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Ani Asoyan⁽¹⁾, Jared Laxton⁽²⁾

ABSTRACT

Since the pandemic, the global economic environment has been characterized by elevated uncertainty driven by overlapping shocks. Under these circumstances, the CBA adopted the Prudent Risk Management Approach to Price Stability (PRMAPS) in 2024, designed to better incorporate uncertainty and nonlinearities while supporting monetary policymaking as a risk-management exercise. PRMAPS adds several improvements to the previous framework, including policy navigation in uncertain environments, the growing importance of tail-risk events, and the role of central bank credibility in influencing expectations and the effectiveness of monetary policy. To support this framework, the paper introduces the Endogenous Credibility (EndoCred) model as a workhorse tool for scenario-based policy analysis. Building on the canonical Quarterly Projection Model (QPM), EndoCred extends the traditional framework by incorporating endogenous monetary policy credibility, nonlinear inflation dynamics, and richer transmission mechanisms, including the role of long-term interest rates as well as credibility-driven risk premium and dollarization effects relevant for small open economies. By allowing credibility to evolve in response to policy performance, the model endogenizes its impact on inflation expectations and policy transmission. These features make the model particularly suitable for economies exposed to volatile external conditions. The framework provides a practical analytical foundation for implementing risk-based monetary policymaking and improving the assessment of policy trade-offs under uncertainty.

Keywords	Central Banking, Credibility, Nonlinearities, Small Open Economy, Monetary Policy, Macroeconomic models
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1 INTRODUCTION

"Uncertainty is not just a pervasive feature of the monetary policy landscape; it is the defining characteristic of that landscape...As a consequence, the conduct of monetary policy in the United States has come to involve, at its core, crucial elements of risk management. This conceptual framework emphasizes understanding as much as possible the many sources of risk and uncertainty that policymakers face, quantifying those risks when possible, and assessing the costs associated with each of the risks."

— Alan Greenspan (2003)¹

Since the onset of the COVID-19 pandemic, the global policy landscape has been shaped by a persistent and elevated level of uncertainty, exacerbated by multiple overlapping shocks such as geopolitical tensions, energy price volatility, and supply chain disruptions. These developments have fundamentally challenged the usefulness of baseline projections, as the world economy has become increasingly susceptible to non-linear, high-impact tail events. For small open economies such as Armenia, the challenge is even greater, as domestic inflation dynamics are strongly influenced by exchange-rate movements, imported inflation, remittances, external financial conditions, and the degree of confidence in the domestic currency. This creates a central policy challenge: how a small open economy central bank should conduct monetary policy under heightened uncertainty, nonlinear inflation risks, imperfect credibility, and persistent exposure to external shocks. This paper addresses this challenge by developing and documenting the Central Bank of Armenia's (CBA) evolving analytical framework for monetary policy analysis under uncertainty.

As uncertainty is inherent and cannot be eliminated, there is growing recognition that central banks can do a better job of managing it. This has led to a paradigm shift in the way monetary policy is formulated: rather than acting as expert forecasters, central banks should operate as risk managers, proactively assessing the distribution of possible outcomes and designing policies that are more robust to a range of scenarios. Ben Bernanke's review of monetary policymaking at the Bank of England advocated for a scenarios-based approach that addresses uncertainty in a more open and transparent way, emphasizing that central banks must clearly communicate how their policy instrument would respond under each scenario being considered.² Reflecting the shift in the philosophy of policymaking, in 2024, the Central Bank of Armenia adopted a new version of forecasting and policy analysis system, defined as the Prudent Risk Management Approach to Price Stability (PRMAPS, previously known as FPAS Mark II), outlined in Archer et al (2022). This new policymaking and institutional setup builds on the success of the previous FPAS Mark I framework by attempting to formally codify, to the extent possible, the principles of the risk-management approach to

¹Greenspan, Alan. "Risk and uncertainty in monetary policy." *American Economic Review* 94, no. 2 (2004): 33-40.

²Laxton, Igityan, and Mkhatrihsvili (2025) respond to Bernanke's recommendations by proposing a concrete strategy for maintaining monetary policy credibility, that is, a scenario-based approach embedded in the PRMAPS, already adopted by the CBA.

monetary policy famously articulated by Alan Greenspan in his 2003 Jackson Hole speech *Monetary Policy under Uncertainty*. Under the FPAS Mark I framework³, initially pioneered by the Reserve Bank of New Zealand and the Bank of Canada in the 1990s, monetary policy analysis revolved around constructing a single baseline forecast, considered the "most likely" macroeconomic path and serving as the basis for both policy decisions and communication. This approach, however, systematically understates the inherent uncertainty in economic projections and risks conveying false assurance to financial markets and the public. It may also constrain policy agility, making it harder to credibly change course when faced with new information or shocks. PRMAPS addresses these limitations by reconceptualizing monetary policymaking as a structured risk management exercise: Rather than anchoring decisions to a central scenario, it prioritizes systematic scenario analysis across a range of plausible macroeconomic risks.⁴

A policy action that is calculated to be optimal based on a simulation of one particular model may not, in fact, be optimal once the full extent of uncertainty in the policymaking environment is taken into account. In general, it is entirely possible that different policies will exhibit different degrees of robustness with respect to the true underlying structure of the economy.

— Alan Greenspan (2003)

This approach requires policy to be robust across a range of scenarios, effectively adopting the principle of the “policy of least regrets, where policymaking is conducted by minimizing the potential costs associated with policy errors. We acknowledge that no policy can be ex ante optimal across all possible realizations but that a well-structured decision-making process can systematically reduce the magnitude of policy errors when adverse or unexpected scenarios materialize. Analytical mistakes are inevitable, particularly when assessing and communicating underlying forces of the economy that are not directly observable or easily quantifiable, such as the NAIRU or inflation premium, however, this approach allows for the development of an ex ante contingency plan for adjusting policy in a credible manner.⁵ In fact, analyzing the current state of the economy and its underlying forces constitutes an essential part of the PRMAPS framework. The most important stage, however, is drawing policy implications from this analysis.⁶ At this stage, the analytical framework becomes particularly useful, as it provides a structured environment for scenario analysis, sensitivity testing, and the evaluation of the policy actions needed to achieve macroeconomic objectives.

The paper presents a newly developed EndoCred model for Armenia, which builds on the elements of traditional QPM⁷ and extends that analytical framework beyond its conventional

³The conceptual and analytical framework underpinning FPAS Mark I is thoroughly documented in the *Practical Model-Based Monetary Policy Analysis* series of papers by Berg, Karam, and Laxton (2006).

⁴The Central Bank of Armenia has published several papers outlining the foundations and principles of PRMAPS, which aim to formalize the risk-management approach to monetary policy in a publicly available set of documents (Archer, Galstyan, and Laxton, 2022; Galstyan, Avagyan, and Laxton, 2024; Laxton, Avetisyan, and Avagyan, 2025, etc).

⁵Laxton, Itigyan, Mkhatrihvi (2024)

⁶The key components of PRMAPS are well documented in the unofficial working draft by Laxton, Galstyan, and Avagyan titled “Prudent Risk Management Approach to Monetary Policy.”

⁷In this paper, QPM refers to the linear model used at the CBA to filter historical data and discuss

role as a baseline-forecasting tool toward one better suited for scenario-based risk analysis. Drawing on the broader EndoCred literature, it incorporates the endogenous nature of policy credibility, which is earned over time in response to actual policy results. This is important, as credibility affects how expectations are formed and how effective monetary policy is. The model also adopts crucial nonlinearities through a convex Phillips curve, credibility formation, and a loss-function-based policy design, to capture the tail risks more realistically and to allow policy to react more forcefully once such risks emerge. Further Armenia-specific innovations are introduced, linking financial dollarization directly to policy credibility and embedding this channel in the effective interest rate. In addition, the model enriches the monetary transmission mechanism by incorporating long-term interest rate dynamics into the effective interest rate structure, together with an explicit specification of the term premium. The model calibration is benchmarked against the simple QPM by comparing results generated under comparable assumptions, ensuring that EndoCred broadly preserves the core transmission mechanisms of the existing framework. At the same time, its value added lies in the additional features introduced in the model, whose policy relevance is illustrated through the simulation exercises. These exercises show that nonlinear specifications capture inflationary pressures more realistically under stressed macroeconomic conditions, where inflation becomes more sensitive to demand pressures and the required policy response may become stronger. The results further underscore the central role of endogenous credibility and timely policy action in anchoring expectations. When policy adjustment is delayed, credibility deteriorates, inflation becomes more persistent, and restoring price stability becomes more costly.

Beyond its modeling contribution, the paper also serves an institutional purpose by documenting CBA's evolving analytical framework. Since the original QPM framework has not been formally documented in a dedicated publication, it explains the main steps involved in adapting the QPM structure to EndoCred and provides insight into some of the analytical choices underlying the original QPM.

The remainder of the paper is organized as follows: Section 2 reviews the evolution of analytical frameworks in monetary policymaking; Section 3 discusses the development of credibility-focused models and motivates the EndoCred framework; Section 4 presents the model structure with its key features; Section 5 illustrates the model's policy relevance through simulation exercises; and Section 6 concludes. The model outline and calibration are provided in the Appendix. The calibration is tested during comparison with standard QPM.

Disclaimer *The reported model structure and calibration should be viewed as an analytical device for scenario design rather than as a mechanical description of the CBA's policy rule, since actual decisions are based on the management of a broad set of risks and uncertainties in the economy.*

unobservable variables in a consistent manner.

2 Evolution of analytical frameworks in the monetary policymaking

"Every model, no matter how detailed or how well designed conceptually and empirically, is a vastly simplified representation of the world that we experience with all its intricacies on a day-to-day basis. Consequently, even with large advances in computational capabilities and greater comprehension of economic linkages, our knowledge base is barely able to keep pace with the ever-increasing complexity of our global economy."

— Alan Greenspan (2003)

⁸The early approach to macroeconomic modeling in policy institutions, from the 1960s through the early 1980s, was to construct large reduced-form econometric models whose sole ambition was to track historical data as closely as possible. Despite their empirical richness, practice showed that they are expensive to maintain, unstable under re-estimation and most importantly, monetary policy had no clearly defined role within them. This approach clearly violates the PRMAPS features, failing to answer the central policy question of how policymakers should use their instruments to achieve their objectives. ⁹ Inflationary episodes during the 1970s exposed the ineffectiveness of these models, leading to their gradual abandonment and the rise of microfounded DSGE (M-DSGE) models, which drew on advances in optimizing behavior, forward-looking expectations, the incorporation of nominal rigidities into New Keynesian frameworks, and internally consistent general-equilibrium analysis.

Although DSGE models have become dominant due to their microfounded framework, they still require substantial improvement. Blanchard (2018) points out some of the core flaws of these models, such as the behavioral assumptions which are usually inconsistent with empirical evidence. He questions the behavior of infinitely lived and highly forward-looking agents and the weak handling of inertia in key macroeconomic variables. Semi-structural models attempt to address these issues by explicitly introducing lag structures in core relationships such as the Phillips curve and the output gap, and by modeling the expectational dynamics with a hybrid approach, allowing for both forward-looking and backward-looking dynamics. Blanchard (2018) goes on criticizing the joint estimation of M-DSGE models by calibration and bayesian estimation: Many calibrated parameters have weak empirical support and are often borrowed from earlier studies without strong justification. Bayesian estimation can then worsen the problem, because if the model is misspecified, the error can distort estimates across the whole system. More importantly, DSGE models make poor normative and communication tools as their policy implications depend heavily on specifications of distortions, and their algebraic complexity obscures rather than illuminates the results. Ultimately, the value of macroeconomic models lies in their ability to provide normative guidance to policymakers

⁸A more comprehensive discussion of the topics covered in this chapter is provided in Laxton, Igityan, and Mkhatrihvi (2024).

⁹Some Non-FPAS central banks like the Bank of England perform in this manner (BOE August 2025 MPR), constructing forecasts based on an exogenous interest rate path, which is not consistent with Friedman's view of the role of monetary policy and his arguments against interest rate pegging (Friedman, 1968).

and to help them communicate their strategy to financial markets, which is the foundation of effective and credible monetary policy. Laxton, Igityan, and Mkhattrishvili (2024) view semi-structural models as an important complement to M-DSGE models: While M-DSGE models are better suited for foundational macroeconomic analysis, semi-structural models translate those theoretical insights into a framework that is more transparent, flexible, and applicable to real-world policymaking. In this sense, M-DSGE models map out the structure, while semi-structural models help with parameterization and dynamics.

"All models are wrong, but some are useful"

— George Box (1976)

The practical needs of inflation-targeting central banks for models with clear economic structure, and sufficient flexibility for forecasting, scenario analysis, and policy communication, brought semi-structural models to prominence. In this sense, their intellectual roots can be traced to the open-economy policy models of Mundell(1963) and Dornbusch(1976), while an important early institutional development took place at the Bank of Canada in the 1990s through a Quarterly Projection Model (QPM).¹⁰ These QPM models were later broadened and systematized by the introduction of the Forecasting and Policy Analysis System (FPAS) framework developed by Berg, Karam, and Laxton (2006), which has revolutionized the view of conducting monetary policy across the central banks, laying a strong foundation for modern monetary policy analysis. As its main analytical tool, the quarterly projection model (QPM), is considered the main guide for many central banks around the world, which adopted inflation targeting.¹¹ These types of models are based on the principles of New Keynesian macroeconomics, such as nominal and real rigidities, the existence of business cycles and rational expectations. An additional monetary policy rule is being implemented to adjust interest rate behavior in order to control inflation toward the target and anchor inflation expectations. The structure of such models are relatively simple and accessible. The CBA, among many other central banks, has implemented this analytical approach (Ashot Mkrtchyan and Arthur Stepanyan, 2006), making it as the main workhorse model for the policy analysis.¹² Mkrtchyan, Dabla-Norris and Stepanyan (2009) further develop a structural DSGE model with key extensions to incorporate specific structural characteristics of the Armenian economy.

However, these conventional frameworks carry certain limitations. Notably, they rely on linear relationships, which may not hold during periods of heightened economic stress, and they treat credibility of central bank as exogenous and static feature, overlooking how it could change based on policy performance. These models tend to assume that expectations are perfectly forward-looking, fully aligned with the central bank's inflation target. However,

¹⁰See the Bank of Canada's sequence of QPM papers, beginning with Black, Laxton, Rose, and Tetlow (1994)

¹¹Since then, a number of QPM-type models based on the Berg, Karam, and Laxton (2006a, 2006b) framework have been developed for various economies, including Ghana (Abradu-Otoo et al., 2022, 2024), India (Laxton et al., 2017), Vietnam (Musa et al., 2022), Congo (Musa et al., 2024), the WAEMU region (Carlos de Resende et al., 2022), etc

¹²Tibor Hledik and Jan Vleck from the Czech National Bank played a key role in supporting the construction and development of the QPM model tailored for the Armenian economy.

real-world conditions often diverge from this ideal. In practice, credibility is rarely perfect, particularly in economies with a history of high inflation volatility or weak and opaque analytical frameworks. This leads to a hybrid expectation structure that includes both forward- and backward-looking components with credibility closely related to the forward lookingness of expectations.

3 Development of credibility-focused models

"We need models in which the credibility of a central bank is endogenous to its actions."

— Mervyn King (2024)

The development of credibility-focused models has been transformative for central banks, leading to important changes in the way inflation-targeting frameworks are designed and implemented. This evolution began with the foundational work of Laxton, Ricketts, and Rose (1993), which showed that credibility is built slowly through consistent policy actions and clear communication, and that policy shocks or inconsistencies can quickly undermine it. Building on this, Isard, Laxton, and Eliasson (2001) demonstrated that when policy credibility is endogenous and there is uncertainty about key structural parameters such as the NAIRU, forward-looking inflation-forecast-based policy rules outperform backward-looking Taylor-type rules in stabilizing inflation and unemployment.

A key driver of the evolution of credibility-centered frameworks has been the development of analytical models that enable central banks to understand and manage the trade-offs between inflation stabilization and economic slack as credibility evolves over time. The experience of the Reserve Bank of New Zealand highlights the risks of inadequate modeling frameworks. Prior to adopting the FPAS in 1998, as documented by Drew and Ben Hunt, the RBNZ relied on relatively rigid inflation targeting that struggled to manage policy trade-offs and at times pushed the economy into a “dark corner” of excessive variability. As noted by Haworth, Kostanyan, and Laxton (2020), policy relied heavily on the exchange rate channel, contributing to significant self-inflicted costs. In the mid-1990s, this approach led to substantial tightening, a sharp appreciation of the New Zealand dollar. The exchange rate appreciation had devastating effects on the tradable goods sector, particularly on farmers, who bore the brunt of the downturn (Figure 1A). The approach was likened to “trying to brush your teeth through your ear”, a method that might achieve the goal but with unnecessary pain and inefficiency. These adverse outcomes revealed the inefficiencies of period-by-period inflation targeting. During the Asian Financial Crisis in 1997, the depreciation of the NZD was interpreted as a loosening of the Monetary Conditions Index (MCI), which prompted further interest rate hikes. However, the currency continued to weaken due to external pressures, leaving the economy with both high interest rates and a depreciating exchange rate, which amplified the downturn and raised unemployment, exposing the procyclical nature of the MCI. Eventually, the RBNZ adopted FPAS around 1998 and replaced the MCI with the Official Cash Rate (OCR) in March 1999, transitioning to a more flexible and forward-looking inflation-targeting framework, that better manages inflation and output trade-off.

Empirical evidence from Laxton and N'Diaye (2002) across 17 OECD countries showed that higher monetary policy credibility improves the inflation-unemployment trade-off and enhances forecasting performance. Goretti and Laxton (2005) extended this inquiry to emerging markets, demonstrating that inflation targeting frameworks help anchor long-term inflation expectations and reduce inflation volatility even when ideal institutional preconditions are not yet in place.

Karam, Epstein, and Laxton (2007) modeled Israel's 2001–2003 episode to show how nonlinearities and credibility loss interact, concluding that inconsistent policy actions carry large output and inflation costs implying that gradual and predictable policy adjustments are preferable for preserving trust. Between 2001 and 2007, the Bank of Israel faced two major economic shocks under distinct credibility regimes: first with low credibility and later with high credibility. In late 2001, the dot-com bubble burst, and in the face of a weakening economy, the Bank of Israel cut the policy rate by 200 basis points. This led to a depreciation of the shekel, which generated upward pressure on prices with headline inflation rising on year-on-year terms to 7% by July 2002 (Figure 1B). Only five months later, the Bank of Israel would begin raising rates by 450 basis points, which raised questions about policy intentions and exacerbated the exchange depreciation via the risk premium when a weaker shekel was already reflecting an economic recession. Inflation continued to rise, with long-run inflation expectations exceeding the target band. The central bank maintained a tight stance at around 9% until mid-2003, although the economy was struggling to get out of a protracted recession. The Bank of Israel eventually succeeded in bringing long-run inflation expectations back inside the target band, restoring credibility despite its high costs. Furthermore, the Bank of Israel would later adopt a more forward-looking approach to inflation targeting, which quickly proved invaluable for efficiently managing the output-inflation trade-off. Notably, in 2006, inflation rose above the upper band due to a one-time pass-through from exchange rate depreciation and a sharp increase in oil prices. Unlike in 2002–03, only a modest policy response was required, without leading to an upward ratcheting of long-term inflation expectations.

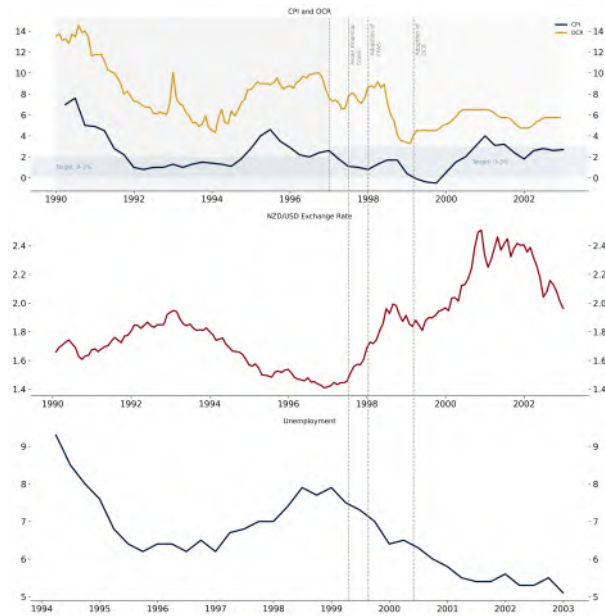
In their evolving inflation-targeting framework, The Reserve Bank of India (RBI) has adopted dual QPM modeling approach, documented by Benes et al. (2016), to address structural challenges in its economy. The first is an endogenous model with nonlinearities designed to capture a broader picture of economic risks, while the second is a linear QPM used for quantitative forecasts. The combination of these models has enhanced the RBI's policy analysis by identifying risks and providing tools to simulate alternate scenarios. This approach has also helped the RBI identify potential errors that might arise from reliance on simpler linear models, underscoring the importance of integrating diverse analytical tools in policy formulation.

These examples illustrate that models serve a dual role in central banking. First, as thinking devices, they help policymakers conceptualize the dynamics of the economy and the evolution of policy trade-offs under different credibility environments. Second, as projection tools, they structure the forecasting process and integrate empirical evidence with policy judgment. The transition from ad hoc, judgment-driven approaches toward structured systems such as FPAS demonstrates the importance of advanced modeling frameworks in strengthening credibility,

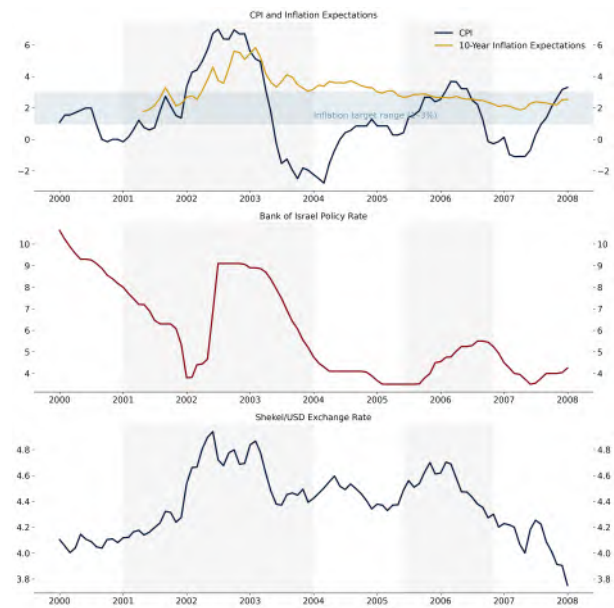
anchoring inflation expectations, and managing macroeconomic trade-offs more effectively.

Figure 1: Early Experiences of Leading Central Banks: Policy Actions and Consequences

A. The Real Costs of Rigid Inflation Targeting in New Zealand's 1990s Policy Framework



B. Policy Reversal and Credibility Restoration: Exchange Rate, Interest Rate, and Inflation Dynamics in Israel (2000–2008)



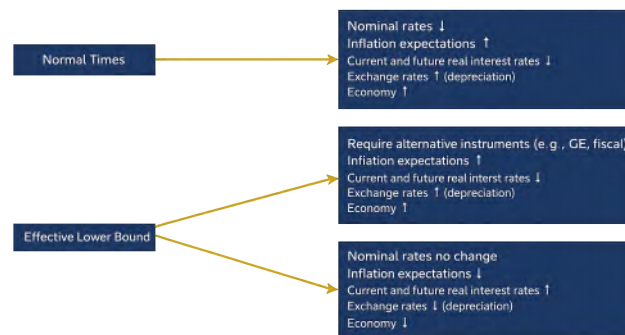
Source: RBNZ, BOI

Archer, Galstyan, and Laxton (2022) introduced the PRMAPS framework, reframing monetary policy as risk management under uncertainty using scenario-based analysis rather than relying on a single baseline forecast. They proposed the following suggestions for improving the analytical framework under PRMAPS:

1. Introduction of crucial nonlinearities - such as endogenous policy credibility and nonlinear inflation dynamics
2. Implementation of an explicit loss function

Endogenous Credibility (EndoCred) models are semi-structural gap models which build on these suggestions and extend the canonical FPAS framework by incorporating a crucial feature recently emphasized by Mervyn King where he expressed the imperative for economic models to reflect the endogenous nature of central bank credibility. Kostanyan, Matinyan, and Papikyan (2022) developed the Open EndoCred model for small open economies, where credibility is modeled as an endogenous state variable and policy analysis is conducted using nonlinear scenario-based simulations.

In this context, this paper develops the EndoCred model as the main workhorse for scenario-based policy analysis at the Central Bank of Armenia, which addresses traditional QPM models shortcomings. Rather than assuming credibility is fixed or perfect, EndoCred treats

Figure 2: Mechanisms of Shock Absorption and Amplification: Exchange Rate and Interest Rate Channels

credibility as a dynamic variable that evolves in response to the central bank's actual policy actions and performance. This approach allows the model to capture how credibility is earned or lost over time, and how credibility, in turn, influences the effectiveness of policy transmission, and ultimately, macroeconomic outcomes. Monetary policy credibility is widely recognized as a cornerstone of macroeconomic stability, as the degree to which medium-to long-term inflation expectations are anchored has a profound effect on the effectiveness of monetary policy. At its core, high credibility implies that the monetary transmission mechanism operates efficiently, so that in response to shocks, variables like the exchange rate and interest rates act as shock absorbers rather than amplifiers.¹³ Under stable economic conditions, exchange rates and interest rates generally help absorb shocks and limit their impact. However, their behavior depends critically on monetary policy credibility during periods of heightened uncertainty. When the economy moves into 'dark corners'—such as episodes of high and volatile inflation or a low-inflation trap—the central bank's credibility is put under significant strain. In these situations, credibility determines whether exchange rates and interest rates continue to dampen shocks (such as a negative demand shock) or instead amplify them, increasing volatility and worsening economic instability.

Under normal times with a credible monetary policy regime, a negative demand shock triggers a stabilizing response: the central bank lowers its policy rate, anchoring medium-term inflation expectations upward and compressing real interest rates, which in turn induces currency depreciation that cushions economic downturn. Even at the effective lower bound (ELB), where nominal rates are constrained, credible forward guidance and higher expected inflation can reduce real interest rates, preserving the effectiveness of the transmission mechanism. In contrast, under weak credibility or a passive policy stance, the adjustment process can reverse. A negative demand shock may lead to expectations of persistently lower inflation, raising real interest rates despite unchanged nominal rates. This can trigger a real appreciation of the exchange rate, amplifying the downturn rather than mitigating it. In

¹³For more details, see Rania al-Mashat, Kevin Clinton, Douglas Laxton, and Hou Wang, "Managing Expectations" chapter in the book of "Advancing the Frontiers of Monetary Policy", by Adrian, Laxton and Obstfeld (2018).

such cases, the exchange rate ceases to function as a shock absorber and instead becomes a source of amplification, deepening the recession. Thus, the value of credibility becomes particularly pronounced during periods of economic turbulence. Its erosion can give rise to persistent inflationary pressures and a bias in inflation expectations, while also triggering exchange rate fluctuations, reinforcing the adverse effects of shocks hitting the economy.

Features of EndoCred and QPM

Before presenting the innovations of the EndoCred model, it is important to highlight several foundational features of the QPM framework.¹⁴ First, the model decomposes headline inflation into three components: non-traded sticky inflation, flexible inflation, and regulated services inflation. Among these, the non-traded sticky inflation is particularly important, as it captures purely domestic inflationary pressures unaffected by exchange rate fluctuations, and plays a central role in shaping inflation expectations. The same inflation target applies uniformly across all three inflation components. Second, the model incorporates exchange rate dynamics through two distinct channels. The bilateral exchange rate against the USD enters the uncovered interest parity (UIP) condition, reflecting the dominant role of USD-denominated capital flows, while the effective exchange rate influences the IS curve, capturing the broader trade-weighted impact of exchange rates on domestic output. The UIP condition also includes two forms of risk premia – country risk and liquidity risk, further enriching the external sector transmission mechanism. Additionally, the QPM employs an effective interest rate to better account for the effects of financial dollarization on the transmission of monetary policy. This rate combines both domestic and external interest rate influences, recognizing that output is affected not only by changes in the policy rate but also by spillovers from external financial conditions.

Building on this solid foundation, the EndoCred model incorporates all of these features while introducing several important enhancements. Most notably, EndoCred endogenizes policy credibility, allowing it to evolve over time in a nonlinear manner depending on the central bank's performance in meeting its mandate of price stability. This time-varying credibility index shapes inflation expectations by governing the degree of their forward-lookingness and erodes symmetrically whenever inflation deviates from target in either direction. These features make EndoCred a useful companion to the standard QPM, offering a richer framework for managing uncertainty in small open economies like Armenia by deepening the understanding of policy trade-offs and their consequences in real time. The credibility loss leads to an inflation bias in expectations and makes inflation more persistent over time. We extend this insight by introducing a credibility-driven bias in the country risk premium, reflecting the heightened perceived risk of the economy under low credibility. This elevated risk premium contributes to additional currency depreciation, reinforcing the adverse effects of credibility erosion on macroeconomic stability.

One of the key features of the EndoCred model is the incorporation of nonlinearities, including a convex Phillips curve. This specification allows the model to capture inflation dynamics more realistically under macroeconomic conditions that are of critical importance to policymakers. This is related to the "dark" corners of the economy such

as high and volatile inflation or deflationary trap.¹⁵ Furthermore, the model extends the IS curve by introducing a long-term effective interest rate, derived from interest rates across different maturities based on the expectations hypothesis and incorporating a time-varying term premium. This addition allows the model to better reflect the broader and persistent effects of monetary policy on output. Another key innovation lies in the treatment of dollarization: the weight of external influences in the effective interest rate is explicitly linked to a dollarization parameter, which is itself inversely related to policy credibility. As credibility increases, dollarization falls, enhancing the effectiveness of domestic monetary policy—highlighting a critical feedback loop between credibility, transmission, and policy outcomes. Finally, instead of relying on a standard Taylor-type rule, the EndoCred framework adopts a loss function-based policy design, enabling more flexible and context-sensitive responses—particularly relevant in periods of heightened uncertainty or when operating near policy limits.

4 Model Overview

4.1 Phillips Curve

The Central Bank of Armenia (CBA), which targets an inflation rate of 3% to maintain price stability, uses Headline Consumer Price Index (CPI) as its primary gauge, however in the model we decomposed headline into three components: non-traded sticky prices, flexible prices, and regulated services prices. We do this so that we can capture different price-setting behavior in the economy which may have different implications for monetary policy.

$$\begin{aligned}\Pi_t^{CPI} &= w^{NTSP}\Pi_t^{NTSP} + w^{Reg}\Pi_t^{Reg} + (1 - w^{NTSP} - w^{Reg})\Pi_t^{Flex} \\ w^{NTSP} &= 17\%, \quad w^{Reg} = 13\%\end{aligned}\tag{1}$$

4.1.1 Non-Traded Sticky Price Inflation

In the context of monetary policy implementation, non-traded sticky prices offer valuable insights into the underlying inflationary environment. These prices, classically associated with services such as haircuts that require domestic labor and are not internationally traded, tend to adjust infrequently and respond more slowly to market dynamics. Unlike flexible prices—such as traded goods, which are directly sensitive to international prices and exchange rate fluctuations—sticky prices are initially insulated from global influences and instead reflect more persistent, domestically driven inflation pressures. This makes them a

¹⁵At the time of writing this paper, the Central Bank of Armenia has not published a paper on its original QPM, exhibiting low levels of transparency in this area (Kostanyan, Laxton, Romero, 2022). Therefore, this paper will not only try to serve to explain the main elements done to adapt the QPM to EndoCred but also offer some insights into the choices and analysis that went into the original QPM. However, QPM should be formally documented on its own.

¹⁵Olivier Blanchard addressed these concepts when discussing the global financial crisis in "Where Danger Lurks", (2014)

useful indicator of whether inflation expectations remain well-anchored—an essential condition for the effective conduct of monetary policy, whose fundamental role is to provide an anchor for inflation and inflation expectations.

$$\Pi_t^{NTSP} = \alpha_{ld}\Pi_t^{EXP} + \alpha_{lag}\Pi_{t-1}^{NTSP} + \alpha_{RMC}RMC_t^{NTSP} + EPS_t^{NTSP} + \varepsilon_t^{NTSP} \quad (2)$$

The sum of the expected and lagged inflation coefficients equals one, meaning any constant inflation rate can be a solution in the absence of sufficient policy intervention. Given that real marginal cost and the shocks are zero in the steady state, inflation is equal to expectations. This leads to indeterminacy, implying that inflation expectations are not known. Thus it is ultimately the responsibility and the fundamental role of monetary policy to provide a nominal anchor and to guide inflation back toward its target. Achieving this requires that the policy instrument—the policy rate—has to be adjusted sufficiently aggressively in response to deviations of inflation from the target. [3]

The way a central bank should communicate monetary policy to the public should reflect this structure. Many central banks in the world only communicate output and inflation forecasts where inflation typically goes back to the target while omitting the role of policy in the outcome. However, without describing how monetary policy is evolving over time to achieve the central banks objective, the central bank is communicating a future where the public must trust that the central bank will do the right thing and is committed to its objective. When introducing the role of monetary policy there is no need to rely on trust anymore. The central bank is telling you exactly how they intend to guide inflation to the target and the potential short-run costs associated with such policy.

The coefficient on expected inflation (α_{ld}) must be strictly positive to ensure that monetary authorities cannot consistently fool the public. If this coefficient were zero, the central bank could permanently maintain output above its potential by continuously surprising agents with higher-than-expected inflation. Having the expectational dynamics embedded in the inflation structure ensures that the implications of the Long-Run Natural Rate Hypothesis, introduced by Friedman (1968) and Phelps (1968), are present and that policymakers cannot exploit the output-inflation tradeoff due to the time-inconsistency problem, as argued by Kydland and Prescott (1977) and Barro and Gordon (1983a). Indeed, given the opportunity to benefit from surprise inflation, authorities will always be tempted to renege on their commitments to gain additional payoffs through higher output. However, there is an enforcement mechanism that prevents authorities from consistently deviating from the rule, resulting in higher inflation expectations, reflected as distrust in the authorities or a fall in credibility in the next period[3]. As stated by Kydland and Prescott (1977), current decisions of economic agents depend upon expected future policy, and these expectations are not invariant to the plans selected. Freedman and Laxton (2009) refer to this phenomenon as the intellectual root of inflation targeting, emphasizing the need for policymakers to understand and acknowledge the long-run monetary neutrality.

The behavior of the economy depends critically on the value of the parameter that dictates how forward- or backward-looking the inflation expectation process is. When inflation expectations are entirely forward-looking—i.e., the weight on the forward-looking compo-

ment equals one—eliminating the lagged component and inflation becomes the sum of all expected future real marginal costs, producing a purely forward-looking Phillips curve akin to the framework in Calvo (1983). In such cases, even slight adjustments in policy rate can generate large and persistent movements in inflation through forward-looking expectations. Conversely, when expectations are predominantly backward-looking—i.e., the coefficient is close to zero—current inflation is primarily driven by past values of real marginal costs. In this “backward-looking” setting, inflation adjusts only gradually, requiring more persistent and sizable changes in the policy interest rate to steer inflation toward its target.

In standard microfoundational DSGE settings, where rational expectations are assumed, the Phillips curve is typically derived based solely on forward-looking inflation. Fortunately, semi-structural models provide the advantage of incorporating backward-looking dynamics, allowing room for judgment stemming from learning, imperfect credibility, or price indexation. Indeed, as the central bank achieves greater credibility, the expectational dynamics become more forward-looking, as people begin to look ahead with more confidence, believing the central bank is credible to bring inflation back to its target. However, even under perfect credibility, some proportion of the economy will remain backward-looking. For emerging countries with fragile credibility, it is reasonable to assume that the parameter is around 0.5.

$\Pi 4_t^{NTSP}$ denotes the average inflation rate over the past four quarters, effectively capturing 1-year moving average inflation rate:

$$\Pi 4_t^{NTSP} = \frac{1}{4} \sum_{j=3}^0 \Pi_{t-j}^{NTSP}$$

The rationale for using a moving average lies in the inherently volatile nature of quarterly inflation data, where temporary spikes or dips may not accurately reflect underlying inflation trends. By filtering out this noise, the one-year average offers a more stable and informative signal of inflation dynamics.

EPS^{NTSP} is serially correlated cost-push shock, modelled as AR(1) process:

$$EPS_t^{NTSP} = \gamma^{NTSP} EPS_{t-1}^{NTSP} + \varepsilon_{EPS}^{NTSP}$$

Serially correlated shocks in the Phillips Curve—typically modeled as AR(1) processes—play a crucial role in capturing the persistence of inflationary dynamics. Unlike purely random, one-off disturbances, many real-world shocks, such as changes in commodity prices, wage negotiations, or supply disruptions, tend to have effects that last over time. The AR(1) specification reflects this persistence, meaning that today’s shock has a lingering effect tomorrow. This enhances the realism of the model, aligning the inflation behavior more closely with the observed data. This persistence also influences expectations: when people recognize that today’s shock is likely to persist, they adjust their behavior accordingly, amplifying the impact on inflation dynamics. From a policy perspective, persistent shocks are more concerning than transitory ones, as they may risk de-anchoring inflation expectations and thus require a stronger policy response.

The real marginal cost of firms in the non-traded sector is modeled as a weighted average of the output gap and the relative price gap. Since non-traded prices reflect purely domestic inflationary pressures, they are unaffected by exchange rate fluctuations. As a result, monetary policy influences inflation in this sector primarily through its impact on domestic demand—captured by the output gap.

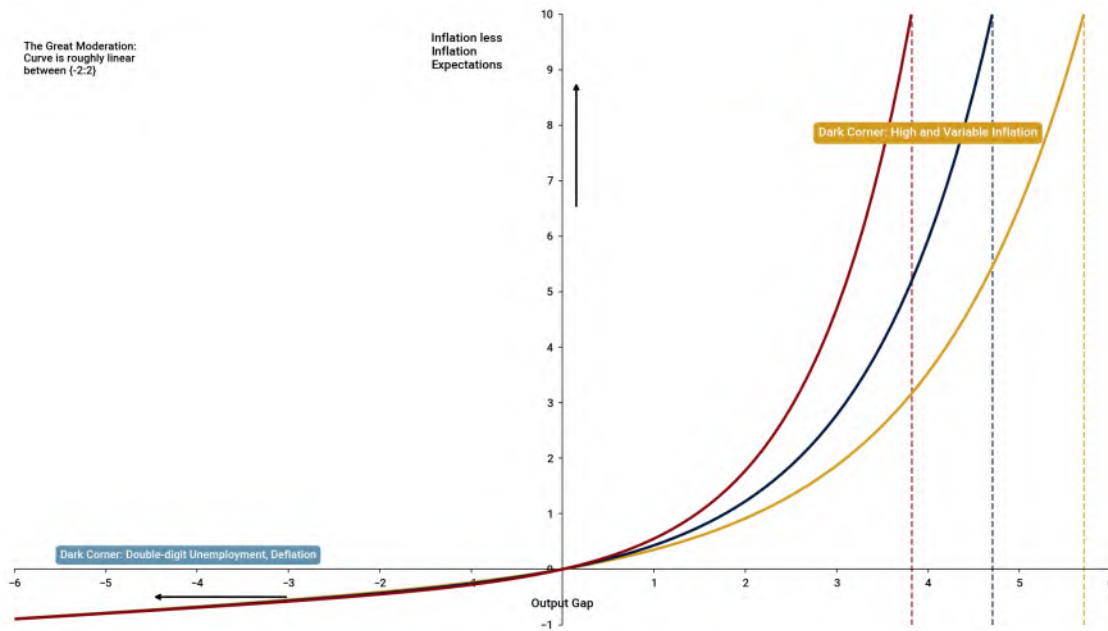
$$RMC_t^{NTSP} = \alpha_y \hat{Y}_t^{max} \cdot \frac{\hat{Y}_t}{\hat{Y}_t^{max} - \hat{Y}_t} + (1 - \alpha_y) \cdot (\hat{RP}_t^{flex}) \quad (3)$$

The parameter α_y captures the relative contribution of the output gap versus the relative price gap of non-tradable sticky prices to real marginal cost, and therefore to inflation. The responsiveness of inflation to the output gap depends on the degree of nominal frictions and the extent of monopolistic competition in the economy. When frictions are low, prices adjust more quickly, and the output gap has a stronger influence on inflation. In the limiting case of zero nominal rigidities—that is, under fully flexible prices—even a small output gap would trigger immediate price adjustments, closing the gap almost instantaneously. Similarly, the degree of monopolistic competition plays a crucial role: the lower the degree of market power among firms, the greater the sensitivity of inflation to the output gap. These mechanisms are rooted in the microfoundations of the New Keynesian framework, as laid out in Galí (2008), where staggered price setting and imperfect competition underpin the Phillips curve and its link to real economic activity.

$\hat{RP}_t^{flex}$ is the price gap of the flexible prices relative to non-traded sticky prices, reflecting the relative cost of goods with flexible prices. Real marginal cost includes this component to reflect the degree of substitution of goods resulting from consumer arbitrage.¹⁶

¹⁶This term influences sectoral inflation dynamics by capturing shifts in demand between tradable and non-tradable goods. When non-tradable prices rise notably, relative demand may weaken, helping to ease inflationary pressures within the sector. While this does not eliminate the need for monetary policy intervention, it introduces a self-correcting tendency that can moderate sector-specific imbalances. Notably, this relative price mechanism remains effective even when price adjustment is highly flexible. In the limiting case where the Calvo parameter approaches zero—implying near-continuous price adjustment—the relative price gap can still dampen localized overheating and mitigate the risk of runaway inflation in the non-tradable sector. Mechanically, this term emerges because firms assess real wages relative to their own output prices, while households evaluate real wages based on the general price level. This mismatch in deflators introduces the relative price of non-tradables directly into the real marginal cost, and thus into the Phillips curve for that sector. Consequently, the model captures a vital channel through which sectoral price misalignments feed into inflation dynamics and reinforces equilibrium across the economy. The seminal paper by Dornbusch (1976) laid the groundwork for open economy macro models, and while its main focus is exchange rate overshooting, it emphasizes how sticky prices in non-tradables versus flexible prices in tradables can create relative price distortions that feed into inflation differently across sectors. The Salter-Swan model (1950s) is one of the earliest to decompose the economy into tradable and non-tradable sectors and show how relative prices adjust to restore internal and external balance. Namely, in response to a contractionary monetary policy shock, the economy must reallocate spending between tradables and non-tradables, a process known as expenditure switching. For this adjustment to occur, the relative price of non-tradables must decline, making them more attractive to consumers. As non-tradables become cheaper, households shift consumption away from tradables and toward non-tradables, facilitating macroeconomic rebalancing. This foundational idea has been extended by Schmitt-Grohé and Uribe (2020), who incorporate it into a modern, microfounded general equilibrium model that includes tradables and non-tradables, along with downward nominal wage

Figure 3: Convex Phillips curve according to different values of y_{max} between 4 and 6.



Source: Authors' Calculations; Kostanyan et al. (2022)

"...A prominent shortcoming of our structural models is that, for ease in parameter estimation, not only are economic responses presumed fixed through time, but they are generally assumed to be linear. An assumption of linearity may be adequate for estimating average relationships, but few expect that an economy will respond linearly to every aberration. "

— Alan Greenspan (2003)

The nonlinear specification of the Phillips curve is one of the most critical features to capture in modern macroeconomic models, particularly when analyzing economic conditions near the so-called "dark corners" of the economy, famously described by Blanchard (2014). We follow the work of Laxton (2024) and Kostanyan (2022), who emphasize the importance of modeling the Phillips curve as convex rather than linear. As output approaches its maximum level, the slope of the Phillips curve steepens significantly, reflecting the emergence of accelerated inflationary pressures.

Historical examples underscore the importance of understanding this dynamic. The U.S. economy, for instance, experienced stagflation in the 1970s—a combination of high inflation and unemployment—due to oil shocks and monetary policy missteps. More recently, tight

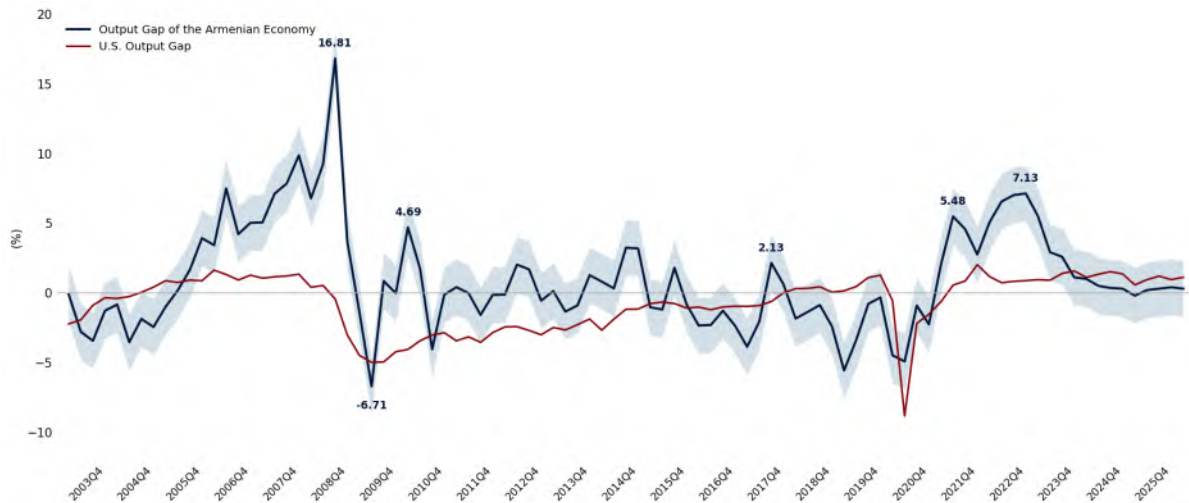
rigidity and financial frictions. Their findings reaffirm that, in small open economies, adjustment occurs primarily through changes in the relative price of non-tradables—that is, the real exchange rate—rather than through movements in global terms of trade. When non-tradable prices fall relative to tradables, the economy is better able to reallocate resources across sectors and restore internal and external balance in response to shocks.

labor markets during the pandemic led to a surge in inflation, with economists like Summers and Blanchard (2023) warning against underestimating the risks of overheating. The asymptotic region of the Phillips curve is characterized by firms reaching their capacity constraints as demand persists. As more sectors hit their bottlenecks, the economy's overall supply becomes less elastic. This reduced flexibility leads to rising wages as labor markets tighten, ultimately transferring to higher inflation without additional gains in output, as highlighted by Evans (1985). However, the economy's maximum productive capacity is not a static limit. It can adjust over time in response to structural changes that expand the availability or efficiency of production factors such as labor and capital. For example, if an economy is able to mobilize underutilized labor, attract new workers through immigration, or experience investment-driven capital expansion, its maximum feasible output gap can increase. In other words, the threshold across the Phillips curve may shift to the right, allowing higher levels of output to be sustained without triggering inflation. A relevant case is Armenia's recent experience in the post-pandemic period. The inflow of Indian workers, along with the relocation of skilled professionals and businesses from Russia and Ukraine due to the war and forced displacement of Artsakhi people into Armenia, has contributed to an expansion in the country's productive capacity. These developments suggest that Armenia's economy may sustain higher levels of the upper bound of output gap currently.¹⁷ Consequently, if a country has access to international labor and can attract investment to expand its capital stock, it can better absorb or serve the increasing demand pressures.

In the central region of the Phillips curve—where the output gap is near zero—the relationship tends to be more linear, corresponding to periods of mild inflation-output trade-off, such as the era of the Great Moderation from the mid-1980s until the onset of the Global Financial Crisis. On the left-hand side the curve flattens, reflecting conditions of high unemployment and deflationary forces. This is particularly relevant for economies with strong downward nominal wage and price rigidities, which often face challenges such as effective lower bound and low inflation trap. A notable example is the Euro Area in the aftermath of the Global Financial Crisis and the European sovereign debt crisis. These events triggered prolonged stagnation, and despite significant policy efforts, it took several years—until the COVID-19 pandemic—for policymakers to decisively escape the low-inflation regime. Blanchard and Summers (1986) emphasize that such prolonged periods of high unemployment can cause lasting damage to an economy's productive capacity through hysteresis effects. These persistent dynamics underline the importance of adopting models that go beyond linear approximations. Indeed, Laxton, Rose, and Tambakis (1999) emphasize that failing to account for the convexity of the Phillips curve can lead to significant costs. Linear assumptions downplay the risks of overheating and deflationary pressures, potentially delaying policy responses. Debelle and Laxton (1997) further underline the critical role of monetary policy in providing a buffer zone to guard against excessive economic variability. They advocate strongly for incorporating convex Phillips curves into models to better capture the complexities of inflation dynamics and to enhance the effectiveness of monetary policy.

In advanced economies, GDP data is relatively stable and well-measured, and the output gap rarely exceeds 3–4%. This level is often viewed as the upper bound or asymptote for

¹⁷CBA MPR, 2024Q3, 2024Q4

Figure 4: Historical output gaps, Armenia and U.S.

Source: Quarterly projection model for Armenia, Fred, CBO

how much the economy can overheat before inflation accelerates. Kostanyan et al. (2022) estimate that the threshold varies between 4% and 6%, ultimately selecting 5% as the maximum sustainable output level for the United States.¹⁸ However, in a small open economy like Armenia, the dynamics are more volatile. Armenia relies heavily on imports, including for essential goods and services. This high import penetration weakens domestic production incentives and puts pressure on the local labor market, limiting job creation and leading to persistent excess capacity, especially in the non-tradable sector. As a result, even if GDP were to rise significantly in response to a demand shock, much of the increase would be absorbed by underutilized resources, especially labor. This acts as a natural buffer, dampening inflationary pressures. In essence, Armenia's structural openness and labor market slack mean the economy can expand more without triggering the same inflationary responses seen in more closed, capacity-constrained advanced economies. This could justify a less aggressive monetary policy response to a high output gap in Armenia compared to advanced economies. However, the reverse is not necessarily true: in the case of a negative output gap or weakening demand, monetary policy may still need to react forcefully to avoid deflation or further underutilization. Furthermore, dollarization risks complicate the picture. A muted policy response in the face of overheating could lead to a loss of confidence in the domestic currency, as agents shift into foreign currency assets to protect their purchasing power. This risk reinforces the importance of maintaining a credible inflation anchor—even in a structurally open economy with excess capacity.

4.1.2 Flexible Price Inflation

In contrast to sticky price inflation, flexible price inflation includes more volatile components that adjust more frequently. It captures spillovers from the global economy, including direct

¹⁸Earlier estimates of this threshold can be found in the IMF's World Economic Outlook, September 2005.

effects of imported prices, commodity price movements, and is subject to exchange rate fluctuations.

$$\begin{aligned}\Pi_t^{flex} = & \beta_{lag}\Pi_{t-1}^{flex} + (1 - \beta_{lag} - \beta_{\pi}^M - \beta_{food}^M - \beta_{oil}^M)\Pi_t^{EXP} + \\ & \beta_{RMC}RMC_t^{flex} + \beta_{\pi}^M\Pi_t^M + \beta_{food}^M\Pi_t^{M_{food}} + \beta_{oil}^M\Pi_t^{M_{oil}} + \varepsilon^{flex}\end{aligned}\quad (4)$$

Π^M is a proxy for imported inflation, calculated as the foreign inflation in USD, (Π_t^F), adjusted for the change in the nominal exchange rate (ΔS_t). this effect is moderated by the rate at which domestic productivity catches up with that of trading partners. This is captured by the trend appreciation of the real exchange rate, ($\Delta \bar{Z}_t$) commonly associated with the Balassa-Samuelson effect. As domestic productivity improves relative to foreign economies, the real exchange rate tends to appreciate, which helps offset some of the inflationary pressure from imports by making them relatively cheaper over time.

$$\Pi_t^M = \Pi_t^F + \Delta S_t - \Delta \bar{Z}_t \quad (5)$$

$$\Pi_t^{M_{food}} = \Pi_t^{F_{food}} + \Delta S_t - \Delta \bar{q}_t^{food} - \Delta \bar{Z}_t^{US} \quad (6)$$

$$\Pi_t^{M_{oil}} = \Pi_t^{F_{oil}} + \Delta S_t - \Delta \bar{q}_t^{oil} - \Delta \bar{Z}_t^{US} \quad (7)$$

$\Pi_t^{M_{food}}$ and $\Pi_t^{M_{oil}}$ represent imported food and oil price inflation, respectively. These are expressed as growth rates of FAO food prices and Brent oil prices, adjusted for changes in the nominal exchange rate and real exchange rate trend depreciation, while subtracting the trend growth real price of food ($\Delta \bar{q}_t^{food}$) and oil ($\Delta \bar{q}_t^{oil}$). This construction filters out the effects driven by long-run fundamentals, emphasizing the cyclical deviations from trend that matter for short- to medium-term inflation dynamics.

Imported food and oil inflation—which incorporates global price changes and exchange rate fluctuations—captures nominal price pressures passed through to domestic inflation, and is treated separately.

Foreign inflation, Π_t^F , is defined as a weighted average of inflation rates in Armenia's main trading partners, using import weights. These inflation rates are expressed in USDs. The main trading partners include the United States—modeled explicitly—and a composite group of other partners, primarily the Euro Area and Russia, which are not modeled separately but captured through an aggregate price index. The foreign inflation index is constructed as:

$$\Pi_t^F = \beta_{trade}^{US} \Pi_t^{US} + (1 - \beta_{trade}^{US})(\Pi_t^{PRT} - \Delta S_t^{PRT}) \quad (8)$$

where β_{trade}^{US} is the trade weight of the United States, Π_t^{US} is U.S. inflation, and Π_t^{PRT} is the aggregate inflation rate of Armenia's other major trading partners (primarily the Euro Area

and Russia), expressed in their respective local currencies. To express this component in USD terms, it is adjusted by the nominal exchange rate change ΔS_t^{PRT} (i.e., the depreciation of partner currencies against the USD).

$$\Delta q_t^{oil} = \Pi_t^{F_{oil}} - \Pi_t^{US}$$

$$\Delta q_t^{food} = \Pi_t^{F_{food}} - \Pi_t^{US}$$

Real world price of oil and food are obtained by subtracting US price Index from their nominal world counterparts. Real world price of oil and food capture the global commodity prices, adjusted for foreign inflation and represent the real input costs faced by firms, particularly in energy-intensive and food-related sectors. We decompose world real oil and food prices into gap and trend components:

$$q_t^{oil} = \bar{q}_t^{oil} + \hat{q}_t^{oil}$$

$$q_t^{food} = \bar{q}_t^{food} + \hat{q}_t^{food}$$

Inflationary pressures arising from sectoral real costs are captured by the real oil and food price gap in the real marginal cost term of the flexible inflation Phillips curve. This term captures cost-push effects stemming from fluctuations in global commodity prices, creating production costs for firms.

$$RMC_t^{flex} = \beta_{RP}(-\widehat{RP}_t^{flex}) + \beta_y \hat{Y}^{max} \frac{\hat{Y}_t}{\hat{Y}^{max} - \hat{Y}_t} + \beta_z \hat{Z}_{t-1} + \beta_{ZUS}(\Delta Z_t - Z_t^{SS}) + \beta_{qoil} \widehat{qoil}_t + \beta_{qfood} \widehat{qfood}_t \quad (9)$$

In addition, the real marginal cost incorporates the lagged real effective exchange rate gap, $\hat{Z}_{t-1}$, highlighting the delayed impact of competitiveness shifts on domestic cost conditions. A depreciation of the real effective exchange rate—signaling increased international competitiveness and leading to stronger external demand—tends to raise the domestic currency price of imported intermediate inputs. This cost pressure feeds into inflation, reflecting the indirect channel of imported inflation through production costs. Together with the direct impact of consumer goods import prices, the model captures both channels through which imported inflation transmits to headline inflation. The relative price gap, $\widehat{RP}_t^{flex}$, measures the deviation of flexible prices from non-traded sticky prices. When flexible prices rise faster than sticky prices, the gap signals temporary excess demand or supply-side pressures in flexible-price goods. As this misalignment builds, it creates downward pressure on future flexible inflation, helping prices adjust back toward their relative equilibrium. Thus, the model captures demand-related dynamics indirectly through relative prices, without explicitly including the output gap, while recognizing that flexible prices are largely driven by supply-side factors.

4.1.3 Regulated Services Inflation

Regulated services inflation captures the price dynamics of goods and services whose prices are set or heavily influenced by government or regulatory authorities rather than determined by market forces. This category typically includes utilities (such as electricity, gas, and water), public transportation, postal services, and in some cases, healthcare or education. These prices often follow administrative decisions, cost-recovery rules, or fiscal policy objectives, and may be revised infrequently or in discrete steps. As a result, regulated services inflation tends to exhibit low volatility and delayed responsiveness to macroeconomic conditions, including exchange rate movements and demand pressures. In inflation modeling and forecasting, it is typically treated as an exogenous or partially exogenous process, and is especially relevant for assessing the pass-through of energy tariffs, administered wage adjustments, and subsidy reforms. Understanding its trajectory is important for anticipating short-term inflation fluctuations and assessing the credibility and impact of government pricing policies.

In our model, regulated services inflation is not treated as entirely exogenous. Instead, it follows an endogenous process that allows for gradual convergence toward the inflation target over time. Specifically, regulated services inflation is modeled as a function of the inflation target and a relative price gap term. This gap captures the need for tariff rebalancing or relative-price correction between regulated and non-regulated components of consumption, allowing administered prices to adjust gradually when their relative level deviates from broader price dynamics.

$$\Pi_t^{Reg} = \gamma_{\pi^*} \Pi_t^* - \gamma_{rp} \widehat{RP}_t^{Reg} + \varepsilon_t^{Reg} \quad (10)$$

4.2 Expectations and Evolution of Credibility

In this model, credibility depends on the extent to which medium- and long-term inflation expectations remain aligned with the central bank's target. However, credibility as a concept is more about whether the monetary policy transmission mechanism is working by design whereby the exchange rate, long-term interest rates and asset prices operate as shock absorbers rather than amplifiers. In this sense, having high levels of credibility is fundamental to achieving macroeconomic stability, as it underpins the effectiveness of monetary policy and by consequence helps anchor inflation expectations.

A central bank builds credibility by achieving its inflation target on average over time. The phrase “on average” is key—because inflation data contains significant noise, and even under optimal policy, inflation will not match the target every single period. In fact, it is neither feasible nor desirable to keep inflation constantly fixed at the target (Freedman and Laxton (2009)). We can think of New Zealand's experience during the early stages of inflation targeting in 1990s—when strict adherence to short-term CPI targets led to overly tight policy, currency appreciation, and export losses—as a clear example of why long-run credibility must be built with flexibility rather than rigid short-run inflation control¹⁹.

When medium- and long-term inflation expectations persistently drift away from the target,

¹⁹See Haworth, Kostanyan, Laxton (2019)

credibility erodes, making it more difficult for monetary policy to influence economic behavior. This deterioration often leads to higher long-term inflation expectations and changes in wage- and price-setting behavior that incorporate those expectations into future outcomes. Inflation tends to become more persistent, economic conditions more volatile, and unemployment higher. In more severe cases—when inflation uncertainty becomes especially pronounced—economic agents may begin pricing key goods and services, such as housing, in foreign currency. This phenomenon, known as dollarization, signals a profound loss of confidence in the domestic currency and the central bank’s ability to conduct effective monetary policy. History has shown that rebuilding credibility is neither quick nor easy—it often requires prolonged periods of tight policy, with significant short-term economic costs. This underscores the importance of maintaining credibility proactively, rather than attempting to restore it reactively after it has eroded.

In traditional linear models—most notably the canonical multicountry gap model developed by Berg, Karam, and Laxton, which has served as the foundation for a system that has revolutionized monetary policy around the world—credibility is still treated as an exogenous and static feature. These models typically assume perfect credibility, with expectations aligning with the central bank’s inflation target. However, real-world conditions often diverge from this ideal. In practice, credibility is rarely perfect—particularly in economies with histories of inflation volatility or policy inconsistencies. Under imperfect credibility, agents tend to rely more on actual policy performance—rather than stated targets—and on past inflation outcomes when forming their expectations, leading to a stronger backward-looking component in inflation dynamics. Even in environments with a high degree of credibility, backward-looking elements tend to persist due to institutional memory, adaptive behavior, or uncertainty about future policy actions.

Our approach aligns with that proposed by Igityan et al. (2024), which conceptualizes credibility as a stock, C_t^{stock} , that evolves over time between the range of 0 (no credibility) and 1 (perfect credibility), in response to the central bank’s actions and its commitment in meeting policy objectives. Credibility directly influences the formation of inflation expectations, Π_t^{EXP} by determining the relative weight placed on past versus forward-looking information.

$$\Pi_t^{EXP} = C_t^{stock} \Pi_{t+4}^{NTSP} + (1 - C_t^{stock}) \Pi_{t-1}^{NTSP} + \kappa^{High} \cdot prob_t^{High} + \kappa^{Low} \cdot prob^{Low} + EPS_t^{EXP} + \varepsilon_t^{EXP} \quad (11)$$

Although headline inflation remains the official policy target, inflation expectations are specified through non-traded sticky-price inflation because it better captures persistent, domestically driven price pressures that monetary policy can influence more directly. Unlike headline inflation, which is often affected by volatile food, energy, import prices, and exchange-rate movements, NTSPi provides a clearer signal of whether expectations remain anchored to the target rather than reacting to temporary external shocks.

We follow Mashat et al. (2018) in defining the formation of expectations. Particularly they define two kind of processes:

1. Optimistic yet watchful. This approach assigns weight to the central bank’s intermediate target, such as 3% for Armenia, while still factoring in past inflation. People believe

that inflation will eventually converge to the target, with expectations partly bounded by past inflationary trends.

2. Skeptical and history-driven. Here, expectations are shaped by historical trends, with people believing that inflation will diverge from the target and revert to historical high or low levels, such as $\Pi^{High} = 7\%$ in a high-inflation regime or $\Pi^{Low} = -1\%$ in a deflationary scenario. In advanced economies like the United States, where inflation dynamics are generally less volatile than in emerging markets, relatively moderate inflation rates like 5% would be considered a high-inflation scenario within this framework.

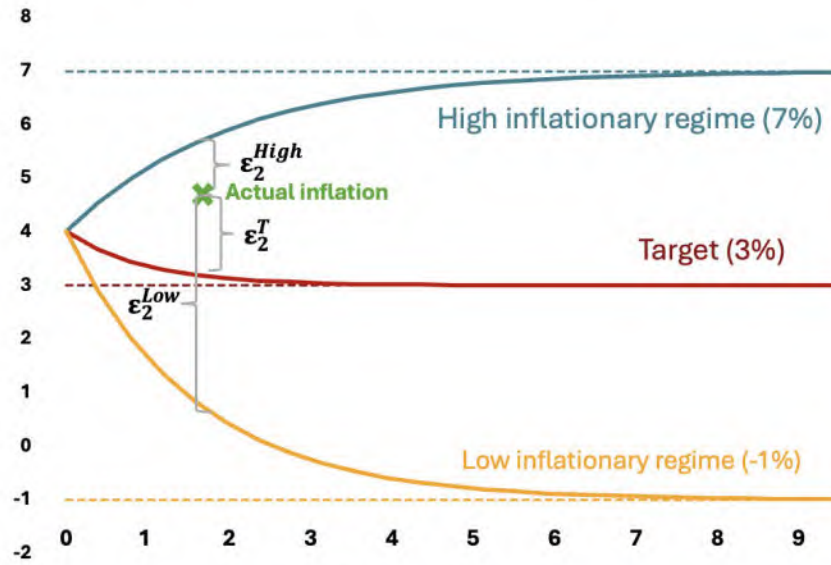
These benchmarks are intended to be illustrative rather than precise historical estimates. They help conceptualize the formation of inflation expectations and the divergence of public sentiment in high- and low-inflation environments—what are often referred to as dark corners. This framework allows economists to define relevant regimes based on subjective assessments or context-specific values, while the underlying methodology offers a versatile tool for exploring inflation dynamics across different countries and alternative regimes.

As inflation expectations move toward the dark corners—either drifting upward toward high inflation or downward toward a low-inflation regime—the probability of entering these regimes increases correspondingly. To formalize this, we define two probabilities: $prob_t^{high}$ for the high-inflation regime and $prob_t^{low}$ for the low-inflation regime. Only one probability can dominate at a given time. If inflation expectations align with a high-inflation environment, the probability of being in the high-inflation regime approaches 100 percent. Conversely, if expectations fall toward very low or negative inflation levels, the probability of entering a low-inflation regime rises to 100 percent. We adopt this approach to illustrate how shifting expectations can reinforce transitions in two different inflation regimes, highlighting the role of Monterey credibility in preventing drift toward extreme cases.

The probabilities of inflation moving toward a particular regime are shaped by the distance between actual observed inflation and the hypothetical inflationary regimes, captured through forecast errors. In this framework, forecast errors represent the gap between actual inflation and the inflation levels expected by optimists and skeptics. These errors adjust dynamically depending on how closely actual inflation aligns with the target or drifts toward the extremes of high or low inflation regimes. When actual inflation moves closer to the target and further away from the dark corners, the forecast error associated with optimistic expectations decreases. If actual inflation fully aligns with the target, the forecast error for optimists disappears, indicating that expectations are perfectly anchored. Conversely, as inflation moves further from the target and toward either a high- or low-inflation regime, the forecast error associated with skeptical expectations narrows. When actual inflation fully matches the levels associated with the high or low inflation regimes, the forecast error for skeptics disappears, signaling that the economy has fully transitioned into one of these extreme regimes.

$$prob_t^{High} = \frac{100(\varepsilon_t^T)^2}{(\varepsilon_t^T)^2 + (\varepsilon_t^{High})^2} \quad (12)$$

Figure 5: Illustrative representation of inflationary regimes and forecast errors



Source: Authors' Calculations

$$prob_t^{Low} = \frac{100(\varepsilon_t^T)^2}{(\varepsilon_t^T)^2 + (\varepsilon_t^{Low})^2} \quad (13)$$

Where

- ε_t^T is the forecast error under optimistic expectations, inclined towards the target:

$$\varepsilon_t^T = \Pi 4_t^{NTSP} - [\delta_1 \Pi 4_{t-1}^{NTSP} + (1 - \delta_1) \Pi_t^*]$$

- ε_t^{High} is the forecast error under skeptic expectations, inclined toward high inflationary regime.

$$\varepsilon_t^{High} = \Pi 4_t^{NTSP} - [\delta_2 \Pi 4_{t-1}^{NTSP} + (1 - \delta_2) \Pi_t^{High}]$$

- ε_t^{Low} is the forecast error under skeptic expectations, inclined toward low inflationary regime.

$$\varepsilon_t^{Low} = \Pi 4_t^{NTSP} - [\delta_3 \Pi 4_{t-1}^{NTSP} + (1 - \delta_3) \Pi_t^{Low}]$$

$$\delta_1 = \text{slider from 0.5 to 0.9} \quad \delta_2 = 0.9, \quad \delta_3 = 0.9$$

Since skeptical expectations are more strongly rooted in historical inflation trends, reflecting a history-driven perspective, it's reasonable to assign higher weight to lagged inflation, setting δ_2 and δ_3 higher than δ_1 .

We impose boundary conditions to ensure a consistent mapping between the level of expectations and the probability of entering different inflation regimes.

$$\text{if } \Pi 4_t^{NTSP} \leq [\delta_1 \Pi 4_{t-1}^{NTSP} + (1 - \delta_1) \Pi_t^*], \text{ then } prob_t^{High} = 0$$

$$\text{if } \Pi 4_t^{NTSP} \geq [\delta_3 \Pi 4_{t-1}^{NTSP} + (1 - \delta_3) \Pi_t^{Low}], \text{ then } prob_t^{Low} = 0$$

If actual inflation is below optimistic expectations, the probability of entering a high inflation regime is set to zero. For advanced economies less prone to dollarization, this condition can be relaxed: if actual inflation is below skeptic expectations under the high inflation regime, the probability of entering a high inflation regime is zero, a weaker condition making this scenario more likely. Conversely, if actual inflation surpasses skeptic expectations under the low inflation regime, the probability of entering the low inflation regime becomes zero. For countries prone to low-inflation traps, such as Japan or Euro Area countries, this condition is strengthened: only if actual inflation exceeds the optimistic expectations (which anticipate convergence to the target) is the probability of entering the low-inflation regime set to zero. This stronger condition reflects the greater difficulty these economies face in avoiding persistent low inflation.

The flow of credibility is inversely related to the probabilities of entering the dark corners of the economy, thus we can obtain it by simply subtracting the combined probabilities from 100 and then dividing by 100:

$$C_t^{flow} = \frac{100 - prob_t^{High} - prob_t^{Low}}{100} \quad (14)$$

Based on the flow of credibility, we construct a credibility stock index that evolves according to a standard stock accumulation process. Its dynamics are driven partly by its own past value and partly by a signal derived from inflation expectations. Additionally, it includes a disturbance term representing a credibility shock, which can be either positive or negative—capturing unexpected shifts in public trust resulting from policy actions or external events.

$$C_t^{stock} = \delta_c C_{t-1}^{stock} + (1 - \delta_c) C_t^{flow} + \varepsilon_t^c, \quad \delta_c = 0.9 \quad (15)$$

$$\delta_c = \begin{array}{c} \text{0.7} \quad \text{0.8} \quad \text{0.9} \end{array}$$

To construct the credibility index, we use non-traded sticky prices, which serve as a particularly suitable indicator in the context of credibility analysis. Reflecting infrequent price adjustments and long-run fundamental drivers of inflation, these prices inherently capture key characteristics of inflation expectations.

For Armenia, the ELB is a less binding constraint, as a credible commitment to intervene in foreign exchange markets—particularly within a well-established inflation-targeting framework—can effectively offset deflationary risks and restore price stability. In that regard, our

framework is sufficiently flexible to allow assigning less weight to the probability of entering a low-inflation regime under alternative scenarios. In principle, open economies are less prone to entering low inflationary trap, characterized by the effective lower bound (ELB), as they possess an additional monetary policy tool: the exchange rate. When interest rates are constrained and monetary policy is running out of space to operate, a well-established and credible FX intervention strategy can provide the necessary monetary stimulus. Indeed, with the legal authority to buy, unlimited amount of foreign assets, a central bank should be fully equipped to prevent deflationary stagnation. The Czech National Bank has demonstrated this approach with notable success. Its credible and well-communicated exchange rate intervention in 2013 helped to stave off deflation and supported a sustained economic recovery.²⁰ While this experience serves as a compelling precedent for small open economies such as Armenia, which may be more agile than advanced economies in deploying FX-based tools, its applicability to Armenia should nonetheless be qualified.²¹

According to the approach mentioned above, we use the actual data for Non-traded sticky price inflation and calculate credibility index for Armenian economy.²² Here the thresholds of entering "dark corners" of economy are adjusted in line with the recent target shift by CBA from 4% to 3%²³. Specifically, Π^{High} and Π^{Low} have been lowered from 8% to 7% and from 0 to -1% respectively, from the moment the inflation target has been shifted. Comparison of historical Non-traded sticky prices with credibility index clearly illustrates that episodes of high and volatile inflation tend to coincide, albeit with some lag, with periods of credibility erosion, while more moderate inflation centered around the target is typically associated with relatively higher levels of credibility.

²⁰See Adrian, Laxton, Obstfeld "Advancing the Frontiers of Monetary Policy", 2018

²¹The effectiveness of the Czech commitment rested on a high level of monetary policy credibility, well-anchored inflation expectations, a low degree of dollarization, and clear communication that the exchange-rate floor was a temporary easing instrument aimed at returning inflation to target. Armenia differs along precisely these dimensions: it is more dollarized, with greater balance-sheet exposure to exchange-rate movements and a potentially higher pass-through from depreciation to inflation expectations. Under imperfect credibility, a commitment to FX purchases or to currency depreciation need not be read purely as monetary stimulus; it may instead be interpreted by households and firms as a signal of heightened exchange-rate risk, raising dollarization, widening risk premia, and weakening confidence in the domestic currency. This state-dependence is built into our framework rather than added as an external caveat: because credibility is endogenous and both dollarization and the country risk premium respond to it, the model can represent how an exchange-rate-based easing that is stabilizing under high credibility may instead amplify dollarization and risk premia when credibility is weak. We therefore treat the weight placed on the low-inflation regime as state-dependent—modest when credibility is high, but far from negligible when it is fragile—rather than dismissing the regime outright.

²²Igityan et al. (2022) introduce a hybrid approach to measuring central bank credibility by combining two key indicators: deviations of non-traded sticky price inflation from its target range and the extent of excessive dollarization in the financial system. By weighting these two measures—70% on NTSPI and 30% on dollarization—the authors construct a composite performance index, with flexibility to adjust weights to reflect changing economic conditions and behavioral dynamics.

²³For the implications of this target shift and its importance, see Avetisyan, Igityan, and Papikyan (2024). Notably, they examine the macroeconomic implications of transitioning to a lower inflation target under conditions of imperfect policy credibility. As a result, inflation-output trade-off becomes more challenging, as inflation expectations adjust more slowly, compared to the case of target shift under perfect credibility. Thus, disinflation requires a stronger and more prolonged increase in both nominal and real interest rates, which leads to a deeper and more persistent output gap compared to the perfect credibility case.

Figure 6: Non-traded Sticky Price Inflation (Y-o-Y % Change) and Credibility Index, Armenia



Source: National Statistical Service of Armenia; Authors' Calculations

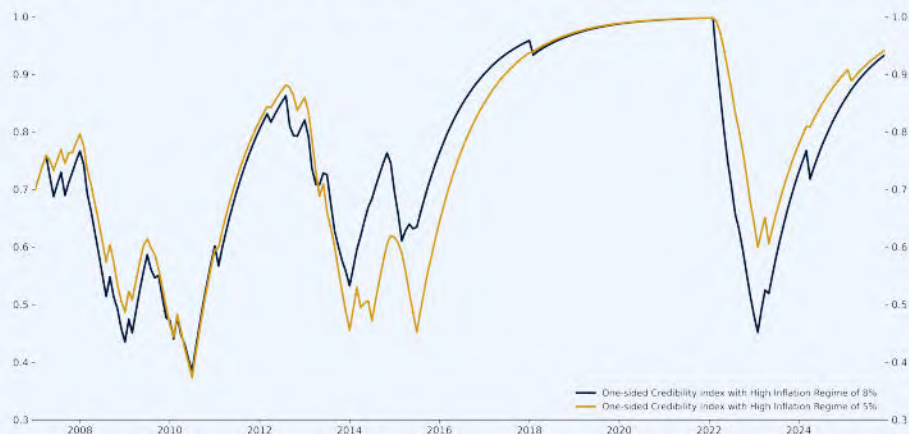
In the early years after the adoption of inflation targeting, strong demand, capital inflows, AMD appreciation, and repeated commodity-price shocks kept inflation above target and limited the ability of the new target to serve as a fully credible nominal anchor. The Global Financial Crisis then produced a sharp deterioration in credibility: weak growth, elevated risk premia, and financial stress were accompanied by a strong increase in dollarization, reflecting households' and firms' desire to hedge against macroeconomic instability. The 2014 external shock was another important test. Depreciation pressures and panic demand for foreign currency again threatened the anchor, but the CBA's decisive tightening and subsequent disinflationary stance helped stabilize markets, re-anchor expectations, and gradually rebuild credibility. This improvement was followed by a visible decline in dollarization, suggesting that credibility gains were reflected in the public's greater willingness to hold domestic-currency assets. The post-pandemic and post-war period again tested the credibility of the framework. COVID-19, the 2020 war, global supply disruptions, and the Russia-Ukraine shock generated large swings in inflation and domestic demand. However, the CBA's preemptive tightening during the pandemic and later aggressive response to the post-2022 demand

surge helped prevent a more persistent de-anchoring of expectations. Importantly, the persistence of NTSPI inflation even after headline inflation declined shows why credibility cannot be assessed from headline inflation alone: underlying domestic price pressures may remain elevated even when external shocks fade. Overall, the historical evidence points to a clear asymmetry: credibility is slow and costly to build, but can be depleted quickly. When credibility is preserved, expectations remain more forward-looking, dollarization is lower, the risk premium is contained, and the exchange rate can act as a shock absorber. When credibility erodes, these channels reverse and reinforce one another.

Credibility Dynamics Under Lower Inflation Regime (Low Inflation Tolerance)

This exercise explores the implications of narrowing the tolerance band related to high inflation regime, which implies less tolerance for inflation deviations.

Figure 7: Credibility calculations under different high inflation regimes

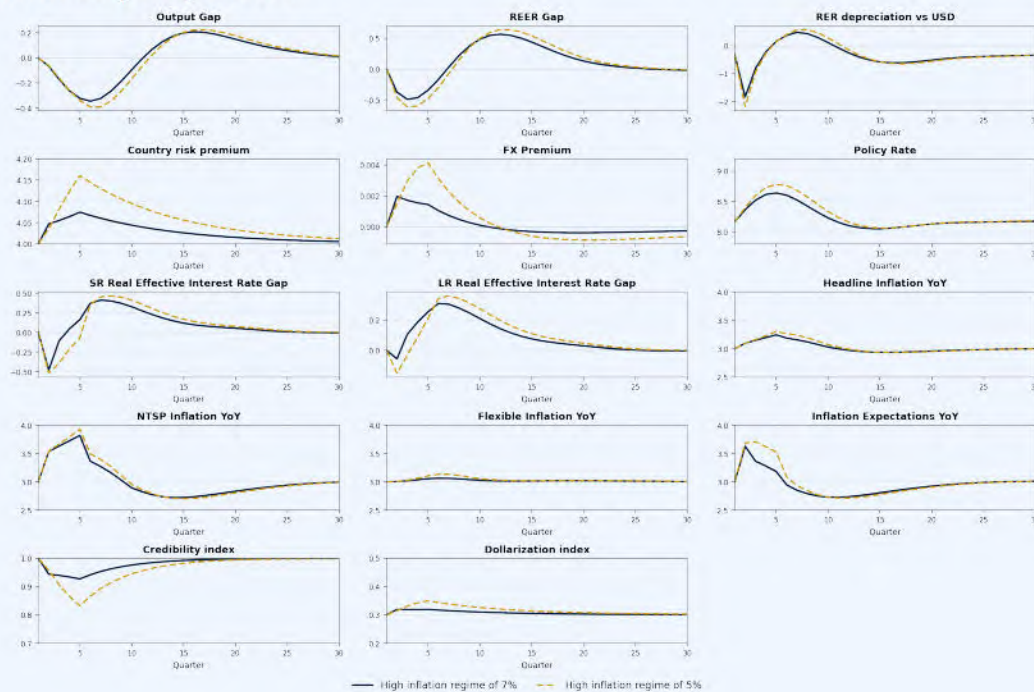


Source: Authors' Calculations

In this context we compare two scenarios: One with a high-inflation threshold set at 8%, and another at 5%, each with a one-percentage-point reduction in the threshold (from 8% to 7%, and from 5% to 4%, respectively) following a reduction in the inflation target from 4% to 3% at the beginning of 2025. For tractability and in light of the features of small open economies, only positive deviations of inflation from the target are considered, yielding a one-sided credibility index. 2008 GFC episode highlights a period of high and volatile inflation where under less tolerance of high inflationary environment (5% high inflation regime) credibility erodes much faster compared to more tolerance towards that regime. This might indicate that in the higher regime, credibility remains stronger because the system tolerates a wider margin for inflationary pressures before signaling entry into the “dark corner.” The post-COVID flip in the credibility pattern comes down to an unfortunate coincidence in where inflation peaked. Credibility in this framework is destroyed most violently not when inflation is highest, but when it lands right on the high inflation threshold, because at that exact point the “skeptic” who believes inflation is anchored at the threshold becomes a perfect forecaster, and the central bank’s “optimist” story loses the contest decisively. In the 2008 episode,

NTSPI inflation blew straight past the 7% threshold and peaked at roughly 9.4% in July–August 2008, so neither the 7%- nor the 4%-skeptical was a perfect fit; under those conditions the 4% regime erodes credibility more on net, because its tighter threshold has been persistently bleeding credibility for many quarters before the peak. In the post-COVID era NTSPI inflation peaked at about 7.4% in January 2023, essentially landing on top of the 7% threshold. That hands the 7%-skeptical a near-perfect validation and crashes credibility under the 7% regime. The 4% skeptic, by contrast, holds a prediction way far away from the actual realized inflation, resulting in a much better position of credibility under that scenario.

Figure 8: Credibility calculations under different high inflation regimes from the model's perspective



Source: Authors' Calculations

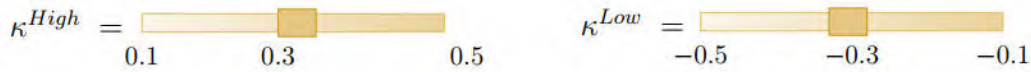
Applying the same shock exercise in the model gives a clear sensitivity result. When the high-inflation threshold is reduced from 7% to 5%, the economy becomes less tolerant of inflationary deviations: the same NTSP inflation shock is interpreted as a stronger signal that inflation may be moving toward a high-inflation regime. As a result, credibility falls more sharply and stays lower for longer compared with the standard calibration. This credibility loss activates the broader EndoCred transmission mechanism. Lower credibility raises the dollarization index, increases the country risk premium and the FX premium, and produces a stronger exchange-rate depreciation response. These external and financial channels then feed back into inflation expectations and domestic inflation, especially NTSP inflation, which becomes higher and somewhat more persistent under the lower-threshold scenario. Monetary policy responds more aggressively: the policy rate and the short- and long-run real effective interest rate gaps rise more than in the standard case. This tighter policy stance helps contain second-round effects and gradually

brings inflation and expectations back toward target.

The stock of credibility feeds into Inflation expectations by determining the weight on the forward looking component relative to backward looking one. Expectations are shaped by non-traded sticky prices, which reflect persistent domestic inflation pressures and are less affected by short-term exchange rate fluctuations, making them more indicative of long-term inflation expectations.

Higher level of credibility results in more forward-lookingness.

$$\Pi_4^{EXP} = C_t^{stock} \Pi_4^{NTSP} + (1 - C_t^{stock}) \Pi_4^{NTSP} + \kappa^{High} \cdot prob_t^{High} + \kappa^{Low} \cdot prob^{Low} + EPS_t^{EXP} + \varepsilon_t^{EXP} \quad (16)$$



Under conditions of lower credibility, agents rely more heavily on past inflation outcomes, while the influence of forward-looking expectations diminishes. This stands in contrast to models assuming perfect credibility, where expectations are largely forward-looking and closely aligned with the central bank's policy goals. By incorporating credibility into the model, we allow for a time-varying process in the evolution of expectations—providing a more realistic alternative to the canonical framework, in which expectation parameters remain fixed over time.

When credibility is imperfect, two key processes come into play. First, existing inflation becomes more persistent, as reflected in the coefficient of the backward-looking component in expectations. Second, inflation expectations adjust upward or downward depending on whether the economy is in a high- or low-inflation regime, driven by the inflation bias that emerges within these regimes.

$\kappa_{High} > 0$ biases inflation expectations higher while $\kappa_{Low} < 0$ biases inflation expectations lower. When $C_t^{Stock} = 1$, credibility is perfect, and inflation expectations become fully forward-looking and the inflation regime bias disappears. This reduces inflation persistence and ties inflation more tightly to the target, such that the central bank must do less in response to shocks, and convergence to the target rate is faster. The other extreme case when $C_t^{Stock} = 0$, $\kappa^{High} = 0$, $\kappa_{low} = 0$, then we get the original backward-looking specification for inflation expectations as in the canonical model.

The parameters κ in the model can be interpreted as capturing the tolerance toward inflationary versus deflationary environments. A higher value of κ^{High} implies that expectations are more responsive to inflation overshooting the target, which is associated with a lower tolerance for high-inflation regimes and a correspondingly stronger policy reaction to inflationary pressures. This approach is intended to analytically reflect policymakers' actual risk appetite—specifically, which types of dark corners (high inflation regime or low inflation regime) policymakers would most seek to avoid in making their least-regrets decision. While

in principle Board members might aim for a symmetric approach to inflation and disinflation risks, in practice, each Board member has a different risk appetite and a different assessment of what types of "dark corner" scenarios they would most regret if they materialized. the PRMAPS framework offers flexibility to accommodate potential differences in preferences or sensitivities of Board members, especially in navigating the more complex or uncertain areas of the economic environment. Although the model allows adjustments to κ to reflect such differences, it is not the role of staff to assign these values based on judgment. Staff should remain neutral, as the responsibility for setting policy preferences appropriately rests with the board, whose individual perspectives and risk assessments are best suited to guide decisions under uncertainty.

4.3 Output Gap

The output gap, $\hat{Y}_t$, measures the deviation (in percentage points) of actual output from its estimated trend or potential level. A positive value indicates that output is above potential, while a negative value implies economic slack. The output gap equation presented here is a function of its past and future values, lagged reactions to the long-term real effective interest rate gap, $\hat{LR}_{t-1}^{Eff}$, and real effective exchange rate gap, $\hat{Z}_{t-1}$ and the world output gap, $\hat{Y}_t^W$:

$$\hat{Y}_t = \lambda_{ld}\hat{Y}_{t+1} + \lambda_{lag}\hat{Y}_{t-1} - \lambda_{LR}\hat{LR}_{t-1}^{Eff} + \lambda_z\hat{Z}_{t-1} + \lambda_Y^w\hat{Y}_t^W + EPS_t^Y + \varepsilon_t^Y \quad (17)$$

Empirical versions of the New-Keynesian forward-looking IS curve often include a backward-looking (lagged) component (Goodhart & Hofmann, 2005; Fuhrer & Rudebusch, 2004). This reflects adjustment costs, habit formation, and inertia (Svensson), which introduce persistence in economic behavior. Unlike DSGE models, semi-structural models provide greater flexibility by incorporating empirically observed lag structures without being strictly bound by theoretical constraints. This enables them to better capture delays in the transmission of shocks—such as monetary policy effects on output and inflation—while blending theoretical rigor with empirical realism. Consequently, semi-structural models are well-suited for policy analysis and forecasting, particularly where the rigidities of DSGE models may reduce practical applicability.

The broader influence of monetary policy on aggregate demand is captured by interest rate and exchange rate channels. Particularly, the inclusion of the lagged effective long-term real interest rate gap, $\hat{LR}_{t-1}^{Eff}$, emphasizes the role of the maturity structure of real interest rates in monetary policy transmission, operating through the intertemporal substitution effect on consumption and investment. The lagged real exchange rate gap, $\hat{Z}_{t-1}$, captures the exchange rate pass-through effects via the substitution between domestic and imported goods. The real effective exchange rate gap represents the difference between the real effective exchange rate and the equilibrium real effective exchange rate, also in percentage points. A positive value for the exchange rate gap represents depreciation of AMD relative to the main trading partners currencies. By accounting for lags, the model acknowledges that policy changes do not instantaneously impact output.

The relative weight assigned to the forward- versus backward-looking components of output gap is determined by the structural characteristics of the economy. Specifically, the coeffi-

cients on the lagged (λ_{lag}) and forward-looking (λ_{ld}) output gap terms depend on the degree of economic rigidities. Economies with a significant share of investment goods production are likely to exhibit higher adjustment costs, resulting in greater inertia and thus a higher weight on lagged output. This reflects slower adjustment due to long production cycles and contractual rigidities. By contrast, economies dominated by flexible, service-based sectors, experience lower inertia, as output can adjust more rapidly in response to shocks. In such economies, the coefficient on the lagged output gap is smaller, and forward-looking behavior plays a greater role in output dynamics. Berg, Karam and Laxton (2006) suggest the coefficient on the forward-looking output gap to be usually small, ranging from 0.05 to 0.15, as forward-looking behavior is typically less dominant than inertia in explaining short-term output dynamics. Moreover, empirical evidence suggests that economies generally exhibit significant lags in the transmission of monetary policy (Havránek & Rusnák, 2013). Consequently, they claim that the combined effect coming from the real interest rate and real exchange rate gaps is typically small relative to the lagged output gap coefficient. They impose a range from 0.1 to 0.25 for the sum of coefficients on real interest rate gap and real exchange rate gap, while the coefficient on the lagged output gap is assumed to float between 0.5 to 0.9. The relative magnitude of λ_{LR} and λ_z depend on the openness of the economy. In relatively closed economies the effect of the real exchange rate gap diminishes, while in economies with higher degrees of openness, exchange rate channel plays a more significant role in transmitting external shocks to domestic output.

4.4 Dollarization and Effective Rates

Small open emerging economies are inherently exposed to external spillovers, and this vulnerability is amplified in the presence of dollarization. In its various forms, dollarization poses deep challenges to macroeconomic stability and reduces the effectiveness of domestic policy tools. Real dollarization, or currency substitution, refers to the use of a foreign currency, typically the USD, as a means of payment. This practice often emerges following episodes of hyperinflation or persistent nominal instability. As a result, exchange rate movements tend to pass through more strongly to domestic prices and the conduct of monetary policy is complicated by the presence of a bi-currency environment. Financial dollarization is characterized by the predominance of foreign currency in savings, deposits, and broader financial assets. This weakens domestic-currency financial intermediation and increases the economy's vulnerability to exchange-rate movements, especially in countries with shallow local-currency capital markets.²⁴ Countries with a floating exchange rate regime and export structures heavily dependent on internationally priced commodities often resist their currencies to adjust freely. This phenomenon, known as the “fear of floating”, stems from the presence of liability dollarization, that is the widespread holding of foreign currency-denominated debt. In such cases, sharp movements in the exchange rate can have destabilizing effects on sectoral balance sheets, undermining financial stability and depressing aggregate output (Reinhart, 2003). Moreover, in highly dollarized financial systems credit conditions are shaped not only by the domestic policy rate, but also by international interest rates to which these liabilities are linked. As a result, the effectiveness of monetary policy in steering domestic prices and

²⁴Yeyati (2021)

influencing aggregate demand is substantially constrained.²⁵

Honig (2012) modifies the standard IS curve by incorporating exchange rate fluctuations into the investment function, thereby capturing the contraction in investment and consumption that can arise under liability dollarization. More recently, Musa et al. (2024) emphasize that dollarization weakens the transmission of monetary policy and creates important valuation effects through foreign-currency-denominated public debt. Building on this literature, we argue that the interest rate relevant for aggregate demand in a highly dollarized economy is not the domestic policy rate alone, but a weighted average of the domestic policy rate and the effective foreign-currency borrowing cost faced by residents. This foreign-currency component reflects the foreign interest rate adjusted for expected depreciation of the domestic currency, country risk premium, and persistent inflation differentials vis-à-vis anchor economies, all of which shape the actual financing conditions faced by firms and households. This leads to the concept of a dollarization-adjusted effective interest rate, which better captures the actual financial conditions faced by economic agents in dollarized economies.

$$I_t^{Eff} = (1 - \sigma_t)I_t + \sigma_t(I_t^{US} + (\Delta\bar{Z}_t^{US} + \Pi_t^* - \Pi_t^{*US} + PREM_t)) \quad (18)$$

Where I_t is the domestic policy rate; I_t^{US} is the foreign (e.g., US) interest rate, $\Delta\bar{Z}_t^{US}$ is the real exchange rate trend depreciation against USD; Π_t^* and Π_t^{*US} are domestic and US inflation targets, respectively, $PREM$ is the country risk premium. We define The relative weight on the external financial conditions in the effective interest rate, σ , as the degree of dollarization.

Historical Dollariation in Armenia

Dollarization has been a persistent feature of the Armenian economy since the early 1990s, emerging during the country's economic transition and coinciding with the introduction of the national currency in 1993. Driven by hyperinflation, exchange rate depreciation, and weak financial institutions, both real and financial dollarization took root as the population substituted the volatile AMD with more stable foreign currencies. Initially, foreign currency use was dominant in everyday transactions (real sector), but by the late 1990s, it had spread to the banking sector, reaching a financial dollarization rate above 0.8 in the early 2000s. However, beginning in 2002, a downward trend emerged, supported by improved macroeconomic stability, legal reforms promoting the use of the AMD, and targeted efforts to reduce USD-denominated debt.

According to Grigoryan and Dallaqyan (2008), these policy measures helped move Armenia toward a lower and more stable dollarization equilibrium, with an optimal level estimated around 0.3 by 2005. Following the fluctuations caused by the Global Financial Crisis and the 2014 inflationary shock, dollarization in Armenia has gradually reduced in recent years, from almost 60 percent, stabilizing around 30-40%. This signals increasing trust in the local currency and the credibility of the Central Bank. This improvement is expected to have strengthened the monetary policy transmission mechanism, particu-

²⁵Vargas & Sanchez (2023)

larly through the exchange rate channel, thereby supporting greater economic stability. Nevertheless, dollarization continues to pose a challenge, as it weakens the connection between domestic monetary policy and broader macroeconomic outcomes.

Figure 9: Dollarization Dynamics in Armenia



Source: CBA

Note: D1-D5 are compiled based on the indicators of the Central Bank of Armenia, commercial banks and credit organizations.

D1 is the ratio of residents' foreign currency deposits and borrowings to the money supply

D2 is the ratio of foreign currency deposits and borrowings of residents to total deposits and borrowings of residents

D3 is the weight of foreign currency demand deposits and borrowings of resident individuals in total demand deposits and borrowings of resident individuals

D4 is the weight of foreign currency time deposits and borrowings of resident individuals in total time deposits and borrowings of resident individuals

D5 is the ratio of foreign currency loans to residents total loans

Despite substantial progress in strengthening the CBA's monetary policy framework, Armenia, like other emerging economies, continues to face transmission constraints stemming from its openness, external dependence, and regional vulnerability. Among these, dollarization remains one of the most important, as it weakens monetary policy autonomy and reduces the effectiveness of domestic policy instruments.²⁶

This became particularly evident during the period of the Federal Reserve's rate hikes beginning in December 2015, following nearly a decade of near-zero interest rates and unconventional policies aimed at stimulating the economy in the aftermath of the Global Financial Crisis. In that period, the debate intensified around whether open economies could implement autonomous monetary policies in a highly integrated global financial system, especially in the presence of dollarization (Obstfeld(2015), Rey (2015)). Obstfeld (2015) argues that financial globalization complicates policy trade-offs, limiting the ability of monetary policy to achieve its objectives effectively.²⁷ Following U.S. interest rate movements since 2015, Cac-

²⁶See Baliño, Bennett, and Borensztein (1999), Ize and Yeyati (2005), Grigoryan and Dallaqyan (2008), and Musa et al. (2024).

²⁷Obstfeld adopts a middle position between the extremes of the debate: unlike Woodford, who largely

eres et al. (2016) find that the independence of monetary policy in many emerging economies is partially compromised, with central banks partially following Fed's hawkish stance despite having low inflationary environment. They emphasize the importance of strong fiscal and monetary credibility, along with low levels of financial dollarization, in safeguarding policy autonomy. This discussion of autonomy naturally leads to the importance of institutional foundations, particularly the role of central bank independence and credibility. The latter plays a critical role: when a central bank is seen as credible, interest rates and exchange rates act as stabilizing mechanisms, helping to absorb shocks. In contrast, when credibility is weak, these same channels can intensify external vulnerabilities instead of cushioning them. Thus, high credibility can mitigate dollarization and its macroeconomic implications on the economy and increase monetary policy effectiveness. In our model, the degree of dollarization is inversely related to credibility index and has a minimum optimal threshold of $Doll_{min} = 30\%$, estimated for Armenian economy:

$$Doll_t = \beta Doll_{t-1} + (1 - \beta) Doll_{min} + \gamma^c \left[\gamma \cdot \min(\Delta C_t^{stock}, 0) + (1 - \gamma) \cdot \Delta C_t^{stock} \right]; \quad (19)$$

Where $\Delta C_t^{stock} = C_t^{stock} - C_{t-1}^{stock}$
 $Doll_{min} = 30\%$ floor

Both real and financial dollarization are widely found to be highly persistent and to display a ratchet, or hysteresis, property: because contracts, payment habits, balance-sheet positions, and risk perceptions adjust only sluggishly, dollarization rises quickly when confidence in the domestic currency erodes, yet recedes only slowly once confidence is restored²⁸. This specification embeds these features by endowing dollarization with its own inertia, ρ_σ , and an asymmetric response to the credibility stock, whereby a credibility loss, $\Delta C_t^{stock} < 0$, is transmitted to σ_t at the full rate $\rho_{c\sigma}$, while a credibility gain passes through only at the damped rate $\rho_{c\sigma}(1 - \gamma_c)$; the parameter γ_c thus governs the degree of downward rigidity—from a pure ratchet at $\gamma_c = 1$ to a symmetric response at $\gamma_c = 0$ —and the floor σ_{min} is preserved as the deterministic steady state, where $C^{stock} = 1$ and the credibility change is zero.

By subtracting inflation expectations, which are mainly formed through non-traded sticky prices, from nominal effective interest rate, we get real effective rate:

$$R_t^{Eff} = I_t^{Eff} - \Pi_t^{EXP}$$

dismisses globalization's impact on policy independence, and Rey (2015), who claims that monetary autonomy is essentially lost without capital controls, Obstfeld argues that EMEs retain some degree of monetary independence—particularly in the short term—but that long-term rates remain closely aligned with global financial conditions, thereby limiting overall policy effectiveness.

²⁸Guidotti and Rodriguez (1992) relate the persistence of dollarization to transaction and switching costs, arguing that once economic agents have adjusted contracts and payment practices toward foreign currency, they may have little incentive to return quickly to domestic currency. Uribe (1997) formalizes this idea through a hysteresis mechanism, in which the cost of using foreign currency declines with accumulated experience, so even temporary inflationary episodes can have lasting effects on currency substitution. Reinhart, Rogoff, and Savastano (2014) provide broad empirical evidence that dollarization often remains high even after successful disinflation, suggesting that confidence in the domestic currency is rebuilt only gradually.

The model incorporates a comprehensive treatment of the monetary transmission mechanism by distinguishing between the central bank's short-term policy rate and longer-term interest rates, which directly influence private-sector borrowing decisions. While the policy rate is explicitly set by the central bank, lending rates relevant to households and businesses depend significantly on market expectations of future policy rates, captured by the yield curve, and risk premiums reflecting uncertainty at longer maturities. This emphasizes the central bank's critical role in shaping market expectations through transparency and clear communication regarding future policy paths. Indeed, interest rates faced by consumers and firms, such as mortgage rates or corporate borrowing costs, are not directly controlled by the central bank but are anchored to government bond yields and adjusted by term premia that compensate investors for bearing duration and uncertainty risks. Thus, the effectiveness of monetary policy hinges on its ability to influence expected future short-term rates and the term premium embedded in the yield curve. To operationalize this transmission mechanism within the model, we employ a long-run effective interest rate, LR_t^{Eff} , following Laxton, Igityan, and Mkhatrishvili (2024), defined as a weighted combination of interest rates across different maturities.

$$LR_t^{Eff} = \lambda_1 R_t^{Eff,1} + \lambda_2 R_t^{Eff,2} + \lambda_4 R_t^{Eff,4} + \lambda_{12} R_t^{Eff,12} + \lambda_{20} R_t^{Eff,20} \quad (20)$$

Particularly, R_t^{Eff} , $R_t^{Eff,2}$, $R_t^{Eff,4}$, $R_t^{Eff,12}$ and $R_t^{Eff,20}$ are 1-quarter, 2-quarters (6-month), 4-quarters (1-year), 12-quarters (3-year) and 20-quarters (5-year) market interest rates. Consistent with the expectations hypothesis augmented with term premia, market interest rates ($R_t^{Eff,i}$) are defined as the sum of the expected path of future short-term interest rates and the corresponding term premium ($TERM_t^i$) for each maturity: This approach of introducing interest rates across various maturities in the long-term effective rate, reflects the heterogeneity of financial markets, where different segments of the market attach importance to interest rates of different maturities. For instance, real estate investors are primarily sensitive to long-term rates, while other sectors' players are more responsive to short-to medium-term rates. This differentiation across maturities arises because financial instruments, risk preferences, and policy transmission channels vary across sectors. As a result, capturing this heterogeneity through a weighted average helps ensure that the model better reflects how long-term expectations are formed and how monetary policy is transmitted across the yield curve.

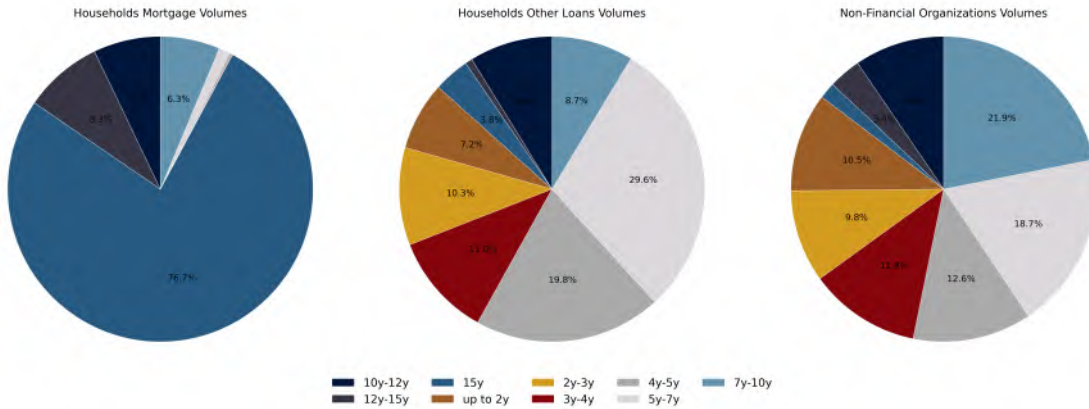
The expected interest rate for a specific maturity is the average of the future short-term interest rates for the respective horizon:

$$R_t^{Eff,i} = \frac{1}{i} \sum_{j=0}^{i-1} R_{t+j}^{Eff} + TERM_t^i \quad for \quad i \in \{2, 4, 12, 20\} \quad (21)$$

The weights on various maturity market rates can be analyzed by examining the AMD-denominated credit maturity structure, which is segmented across three categories: household mortgage loans, household other loans, and loans to non-financial organizations. Mortgage loans are heavily concentrated in long-term maturities, with the 15-year bucket alone accounting for AMD1.28 trillion (as of Dec. 2025), indicating the long-horizon nature of mortgage

commitments. In contrast, household loans outside of mortgages are more evenly distributed across maturities, with significant volumes in both short- and medium-term buckets such as 1–2 years and 4–7 years, while also maintaining a notable long-term component (Figure 10). This distribution suggests a mix of short-term consumption and medium-term investment financing. Loans to non-financial organizations exhibit the most balanced maturity structure, with significant amounts in both short-term and long-term categories, especially between 5 and 10 years.

Figure 10: Credit Maturity Structure in Armenia (AMD-Denominated Loans)



Source: CBA

Although most mortgage loans have long maturities, their interest rates are often linked to shorter-term benchmark yields, such as 6-month government bond rates in Armenia, with an additional spread reflecting credit risk and other factors. As a result, the 6-month rate can serve as an approximate indicator of mortgage rate dynamics, although it does not fully capture the longer-term component embedded in such contracts. In Armenia, long-term interest rates on deposits and loans have historically moved in line with policy rate changes and short-term government bond yields during both tightening and easing cycles, indicating a relatively effective monetary transmission mechanism (Figure 11). However, this alignment weakened in the post-COVID period. When the CBA began reducing rates in early 2020 to address the economic fallout from the pandemic, long-term rates declined only marginally. This divergence suggests that, despite easing policy expectations, elevated uncertainty and increased risk perceptions raised term premia, thereby limiting the pass-through of policy rate reductions to longer-term borrowing costs.

Term premiums are defined as AR(1) processes:

$$TERM_t^i = \rho_{term}^i TERM_{t-1}^i + (1 - \rho_{term}^i) TERM_{ss}^i + \rho_{term}^{\varepsilon, i} \varepsilon_t^{term} + \varepsilon_t^{term, i}, \quad i \in \{2, 4, 12, 20\} \quad (22)$$

We take ρ_{term}^i coefficients as 0.9, considering heavy persistence in term premium structure.

In modeling term premiums, we distinguish between two types of shocks to better capture the structure of the yield curve. The first is a common term premium shock, ε_t^{term} , which reflects the high degree of co-movement across maturities, represented by the coefficient $\rho_{term}^{\varepsilon, i}$ for

Figure 11: Yields of 6-month Government bonds and Mortgage Loans to Individuals

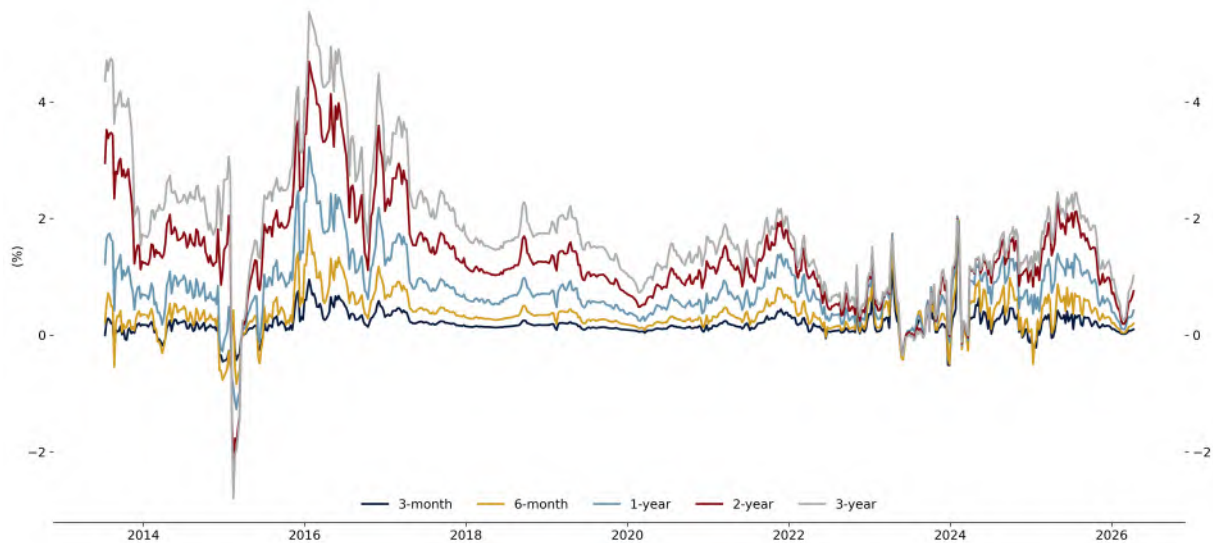
Source: CBA

various maturities indexed by i . This shock captures broad, market-wide factors that affect all segments of the yield curve simultaneously, generating shifts in its overall level. The second type is a maturity-specific term premium shock, $\varepsilon_t^{term,i}$, introduced to capture heterogeneity across maturities. In practice, different markets or investor groups may focus on distinct maturity ranges, leading to maturity-dependent pricing behavior and risk sensitivities. As a result, shocks may affect particular segments of the curve (e.g., short- or long-term maturities) without uniformly influencing others, thereby altering its slope or curvature. Including both types of shocks allows the model to capture both the strong co-movement of term premia across maturities and the idiosyncratic variations along the curve.

The expectations hypothesis provides the benchmark for interpreting long-term yields, implying that they reflect the expected path of future short-term rates. In practice, this relationship does not hold exactly, as long-term bonds expose investors to bear duration risk, giving rise to the term premium.

This distinction is central for policymaking. While central banks directly control short-term policy rates, financing conditions relevant for households, firms, and governments are determined by long-term yields. Because these yields embed both expectations and term premia, identical movements can carry different macroeconomic implications. Increases driven by expectations signal a repricing of the future policy path, whereas increases in term premia reflect a tightening in risk compensation, often linked to uncertainty, fiscal concerns, or market functioning.

Shocks to the term premium fall broadly into common factors, which shift compensation along the whole curve, and idiosyncratic factors, which operate on particular maturity segments.

Figure 12: Term Premium Structure

Source: CBA

Common shocks primarily reflect broad shifts in risk perception and macro uncertainty. Changes in global risk appetite are a key driver: when risk appetite collapses, safe-haven demand flows into Treasuries and Bunds and compresses term premia, as in the sharp fall in the ACM 10-year term premium through late 2008. Stress can also reverse the pattern, as in March 2020, when the initial flight to quality gave way to a "dash for cash" and even Treasuries were sold for liquidity, pushing premia higher. Inflation uncertainty is another central factor. When inflation is well anchored, term premia tend to be low or even negative, as bonds hedge adverse states; when inflation becomes volatile, long-duration assets become riskier and investors demand higher compensation, particularly at medium and long maturities. This was evident both during the Volcker disinflation and more recent 2022–2023 inflation surge. Monetary policy surprises and forward-guidance shocks affect term premia by altering uncertainty around the future policy path. The 2013 taper tantrum is the canonical example, when Bernanke's hint at a slowdown in asset purchases triggered a rise of more than 100 basis points in the 10-year Treasury yield over four months, largely reflecting term-premium repricing rather than revised short-rate expectations. Fiscal, growth, and long-horizon macro uncertainty concentrate their effects at the long end, where bonds are most exposed to far-forward risk. Anticipated increases in government debt issuance and uncertainty about future adjustment mechanisms lead investors to demand additional compensation. The 2023 Treasury tantrum illustrates this mechanism, with the 10-year term premium rising roughly 150 basis points in a single quarter amid a \$1.6 trillion deficit and debt near 100 percent of GDP. These common factors are reinforced by global financial spillovers such as US monetary policy and risk appetite.

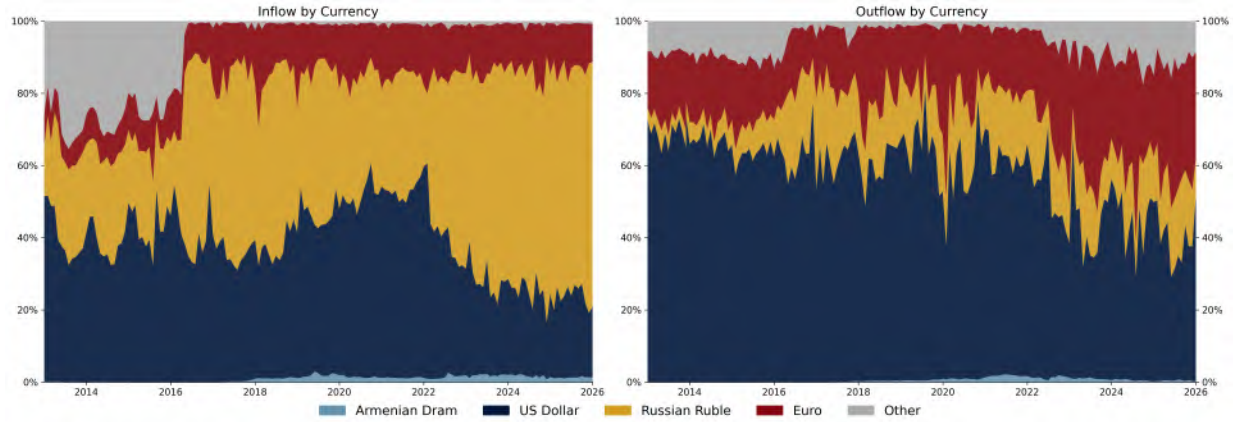
Figure 13: US Inflation, Term Premium and Unconventional Policy

Source: New York Fed, Fed

Idiosyncratic shocks affect specific maturity buckets or narrow segments of the curve, changing its slope or curvature. Investors are not indifferent across maturities — some are natural buyers of bills, others of 5- to 10-year notes, 30-year bonds, or inflation-linked securities. When arbitrageurs are balance-sheet constrained, local imbalances pass directly into local term premia. Local liquidity shocks raise yields when a bond becomes hard to trade, finance, or hedge, as in March 2020, when off-the-run 30-year Treasuries traded more than 30 bp cheap to on-the-run issues. Local supply shocks such as unexpected issuance or weak auction demand lift yields in the affected segment, while targeted purchases or reduced supply compress term premia. The limiting case is yield curve control, most notably the Bank of Japan's 10-year yield target, where policy effectively anchors the term premium at a specific maturity while allowing other parts of the curve to adjust. Preferred-habitat effects reflect the concentration of natural demand at specific points on the curve. Pension funds and insurers typically demand long-dated bonds, while banks and reserve managers favor shorter maturities. The forced withdrawal of such investors can produce sharp, localized yield moves, as in the September 2022 U.K. LDI episode, which required Bank of England intervention.

4.5 Exchange Rates and UIP

The Uncovered Interest Parity (UIP) condition is a cornerstone of international finance and monetary policy, especially for small open economies such as Armenia that are exposed to exchange rate fluctuations. The UIP posits that the difference in nominal interest rates between two countries should be equal the expected change in their exchange rates. In theory, this implies that an investor should earn equal returns from domestic and foreign assets once exchange rate movements are taken into account. For example, if domestic interest rates are higher than foreign rates, the domestic currency is expected to depreciate to neutralize the return differential and eliminate arbitrage opportunities. However, empirical evidence shows that UIP often fails to hold, especially in the short run (Fama, 1984 Chinn and Meredith, 2004). Exchange rates are driven by a range of factors beyond interest rate differentials,

Figure 14: Currency Structure of Individual Transfers: Inflows from Abroad and Outflows from Armenia via Armenian Banks

Source: CBA

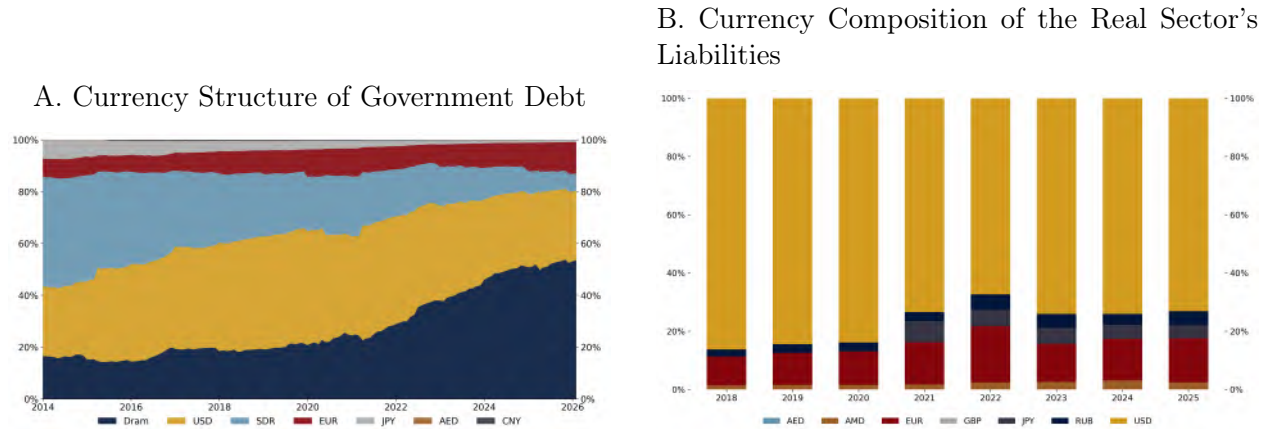
including investor behavior, market expectations, and global risk sentiment. These deviations have led to the development of a risk-adjusted UIP framework, which incorporates a risk premium to account for the additional compensation investors require for holding riskier assets. This risk premium reflects various country-specific and global factors such as market volatility, economic and political stability, and liquidity conditions. In particular, the liquidity risk premium captures the costs and uncertainties associated with entering or exiting positions in currency markets, including the impact of central bank interventions. In the model, the nominal exchange rate is determined through a modified UIP equation. This specification includes a weighted average of short-term nominal interest rates and long-term equilibrium nominal interest rates (comprising the long-run real interest rate and the inflation target) for both domestic and foreign economies. The domestic side of the equation is: $\rho \cdot RS + (1 - \rho)[\bar{R}R + \Pi^*]$, and the foreign side: $\rho \cdot RS^{US} + (1 - \rho)[\bar{R}R^{US} + \Pi^{*US}]$. The difference between expected and current spot exchange rates is scaled by four to align the annual interest rate and risk premium data with the quarterly exchange rate data.

$$\rho \cdot RS_t + (1 - \rho)[\bar{R}R_t + \Pi_t^*] = \rho \cdot RS_t^{US} + (1 - \rho)[\bar{R}R_t^{US} + \Pi_t^{*US}] + 4(S_t^{EXP} - S_t^{AMD/USD}) + PREM_t + fxPREM_t + \varepsilon_t^S \quad (23)$$

ε^S captures the noise in the data and distortions in the markets. The parameter ρ captures the degree of financial market development and central bank exchange rate management. A higher ρ indicates greater responsiveness of the exchange rate to short-term interest rates, typical of developed and liberalized financial systems. Conversely, a lower ρ implies a greater role for long-term fundamentals and more active exchange rate management by the monetary authority. In the case of developed financial markets and a freely floating exchange rate, ρ equals to 1 and we recover the standard risk-adjusted UIP equation.

In Armenia, as a small open emerging economy with dollarization, the majority of foreign-currency-denominated capital flows occur in USDs. This is evident in the dominance of USD-denominated financial indicators. In particular, the share of government debt in USD has consistently been the highest among all foreign currency exposures. Transfers from abroad sent to individuals through Armenian banks, as well as those sent from Armenia to other countries, are mainly conducted in USDs (Figure 14). Similarly, foreign currency-denominated deposits and loans within the domestic banking system which cover both financial and real sector transactions with non-residents, are predominantly held in USD (Figure 15 & 16). These include loans extended to and received from non-residents, as well as deposits placed with non-residents and those held by non-residents in domestic banks. These patterns support using the bilateral AMD/USD exchange rate, $S^{AMD/USD}$, in the UIP condition, as capital flows and balance sheet effects are mainly driven by U.S. interest rates and expectations related to the USD.²⁹

Figure 15: Currency Structure of Government Debt and Real Sector's Liabilities

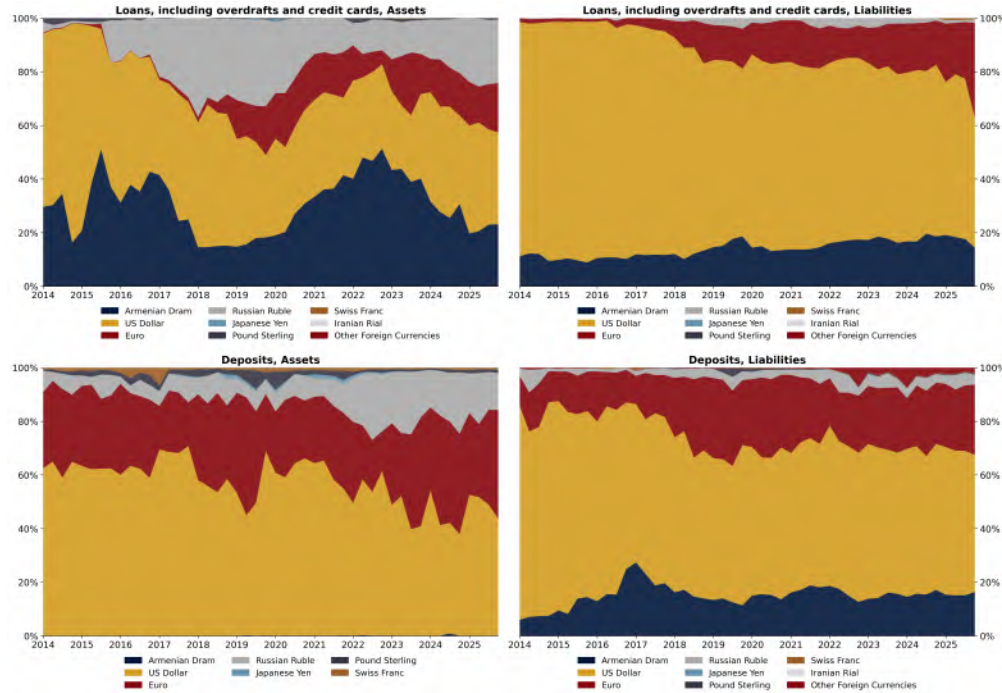


Source: CBA

In standard QPM settings, country risk premium, $PREM$, is represented as an AR(1) process. However, by incorporating imperfect credibility, we explicitly include a bias through the probability of entering high inflation regime, which reinforces the depreciation pressures by amplifying country risk premium. Having the stock of the probability of high inflation regime, rather than its flow incorporated, reflects the idea that sustained low credibility, captured by a persistently high probability of a high-inflation regime, discourages investment and raises investor risk aversion. As confidence erodes, foreign and domestic investors become more reluctant to hold local assets and invest within the country, demanding additional compensation for their investment and leading to increased capital outflows and a rise in the country risk premium. This elevated risk premium, in turn, can exert depreciation pressure on the local currency.

$$PREM_t = \rho^p PREM_{t-1} + (1 - \rho^p) \bar{PREM}_t + \rho_{high}^p \cdot prob_t^{High} + \varepsilon_t^{PREM} \quad (24)$$

²⁹The same strategy is applied by NBG. See Tvalodze et al. (2016).

Figure 16: Currency Composition of Financial Sector Loans and Deposits

Source: CBA

$\bar{PREM}_t$ is the trend component of $PREM$, defined as an AR(1) process itself.

$fxPREM_t$ is the premium, capturing the liquidity risk of currency market, including interventions. Instead of being modeled as an AR(1) process, it is influenced by the flow of dollarization, $\sigma_t - \sigma_{t-1}$. An increase in dollarization reflects a move away from the local currency, reducing its effective liquidity in the financial system. As more AMD is exchanged for USDs, both the demand for and willingness to hold AMD decline. This raises concerns about the ease with which AMD-denominated assets can be used or liquidated, prompting economic agents to demand a higher compensation for holding a currency that is becoming less liquid and less trusted. This results in an increase in liquidity risk premium. In effect, the increasing demand for foreign currency leads to a depreciation of the AMD and a rise in the cost of holding or transacting in local currency. It is important to emphasize that the flow of dollarization, rather than its stock, drives the dynamics of the liquidity risk premium. This approach captures dynamic pressure on liquidity more accurately. Under normal conditions, when dollarization remains stable, it has no impact on the premium. However, it is the change in dollarization, when households and firms start shifting their portfolios more toward foreign currency, that signals rising stress in the domestic currency market and increases liquidity concerns.

$$fxPREM_t = \rho^{fxp} fxPREM_{t-1} + \rho_{\sigma}^{fxp} \cdot (Doll_t - Doll_{t-1}) + \varepsilon_t^{fxPREM} \quad (25)$$

In standard economic frameworks, it is often assumed that exchange rates are determined

solely by fundamentals. This means that the exchange rate aligns each period with its expected real value, implying that financial markets operate in a fully forward-looking and rational manner. Under this assumption, market participants align exchange rate with economic conditions through rational expectations. However, real-world observations contradict this purely forward-looking behavior. Empirical studies and practical experience show that exchange rate movements are often sluggish and persistent. In reality, exchange rate markets display partial inertia, where past trends continue to influence current exchange rate behavior. Instead of immediately responding to changes in fundamentals, the exchange rate exhibits a degree of backward-looking behavior, revealing a mix of expectation formations among market participants. According to Benes et al. (2008), the pure forward-looking UIP fails to capture realistic exchange rate dynamics because it lacks persistence, causing exchange rates to jump erratically in response to shocks. This behavior is inconsistent with empirical evidence and distorts the transmission mechanism of monetary policy, making the model less useful for policy analysis, particularly in emerging markets where the exchange rate channel is crucial (Eichenbaum Evans, 1995). Their findings highlight that such unrealistic dynamics stem from the UIP condition's reliance on perfect foresight, which assumes agents instantly adjust to the full path of expected future interest rate differentials. In particular, purely rational expectations would force the exchange rate to instantly reflect the differential between domestic and foreign interest rates and shifts in risk premia, while the observed exchange rate shows smaller variations, suggesting the presence of gradual adjustments and adaptive behavior. The intuition of having backward-looking dynamics is in line with Berg, Karam and Laxton (2006), where they employ hybrid approach for exchange rate expectations. In our framework the market is a blend of two types of agents: some are backward-looking, relying on past exchange rate behavior, while others are forward-looking and form expectations based on economic fundamentals. Following Beneš, Vávra, and Vicek (2002), we model exchange rate expectations, S_t^{EXP} , as a hybrid of model-consistent (forward-looking) and myopic (backward-looking) expectations, consistent with the model behavior of the exchange rate in the long run. Myopic agents base their expectations on the last observation of exchange rate and update it by the nominal exchange rate trend depreciation.³⁰

$$S_t^{EXP} = \rho S_{t+1}^{AMD/USD} + (1 - \rho) \cdot \left[S_{t-1}^{AMD/USD} + \frac{2}{4} \Delta \bar{S}_t^{AMD/USD} \right] \quad (26)$$

The coefficient ρ , captures the degree of forward-looking behavior in the financial market, or, alternatively, the intensity of central bank interventions aimed at dampening short-term exchange rate fluctuations. Setting ρ equal to 1 yields the conventional purely forward-looking UIP formulation. The trend nominal depreciation, comprises the trend real exchange rate depreciation and inflation target differential between Armenia and US:

$$\Delta \bar{S}_t^{AMD/USD} = \Delta \bar{Z}_t^{AMD/USD} + \Pi_t^* - \Pi^{*US} \quad (27)$$

The real effective exchange rate (REER) is defined as the weighted average of a country's

³⁰Such specification is consistent with Resende et al. (2022), Benes et al. (2017), Al Mashat et al. (2018), Abradu-Otoo et al. (2022), Abradu-Otoo et al. (2024), Epstein et al. (2022), Musa et al. (2024), Tvalodze et al. (2016), and many others.

bilateral real exchange rates with its main trading partners, where the weights reflect each partner's relative importance in trade. In our model, we explicitly include the United States and represent all other trading partners as a composite group. Accordingly, the REER is constructed using the real exchange rate of Armenia vis-à-vis the USD and the composite partner group's exchange rate vis-à-vis the U.S. USD:

$$Z_t^{AMD/USD} = Z_t + (1 - \beta^{US} trade) Z_t^{PRT/USD} \quad (28)$$

Here, Z_t denotes the real effective exchange rate, where an increase implies a real depreciation of the AMD against the basket of currencies:

$$Z_t = S_t^{AMD/USD} + P F_t^{USD} - P_t^{Headline} \quad (29)$$

The term $P F_t^{USD}$ represents the foreign price index expressed in USD, defined as a weighted average of U.S. and partner-country price levels. Alternatively it can be expressed in inflation terms as $P F_t^{USD} = P F_{t-1}^{USD} + 4 \cdot \Pi_t^F$, where Π_t^F is the foreign inflation in USD:

$$P F_t^{USD} = \beta_{trade}^{US} P_t^{US} + (1 - \beta_{trade}^{US})(P_t^{PRT} - S_t^{PRT}) \quad (30)$$

$Z_t^{PRT/USD}$ captures the real exchange rate between the composite trading partner group and the USD:

$$Z_t^{PRT/USD} = S_t^{PRT/USD} + P_t^{US} - P_t^{PRT} \quad (31)$$

4.6 Monetary Policy

This section distinguishes between two monetary policy closures. We first present a conventional Taylor-type reaction function, which corresponds to the rule-based closure commonly used in earlier versions of the framework and serves as a useful benchmark for explaining the monetary transmission mechanism. However, the simulations in the extended framework developed in this paper are generated using a loss-function-based optimal policy closure. Thus, the reaction function below should be interpreted as a benchmark and a point of comparison, while the quadratic loss function represents the operative monetary policy closure in the new framework.

At first, we examine a monetary policy reaction function similar to that of Berg, Karam, and Laxton (2006):

$$RS_t = \lambda_{RSlag} RS_{t-1} + (1 - \lambda_{RSlag}) \cdot \left[\bar{R} R_t + \Pi 4_t^{EXP} + \lambda_{RS\pi} (\Pi_{t+4}^{CPI} - \Pi_t^*) + \lambda_{RSy} \hat{Y}_t \right] + \varepsilon_t^{RS} \quad (32)$$

In this specification, the policy rate RS_t responds gradually to economic conditions, with the degree of interest rate smoothing governed by λ_{RSlag} . The central bank adjusts the policy

rate toward a level determined by the equilibrium real interest rate $\bar{R}_t$, four-quarter-ahead expected inflation Π_t^{EXP} , the deviation of current inflation from its target $(\Pi_t^{CPI} - \Pi_t^*)$, and the output gap $\hat{Y}_t$. We assume that the central bank smooths interest rates, adjusting them gradually toward the desired level in response to deviations of inflation and output from their equilibrium values, with the smoothing parameter set at $\lambda_{RS\text{lag}} = 0.5$.

For the system to remain stable, the parameter $\lambda_{RS\pi}$ —capturing the response to inflation deviations—must be strictly positive. This aligns with the Taylor principle, according to which monetary authorities should react to inflation deviations from target sufficiently aggressively to anchor inflation expectations and keep inflation around the target.³¹ The optimal degree of responsiveness in the reaction function depends critically on the structural characteristics of the economy, particularly the degree of forward-looking behavior in price-setting. In economies where inflation expectations are well-anchored and firms and households adjust prices with foresight, smaller and more persistent adjustments in the interest rate can suffice to stabilize inflation. Conversely, in economies where inflation dynamics are more inertial or expectations are less anchored, more aggressive policy adjustments may be necessary to prevent inflation from drifting away from target. The cost of misjudging these structural features can be asymmetric: underestimating the required response in a more inertial economy can result in significant inflation instability. Therefore, a more cautious policy design that allows for stronger short-run responses may be preferable in uncertain environments, particularly to preserve credibility.

Laxton and Pesenti (2002) emphasize that while traditional policy rules, such as the Taylor (1993) rule, perform reasonably well in relatively closed economies, they tend to be inefficient in small open economies. This inefficiency stems from placing too little weight on inflation forecasts and too much on the output gap, making such rules less effective in environments characterized by high external volatility. In light of this, we incorporate a forward-looking inflation component into our rule, specifically, the four-quarter-ahead deviation of headline inflation from the target, $\Pi_{t+4}^{CPI} - \Pi_t^*$.

As the CBA enters the PRMAPS framework era, it becomes essential to conduct monetary policy in a risk-averse manner, guided by the principle of least regrets. In this context, the most appropriate policy response to prevent the economy from falling into a bad monetary equilibrium is to replace the rule-based closure by an optimal policy closure, represented by a quadratic loss function.³² This loss function is the closure used in the simulations reported in this paper. Conventional linear reaction rules become inadequate under conditions of heightened uncertainty. By contrast, a quadratic loss function offers a more effective risk-management strategy, particularly as the economy approaches the "dark corners" where nonlinearities and credibility risks intensify. This approach implies an increasingly forceful policy response as deviations from inflation and output targets become larger, thereby helping to stabilize expectations and maintain macroeconomic stability. In light of this, monetary policy is modeled as minimizing the following intertemporal loss function, subject to all equations and constraints of the economy:

³¹Freedman and Laxton (2009)

³²See: Adrian, Laxton, Obstfeld (2018), "Advancing Frontiers of Monetary Policy"

$$Loss = \sum_{j=0}^{\infty} \lambda^j \left[\omega_{\pi} (\Pi_t^{CPI} - \Pi_t^*)^2 + \omega_y \hat{Y}_t^2 + \omega_{rs} (RS_t - RS_{t-1})^2 + \omega_p (P_{t+j} - P_t^*)^2 \right] \quad (33)$$

λ^j is the discount rate, and the weights show how much importance policymakers place on different goals like inflation, output, and interest rate stability, $(RS_t - RS_{t-1})^2$, and price level stability, $(P_{t+j} - P_t^*)^2$. The latter term is perhaps the most controversial but should not be. The price level among Inflation targeting central banks also tends to be highly predictable. Such behavior has been described as luck where positive and negative shocks to inflation cancel each other out over time. There are many reasons why the central bank should care about the price level that are outlined in Kamenik et al. (2008) but all we are doing in this instance is making the price level consideration explicit versus implicit. However, the weight on the price level term is quite small so as not to take away from the overarching goal of the inflation target but is important to include nonetheless since it more accurately represents the preferences among policymakers. If there is a drift in price levels, monetary policy gradually compensates for it by responding to deviations from the target level with a small coefficient. This is because price levels, alongside inflation rates, can influence inflation expectations. Although we operate under an inflation-targeting framework, in cases where the price level has shifted upward due to, for example, supply shocks, policy needs to slightly undershoot inflation in subsequent periods. This helps bring the price level back toward the trajectory it would have followed under a counterfactual scenario without the shock. The same logic applies in reverse if the price level drifts downward. This kind of compensation is generally only necessary when price-level deviations arise from persistent, one-sided supply shocks. The principle of inflation targeting assumes that supply shocks are symmetric over time - sometimes inflationary, sometimes deflationary, and roughly equal in magnitude. If that symmetry holds, there's no need to adjust for price level drift, as these effects cancel out in the long run. However, if the shocks are not symmetric and instead cause a persistent drift in the price level, then a modest corrective response becomes necessary. This is why the monetary policy rule incorporates only a small coefficient on the price level gap - to allow gradual correction without undermining the inflation-targeting framework. It reflects the understanding that people tend to think in terms of price levels rather than growth rates, and unaddressed level shifts could distort inflation expectations over time.

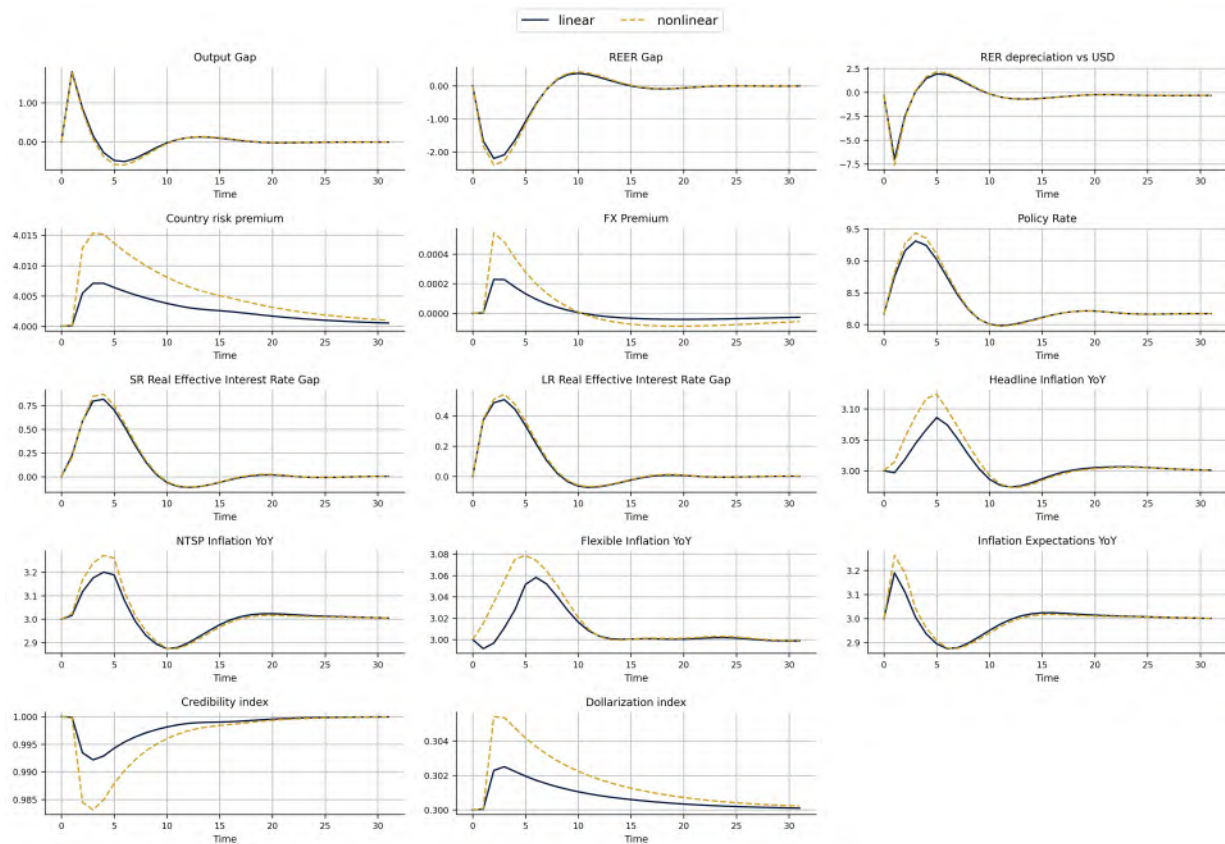
Monetary policy aims to minimize this loss function with respect to all the equations and constraints of the economy. The standard quadratic loss function assumes symmetric preferences, meaning that deviations above and below the inflation target or potential output are treated equally. In this setup, an inflation overshoot is penalized just as much as an undershoot, and both positive and negative output gaps carry the same weight. However, in practice, central banks often exhibit asymmetric preferences. For instance, policymakers may be more concerned about inflation falling below target than temporarily exceeding it (the case of Euro Area), or more focused on negative output gaps (recessions) than on modest overheating (Fed's case).

5 Model Exercises

In this section, we present model exercises that illustrate the key features and advantages of the EndoCred framework, which is designed to structure policy judgment rather than replace it.

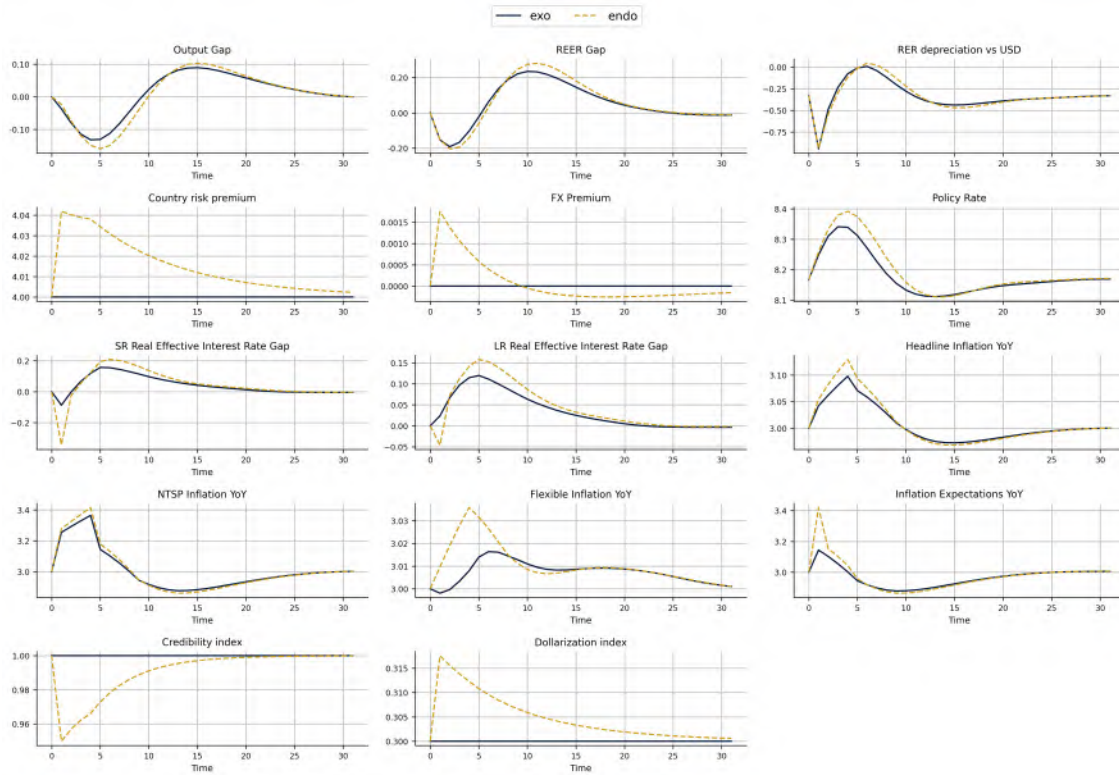
1. Linear vs. Nonlinear Phillips Curve under a 2% Output Gap Shock

The first exercise compares the model responses under linear and nonlinear Phillips curve specifications. The results illustrate the value of introducing nonlinear inflation dynamics, as the nonlinear version allows the model to capture tail-risk behavior more realistically. In particular, under a 2 percent aggregate demand shock, the nonlinear specification generates a stronger inflationary response than the linear version. This reflects the idea that inflation becomes more sensitive to demand pressures when the economy is already operating under stressed conditions, thereby requiring a stronger monetary policy response from the central bank. The exact magnitude of these responses is, of course, calibration-dependent and can be adjusted if the purpose of the exercise is to emphasize a stronger or more moderate nonlinear reaction. Nevertheless, the comparison highlights that the nonlinear specification makes the model more flexible and policy-relevant for analyzing scenarios involving elevated uncertainty and tail risks.



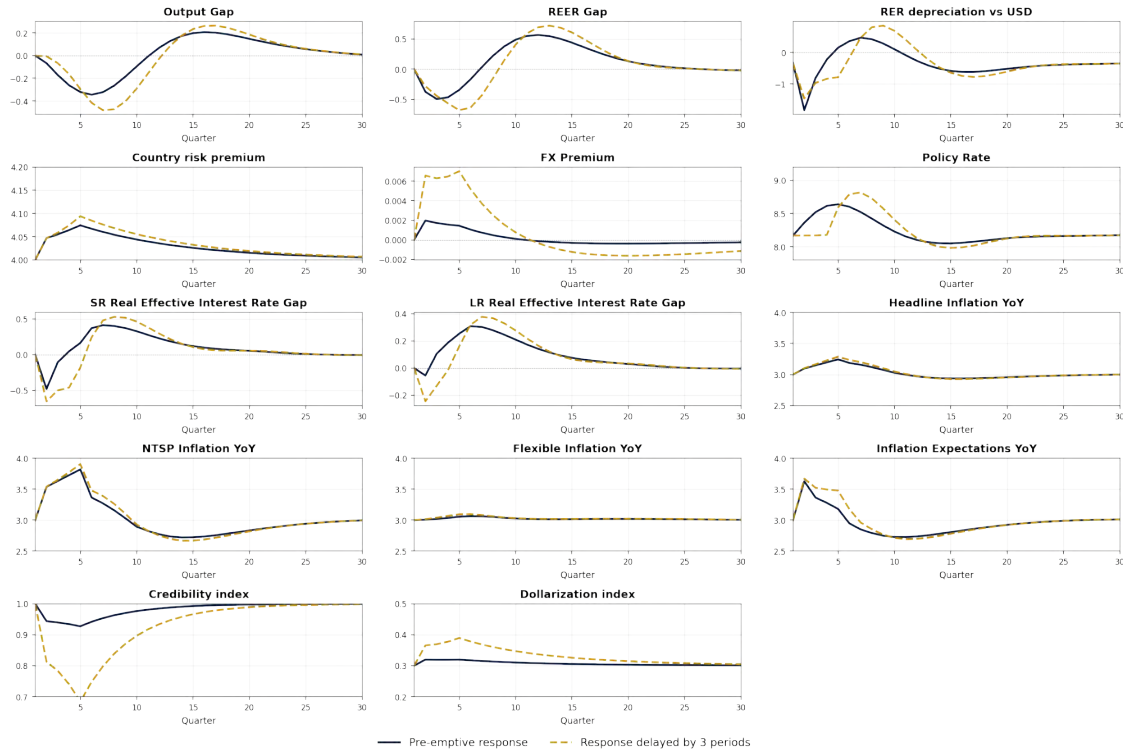
2. Exogenous vs Endogenous Credibility under a 1% NTSPI shock

The second exercise compares exogenous and endogenous monetary policy credibility settings. Under endogenous credibility, the model captures the implicit decline in credibility following an inflation shock, reflecting the risk of expectations becoming less anchored. This amplifies inflation persistence and requires a stronger monetary policy response to restore credibility and bring inflation back to target. In contrast, under exogenous credibility, this amplification channel is absent, leading to a more muted policy reaction.



3. Delayed vs Not delayed policy reaction under a 2% NTSPI shock

The third exercise compares timely and delayed monetary policy reactions. The results show that delaying the policy response under 2% shock to NTSPI makes inflation more persistent by weakening credibility and increasing the risk of expectations becoming disanchored. As a result, a stronger and more prolonged increase in the policy rate is required to bring inflation back to target. This worsens the inflation-output trade-off, as the delayed response raises the eventual output cost of restoring price stability.



6 Conclusion

This paper develops an EndoCred analytical framework extension of Armenia's Quarterly Projection Model to better support monetary policy analysis under newly developed PRMAPS framework. The framework moves beyond the traditional QPM by embedding endogenous policy credibility, nonlinear inflation dynamics, dollarization-sensitive transmission, long-term effective interest rates, and a loss-function-based monetary policy closure.

The main contribution of the paper is to show that credibility is not a fixed background assumption, but a state variable that evolves with policy performance. When credibility is strong, expectations are more forward-looking, inflation is less persistent, and the exchange rate and interest-rate channels operate more effectively as shock absorbers. When credibility weakens, expectations ratchet upward and become more backward-looking along with the rise in inflation persistence, country and liquidity risk premia increase, dollarization pressures intensify, and monetary policy becomes less effective. This makes the cost of restoring price stability larger, especially when policy action is delayed.

The model exercises highlight the policy relevance of these mechanisms. A nonlinear Phillips curve generates stronger inflationary pressures under overheated conditions than a linear specification, making it better suited for analyzing tail-risk scenarios. Endogenous credibility amplifies the consequences of inflation shocks by allowing expectations and risk premia to respond to policy performance. Finally, the comparison between timely and delayed policy responses shows that preserving credibility is less costly than rebuilding it after expectations have become disanchored.

Overall, the EndoCred framework provides a richer and more realistic analytical environment for a small open and partially dollarized economy such as Armenia. It strengthens the CBA's ability to evaluate alternative scenarios, assess policy trade-offs, and design decisions consistent with the principle of least regrets. The framework should therefore be viewed not as a replacement for judgment, but as a structured tool that supports clearer policy analysis, more transparent communication, and more robust monetary policy under uncertainty.

Future work should further refine the calibration of credibility, dollarization, and term-premium channels, strengthen the empirical grounding of the model parameters, and expand the use of historical and real-time scenarios. A separate documentation of the original QPM calibration would also improve transparency and provide a stronger benchmark for evaluating the added value of the EndoCred framework.

A Model Outline

A.1 Endogenous Variables

Table 1: Endogenous Variables

Dynare Notation	LaTeX Notation	Definition
<i>Inflation Variables</i>		
PIE_NTSPi	π^{ntspi}	QoQ Annualized NTSP Inflation
PIE_REG	π^{reg}	QoQ Annualized Regulated Services Inflation
PIE_FLEX	π^{flex}	QoQ Annualized Flexible Inflation
PIE_HEADLINE	π^{CPI}	QoQ Annualized Headline Inflation
PIE4_NTSPi	$\pi 4^{ntspi}$	YoY NTSP Inflation
PIE4_REG	$\pi 4^{reg}$	YoY Regulated Services Inflation
PIE4_FLEX	$\pi 4^{flex}$	YoY Flexible Inflation
PIE4_HEADLINE	$\pi 4^{CPI}$	YoY Headline Inflation
PIE_imp	π^{imp}	Imported Inflation
PIE_food_imp	$\pi^{food-imp}$	Imported Food Inflation
PIE_oil_imp	$\pi^{oil-imp}$	Imported Oil Inflation
PIE_PRT	π^{prt}	Partners excluding USA Inflation in Respective Currencies
PIE_F	π^F	Foreign Inflation
<i>Real Marginal Costs and Price Levels</i>		
RMC_NTSPi	RMC^{ntspi}	Real Marginal Cost of NTSPi
RMC_REG	RMC^{reg}	Real Marginal Cost of Regulated Services Inflation
RMC_FLEX	RMC^{flex}	Real Marginal Cost of Flexible Inflation
P_NTSPi	P^{ntspi}	Non Traded Sticky Price Level
P	P^{CPI}	CPI Price Index
P_REG	P^{reg}	Regulative Services Price Level
P_FLEX	P^{flex}	Flexible Price Level
P_food_imp	$P^{food-imp}$	Imported Food Prices
P_oil_imp	$P^{oil-imp}$	Imported Oil Prices
P_PRT	P^{prt}	Partners Excluding USA CPI in Respective Currencies
P_F	P^F	Foreign Price Level
<i>Relative Prices</i>		
RP_REG	RP^{reg}	Relative Price of Regulative Services vs Headline
RP_FLEX	RP^{flex}	Relative Flexible Price vs Headline

Table 1 – continued

Dynare Notation	LaTeX Notation	Definition
RP_REG_t	$\bar{R}P^{reg}$	Regulative Services Relative Price Trend
gRP_REG_t	$g\bar{R}P^{reg}$	Persistence in Regulated Services Relative Price Trend
RP_REG_g	$\hat{R}P^{reg}$	Regulative Services Relative Price Gap
RP_FLEX_t	$\bar{R}P^{flex}$	Flexible Relative Price Trend
gRP_FLEX_t	$g\bar{R}P^{flex}$	Persistence in the Trend of Flexible Relative Price
RP_FLEX_g	$\hat{R}P^{flex}$	Flexible Relative Price Gap
<i>Oil and Food Prices</i>		
qoil	$qoil$	Real Price of Oil
qoil_t	$\bar{qoil}$	Trend in Real Price of Oil
d_qoil_t	$\Delta\bar{qoil}$	QoQ Annualized Growth of Oil Price Trend
qoil_g	$\hat{qoil}$	Gap of Real Price of Oil
PFoil	PF^{oil}	Price of Oil
qfood	$qfood$	Real Price of Food
qfood_t	$\bar{qfood}$	Trend of Real Price of Food
d_qfood_t	$\Delta\bar{qfood}$	QoQ Annualized Growth in Real Food Price Trend
qfood_g	$\hat{qfood}$	Gap of Real Price of Food
PFfood	PF^{food}	Price of Food
<i>Inflation Expectations and Credibility</i>		
EPS_PIE_NTSPi	EPS^π	Serially Correlated Sticky Inflation Shock
PIE_NTSPi_EXP	π^{exp}	Non Traded Sticky Price Inflation Expectations
PIE_DEV_TAR	ε^{TAR}	Deviation of Inflation from Optimistic Expectations
PIE_DEV_HIGH	ε^{HIGH}	Deviation of Inflation from Expectations Towards High Inflation Regime
PIE_DEV_LOW	ε^{LOW}	Deviation of Inflation from Expectations Towards Low Inflation Trap
P_HIGH	P^{HIGH}	Probability of High Inflation Regime
P_LOW	P^{LOW}	Probability of Low Inflation Regime
C_FLOW	C^{FLOW}	Flow of Credibility
C	C	Credibility
EPS_PIE_NTSPi_EXP	EPS^{exp}	Serially Correlated Non-Traded Sticky Inflation Expectations Shock
EPS_C	EPS^C	Serially Correlated Credibility Shock

Table 1 – continued

Dynare Notation	LaTeX Notation	Definition
PIE_STAR	π^*	Time Varying Inflation Target
<i>Output and Real Activity</i>		
Y	$\hat{Y}$	Output Gap
RR_GAP	$\hat{R}\bar{R}$	Real Interest Rate Gap
Y_WORLD	$\hat{Y}^W$	World Output Gap
EPS_Y	$EPS^{\hat{Y}}$	Serially Correlated Output Gap Shock
CUMSUMY	$CUM^{\hat{Y}}$	Cumulative Output Gap
DL_GDP	ΔGDP	QoQ Annualized Log Growth of Real GDP
DL_GDP_BAR	$\Delta \bar{GDP}$	QoQ Annualized Log Growth of Potential GDP
G_GDP_BAR	$g\bar{GDP}$	Persistence in Potential GDP
<i>Unemployment</i>		
UNR_GAP	$\hat{U}$	Unemployment Gap
UNR_BAR	$\bar{U}$	NAIRU
UNR	U	Unemployment Rate
G_UNR	$g\bar{U}$	Persistent Component in NAIRU
EPS_UNR_BAR	$EPS^{\bar{U}}$	Serially Correlated NAIRU Shock
<i>Interest Rates and Term Premia</i>		
RS	RS	Policy Rate
TERM6M	$Term_2$	6-Month Term Premium
TERM1Y	$Term_4$	1-Year Term Premium
TERM2Y	$Term_8$	2-Year Term Premium
TERM3Y	$Term_{12}$	3-Year Term Premium
TERM5Y	$Term_{20}$	5-Year Term Premium
TERM10Y	$Term_{40}$	10-Year Term Premium
RR	RR	Short Term Real Interest Rate
RR_BAR	$\bar{R}\bar{R}$	Real Interest Rate Trend
<i>Effective Interest Rates</i>		
EFF_RS	RS^{eff}	Effective Nominal Interest Rate
EFF_RR	RR^{eff}	Effective Real Rate
EFF_RR_g	$\hat{R}\bar{R}^{eff}$	Effective Real Rate Gap
EFF_RR_BAR	$\bar{R}\bar{R}^{eff}$	Effective Real Rate Trend
sigma	σ	Dollarization Parameter
EFF_RR6m	$RR2^{eff}$	6-Month Expected Effective Real Interest Rate

Table 1 – continued

Dynare Notation	LaTeX Notation	Definition
EFF_RR4	$RR4^{eff}$	1-Year Expected Effective Real Interest Rate
EFF_RR12	$RR12^{eff}$	3-Year Expected Effective Real Interest Rate
EFF_RR20	$RR20^{eff}$	5-Year Expected Effective Real Interest Rate
EFF_RR40	$RR40^{eff}$	10-Year Expected Effective Real Interest Rate
EFF_RR_BAR6m	$R\bar{R}2^{eff}$	6-Month Expected Effective Real Interest Rate Trend
EFF_RR_BAR4	$R\bar{R}4^{eff}$	1-Year Expected Effective Real Interest Rate Trend
EFF_RR_BAR12	$R\bar{R}12^{eff}$	3-Year Expected Effective Real Interest Rate Trend
EFF_RR_BAR20	$R\bar{R}20^{eff}$	5-Year Expected Effective Real Interest Rate Trend
EFF_RR_BAR40	$R\bar{R}40^{eff}$	10-Year Expected Effective Real Interest Rate Trend
EFF_LR	LR^{eff}	Long-run Effective Real Interest Rate
EFF_LR_BAR	$\bar{L}R^{eff}$	Long-run Effective Real Interest Rate Trend
EFF_LR_GAP	$\hat{L}R^{eff}$	Long-run Effective Real Interest Rate Gap
<i>Monetary Policy and Loss Function</i>		
EPS_RS	EPS^{RS}	Serially Correlated Monetary Policy Shock
LOSS	$LOSS$	Loss Function
PIE_GAP	π^{gap}	Inflation Deviation from its Target
DRS	ΔRS	Swings in Policy Rate
P_GAP	P^{gap}	Price Level Gap
DC	ΔC	Changes in Credibility
YNEG	$\hat{Y}^{neg}$	Negative Output Gap
PGAPNEG	P^{ngap}	Negative Price Level Gap
DCNEG	ΔC^{neg}	Negative Changes in Credibility
<i>External Sector and Risk Premia</i>		
PREM	$PREM$	Risk Premium
RR_US	RR^{US}	US Real Interest Rate
RS_US	RS^{US}	US Interest Rate
RR_BAR_US	$\bar{R}R^{US}$	US Real Neutral Rate

Table 1 – continued

Dynare Notation	LaTeX Notation	Definition
PREM_BAR	$\overline{PREM}$	Risk Premium Trend
FX_PREM	$fxPREM$	Liquidity Risk Premium
PIE_US	π^{US}	US Inflation
P_US	P^{US}	US Price Level
<i>Exchange Rates</i>		
Z	Z	Real Exchange Rate
Z_g	$\hat{Z}$	Real Exchange Rate Gap
Z_t	$\bar{Z}$	Real Exchange Rate Trend
dZ	ΔZ	RER Depreciation
dZ_t	$\Delta \bar{Z}$	RER Trend Depreciation
Z_US	Z^{US}	RER vs USD
Z_US_g	$\hat{Z}^{US}$	RER Gap vs US
Z_US_t	$\bar{Z}^{US}$	RER Trend vs US
dZ_US	ΔZ^{US}	Change in RER vs US
dZ_US_t	$\Delta \bar{Z}^{US}$	RER Trend Depreciation vs US
Z_PRT	Z^{prt}	RER Partners vs USA (increase is appreciation of USD)
Z_PRT_g	$\hat{Z}^{PRT}$	RER Gap Partners vs USA
Z_PRT_t	$\bar{Z}^{PRT}$	RER Trend Partners vs USA
dZ_PRT	ΔZ^{PRT}	RER Depreciation Partners vs USA
dZ_PRT_t	$\Delta \bar{Z}^{PRT}$	RER Trend Depreciation Partners vs USA
S	S	Nominal Exchange Rate
dS	ΔS	Nominal Exchange Rate Depreciation
S_exp	S^e	Expected Nominal Exchange Rate
S_PRT	S^{prt}	Nominal Exchange Rate, Partners
dS_PRT	ΔS^{prt}	Nominal Exchange Rate Change, Partners

A.2 Exogenous Variables

Table 2: Exogenous Variables

Dynare Notation	LaTeX Notation	Definition
<i>Inflation Shocks</i>		
E_PIE_NTSPi	ε_{ntsp}^π	Serially Uncorrelated Sticky Inflation Shock

Table 2 – continued

Dynare Notation	LaTeX Notation	Definition
E_EPS_PIE_NTSPi	ε_{eps}^{ntsp}	Shock to Serially Correlated Sticky Inflation Shock
E_PIE_REG	ε_{reg}^{π}	Regulated Services Inflation Shock
E_PIE_FLEX	ε_{flex}^{π}	Flexible Inflation Shock
E_RPREG_t	ε_{reg}^{RP}	Shock to Regulated Services Relative Price Trend
E_RPFLEX_t	ε_{flex}^{RP}	Shock to Flexible Relative Price Trend
E_gRPREGt	ε_{reg}^{gRP}	Persistence Shock to Regulated Services Relative Price Trend
E_gRPFLEXt	ε_{flex}^{gRP}	Persistence Shock to Flexible Relative Price Trend
<i>Commodity Price Shocks</i>		
E_d_qoil_t	ε_{oil}^{dqt}	Shock to Growth of Oil Price Trend
E_d_qfood_t	ε_{food}^{dqt}	Shock to Growth of Food Price Trend
E_qoil_g	ε_{oil}^{qg}	Shock to Oil Price Gap
E_qfood_g	ε_{food}^{qg}	Shock to Food Price Gap
<i>Credibility and Expectations Shocks</i>		
E_C	ε^C	Serially Uncorrelated Credibility Shock
E_EPS_C	ε_{eps}^C	Shock to Serially Correlated Credibility Shock
E_PIE_NTSPi_EXP	$\varepsilon_{ntsp,e}$	Serially Uncorrelated Inflation Expectations Shock
E_EPS_PIE_NTSPi_EXP	$\varepsilon_{eps}^{ntsp,e}$	Shock to Serially Correlated Inflation Expectations Shock
E_PiESTAR	ε^{π^*}	Shock to Time Varying Inflation Target
<i>Output and Labour Market Shocks</i>		
E_Y	ε^Y	Serially Uncorrelated Output Gap Shock
E_EPS_Y	ε_{eps}^Y	Shock to Serially Correlated Output Gap Shock
E_DL_GDP_BAR	$\varepsilon^{\bar{Y}}$	Potential GDP Level Shock
E_G_GDP_BAR	$\varepsilon_{\bar{G}}$	Potential GDP Growth Shock
E_UNR_GAP	$\varepsilon^{\bar{U}}$	Unemployment Gap Shock
E_UNR_BAR	$\varepsilon^{\bar{U}}$	Serially Uncorrelated NAIRU Shock
E_UNR_G	ε^{UG}	Shock to NAIRU Persistence
E_EPS_UNR_BAR	$\varepsilon_{eps}^{\bar{U}}$	Shock to Serially Correlated NAIRU Shock
<i>Interest Rate and Term Premium Shocks</i>		
E_TERM	ε^{Term}	General Term Premium Shock

Table 2 – continued

Dynare Notation	LaTeX Notation	Definition
E_TERM6M	ε^{Term_2}	6-Month Term Premium Shock
E_TERM1Y	ε^{Term_4}	1-Year Term Premium Shock
E_TERM2Y	ε^{Term_8}	2-Year Term Premium Shock
E_TERM3Y	$\varepsilon^{Term_{12}}$	3-Year Term Premium Shock
E_TERM5Y	$\varepsilon^{Term_{20}}$	5-Year Term Premium Shock
E_TERM10Y	$\varepsilon^{Term_{40}}$	10-Year Term Premium Shock
E_RR_BAR	$\varepsilon^{\bar{R}R}$	Serially Uncorrelated Shock to Real Neutral Rate
E_EPS_RS	ε_{eps}^{RS}	Shock to Serially Correlated Monetary Policy Shock
<i>External and Exchange Rate Shocks</i>		
E_PREM	ε^{PREM}	Shock to Risk Premium
E_FX_PREM	ε^{fxPREM}	Shock to Liquidity Risk Premium
E_RR_BAR_US	$\varepsilon_{US}^{\bar{R}R}$	Shock to US Real Neutral Rate
E_Y_WORLD	ε^{Y^*}	Shock to World Output Gap
E_RR_US	ε_{US}^{RR}	Shock to US Real Interest Rate
E_RS_US	ε_{US}^{RS}	Shock to US Nominal Interest Rate
E_PREM_BAR	ε^{PREM}	Shock to Risk Premium Trend
E_PIE_US	ε_{US}^{π}	Shock to US Inflation
E_PIE_PRT	ε_{prt}^{π}	Shock to Partners Inflation
E_Z_t	$\varepsilon^{\bar{Z}}$	Shock to RER Trend
E_dZ_t	$\varepsilon^{d\bar{Z}}$	Shock to RER Trend Depreciation
E_dZ_PRT_t	$\varepsilon_{prt}^{d\bar{Z}}$	Shock to Partners RER Trend Depreciation
E_Z_PRT_g	$\varepsilon_{prt}^{\hat{Z}}$	Shock to Partners RER Gap
E_S	ε^S	Shock to Nominal Exchange Rate
E_EFF_RR_BAR	$\varepsilon_{eff}^{\bar{R}R}$	Shock to Effective Real Interest Rate Trend

A.3 Parameters

"The Federal Reserve should, some conclude, attempt to be more formal in its operations by tying its actions solely to the prescriptions of a formal policy rule. That any approach along these lines would lead to an improvement in economic performance, however, is highly doubtful. Our problem is not the complexity of our models but the far greater complexity of a world economy whose underlying linkages appear to be in a continual state of flux. Rules by their nature are simple, and when significant and shifting uncertainties exist in the economic environment, they cannot substitute for risk-management paradigms, which are far better suited to policymaking."

— Alan Greenspan (2003)

The reported calibration should be interpreted as an analytical representation of the model environment rather than as a mechanical description of the central bank’s policy rule. Each model provides a structured framework for scenario analysis, but it does not necessarily represent the central bank’s rule, which is based on the management of a broad set of risks and uncertainties in the economy. We therefore disclose the economic logic underlying the model structure and selected calibration choices while recognizing that policy judgment remains an essential component of the decision-making process, as policymakers continually assess a broad range of risks, uncertainties, and evolving economic conditions. This strategy is consistent with a risk-management approach to monetary policy. As emphasized by Greenspan (2003), a policy action that appears optimal in one model may not remain optimal once broader uncertainty is taken into account. Accordingly, the framework is intended to support disciplined policy analysis while preserving the discretion needed to respond to risks, uncertainty, and evolving economic conditions.

Table 3: Parameters

Dynare Notation	LaTeX Notation	Definition	Calibration
<i>Phillips Curve Parameters</i>			
n_alpha1	α_1^n	Persistence in NTSPI PC	0.65
n_alpha2	α_2^n	Coefficient of RMC in NTSPI PC	0.35
n_alpha3	α_3^n	Weight on the Output Gap in the NTSPI RMC vs the Relative NTSPI Price Gap	0.6
r_alpha1	α_1^r	Coefficient of Inflation Target in Regulated Services PC	1
r_alpha2	α_2^r	Coefficient on RMC under Regulated Services Prices in the Regulated Service-price PC	1.5
f_alpha1	α_1^f	Persistence in Flexible-Price PC	0.5
f_alpha2	α_2^f	Coefficient on RMC under Flexible Prices in the Flexible-Price PC	0.2
f_alpha3	α_3^f	Coefficient of Imported Inflation in Flexible-Price PC	0.028
f_alpha4	α_4^f	Coefficient of Imported Food Inflation in Flexible-Price PC	0.012
f_alpha5	α_5^f	Coefficient of Imported Oil Inflation in Flexible-Price PC	0.01
f_alpha6	α_6^f	Coefficient of Relative Flexible Price Gap in Flexible RMC	0.24

Table 3 – continued

Dynare Notation	LaTeX Notation	Definition	Calibration
f_alpha7	α_7^f	Coefficient of Output Gap in Flexible RMC	0.8
f_alpha8	α_8^f	Coefficient of RER Gap vs US in Flexible RMC	0.03
f_alpha9	α_9^f	Coefficient of RER Change Deviation from SS Trend in Flexible RMC	0.01
f_alpha10	α_{10}^f	Coefficient of Real Oil Price Gap in Flexible RMC	0.1
f_alpha11	α_{11}^f	Coefficient of Real Food Price Gap in Flexible RMC	0.1
<i>Commodity Price Parameters</i>			
alpha1_oil	α_1^{oil}	Persistence in Real Oil Price Trend Growth	0.9
alpha2_oil	α_2^{oil}	Persistence in Real Oil Price Gap	0.75
alpha1_food	α_1^{food}	Persistence in Real Food Price Trend Growth	0.85
alpha2_food	α_2^{food}	Persistence in Real Food Price Gap	0.75
<i>Headline Inflation Weights</i>			
w_ntspi	w_{ntspi}	NTSPI Weight in Headline	0.1718
w_reg	w_{reg}	Weight of Regulated Prices in Headline	0.13
<i>Steady State Values</i>			
d_qoil_ss	$dq\bar{oil}^{ss}$	Steady State of Oil Price Trend Growth	0
d_qfood_ss	$dq\bar{food}^{ss}$	Steady State of Food Price Trend Growth	0.5
EXCH_TREND_SS	$d\bar{REER}^{ss}$	Steady State REER Trend Quarterly Depreciation	-0.4557
<i>Persistence Parameters</i>			
gamma_1	γ_1	Persistence of Sticky Inflation Shock	0.5
gamma_2	γ_2	Persistence of Credibility Shock	0.5
gamma_3	γ_3	Persistence of Inflation Expectations Shock	0.2
gamma_4	γ_4	Persistence in Output Gap Shock	0.5

Table 3 – continued

Dynare Notation	LaTeX Notation	Definition	Calibration
gamma_5	γ_5	Persistence in NAIRU Shock	0.5
gamma_6	γ_6	Persistence in Monetary Policy Shock	0.5
<i>Credibility and Inflation Regime Parameters</i>			
delta	δ	Credibility Persistence Parameter	0.8
delta_1	δ_1	Inflation Persistence under Optimistic Expectations	0.9
delta_2	δ_2	Inflation Persistence under Expectations of High Inflation Regime	0.9
delta_3	δ_3	Inflation Persistence under Expectations of Low Inflation Trap	0.9
delta_4	δ_4	Persistence in Inflation Target	0.9
PIEDOUBLESTAR	π^{**}	Inflation Target	3
PIE_HIGH	π^{high}	Inflation in High Inflation Regime	7
PIE_LOW	π^{low}	Inflation in Low Inflation Trap Regime	-1
kappa_high	κ^{high}	Parameter of Inflation Bias Towards High Inflation Regime in Expectations	0.3
kappa_low	κ^{low}	Parameter of Inflation Bias Towards Low Inflation Regime in Expectations	-0.3
<i>Output Gap Equation Parameters</i>			
lambda_1	λ_1	Parameter on Lead in Output Gap Equation	0.12
lambda_2	λ_2	Parameter on Lag in Output Gap Equation	0.7
lambda_3	λ_3	Parameter on SR/LR Real Interest Rate Gap in Output Gap Equation	0.18
lambda_4	λ_4	Parameter on Real Exchange Rate Gap in Output Gap Equation	0.15
lambda_5	λ_5	Parameter on World Output Gap in Output Gap Equation	0.12
<i>GDP and Labour Market Parameters</i>			

Table 3 – continued

Dynare Notation	LaTeX Notation	Definition	Calibration
theta_1	θ_1	Persistence in GDP Potential	0.8
theta_2	θ_2	Persistence in GDP Persistence Component	0.8
GROWTH_SS	$GROWTH^{ss}$	Long Run GDP Growth	5
theta_3	θ_3	Persistence in Unemployment Gap	0.8
theta_4	θ_4	Coefficient of Output Gap in Unemployment Gap Equation	0.15
theta_5	θ_5	Coefficient of Expected Output Gap in Unemployment Gap Equation	0.05
UNR_BAR_SS	$\bar{U}^{ss}$	Steady State Level of NAIRU	13
theta_6	θ_6	Persistence in NAIRU Persistence	0.6
<i>Interest Rate and Dollarization Parameters</i>			
rho_EFFR_BAR	ρ^{eff}	Effective Real Interest Rate Trend Persistence	0.5
DOLL	$DOLL$	Dollarization Response to Credibility Changes	0.35
rho_doll1	ρ_1^{doll}	Dollarization Persistence	0.9
rho_doll2	ρ_2^{doll}	Dollarization asymmetry	0.9
TERM6M_SS	$term2^{ss}$	6-Month Steady State Term Premium	0.05
TERM1Y_SS	$term4^{ss}$	1-Year Steady State Term Premium	0.10
TERM2Y_SS	$term8^{ss}$	2-Year Steady State Term Premium	0.20
TERM3Y_SS	$term12^{ss}$	3-Year Steady State Term Premium	0.3
TERM5Y_SS	$term20^{ss}$	5-Year Steady State Term Premium	0.50
TERM10Y_SS	$term40^{ss}$	10-Year Steady State Term Premium	1
RHO_TERM6M	ρ^{term2}	Persistence in 6-Month Term Premium	0.90
RHO_TERM1Y	ρ^{term4}	Persistence in 1-Year Term Premium	0.90
RHO_TERM2Y	ρ^{term8}	Persistence in 2-Year Term Premium	0.90
RHO_TERM3Y	ρ^{term12}	Persistence in 3-Year Term Premium	0.90

Table 3 – continued

Dynare Notation	LaTeX Notation	Definition	Calibration
RHO_TERM5Y	ρ^{term20}	Persistence in 5-Year Term Premium	0.90
RHO_TERM10Y	ρ^{term40}	Persistence in 10-Year Term Premium	0.90
RR_BAR_STAR	$\bar{RR}^*$	Steady State Real Neutral Interest Rate	5.1675
<i>Exchange Rate and External Parameters</i>			
RR_BAR_STAR_US	$\bar{RR}_{US}^*$	US Real Equilibrium Interest Rate	1.5
PREM_BAR_STAR	$\bar{PREM}^*$	Equilibrium Risk Premium	4
rho_1	ρ_1	Persistence in RER Trend Depreciation / Partners vs US	0.85
rho_2	ρ_2	Persistence in Real Exchange Rate Gap / Partners vs US	0.7
rho_3	ρ_3	Persistence in Partners Inflation	0.86
rho_4	ρ_4	Persistence in RER /Effective/ Trend Depreciation	0.95
rho	ρ	UIP Parameter	1
rho_5	ρ_5	Lead Parameter in Expected Exchange Rate	0.7
rho_6	ρ_6	Persistence in Country Risk Premium	0.9
rho_7	ρ_7	Coefficient of Country Risk Bias	0.05
rho_8	ρ_8	Persistence in Country Risk Premium Trend	0.9
rho_9	ρ_9	Persistence in Liquidity Risk Premium	0.9
rho_10	ρ_{10}	Coefficient of Liquidity Risk Bias Change	0.1
PIE_STAR_US	π_{US}^*	US Inflation Target	2.4
trade_AM_US	$trade^{US}$	US Share in Trade	0.0525
<i>Additional Steady State Parameters</i>			
dRP_REG_SS	$\bar{RP}_{reg}^{ss}$	Steady State Relative Price of Regulated Services	0
dRP_FLEX_SS	$\bar{RP}_{flex}^{ss}$	Steady State Flexible Relative Price	0
PIE_PRT_SS	π_{prt}^{ss}	Steady State Partners Inflation	4
dZ_PRT_SS	dZ_{prt}^{ss}	Steady State RER Depreciation Partners	0.13

Table 3 – continued

Dynare Notation	LaTeX Notation	Definition	Calibration
dZ_US_t_SS	$\Delta \bar{Z}_{US}^{ss}$	Steady State Value for RER Trend Change vs US	-0.3325
RS_SS	RS^{ss}	Steady State Nominal Interest Rate	8.1675
sigma_min	σ_{min}	Minimum Value for Dollarization	0.3
RS_US_SS	RS_{US}^{ss}	Steady State Value for Nominal Interest Rate for US	3.9
EFF_RR_BAR_STAR	$\bar{R}R_{eff}^*$	Steady State Value for Real Effective Interest Rate Trend	5.1675
dS_PRT_SS	ΔS_{prt}^{ss}	Steady State Value for NER Depreciation Partners	1.73
PIE_F_SS	π_F^{ss}	Steady State Value for Foreign Inflation	2.2768
dS_SS	ΔS^{ss}	Steady State Value for Exchange Rate Depreciation	0.2675

A.4 Equations

Inflation Block

1. Nontraded Sticky Phillips Curve

$$\pi_t^{ntspi} = \alpha_1^n \pi_{t-1}^{ntspi} + (1 - \alpha_1^n) \pi_t^{exp} + \alpha_2^n RMC_t^{ntspi} + EPS_t^\pi + \varepsilon_{ntsp,t}^\pi \quad (1)$$

2. Nontraded Sticky RMC

$$RMC_t^{ntspi} = \alpha_3^n \hat{Y}_{t-1} + (1 - \alpha_3^n) \hat{R}P_{t-1}^{flex} \quad (2)$$

3. AR(1) Process for Sticky Inflation Shock

$$EPS_t^\pi = \gamma_1 EPS_{t-1}^\pi + \varepsilon_{eps,t}^{ntsp} \quad (3)$$

4. Regulated Services Phillips Curve

$$\pi_t^{reg} = \alpha_1^r \pi_t^* + \alpha_2^r RMC_t^{reg} + \varepsilon_{reg,t}^\pi \quad (4)$$

5. Real Marginal Cost of Regulated Services

$$RMC_t^{reg} = -\hat{R}P_{t-1}^{reg} \quad (5)$$

6. Flexible Inflation Phillips Curve

$$\begin{aligned} \pi_t^{flex} = & \alpha_1^f \pi_{t-1}^{flex} + \left(1 - \alpha_1^f - \alpha_3^f - \alpha_4^f - \alpha_5^f\right) \frac{\pi_t^{exp} (\pi^{**} - 1) \pi_t^*}{\pi^{**}} + \alpha_2^f RMC_t^{flex} \\ & + \alpha_3^f \pi_t^{imp} + \alpha_4^f \pi_t^{food-imp} + \alpha_5^f \pi_t^{oil-imp} + \varepsilon_{flex,t}^\pi \end{aligned} \quad (6)$$

7. Imported Food Price

$$P_t^{food-imp} = PF_t^{food} + S_t - qf\bar{o}od_t - \bar{Z}_t^{US} \quad (7)$$

8. Imported Food Inflation

$$\pi_t^{food-imp} = \left(P_t^{food-imp} - P_{t-1}^{food-imp} \right) \times 4 \quad (8)$$

9. Imported Oil Price

$$P_t^{oil-imp} = PF_t^{oil} + S_t - q\bar{o}il_t - \bar{Z}_t^{US} \quad (9)$$

10. Imported Oil Inflation

$$\pi_t^{oil-imp} = \left(P_t^{oil-imp} - P_{t-1}^{oil-imp} \right) \times 4 \quad (10)$$

11. Real Marginal Cost of Flexible Prices

$$\begin{aligned} RMC_t^{flex} = & -\alpha_6^f \hat{R}P_{t-1}^{flex} + \alpha_7^f \hat{Y}_t + \alpha_8^f \hat{Z}_{t-1}^{US} + \alpha_9^f (\Delta Z_t - d\bar{R}\bar{E}\bar{E}R^{ss}) \\ & + \alpha_{10}^f q\hat{o}il_t + \alpha_{11}^f qf\hat{o}od_t \end{aligned} \quad (11)$$

12. QoQ Headline Inflation

$$\pi_t^{CPI} = w_{ntspi} \pi_t^{ntspi} + w_{reg} \pi_t^{reg} + (1 - w_{ntspi} - w_{reg}) \pi_t^{flex} \quad (12)$$

13. Sticky Price Index

$$P_t^{ntspi} = P_{t-1}^{ntspi} + \frac{\pi_t^{ntspi}}{4} \quad (13)$$

14. Regulative Services Price Index

$$P_t^{reg} = P_{t-1}^{reg} + \frac{\pi_t^{reg}}{4} \quad (14)$$

15. Flexible Price Index

$$P_t^{flex} = P_{t-1}^{flex} + \frac{\pi_t^{flex}}{4} \quad (15)$$

16. CPI Price Index

$$P_t^{CPI} = P_{t-1}^{CPI} + \frac{\pi_t^{CPI}}{4} \quad (16)$$

17. YoY Sticky Inflation Rate

$$P_t^{ntspi} = P_{t-4}^{ntspi} + \pi_4^{ntspi} \quad (17)$$

18. YoY Regulated Services Inflation

$$P_t^{reg} = P_{t-4}^{reg} + \pi_4^{reg} \quad (18)$$

19. YoY Flexible Inflation

$$P_t^{flex} = P_{t-4}^{flex} + \pi 4_t^{flex} \quad (19)$$

20. YoY Headline Inflation

$$P_t^{CPI} = P_{t-4}^{CPI} + \pi 4_t^{CPI} \quad (20)$$

21. Relative Price of Regulative Services

$$RP_t^{reg} = P_t^{reg} - P_t^{ntspi} \quad (21)$$

22. Relative Flexible Price

$$RP_t^{flex} = P_t^{flex} - P_t^{ntspi} \quad (22)$$

23. Regulative Services Relative Price Gap

$$RP_t^{reg} = \bar{R}P_t^{reg} + \hat{R}P_t^{reg} \quad (23)$$

24. Regulative Services Relative Price Trend

$$\bar{R}P_t^{reg} = 0.75 \bar{R}P_{t-1}^{reg} + 0.25 g \bar{R}P_t^{reg} + \varepsilon_{reg,t}^{RP} \quad (24)$$

25. Persistence in the Trend of Regulative Services Relative Price

$$g \bar{R}P_t^{reg} = 0.5 g \bar{R}P_{t-1}^{reg} + 0.5 \bar{R}P_{reg}^{ss} + \varepsilon_{reg,t}^{gRP} \quad (25)$$

26. Flexible Relative Price Gap

$$RP_t^{flex} = \bar{R}P_t^{flex} + \hat{R}P_t^{flex} \quad (26)$$

27. Flexible Relative Price Trend

$$\bar{R}P_t^{flex} = 0.75 \bar{R}P_{t-1}^{flex} + 0.25 g \bar{R}P_t^{flex} + \varepsilon_{flex,t}^{RP} \quad (27)$$

28. Persistence in the Trend of Flexible Relative Price

$$g \bar{R}P_t^{flex} = 0.5 g \bar{R}P_{t-1}^{flex} + 0.5 \bar{R}P_{flex}^{ss} + \varepsilon_{flex,t}^{gRP} \quad (28)$$

29. Real Price of Oil

$$qoil_t = PF_t^{oil} - P_t^{US} \quad (29)$$

30. Oil Trend and Gap Decomposition

$$qoil_t = \bar{qoil}_t + \hat{qoil}_t \quad (30)$$

31. Definition of Change in Oil Price Trend

$$\Delta \bar{qoil}_t = (\bar{qoil}_t - \bar{qoil}_{t-1}) \times 4 \quad (31)$$

32. AR Process for Change in Oil Price Trend

$$\Delta \bar{qoil}_t = \alpha_1^{oil} \Delta \bar{qoil}_{t-1} + (1 - \alpha_1^{oil}) dqoil^{ss} + \varepsilon_{oil,t}^{dqt} \quad (32)$$

33. Oil Price Gap

$$\hat{qoil}_t = \alpha_2^{oil} \hat{qoil}_{t-1} + \varepsilon_{oil,t}^{qg} \quad (33)$$

34. Real Price of Food

$$qfood_t = PF_t^{food} - P_t^{US} \quad (34)$$

35. Food Trend and Gap Decomposition

$$qfood_t = q\bar{food}_t + q\hat{food}_t \quad (35)$$

36. Definition of Change in Real Food Price Trend

$$\Delta q\bar{food}_t = (q\bar{food}_t - q\bar{food}_{t-1}) \times 4 \quad (36)$$

37. AR Process for Change in Real Food Price Trend

$$\Delta q\bar{food}_t = \alpha_1^{food} \Delta q\bar{food}_{t-1} + (1 - \alpha_1^{food}) dq\bar{food}^{ss} + \varepsilon_{food,t}^{dqt} \quad (37)$$

38. Food Price Gap

$$q\hat{food}_t = \alpha_2^{food} q\hat{food}_{t-1} + \varepsilon_{food,t}^{qg} \quad (38)$$

Credibility and Expectations Block

39. Residual Under Optimistic Expectations

$$\varepsilon_t^{TAR} = \pi 4_t^{ntspi} - (\delta_1 \pi 4_{t-1}^{ntspi} + (1 - \delta_1) \pi^{**}) \quad (39)$$

40. Residual Under Skeptical Expectations of a High Inflation Regime

$$\varepsilon_t^{HIGH} = \pi 4_t^{ntspi} - (\delta_2 \pi 4_{t-1}^{ntspi} + (1 - \delta_2) \pi^{high}) \quad (40)$$

41. Residual Under Skeptical Expectations of a Low Inflation Trap

$$\varepsilon_t^{LOW} = \pi 4_t^{ntspi} - (\delta_3 \pi 4_{t-1}^{ntspi} + (1 - \delta_3) \pi^{low}) \quad (41)$$

42. Probability of Entering High Inflation Regime

$$P^{HIGH} = \begin{cases} \frac{(\varepsilon^{TAR})^2}{(\varepsilon^{TAR})^2 + (\varepsilon^{HIGH})^2} & \text{if } \varepsilon^{TAR} > 0, \\ 0 & \text{if } \varepsilon^{TAR} \leq 0. \end{cases} \quad (42)$$

43. Probability of Entering Low Inflation Trap

$$P^{LOW} = \begin{cases} \frac{(\varepsilon^{TAR})^2}{(\varepsilon^{TAR})^2 + (\varepsilon^{LOW})^2} & \text{if } \varepsilon^{LOW} < 0, \\ 0 & \text{otherwise.} \end{cases} \quad (43)$$

44. Flow of Credibility

$$C_t^{FLOW} = 1 - P_t^{LOW} - P_t^{HIGH} \quad (44)$$

45. Formation of Credibility

$$C_t = \delta C_{t-1} + (1 - \delta) C_t^{FLOW} + EPS_t^C + \varepsilon_t^C \quad (45)$$

46. AR(1) Process for Credibility Shock

$$EPS_t^C = \gamma_2 EPS_{t-1}^C + \varepsilon_{eps,t}^C \quad (46)$$

47. Formation of Inflation Expectations

$$\pi_t^{exp} = C_t \pi_{t+4}^{ntspi} + (1 - C_t) \pi_{t-1}^{ntspi} + \kappa^{low} P_t^{LOW} + \kappa^{high} P_t^{HIGH} + EPS_t^{exp} + \varepsilon_t^{ntsp,e} \quad (47)$$

48. AR(1) Process for Expectations Shock

$$EPS_t^{exp} = \gamma_3 EPS_{t-1}^{exp} + \varepsilon_{eps,t}^{ntsp,e} \quad (48)$$

49. Time Varying Inflation Target

$$\pi_t^* = \delta_4 \pi_{t-1}^* + (1 - \delta_4) \pi^{**} + \varepsilon_t^{\pi^*} \quad (49)$$

Output and Unemployment Block

50. Output Gap

$$\hat{Y}_t = \lambda_1 \hat{Y}_{t+1} + \lambda_2 \hat{Y}_{t-1} - \lambda_3 \hat{L}R_t^{eff} + \lambda_4 \hat{Z}_t + \lambda_5 \hat{Y}_t^W + EPS_t^{\hat{Y}} + \varepsilon_t^Y \quad (50)$$

51. AR(1) Process for Output Gap Persistence

$$EPS_t^{\hat{Y}} = \gamma_4 EPS_{t-1}^{\hat{Y}} + \varepsilon_{eps,t}^Y \quad (51)$$

52. Cumulative Output Gap

$$CUM_t^{\hat{Y}} = CUM_{t-1}^{\hat{Y}} + \frac{\hat{Y}_t}{4} \quad (52)$$

53. Real GDP YoY Log Growth

$$\Delta GDP_t = \Delta \bar{GDP}_t + (\hat{Y}_t - \hat{Y}_{t-4}) \quad (53)$$

54. Potential GDP QoQ Annualized Log Growth

$$\Delta \bar{GDP}_t = \theta_1 \Delta \bar{GDP}_{t-1} + (1 - \theta_1) g\bar{GDP}_t + \varepsilon_t^{\bar{Y}} \quad (54)$$

55. Persistent Component in Potential GDP Growth

$$g\bar{GDP}_t = \theta_2 g\bar{GDP}_{t-1} + (1 - \theta_2) GROWTH^{ss} + \varepsilon_{G,t}^{\bar{Y}} \quad (55)$$

56. Unemployment Gap

$$\hat{U}_t = \theta_3 \hat{U}_{t-1} - \theta_4 \hat{Y}_t - \theta_5 \hat{Y}_{t+1} + \varepsilon_t^{\hat{U}} \quad (56)$$

57. NAIRU

$$\bar{U}_t = \bar{U}^{ss} + g\bar{U}_t + EPS_t^{\bar{U}} + \varepsilon_t^{\bar{U}} \quad (57)$$

58. Persistent Component in NAIRU

$$g\bar{U}_t = \theta_6 g\bar{U}_{t-1} + \varepsilon_t^{UG} \quad (58)$$

59. Serially Correlated NAIRU Shock

$$EPS_t^{\bar{U}} = \gamma_5 EPS_{t-1}^{\bar{U}} + \varepsilon_{eps,t}^{\bar{U}} \quad (59)$$

60. Unemployment Rate

$$U_t = \bar{U}_t + \hat{U}_t \quad (60)$$

Interest Rate Block

61. Effective Nominal Interest Rate

$$RS_t^{eff} = (1 - \sigma_t) RS_t + \sigma_t (RS_t^{US} + \Delta \bar{Z}_t^{US} + \pi_t^* - \pi_{US}^* + PREM_t) \quad (61)$$

62. Effective Real Interest Rate

$$RS_t^{eff} = RR_t^{eff} + \pi_t^{exp} \quad (62)$$

63. Effective Real Interest Rate Gap

$$\hat{RR}_t^{eff} = RR_t^{eff} - \bar{RR}_t^{eff} \quad (63)$$

64. Effective Real Interest Rate Trend

$$\bar{RR}_t^{eff} = \rho^{eff} \bar{RR}_{t-1}^{eff} + (1 - \rho^{eff}) \bar{RR}_{eff}^* + \varepsilon_{eff,t}^{\bar{RR}} \quad (64)$$

65. Dollarization

$$\sigma_t = \rho_1^{doll} * \sigma_{t-1} + (1 - \rho_1^{doll}) * \sigma_{min} - DOLL * (\rho_2^{doll} * \min(C_t - C_{t-1}, 0) + (1 - \rho_2^{doll}) (C_t - C_{t-1})) \quad (65)$$

66. 6-Month Term Premium

$$Term_{2t} = \rho^{term2} Term_{2t-1} + (1 - \rho^{term2}) term2^{ss} + 0.3 \varepsilon_t^{Term} + \varepsilon_t^{Term2} \quad (66)$$

67. 1-Year Term Premium

$$Term_{4t} = \rho^{term4} Term_{4t-1} + (1 - \rho^{term4}) term4^{ss} + 0.4 \varepsilon_t^{Term} + \varepsilon_t^{Term4} \quad (67)$$

68. 2-Year Term Premium

$$Term_{8t} = \rho^{term8} Term_{8t-1} + (1 - \rho^{term8}) term8^{ss} + 0.7 \varepsilon_t^{Term} + \varepsilon_t^{Term8} \quad (68)$$

69. 3-Year Term Premium

$$Term_{12t} = \rho^{term12} Term_{12t-1} + (1 - \rho^{term12}) term12^{ss} + \varepsilon_t^{Term} + \varepsilon_t^{Term12} \quad (69)$$

70. 5-Year Term Premium

$$Term_{20t} = \rho^{term20} Term_{20t-1} + (1 - \rho^{term20}) term20^{ss} + 1.1 \varepsilon_t^{Term} + \varepsilon_t^{Term20} \quad (70)$$

71. 10-Year Term Premium

$$Term_{40t} = \rho^{term40} Term_{40t-1} + (1 - \rho^{term40}) term40^{ss} + 1.4 \varepsilon_t^{Term} + \varepsilon_t^{Term40} \quad (71)$$

72. Real Interest Rate

$$RR_t = RS_t - \pi_t^{exp} \quad (72)$$

73. Real Interest Rate Trend

$$\bar{R}R_t = 0.95 \bar{R}R_{t-1} + 0.05 \bar{R}R^* + \varepsilon_t^{\bar{R}R} \quad (73)$$

74. Real Interest Rate Gap

$$\hat{R}R_t = RR_t - \bar{R}R_t \quad (74)$$

Loss Function and Monetary Policy Block**75. AR(1) Process for Monetary Policy Shock**

$$EPS_t^{RS} = \gamma_6 EPS_{t-1}^{RS} + \varepsilon_{eps,t}^{RS} \quad (75)$$

76. 101. Loss Function

$$LOSS_t = (\pi_t^{gap})^2 + 1.0 (\hat{Y}_t)^2 + 0.5 (\Delta RS_t)^2 + 0.1 (P_t^{gap})^2 \quad (76)$$

77. Change in Policy Rate

$$\Delta RS_t = RS_t - RS_{t-1} \quad (77)$$

78. YoY Inflation Deviation from Target

$$\pi_t^{gap} = \pi 4_t^{CPI} - \pi_t^* \quad (78)$$

79. Negative Output Gap

$$\hat{Y}_t^{neg} = \frac{\hat{Y}_t - |\hat{Y}_t|}{2} \quad (79)$$

80. Price Level Gap

$$P_t^{gap} = P_{t-1}^{gap} + \frac{\pi_t^{CPI}}{4} \quad (80)$$

81. Negative Price Level Gap

$$P_t^{ngap} = \frac{P_t^{gap} - |P_t^{gap}|}{2} \quad (81)$$

82. Changes in Credibility

$$\Delta C_t = C_t - C_{t-1} \quad (82)$$

83. Negative Changes in Credibility

$$\Delta C_t^{neg} = \frac{\Delta C_t - |\Delta C_t|}{2} \quad (83)$$

UIP and Exchange Rate Block

84. Change in the Real Exchange Rate Trend / Partners vs US

$$\bar{\Delta Z}_t^{PRT} = \rho_1 \bar{\Delta Z}_{t-1}^{PRT} + (1 - \rho_1) dZ_{prt}^{ss} + \varepsilon_{prt,t}^{d\bar{Z}} \quad (84)$$

85. Real Exchange Rate Trend / Partners vs US

$$\bar{Z}_t^{PRT} = \bar{Z}_{t-1}^{PRT} + \frac{\bar{\Delta Z}_t^{PRT}}{4} \quad (85)$$

86. Real Exchange Rate Gap / Partners vs US

$$\hat{Z}_t^{PRT} = \rho_2 \hat{Z}_{t-1}^{PRT} + \varepsilon_{prt,t}^{\hat{Z}} \quad (86)$$

87. Real Exchange Rate Level / Partners vs US

$$\hat{Z}_t^{PRT} = Z_t^{prt} - \bar{Z}_t^{PRT} \quad (87)$$

88. Change in Real Exchange Rate / Partners vs US

$$Z_t^{prt} = Z_{t-1}^{prt} + \frac{\Delta Z_t^{PRT}}{4} \quad (88)$$

89. Partners Inflation in Respective Currencies

$$\pi_t^{prt} = \rho_3 \pi_{t-1}^{prt} + (1 - \rho_3) \pi_{prt}^{ss} + \varepsilon_{prt,t}^{\pi} \quad (89)$$

90. Partners CPI in Respective Currencies

$$P_t^{prt} = P_{t-1}^{prt} + \frac{\pi_t^{prt}}{4} \quad (90)$$

91. Nominal Exchange Rate / Partners vs US

$$Z_t^{prt} = S_t^{prt} + P_t^{US} - P_t^{prt} \quad (91)$$

92. 117. Nominal Exchange Rate Change / Partners vs US

$$S_t^{prt} = S_{t-1}^{prt} + \frac{\Delta S_t^{prt}}{4} \quad (92)$$

93. Foreign Inflation in USD

$$\pi_t^F = trade^{US} \pi_t^{US} + (1 - trade^{US}) (\pi_t^{prt} - \Delta S_t^{prt}) \quad (93)$$

94. Foreign Price Level in USD

$$P_t^F = P_{t-1}^F + \frac{\pi_t^F}{4} \quad (94)$$

95. Change in Real Effective Exchange Rate Trend

$$\Delta \bar{Z}_t = \rho_4 \Delta \bar{Z}_{t-1} + (1 - \rho_4) dREER^{ss} + \varepsilon_t^{d\bar{Z}} \quad (95)$$

96. Real Effective Exchange Rate Trend

$$\bar{Z}_t = \bar{Z}_{t-1} + \frac{\Delta \bar{Z}_t}{4} + \varepsilon_t^{\bar{Z}} \quad (96)$$

97. Change in the Nominal Bilateral Exchange Rate

$$S_t = S_{t-1} + \frac{\Delta S_t}{4} \quad (97)$$

98. Imported Inflation

$$\pi_t^{imp} = \pi_t^F + \Delta S_t - \Delta \bar{Z}_t \quad (98)$$

99. Real Effective Exchange Rate Level

$$Z_t = S_t + P_t^F - P_t^{CPI} \quad (99)$$

100. Change in Real Effective Exchange Rate

$$Z_t = Z_{t-1} + \frac{\Delta Z_t}{4} \quad (100)$$

101. Real Effective Exchange Rate Gap

$$\hat{Z}_t = Z_t - \bar{Z}_t \quad (101)$$

102. Real Exchange Rate Trend vs US

$$\bar{Z}_t^{US} = \bar{Z}_t + (1 - trade^{US}) \bar{Z}_t^{PRT} \quad (102)$$

103. Change in Real Exchange Rate Trend vs US

$$\bar{Z}_t^{US} = \bar{Z}_{t-1}^{US} + \frac{\Delta \bar{Z}_t^{US}}{4} \quad (103)$$

104. Real Exchange Rate Level vs US

$$Z_t^{US} = Z_t + (1 - trade^{US}) Z_t^{prt} \quad (104)$$

105. Change in Real Exchange Rate Level vs US

$$Z_t^{US} = Z_{t-1}^{US} + \frac{\Delta Z_t^{US}}{4} \quad (105)$$

106. Real Exchange Rate Gap vs US

$$\hat{Z}_t^{US} = Z_t^{US} - \bar{Z}_t^{US} \quad (106)$$

107. UIP Condition

$$\begin{aligned} \rho RS_t + (1 - \rho)(\bar{R}R_t + \pi_t^*) &= \rho RS_t^{US} + (1 - \rho)(\bar{R}R_t^{US} + \pi_{US}^*) \\ &+ 4(S_t^e - S_t) + PREM_t + fxPREM_t + \varepsilon_t^S \end{aligned} \quad (107)$$

108. Expected Exchange Rate

$$S_t^e = \rho_5 S_{t+1} + (1 - \rho_5) \left(S_{t-1} + \frac{2(\Delta \bar{Z}_t^{US} + \pi_t^* - \pi_{US}^*)}{4} \right) \quad (108)$$

109. Risk Premium

$$PREM_t = \rho_6 PREM_{t-1} + (1 - \rho_6) P\bar{R}EM_t + \rho_7 P_t^{HIGH} + \varepsilon_t^{PREM} \quad (109)$$

110. Risk Premium Trend

$$P\bar{R}EM_t = \rho_8 P\bar{R}EM_{t-1} + (1 - \rho_8) P\bar{R}EM^* + \varepsilon_t^{P\bar{R}EM} \quad (110)$$

111. Liquidity Risk Premium

$$fxPREM_t = \rho_9 fxPREM_{t-1} + \rho_{10}(\sigma_t - \sigma_{t-1}) + \varepsilon_t^{fxPREM} \quad (111)$$

External Sector Block

112. US Real Interest Rate

$$RR_t^{US} = 0.85 RR_{t-1}^{US} + 0.15 \bar{RR}_t^{US} + \varepsilon_{US,t}^{RR} \quad (112)$$

113. US Real Interest Rate Trend

$$\bar{RR}_t^{US} = \bar{RR}_{US}^* + \varepsilon_{US,t}^{\bar{RR}} \quad (113)$$

114. US Nominal Interest Rate

$$RS_t^{US} = 0.85 RS_{t-1}^{US} + 0.15 \left(\bar{RR}_t^{US} + \pi_{US}^* \right) + \varepsilon_{US,t}^{RS} \quad (114)$$

115. World Output Gap

$$\hat{Y}_t^W = \varepsilon_t^{Y^*} \quad (115)$$

116. US Inflation

$$\pi_t^{US} = 0.23 \pi_{t-1}^{US} + 0.77 \pi_{US}^* + \varepsilon_{US,t}^{\pi} \quad (116)$$

117. US Price Level

$$P_t^{US} = P_{t-4}^{US} + \pi_t^{US} - \pi_{US}^* \quad (117)$$

Long-Run Effective Interest Rate Block

118. 6-Month Expected Effective Real Interest Rate

$$RR2_t^{eff} = \frac{1}{2} \sum_{i=0}^1 RR_{t+i}^{eff} \quad (118)$$

119. 1-Year Expected Effective Real Interest Rate

$$RR4_t^{eff} = \frac{1}{4} \sum_{i=0}^3 RR_{t+i}^{eff} \quad (119)$$

120. 3-Year Expected Effective Real Interest Rate

$$RR12_t^{eff} = \frac{1}{12} \sum_{i=0}^{11} RR_{t+i}^{eff} \quad (120)$$

121. 5-Year Expected Effective Real Interest Rate

$$RR20_t^{eff} = \frac{1}{20} \sum_{i=0}^{19} RR_{t+i}^{eff} \quad (121)$$

122. 10-Year Expected Effective Real Interest Rate

$$RR40_t^{eff} = \frac{1}{40} \sum_{i=0}^{39} RR_{t+i}^{eff} \quad (122)$$

123. Long-Run Real Effective Interest Rate

$$\begin{aligned}
LR_t^{eff} = & 0.1 RR_t^{eff} + 0.2 \left(RR2_t^{eff} + Term_{2,t} - term2^{ss} \right) \\
& + 0.25 \left(RR4_t^{eff} + Term_{4,t} - term4^{ss} \right) \\
& + 0.25 \left(RR12_t^{eff} + Term_{12,t} - term12^{ss} \right) \\
& + 0.2 \left(RR20_t^{eff} + Term_{20,t} - term20^{ss} \right)
\end{aligned} \tag{123}$$

124. 6-Month Expected Effective Real Interest Rate Trend

$$R\bar{R}2_t^{eff} = \frac{1}{2} \sum_{i=0}^1 \bar{R}R_{t+i}^{eff} \tag{124}$$

125. 1-Year Expected Real Effective Interest Rate Trend

$$R\bar{R}4_t^{eff} = \frac{1}{4} \sum_{i=0}^3 \bar{R}R_{t+i}^{eff} \tag{125}$$

126. 3-Year Expected Real Effective Interest Rate Trend

$$R\bar{R}12_t^{eff} = \frac{1}{12} \sum_{i=0}^{11} \bar{R}R_{t+i}^{eff} \tag{126}$$

127. 5-Year Expected Real Effective Interest Rate Trend

$$R\bar{R}20_t^{eff} = \frac{1}{20} \sum_{i=0}^{19} \bar{R}R_{t+i}^{eff} \tag{127}$$

128. 10-Year Expected Real Effective Interest Rate Trend

$$R\bar{R}40_t^{eff} = \frac{1}{40} \sum_{i=0}^{39} \bar{R}R_{t+i}^{eff} \tag{128}$$

129. Long-Run Real Effective Interest Rate Trend

$$\begin{aligned}
\bar{L}R_t^{eff} = & 0.1 \bar{R}R_t^{eff} + 0.25 R\bar{R}2_t^{eff} + 0.25 R\bar{R}4_t^{eff} \\
& + 0.2 R\bar{R}12_t^{eff} + 0.2 R\bar{R}20_t^{eff}
\end{aligned} \tag{129}$$

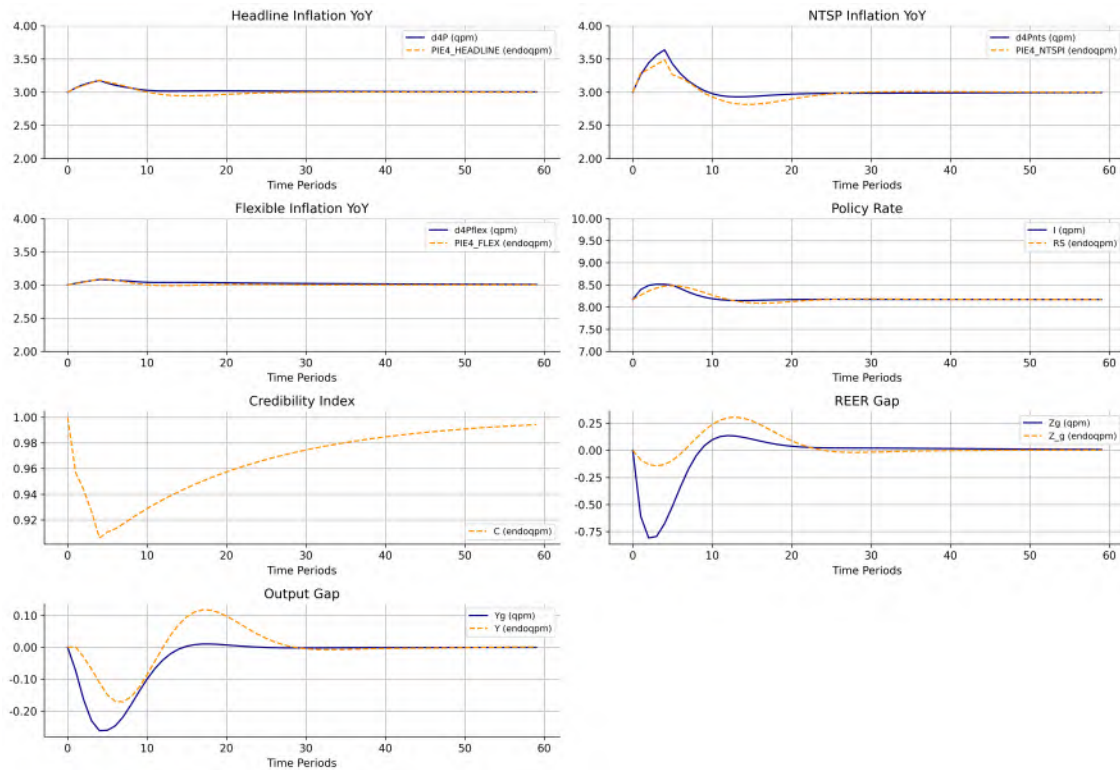
130. Long-Run Real Effective Interest Rate Gap

$$\hat{L}R_t^{eff} = LR_t^{eff} - \bar{L}R_t^{eff} \tag{130}$$

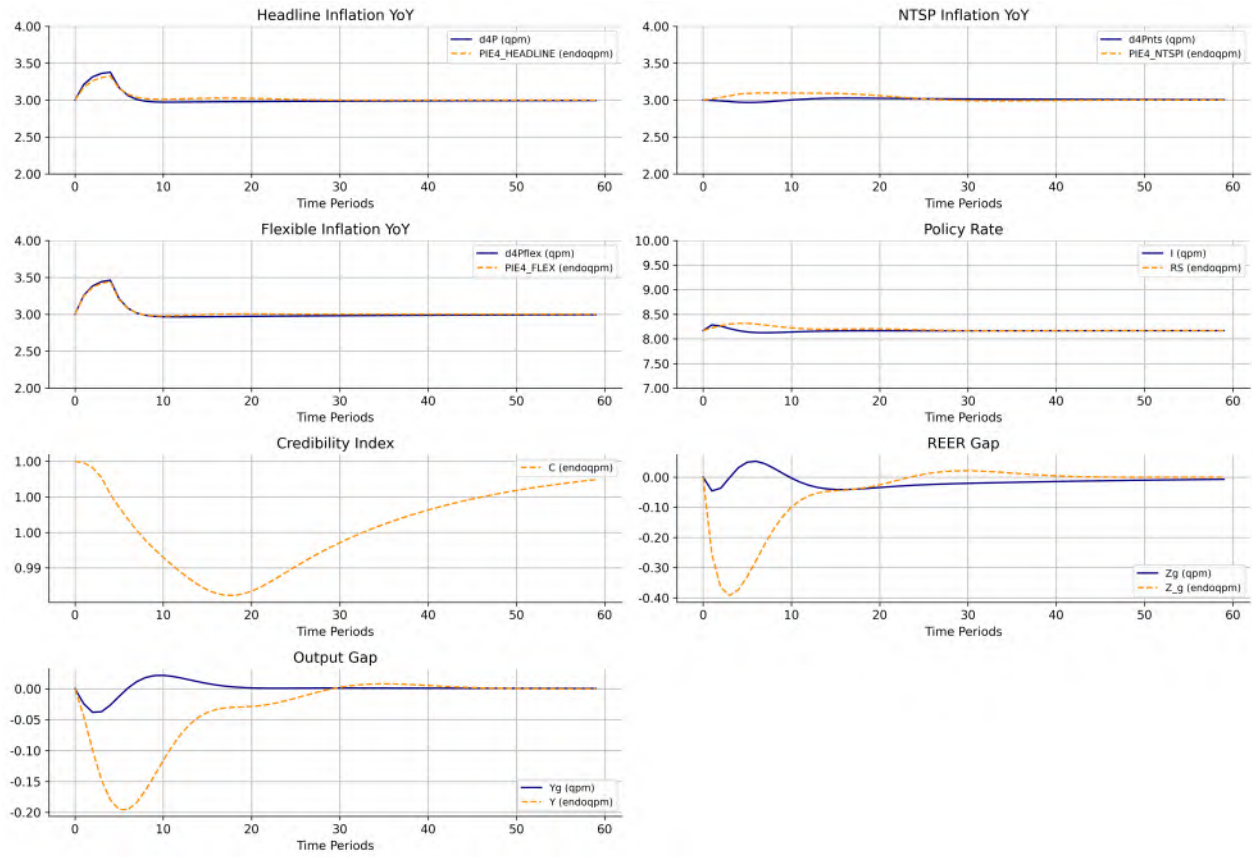
B Model Comparison under Key Macroeconomic Shocks

The application of the model is assessed by comparing the responses of the baseline QPM and the EndoCred model under key macroeconomic shocks, with detailed impulse responses. Overall, the two models generate broadly consistent transmission mechanisms and macroeconomic dynamics, confirming that the extended framework preserves the core logic of the original QPM and can serve as a complementary tool for scenario design. Slight differences naturally emerge from the specific calibration and specification of the EndoCred block. For instance, under an output gap shock, the EndoCred model produces a more balanced response of flexible and non-traded sticky-price inflation, without generating a large relative price gap. This reflects the interpretation that flexible prices may also respond meaningfully to domestic demand pressures. In contrast, the baseline QPM assigns a stronger role to non-traded sticky-price inflation, emphasizing its tighter dependence on domestic demand conditions. These differences remain within an acceptable range, as they do not weaken the model's usefulness for scenario design or policy analysis. Moreover, the analytical framework remains sufficiently flexible to accommodate alternative narratives through introduction of additional shocks or, in some rare cases, recalibration and modest specification changes. This flexibility is important for practical policy work, where the model must remain agile enough to support scenario production. In this respect, the EndoCred framework has already been tested in applications involving recent supply-side inflationary shocks amid possible overheated conditions and their policy implications.

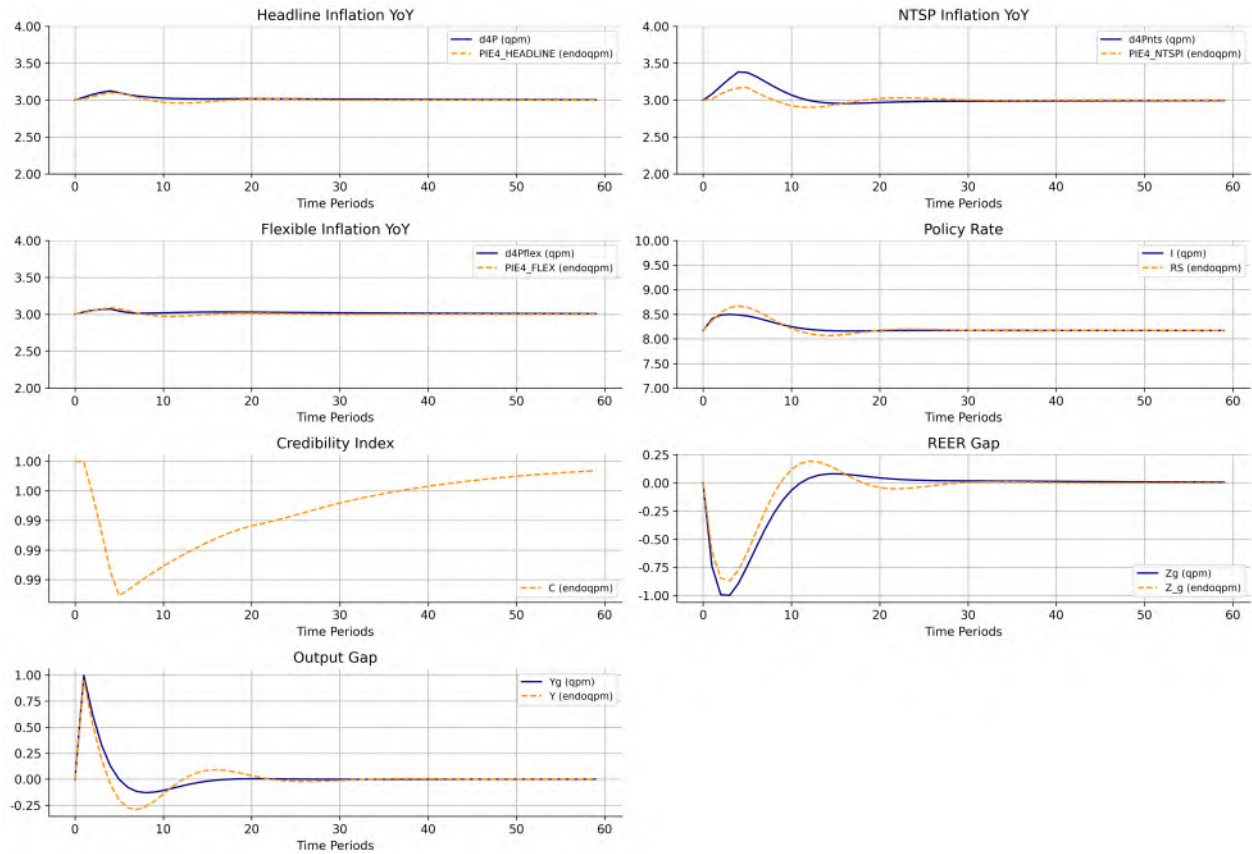
1. 1pp. shock to non-traded sticky price inflation



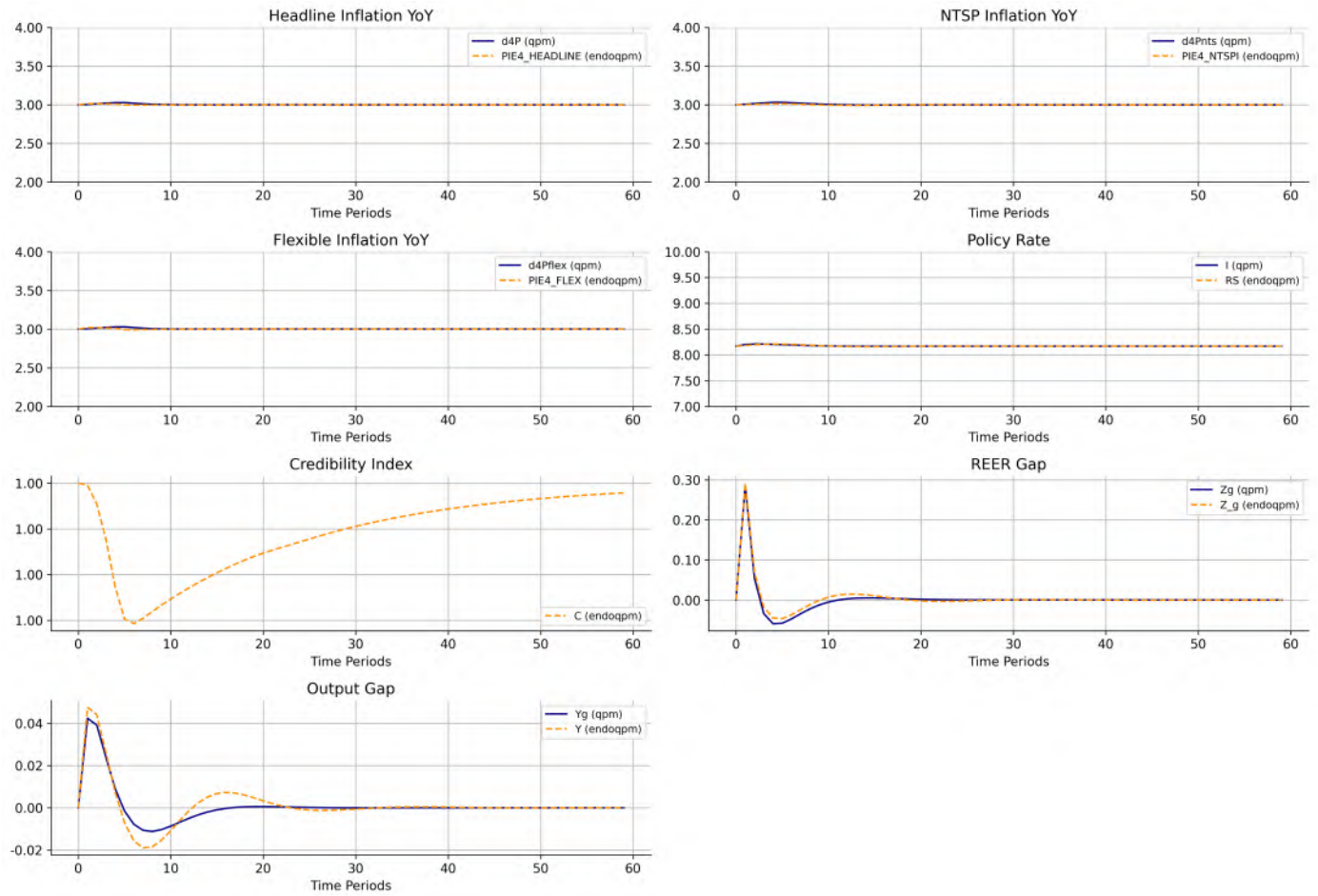
2. 1pp. shock to flexible price inflation



3. 1pp. shock to output gap



4. 1% shock to exchange rate



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