased non-oil revenues and higher transfers from SOFAZ. Despite the significant fiscal impulse, the non-oil GDP growth was significantly below the pre-devaluation rates and inflation was below 3% (Figure 1 and Figure 4). As the oil prices began to rise, the trade balance showed marked improvements (Figure 2).

Period 4: The COVID-19 Pandemic and Post-COVID Recovery (2020-2022)

No sooner had Azerbaijan recovered from the terms-of-trade shock than it faced with new challenges posed by the COVID-19 pandemic. The pandemic-induced restrictions severely constrained economic activities, leading to a 4.2% contraction in GDP in 2020 (Figure 1). In response, the government implemented fiscal stimulus measures aimed at supporting households and businesses during the economic downturn. These measures helped prevent a deeper recession. As the demand remained low, inflation stayed below the mid-target of 4% (Figure 5). However, the Azerbaijani economy faced additional, but temporary challenges due to a significant decline in oil prices, which affected the surplus of the trade balance (Figure 2). Despite some demand-side pressures in the foreign currency market, the exchange rate remained stable.

Following the easing of restrictions, the economy showed signs of recovery, with GDP growth of 5.6% in 2021 and 4.6% in 2022 (Figure 1). The recovery phase was also marked by high inflation, primarily driven by supply chain disruptions, which led to a demand-supply imbalance and pent-up consumer demand. In 2022, the inflation surpassed single-digit levels (Figure 4). The global economic recovery had a favorable impact on oil prices, which, in turn, led to a significant improvement in the trade balance. In the post-pandemic period, both government spending and tax revenues exhibited growth (Figure 3). This fiscal expansion was primarily driven by the need to finance infrastructure development in the liberated territories.

As we conclude our analysis of the stylized facts that shape Azerbaijan's economic landscape, we turn to an examination of the structure of the Quarterly Projection Model of Azerbaijan (AzIM). This model provides a comprehensive framework for understanding past economic trends and identifying the key drivers behind periods of economic expansion and contraction. Moreover, the model enables us to offer insightful projections regarding the potential macroeconomic scenarios Azerbaijan may encounter in the medium-term. Such information is invaluable for central bankers, assisting them in making well-informed decisions. Let us now explore the key components of the model and explore its underlying mechanics.

Model Structure

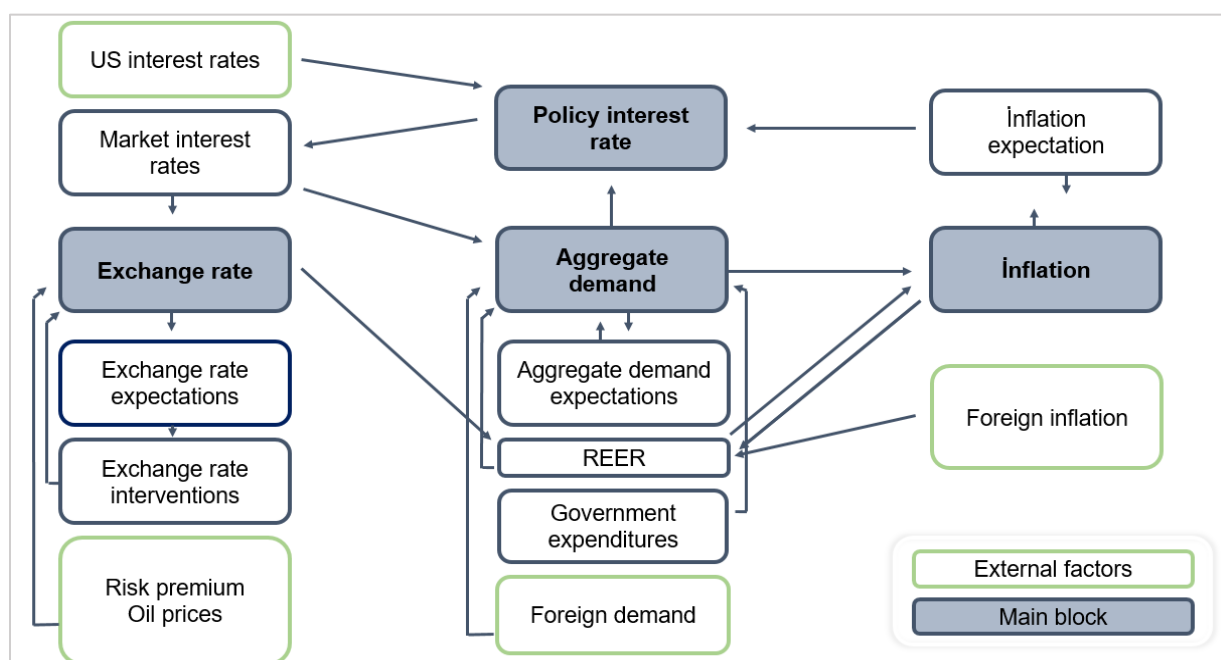
Model

The structure of the model primarily reflects the country's current monetary policy regime, key transmission channels, and the essential features of the economy. The quarterly projection model

(QPM) of the CBAR is highly aggregated, semi-structural, small open economy model designed to capture main characteristics of the economy of Azerbaijan. It is a reduced form New-Keynesian model, which includes real and nominal rigidities, rational expectations, and forward-looking endogenous monetary policy (Epstein et al, 2022). Thus, monetary policy in this model affects real variables in the short-term and converge to their steady state in the long-term.

Monetary policy influences the economy through two primary transmission channels: the interest rate and the exchange rate. First, interest rates directly affect the choices of economic agents regarding savings and consumption, which, in turn, impacts domestic demand. Specifically, higher interest rate encourages agents to save more and spend less, thereby reducing domestic demand and alleviating demand-side inflationary pressures. Second, monetary policy also affects aggregate demand and inflation via the exchange rate channel. Initially, interest rate influences the exchange rate through the uncovered interest rate parity condition: lower interest rates typically lead to a depreciation of the domestic currency. This could be one of several factors contributing to the improvement in the competitiveness of domestic production. However, the extent to which domestic production depends on imports determines the net effect of the exchange rate on economic activity. Currency depreciation can also make imported goods more expensive, resulting in supply-side inflationary pressure. Figure 6 displays a standard illustration of the transmission mechanism in the model.

Figure 6. Monetary policy transmission mechanism of the QPM



Source: Central Bank of the Republic of Azerbaijan

Main Model Equation

The subsequent subsection describes the four gaps and main model equations that underlie the core economic projections. Here we focus on four gaps that are critical for the policy analysis and forecasting in QPM: 1) inflation's deviation from output gap; 2) the real exchange rate's overvaluation or undervaluation;

The main equations of the core model are aggregate demand, Philips curves, uncovered interest rate parity, and Taylor rule.

Aggregate Demand

The output gap is modelled as an extended investment-savings (IS) curve. Equation (1) summarizes the behavior of aggregate demand and is expressed as follows:

$$\hat{y}_t = \alpha_1 * \hat{y}_{t-1} + \alpha_2 * \hat{y}_{t+1} - \alpha_3 * \hat{r}_t - \alpha_4 * \hat{z}_t + \alpha_5 * \widehat{gex}_t + \alpha_6 * \hat{y}_{t-1}^w + \varepsilon_t^y \quad (1)$$

In this equation, \hat{y}_t is the output gap, defined as the deviation of the logarithm of real output from its potential level. The output gap depends on its past value \hat{y}_{t-1} , which captures the persistence in the business cycle, as well as its future value \hat{y}_{t+1} .

The subsequent two terms are real interest rate gap (\hat{r}_t) and real effective exchange rate gap (\hat{z}_t). These terms capture real monetary conditions, through which monetary policy impacts the real economy. In the estimated model, both variables the real interest rate and the real exchange rate with negative coefficients, implying that tighter monetary policy - either through higher real interest rates or an appreciation of the real exchange rate – reduces the output gap. Given Azerbaijan's characteristics as a small open economy, the real effective exchange rate influences aggregate demand through primarily its impact on net exports.

Considering the country's strong reliance on fiscal policy, it is essential to incorporate fiscal variables into the model. Government expenditures, denoted as (\widehat{gex}_t), captures the direct impact of a fiscal policy on economic activity.

As an open economy, Azerbaijan's cyclical position is also influenced by external conditions. Foreign demand is represented by the lagged foreign output gap, \hat{y}_{t-1}^w , which reflects external demand for domestic goods and services. The lag structure indicates that foreign demand affects domestic output a one-quarter delay. The term ε_t^y captures aggregate demand shock.

Phillips curve

Equation (2) represents forward-looking open economy version of the New Keynesian Phillips curve for core inflation (π_t^{core}), defined as headline CPI excluding food and energy prices.

$$\pi_t^{core} = \beta_1 * \pi_{t-1}^{core} + (1 - \beta_1) * E(\pi_t^{core}) + \beta_2 * \hat{y}_t - \beta_3 * \hat{z}_t + \varepsilon_t^\pi \quad (2)$$

Core inflation depends on its lagged value (π_{t-1}^{core}), expected inflation ($E(\pi_t^{core})$), output gap (\hat{y}_t) and the real exchange rate (\hat{z}_t) gap. The last two terms (\hat{y}_t and \hat{z}_t) capture real marginal costs. The output gap (\hat{y}_t) reflects inflationary pressures from the demand side. The real effective exchange rate gap (\hat{z}_t) expresses the real marginal costs of importers. The residual term ε_t^π captures supply-side shocks.

Uncovered interest rate parity

Equation (3) represents a modified version of the Uncovered Interest Parity (UIP) condition, adapted to domestic exchange rate regime, where the USD/AZN nominal exchange rate is not flexible. The monetary authority influences interest rates. Hence, the UIP condition explains the behavior of domestic and foreign interest rates as follows:

$$i_t - i_t^{US} = -4 * \left(\frac{USD}{AZN_{t+1}} - \frac{USD^{market}}{AZN_t} \right) + prem_t - \gamma_1 * \widehat{oil}_t + \varepsilon_t^i \quad (3)$$

Here i_t is domestic nominal interest rate, i_t^{US} is US nominal interest rates, respectively. The term in parentheses is the expected nominal exchange rate, annualized to quarterly frequency by a factor of 4, $(\frac{USD}{AZN_{t+1}} - \frac{USD^{market}}{AZN_t})$ the expected nominal exchange rate. The risk premium, $prem_t$ which is unobservable, reflects investor perceptions of country-specific risk. The oil price gap, \widehat{oil}_t influences the exchange rate by affecting trade and capital flow. ε_t^i denotes exchange rate shocks.

A positive expected depreciation or an increase in risk premium leads to higher domestic interest rates. Oil price appreciation, in contrast, reduces pressures on the domestic interest rate.

To capture the dual role of foreign exchange interventions (int) and interest rate policy the following relationship is introduced:

$$(1 - h_1) * (i_t - i^{tar}) = h_1 * int \quad (4)$$

This equation models how the central bank balances its policy rate with exchange rate stabilization. The central bank conducts foreign exchange interventions, if needed to support the stability of the exchange rate, which has a higher path-through to inflation and uses a policy rate to affect the aggregated demand.

Taylor rule

Equation (5) specifies a forward-looking monetary policy rule based on a Taylor-type reaction function:

$$i_t^{tar} = \theta_1 * i_{t-1} + (1 - \theta_1) * [i_t^{nd} + \{\theta_2 * (\pi_{4_{t+3}} - \pi^{tar}) + \theta_3 * \hat{y}_t\} + \varepsilon_t^i \quad (5)$$

Here, i_t^{tar} is the target nominal interest rate, and (i_{t-1}) captures persistence in the reaction function. This term has the effect of smoothing the policy rate, to reflect the conservative behavior of the central bank.

The policy interest rate reacts to the next period expected y-o-y headline inflation deviation from the target $(\pi_{4_{t+3}} - \pi^{tar})$. Monetary policy also reacts to the output gap (\hat{y}_t) . However, the response to the output gap reflects its role as a leading indicator of future inflation rather than a dual mandate.

Over the long term, when shocks dissipate, the interest rate converges to its neutral level $r_t + E(\pi_{4_{t+1}})$, where the real neutral rate and inflation expectations determine the equilibrium nominal interest rate. The nominal neutral interest rate is determined endogenously as the sum of the real neutral rate and expected inflation. It serves both an equilibrium value for the nominal interest rate and as a driver of short-term dynamics in the model. When the policy rate aligns with its neutral level, monetary policy is neither accommodative nor restrictive.

Shocks in the monetary policy rule (ε_t^i) are interpreted as policy deviations from the rule.

External sector

Azerbaijan is a small open economy with a high import-to-GDP ratio, making the foreign sector a critical component of the macroeconomic model. The foreign block includes key external variables such as trade partners' output and inflation, foreign nominal interest rate and real interest rate trends, the nominal AZN/USD exchange rate and oil price.

The global economic environment is approximated by Azerbaijan's fifteen main trading partners. Foreign demand, incorporated into the IS curve (Equation 1), is constructed as a weighted average of these countries' output gaps, reflecting their effective demand for Azerbaijan's exports. Similarly,

foreign inflation is represented as a weighted average of the same partners' inflation rates. The foreign interest rate, which enters the uncovered interest parity (UIP) condition (Equation 3), is proxied by the U.S. Federal Funds Rate. Oil prices, expressed in USD, are also included in UIP equation. All foreign sector variables are treated observed and exogenous.

Calibration

Key model parameters are calibrated based on a combination of theoretical foundations, empirical regularities in Azerbaijan's economy, and international benchmarks found in the literature (Berg, 2006). Table 1 summarizes the baseline parameterization used in the core model equations.

For the dynamic IS curve, the coefficient on the lag of the real non-oil GDP gap is estimated using ordinary least squares (OLS) and falls within a range of 0.1 and 0.95. The parameter α_2 is calibrated using the expert judgement. The pass-through from monetary conditions to real economy – captured by the sum of coefficients α_3 and α_4 ranges between 0.1 and 0.4 (Laxton & Scott, 2000). In the model, a lower-bound value is used, reflecting limited transmission of monetary policy. The parameter α_3 should be higher than α_4 . The coefficient (α_5), reflecting the impact of the government expenditure is derived from independent estimation. The external spillover coefficient, (α_6) is calibrated based on the share of non-oil exports in non-oil GDP (Grui&Vdovychenko, 2019).

In the Phillips curve, inflation persistence – which reflects the share of forward- versus backward-looking agents in the price setting – ranges between 0.4 and 0.9. The parameter is estimated through an OLS regression of the inflation rate on its lagged value. The sensitivity of inflation to real marginal costs – captured by the sum of coefficients β_2 and β_3 - typically falls between 0.1 and 0.5. The coefficient the output gap is similarly estimated by OLS regression while the parameter of the real exchange rate gap was calibrated on the share of imported goods in the consumer good basket.

For the UIP condition, the parameter on the oil price gap is set using the expert judgement. The exchange rate smoothing parameter h_1 reflects central bank's intervention behavior and ranges between 0 and 1.

Within the Taylor-type monetary policy rule, the persistence of the policy rate – estimated through OLS and informed by expert evaluation – varies between 0 and 0.8. A value close to 1 indicates a cautious “wait-and-see” stance, whereas a value near 0 implies no persistence. The central bank's responsiveness to deviations of inflation from its target is calibrated to lie between 0.3 to 1, based on expert judgment.

Table 1. Calibration of the main model parameters

| IS curve | | Phillips curve | | UIP condition | | Taylor rule | |
|------------|-------|----------------|-------|---------------|-------|-------------|-------|
| Parameter | Value | Parameter | Value | Parameter | Value | Parameter | Value |
| α_1 | 0.75 | β_1 | 0.55 | γ_1 | 0.15 | θ_1 | 0.75 |
| α_2 | 0.1 | β_2 | 0.1 | h_1 | 0.2 | θ_2 | 4 |
| α_3 | 0.1 | β_3 | 0.06 | | | θ_3 | 0 |
| α_4 | 0.02 | | | | | | |
| α_5 | 0.09 | | | | | | |
| α_6 | 0.1 | | | | | | |

Source: Authors' calculation

Model properties

Impulse responses

The following sections examine the impulse-response functions for unit standard deviation shocks, focusing on deviations from equilibrium levels and how variables respond over time. Our analysis begins with shifts in steady-state inflation and is extended to include shocks to policy, demand, cost, and the external sector. The objective is to uncover the dynamic interactions between macroeconomic variables and to examine how different shocks influence the economy's trajectory.

Shock to Inflation Target

Prior to examining the effects of decreasing the inflation target from 4 percent to 3 percent, it is essential to first understand the underlying framework in which the inflation target operates within the economy. Notably, since the USD/AZN exchange rate is not flexible and the NEER fluctuates primarily in response to the exchange rates of Azerbaijan's trading partners against the USD, the inflation target is determined endogenously rather than externally imposed by the Central Bank. This determination occurs over the long term due to the specific economic setup.

$$\overline{REER} = NEER + CPI - CPI^{foreign} \quad (6)$$

In the long term, the Real Effective Exchange Rate (REER) acts as a proxy of productivity, a variable that lies beyond the scope of direct monetary policy control. Both the NEER and the foreign Consumer Price Index (CPI) are exogenously determined, with the USD/AZN exchange rate being managed with relative stability. Consequently, in the long run, CPI becomes an endogenous output within the framework described by equation 6.

$$CPI = \overline{REER} - NEER + CPI^{foreign} \quad (7)$$

As a result, the inflation target, in the long run, is inherently linked to the value derived from Equation (7), rather than being a direct policy choice of the central bank. This implies that if policymakers choose an inflation target different from the one implied by equation's outcome, adjustments must be made to the targeted exchange rate. Essentially, a trade-off exists between the desired inflation target and the exchange rate target, presenting a challenge for exchange rate targeting regimes. Changes in one target inevitably influence the other, requiring complex policy decisions.

According to economic theory, if the chosen inflation target is lower than the equilibrium rate of 4 percent, this discrepancy would need to be compensated by an equivalent appreciation of the AZN against the USD. Figure 7 illustrates this relationship, demonstrating that targeting an inflation rate 1 percentage point lower results in a 1 percentage point appreciation of the AZN. This appreciation, in turn, increases the steady-state value of the NEER by 1 percent, thereby restoring equilibrium as per Equation (6). This balancing process assumes a constant level of productivity.

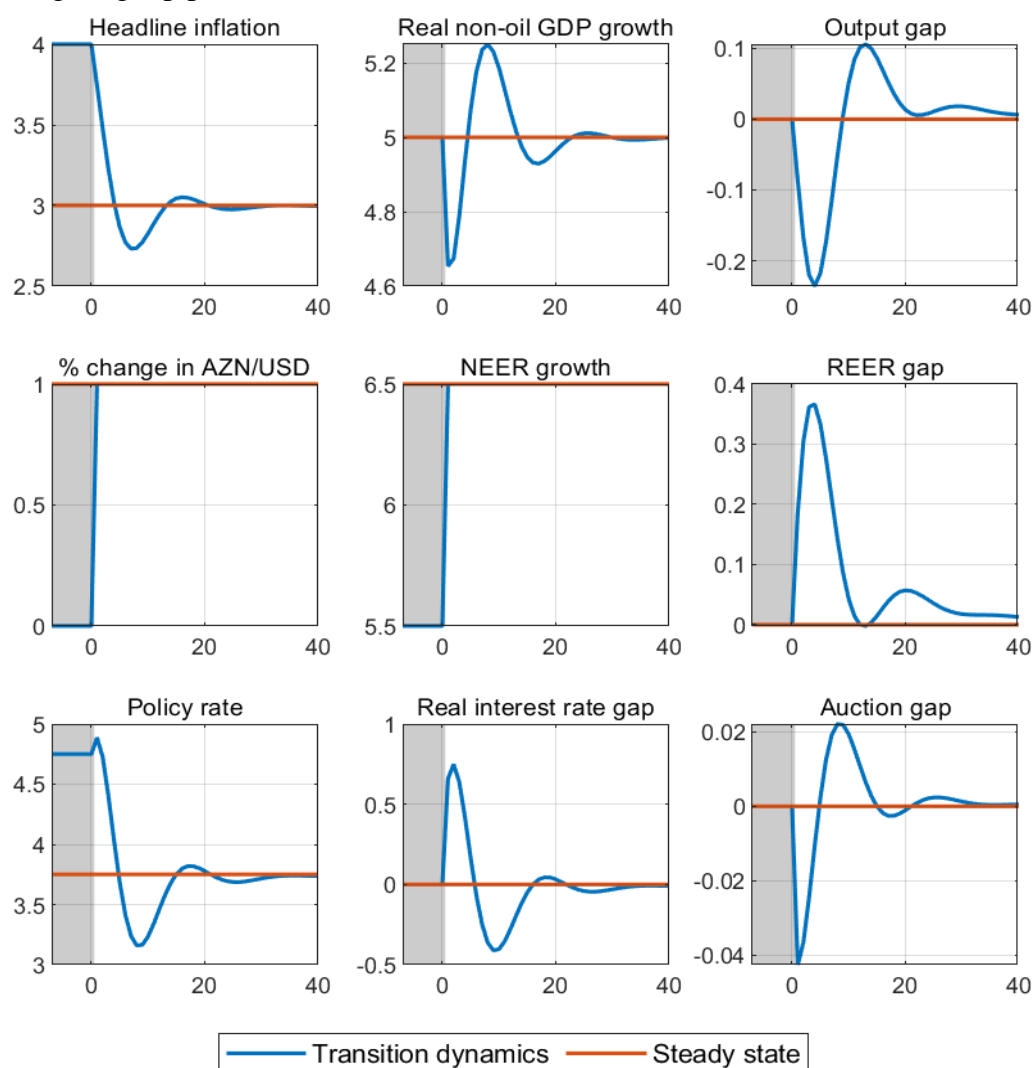
Moreover, a reduction in the inflation target leads to a lower the long-term policy rate requirement to maintain real interest rates at the steady-state level of 0.75%. This adjustment is crucial to ensuring the economic equilibrium is sustained.

However, over time, the initial tightening of interest rates, compared to the newly established steady-state, is notable. This occurs because the inflation rate exceeds its new target value, causing an

immediate surge in the Real Effective Exchange Rate (REER). As a result, output experiences a sharp decline, driven by the restrictive monetary conditions stemming from the inflation overshooting.

However, over time, the economy gradually adjusts, and real economic variables converge back to their equilibrium levels, signaling the restoration of stability. Similar to the output gap, the demand for USD in currency auctions diminishes, reflecting the tightening of interest rates relative to their revised steady-state value. This progression illustrates the complex adjustments the economy undergoes during the transition period.

Figure 7: Targeting 1 p.p. less inflation



Source: Authors' calculation

Monetary policy shock

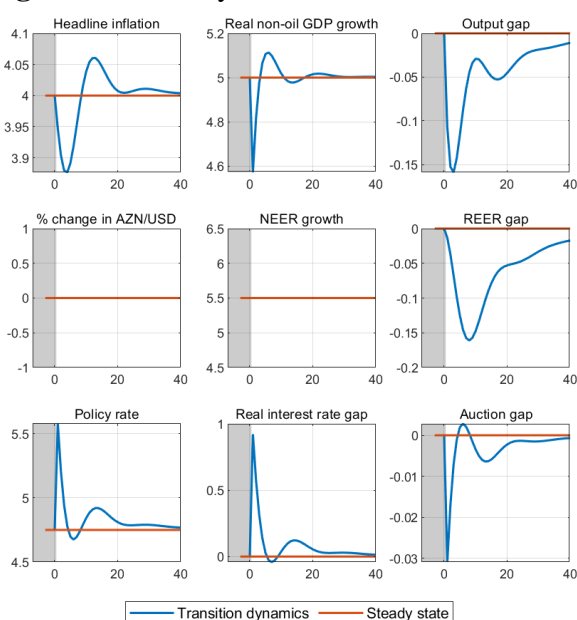
Monetary policy shocks reflect active interventions aimed at ensuring price stability and anchoring inflation expectations. In contrast to economies that operate under strict inflation-targeting regimes, the structure of our economy allows for two distinct types of monetary policy shocks. The first type is a conventional policy rate shock, wherein the central bank increases the policy interest rate. This action curtails aggregate demand by raising the cost of borrowing, resulting in a negative output gap – a standard channel within the monetary policy transmission framework. The second type is a

policy exchange rate shock, implemented with the aim of mitigating imported inflation. While less prominent in conventional policy discussions, this form Although this option might not be as commonly pursued in mainstream policy discussions, both policies contribute to completing the transmission mechanism within our country.

In the context of the Azerbaijan economy, the traditional transmission channels of monetary policy include interest rates, credit availability, asset prices, and expectations. However, the exchange rate channel has received relatively limited attention within this framework. Addressing this gap, the second policy option offers the potential to directly influence the exchange rate channel, thereby complementing and strengthening the monetary policy transmission mechanism. This strategic approach could significantly enhance the effectiveness of policy implementation in the specific context of the Azerbaijani economy.

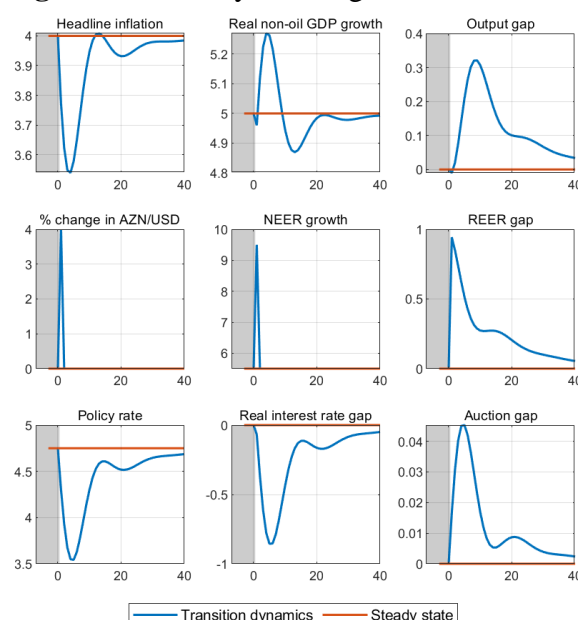
Within this framework, both an increase in policy rates and an appreciation of the national currency contribute to a short-term reduction in inflation. It is important, however, to underscore the interdependence of these policies and their mutual effects. A shock to the policy rate does not exert a direct impact on bilateral exchange rate. Conversely, a shock to the USD/AZN exchange rate influences policy rates in the short and medium term. Unlike a policy rate hike, which dampens demand while reducing inflation, an exchange rate appreciation shock tends to reduce inflation while simultaneously aggregate demand.

Figure 8.A: Policy rate shock



Source: Authors' calculation

Figure 8.B: Policy exchange rate shock



Demand shock

In the context of the Azerbaijan economy, demand shocks can be identified through movements in two key macroeconomic indicators: the output gap and government expenditures, both of which play a significant role in driving the aggregate demand. Typically, during a positive demand shock, both the output and inflation tend to rise simultaneously.

Within this framework, increases in the policy are employed to counteract both excessive demand and rising inflation – an outcome consistent with exhibiting what is known as the "Divine Coincidence." This term describes a scenario in which monetary policy measures aimed at stabilizing inflation also contribute to closing the output gap, thereby eliminating the usual trade-off between inflation control and output stabilization.

The tightening of monetary conditions – reflected in higher real interest rates and an appreciated real exchange rate – services as the main transmission channel. These tighter conditions lead to a gradual decline in excess demand, which in turn results in a concurrent reduction in inflation over subsequent periods. This adjustment process guides the economy back towards its long-run steady-state equilibrium.

Figure 9.A: Demand shock

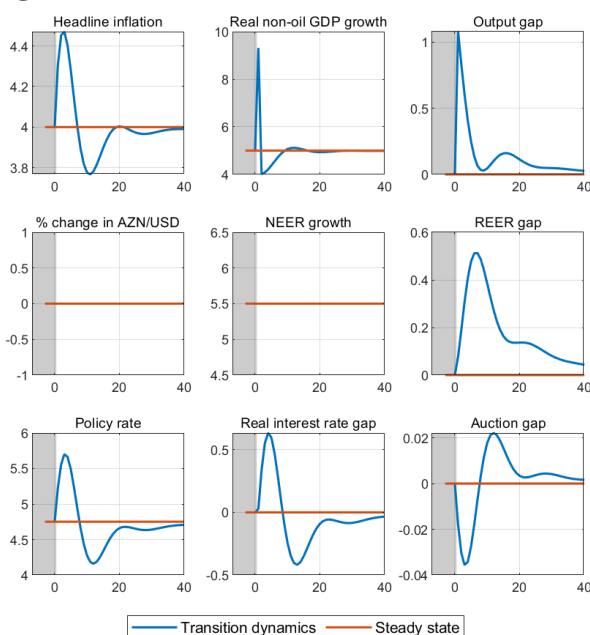
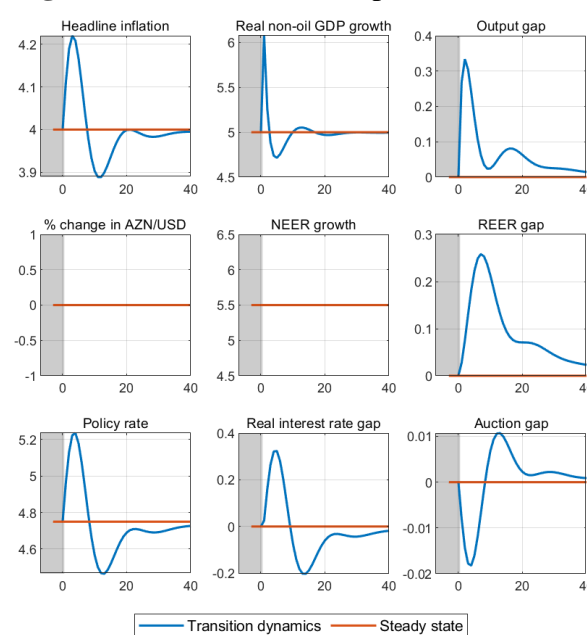


Figure 9.B: Government expenditure shock



Source: Authors' calculation

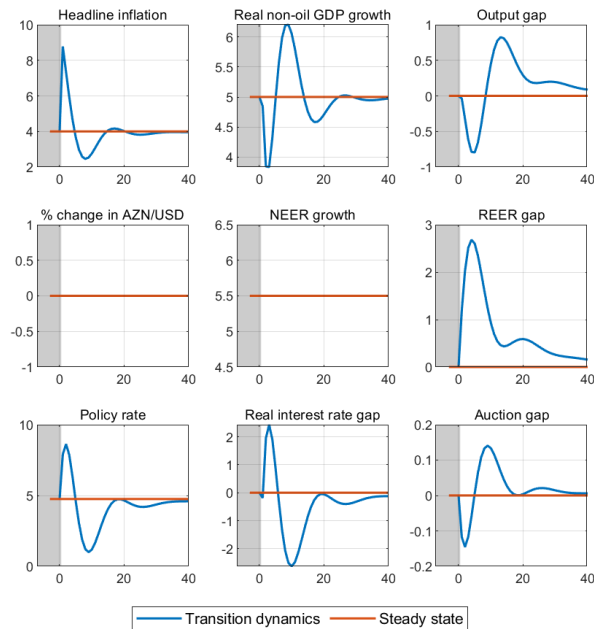
Cost-push shock

Cost-push shocks, particularly those affecting core inflation, pose a distinct and complex challenge for monetary policy, differing substantially from demand-driven disturbances. Two primary sources of cost shocks are observed: domestic production costs and import-related costs. Given the economy's substantial dependence on imports – especially of non-food goods – inflation is particularly sensitive to price fluctuations in trading partner economies.

In response to such shocks, the central bank typically raises the policy interest rate to steer inflation back towards its target over the medium term. However, this disinflationary policy response, implemented through higher real interest rates, can also result in a negative output gap, reflecting the contractionary effects of tighter monetary conditions.

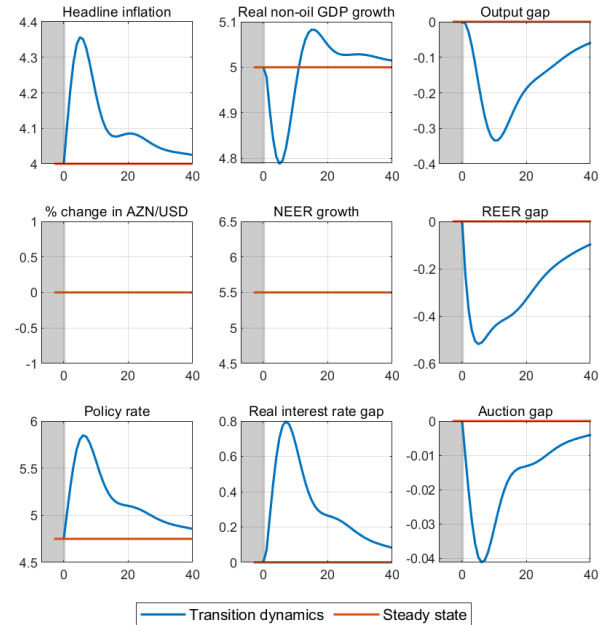
It is crucial to distinguish between the economic impacts of domestic cost-push shocks and those originating from import prices. While domestic cost shocks tend to induce a short-term appreciation of Real Effective Exchange Rate (REER), external cost shocks, by contrast, often lead to a more persistent depreciation of the REER. As a result, the macroeconomic adjustment process following foreign shocks tends to be more prolonged. In essence, the external cost shocks exert a more enduring influence on the economy, delaying its return to a stable, steady-state equilibrium compared to domestically driven cost shocks.

Figure 10.A: Cost-push shock



Source: Authors' calculation

Figure 10.B: Trading partners' inflation shock



Other foreign shocks

Beyond inflationary pressures from trading partners, surges in global demand can also transmit to the domestic economy by fueling excessive local demand, thereby placing upward pressure on domestic prices. Although the direct magnitude of such shocks may be relatively modest, monetary authorities typically respond by raising policy interest rates to realign inflation with its target level.

Another significant external factor influencing domestic monetary policy is the policy stance of the U.S. Adjustments in the Federal Reserve's policy rates necessitate corresponding changes in local policy rates to maintain the conditions implied by Uncovered Interest Parity (UIP). Instead, the determination of the policy rate must strike a balance between adherence to UIP conditions and alignment with the Taylor rule framework described earlier.

This dual framework – accounting for both external influences through UIP and internal macroeconomic conditions via the Taylor rule – adds complexity to the monetary policy decision-making process. A well-calibrated balance between these global and domestic considerations is essential to effectively manage domestic inflation, maintain exchange rate stability, and ensure macroeconomic and financial resilience.

Figure 11.A: Trading partners' demand shock

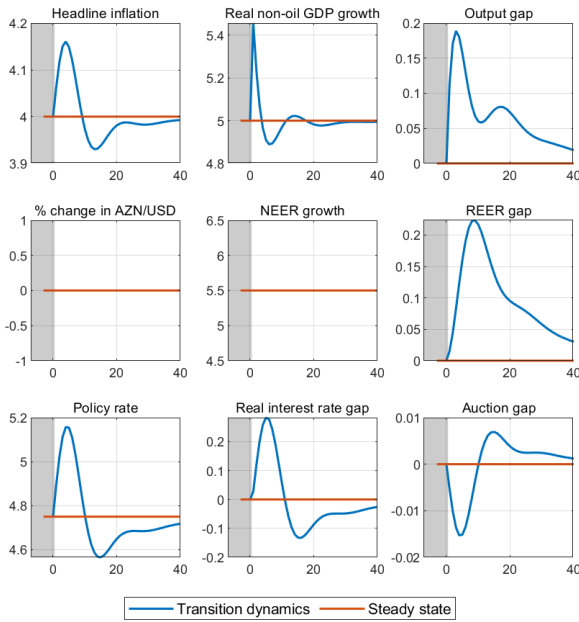
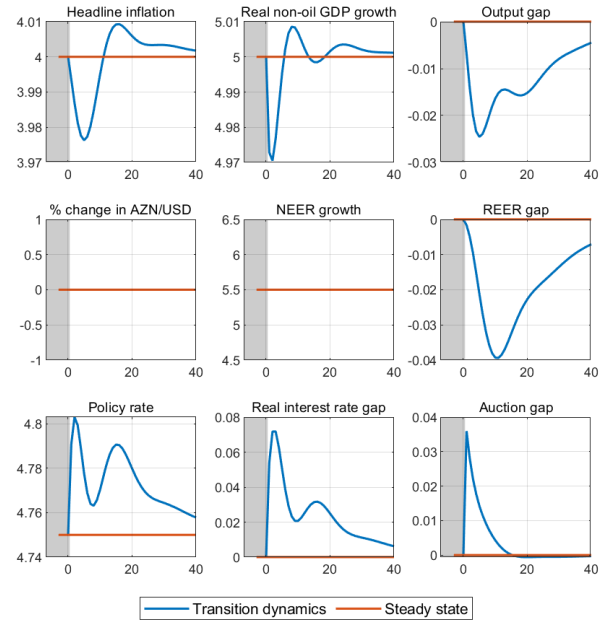


Figure 11.B: US policy rate shock



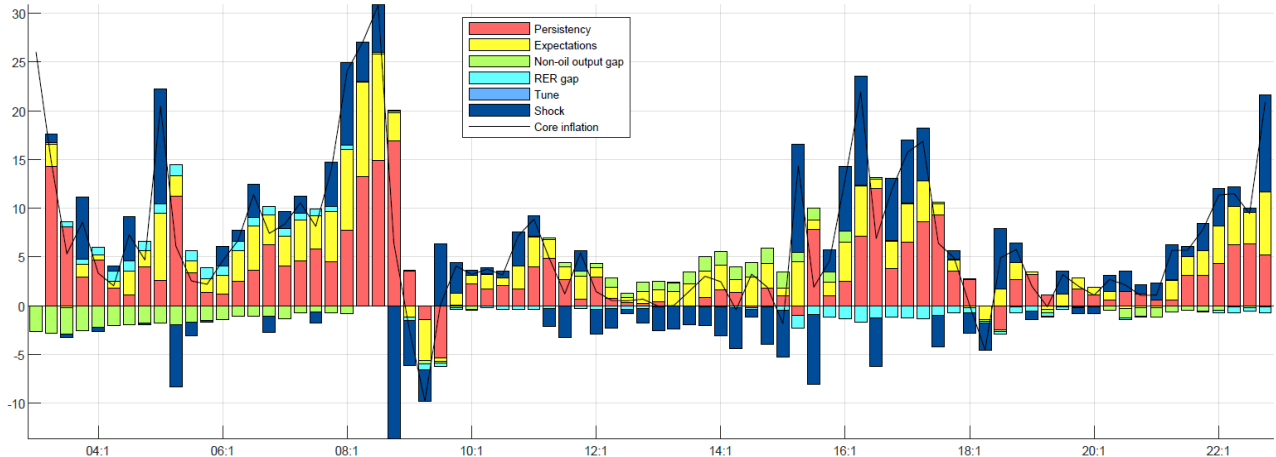
Source: Authors' calculation

Equation decompositions

To assess the semi-structural model's ability to capture historical economic dynamics through its internal mechanisms and transmission channels, we apply the Kalman filtering technique over the period from Q1 2004 to Q4 2022. This approach enables us to evaluate the model's effectiveness in interpreting complex interactions among macroeconomic variables over an extended timeframe.

Within this framework, we focus on the dynamics of Azerbaijan's output gap and core inflation, undertaking a detailed decomposition analysis to identify the underlying drivers of these variables. By isolating the contributions of various structural shocks and determinants, we highlight the model's capacity to replicate the observed behavior of the economy. This analysis sheds light on the multifaceted influences that have shaped the evolution of the output gap and core inflation, thereby reinforcing the model's credibility as a tool for historical interpretation and policy analysis.

Figure 12: Core inflation decomposition, quarterly annualized, %



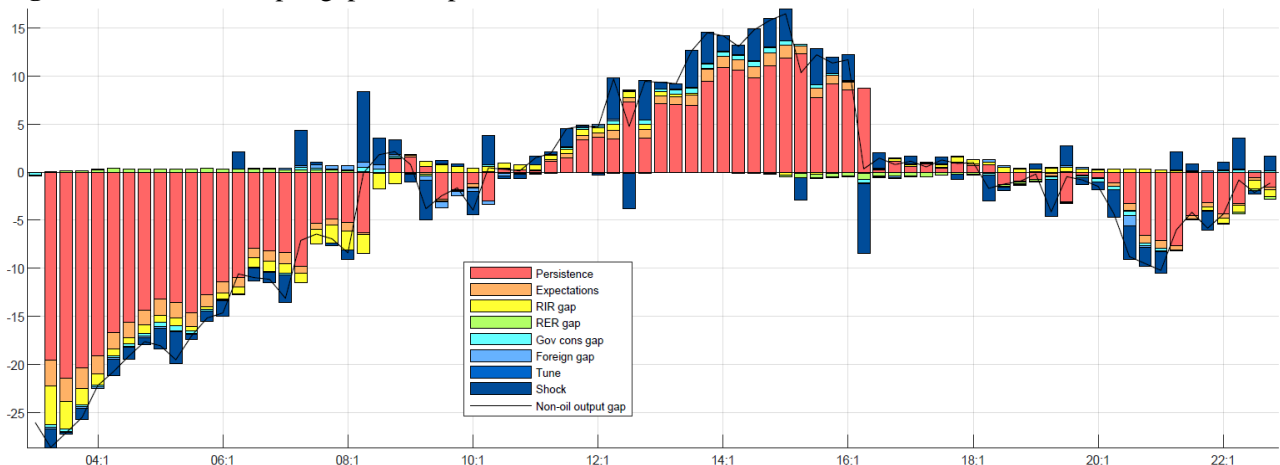
Source: Authors' calculation

Figure 12 presents the decomposition of core inflation (expressed as quarterly annualized rates) based on a Phillips curve framework. This analysis underscores the dominant role of inflation expectations and inflation persistence, aligning well with the hybrid structure of the inflation formation process. In this formulation, both backward-looking (adaptive) and forward-looking (rational) expectations significantly influence inflation dynamics.

The Kalman filter results reveal notable pattern. Prior to 2008 and again during the COVID-19 pandemic period, the negative output gap contributed to a decline in core inflation consistent with subdued demand conditions. Conversely, during the period from 2012 to 2016, the output gap exerted a positive influence on inflation, reflecting stronger domestic demand pressures. Additionally, the Real Effective Exchange Rate (REER) gap has generally exerted a dampening effect on inflationary pressures since 2009, indicating the disinflationary impact of exchange rate appreciation relative to fundamentals.

However, the model attributes relatively limited explanatory power to both the output gap and the REER gap over the full sample period. This muted influence is indicative of historically constrained macroeconomic transmission mechanisms, suggesting that structural frictions may have hindered the full pass-through of economic shocks in inflation outcomes.

Figure 13: Non-oil output gap decomposition



Source: Authors' calculation

The application of the Kalman filter to decompose the non-oil output gap yields valuable insights into macroeconomic dynamics. The results indicate that output remained below potential during two distinct periods: prior to 2009 and following 2018. Specifically, before 2008, the Real Effective Exchange Rate exerted a positive influence on output, while elevated real interest rates had a contractionary effect. In contrast, the period from 2010 to 2016 was characterized by output exceeding potential, with nearly all structural determinants contributing positively to economic activity.

More recently, a notable contraction in the output gap was observed in the first quarter of 2021, followed by a partial recovery. During this period, the foreign output gap, inflation expectations, and government consumption all exerted significant downward pressure on output - largely reflecting the global economic disruptions induced by pandemic-related shutdowns. Interestingly, monetary conditions did not exert a contractionary influence on output during this time.

A turning point emerged in the quarter of 2021, when monetary conditions began to tighten in response to rising global policy rates. This tightening introduced new demand-side constraints, making significant shift from previous periods in the decomposition of the output gap. The evolving stance of monetary policy underscores the increasing importance of global financial conditions in shaping domestic output dynamics.

In-sample simulations

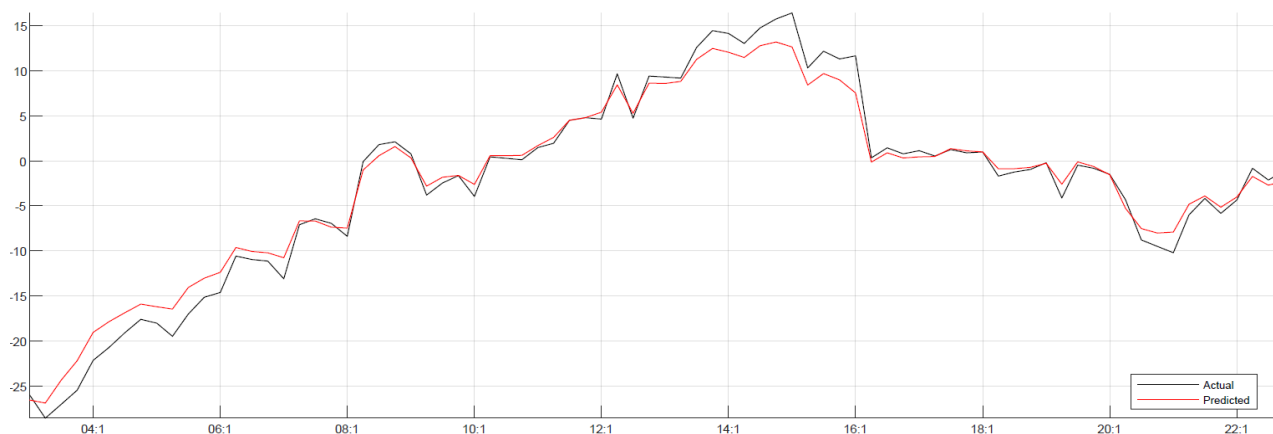
To further evaluate the QPM, we conduct in-sample simulations aimed at assessing the model's ability to replicate observed macroeconomic trends. Using the full sample dataset, we compare actual observations with the model-generated fitted values for key variables, including core inflation and the non-oil output gap.

The simulation results demonstrate a strong correspondence between the model's estimates and observed data. Although some discrepancies arise—particularly during periods of heightened macroeconomic volatility, such as the inflation surges and structural shifts between 2012 and 2015—the model reliably captures the turning points and dynamic behavior of key indicators. Notably, the model performs well even during the early years of heightened volatility, affirming its robustness and credibility as policy analysis tool. The overall alignment with actual data highlights the QPM's capacity to represent critical trends and structural transitions in the Azerbaijan economy.

Figure 14.A: In-sample core inflation estimation, quarterly annualized %



Figure 14.B: In-sample non-oil output gap decomposition



Source: Authors' calculation

Conclusion

This study introduces a tailored Quarterly Projection Model (QPM) designed to capture the specific dynamics of the Azerbaijani economy. The model offers a robust framework for analyzing the interactions between various domestic economic drivers and external influences impacting national economic performance. Through rigorous calibration and successful validation via impulse response analysis, equation decomposition, and in-sample simulations, the QPM demonstrates its reliability and utility for forecasting, policy analysis, and scenario simulations.

Looking ahead, future developments of the model must acknowledge the central role of the government in advancing the non-oil sector. In light of the relevant role of fiscal policy, we plan to enhance the model's predictive capacity by integrating a comprehensive fiscal block. This addition will enable the model to account for the government's influence in driving economic activity, providing a more holistic view of the interdependence between fiscal and monetary policies.

Moreover, recognizing the significant impact of bank credit on durable consumption, our future plans include incorporating a detailed framework to capture the dynamics of the banking sector. By examining the role of bank credit, the model will better reflect the consumption channel and assess the implications of credit availability on economic growth and stability.

In addition, given the importance of the external sector for a small open economy, we intend to expand the foreign block of the model. This expansion will include analysis of global commodity market developments and their effects on inflation in the trading partner countries. The enhanced model will therefore provide a more comprehensive understanding of the influence of global commodity trends on both foreign and domestic inflation.

In conclusion, this paper lays the groundwork for the future evolution of the Quarterly Projection Model. By incorporating key economic dimensions – such as the fiscal block, bank credit dynamics, and a deeper analysis of the external sector – the model will become an even more valuable tool for central bankers. These enhancement will enable policymakers to make informed decisions, design effective policies, and maintain price stability in Azerbaijan.

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