Post-Communist Economies

ISSN: 1463-1377 (Print) 1465-3958 (Online) Journal homepage: www.tandfonline.com/journals/cpce20

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**To cite this article:** Ihlas Sovbetov (29 Oct 2025): The hybrid Phillips curve and inflation in post-Soviet Central Asia and the South Caucasus, Post-Communist Economies, DOI: 10.1080/14631377.2025.2576203

**To link to this article:** https://doi.org/10.1080/14631377.2025.2576203

Published online: 29 Oct 2025.

POST-COMMUNIST ECONOMIES
https://doi.org/10.1080/14631377.2025.2576203

Routledge
Taylor & Francis Group



# The hybrid Phillips curve and inflation in post-Soviet Central Asia and the South Caucasus

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**ABSTRACT**

Using the hybrid New Keynesian Phillips Curve, this paper provides the first multi-country estimation for Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan using quarterly data from 1996 to 2023, and continuously-updating GMM. We estimate closed- and open-economy specifications with perfect and imperfect pass-through. Inflation combines substantial backward-looking inertia with a meaningful forward-looking component: persistence is strongest in Tajikistan and Turkmenistan, while Georgia and Armenia are the most forward-oriented, and Kazakhstan is balanced. In panel estimates the backward- and forward-looking weights are about 0.55 and 0.45. Cost slopes indicate that domestic real marginal costs dominate, but imported pressures are material, accounting for about 46% of cost slopes under perfect pass-through and 41% under imperfect pass-through, with external channels especially salient in Kyrgyzstan and Tajikistan. Structural parameters imply price resets roughly every two to two and a half quarters and a high yet incomplete exchange-rate pass-through near 0.87.

**ARTICLE HISTORY**
Received 18 December 2024
Accepted 11 October 2025

**KEYWORDS**
Inflation; hybrid NKPC; post-Soviet; Central Asia; South Caucasus; pass-through

## 1. Introduction

Inflation dynamics and their interaction with real activity remain central in macroeconomics. A large literature models inflation with the New Keynesian Phillips Curve (NKPC), which links current inflation to expected future inflation and real marginal costs within a micro-founded sticky-price environment (Calvo, 1983; Gali & Gertler, 1999; Mankiw & Reis, 2002; Roberts, 1995; Sbordone, 2002). In its forward-looking form, the NKPC can be written as:

$$\pi_t = \alpha_f E_t[\pi_{t+1}] + \lambda \widehat{mc}_t + \varepsilon_t \tag{1}$$

where $\pi_t$ is inflation, $E_t[\pi_{t+1}]$ is expected inflation, $\widehat{mc}$ is the real marginal costs gap (often proxied by output gap), $\alpha_f$ is the weight on expectations, and $\lambda$ reflects the cyclical relationship between inflation and the output gap. Hybrid specifications augment this baseline by allowing a fraction of firms to index to past inflation, which improves the model's ability to capture inertia in price-setting (Gali & Gertler, 1999).

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Despite extensive empirical work for advanced and several emerging economies (Fidrmuc & Daniskova, 2019; Hubert & Mirza, 2019; Norkute & Westerlund, 2024), the post-Soviet economies of Central Asia and the South Caucasus (CCA) remain underexplored within a unified hybrid NKPC framework. This region comprises Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. These economies share a common Soviet legacy in production structures and policy institutions, have faced similar transition challenges in building market-based monetary frameworks, and are tightly linked through trade, remittances, and exposure to external shocks such as commodity price swings and regional geopolitical events. Studying them jointly allows for a structured assessment of how openness, exchange rate transmission, and policy regimes shape expectation formation and the inflation–cost linkage.

This paper provides the first multi-country estimation of the hybrid NKPC for all eight CCA economies using quarterly data from 1996 to 2023 and continuously updating the generalised method of moments (CUE-GMM). We consider three environments that are relevant for small open economies: a closed-economy benchmark; an open-economy version with perfect pass-through; and an open-economy version with imperfect pass-through. The open specifications incorporate imported inflation channels through terms of trade and exchange rate pass-through, which is important for commodity-dependent and import-intensive economies in the region. In all cases, we estimate both reduced-form coefficients and the underlying structural parameters that govern backwardness, price stickiness, openness, pass-through, and discounting.

Two sets of findings preview our contribution. First, inflation in the CCA region exhibits substantial persistence alongside a meaningful forward-looking component. At the panel level, backward-looking and forward-looking weights are roughly 0.55 and 0.45, with price stickiness implying average price durations of about two to two and a half quarters and a high yet incomplete pass-through near 0.87. Second, cost slopes show that domestic real marginal costs dominate on average, while external cost pressures are material and larger in the more open economies. These patterns vary across countries and align with differences in monetary regimes and openness documented in the regional background section.

The analysis also recognises data challenges typical of transition and developing contexts. We use internationally harmonised sources, document missing observations and the limited use of transparent linear interpolation, and discuss uneven statistical reliability in a subset of countries. These steps, together with panel estimation that absorbs time-invariant country heterogeneity, help to gauge robustness and external validity.

The remainder of the paper proceeds as follows. Section 2 provides the institutional and macroeconomic context for inflation in the CCA region and discusses the role of major shocks. Section 3 outlines the hybrid NKPC and reviews related empirical work. Section 4 describes the data, seasonal adjustment, and identification strategy. Section 5 presents country and panel estimates for the reduced and structural models. Section 6 concludes with policy implications.

## 2. Background on inflation dynamics in the CCA region

The post-Soviet economies of the CCA region (Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) share a distinctive macroeconomic

heritage shaped by their common Soviet past. This legacy includes centrally planned industrial structures, state-dominated banking sectors, and monetary institutions that evolved from highly centralised systems. The abrupt exposure to market forces after independence in the early 1990s triggered large-scale price liberalisation, output collapses, and hyperinflation episodes. While the subsequent decades brought gradual integration into global markets, inflationary dynamics in the region remain strongly influenced by these structural and institutional continuities.[1]

The CCA economies are economically and geographically interconnected through trade, remittances, and shared infrastructure. Kazakhstan and Azerbaijan are energy exporters whose fiscal and external balances are closely tied to global commodity cycles. Armenia, Georgia, and Kyrgyzstan rely more heavily on remittances and imports, making them vulnerable to exchange rate pass-through. Tajikistan, Turkmenistan, and Uzbekistan exhibit varying degrees of administrative price controls and capital account restrictions. Despite differences in resource endowments and openness, these economies face common external shocks, such as oil price swings, Russian economic fluctuations, and global financial instability, which often produce correlated inflationary episodes.

Inflation trajectories can be divided into three broad phases. The first, in the early 1990s, was marked by hyperinflation following the removal of Soviet-era price controls and the unwinding of monetary overhang. The second, in the late 1990s and early 2000s, reflected stabilisation through tighter monetary policy, exchange rate realignments, and fiscal consolidation. The third phase, from the mid-2000s onward, has been characterised by deeper integration with global markets, heightened sensitivity to commodity price volatility, and recent disruptions from the COVID-19 pandemic and geopolitical tensions. Across these phases, the persistence of inflation and the speed of disinflation have varied widely, reflecting differences in policy regimes, external exposure, and structural rigidities.

Figure 1 traces annual inflation rates across the CCA region. Initial triple- or quadruple-digit rates converged to single-digit or low double-digit levels by the late 2000s, but volatility persisted. Systemic shocks repeatedly interrupted disinflation: the 2007–2008 Global Financial Crisis transmitted through trade and remittance channels, triggering exchange rate pressures; the 2014–2016 oil price collapse hit energy exporters via fiscal revenue declines and currency depreciation; the COVID-19 pandemic in 2020–2021 generated supply chain disruptions and food price spikes; and Russia's 2022 invasion of Ukraine amplified global commodity price surges and logistical constraints. These events influenced inflation through exchange rate pass-through, imported commodity inflation, and shifts in inflation expectations. While the hybrid NKPC framework does not model these discrete shocks explicitly, its open-economy specification incorporates imported inflation channels through terms of trade and exchange rate pass-through. These mechanisms embed the effects of external price shocks into quarterly inflation and cost data, thereby influencing the relative weights on forward- and backward-looking components over time.

The region's monetary policy frameworks vary considerably (Table 1). Armenia, Georgia, and Kazakhstan operate formal inflation-targeting regimes, which tend to anchor expectations and strengthen the forward-looking channel in the NKPC. Azerbaijan and Turkmenistan maintain long-standing fixed pegs, while Uzbekistan has transitioned from a *de facto* peg to a crawl-like arrangement with inflation-targeting elements. Kyrgyzstan and Tajikistan follow more discretionary approaches without a formal nominal anchor.

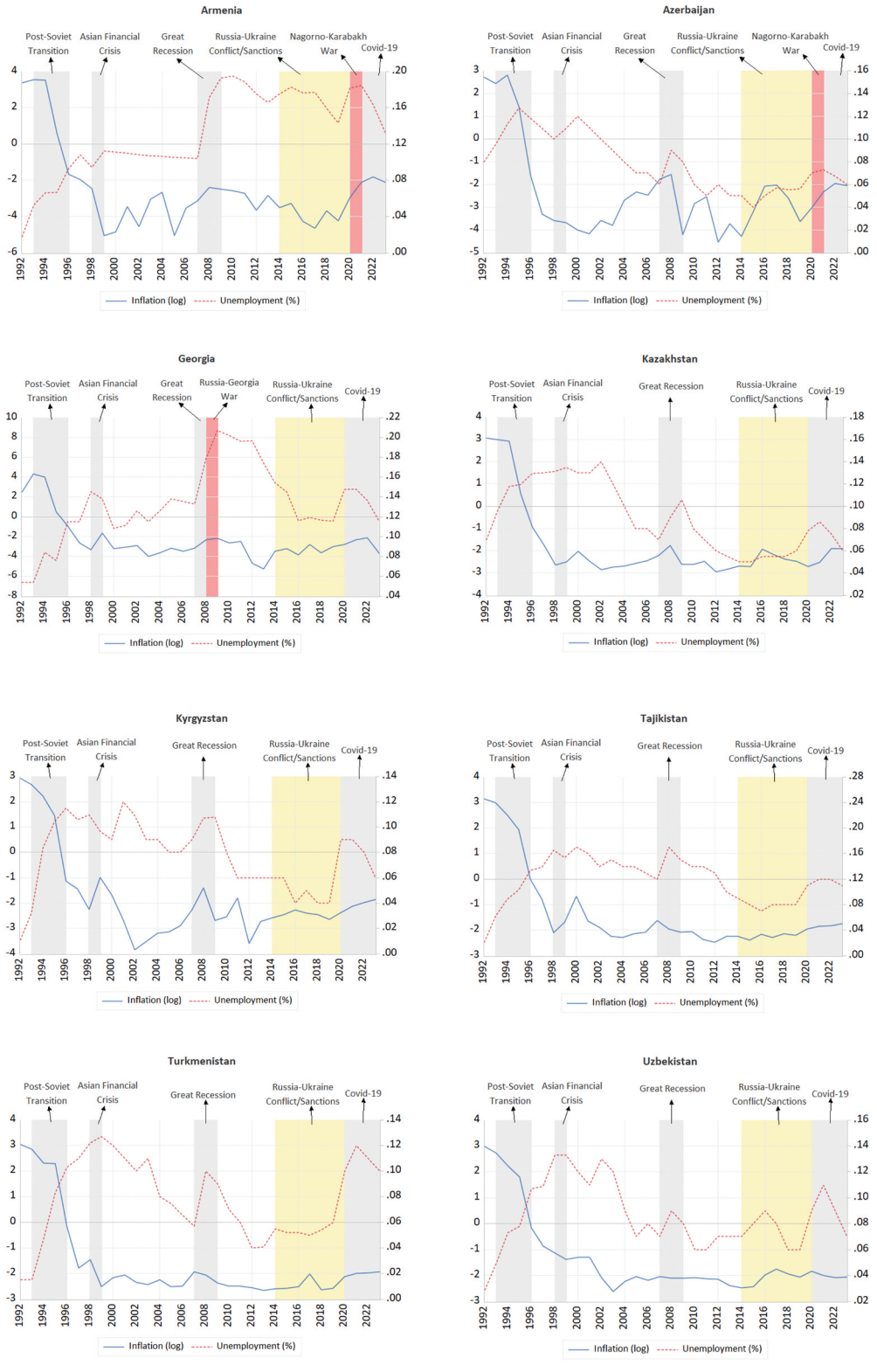


**Figure 1.** Inflation and unemployment rates in the CCA countries.

**Table 1.** Monetary regimes and policy frameworks.

| Regime | Exchange Rate Targeting | Monetary Targeting | Inflation Targeting | Other/No Anchor |
|---|---|---|---|---|
| Fixed/ Stabilized Peg | • Turkmenistan (1993–present)<br>• Azerbaijan (1994–present)<br>• Uzbekistan (1994–2017)<br>• Georgia (1995–1997) | • Tajikistan (1995–present) | | • Armenia (1991–1993)<br>• Azerbaijan (1991–1994)<br>• Georgia (1991–1995)<br>• Kazakhstan (1991–1993)<br>• Kyrgyzstan (1991–1993)<br>• Tajikistan (1991–1995)<br>• Turkmenistan (1991–1993)<br>• Uzbekistan (1991–1994) |
| Crawl-like Peg | • Kazakhstan (1993–1999) | • Uzbekistan (2017–2020) | • Uzbekistan (2021-present) | • Kyrgyzstan (1993-present) |
| Floating Peg | | • Armenia (1994–2005)<br>• Georgia (1997–2008)<br>• Kazakhstan (1999–2015) | • Armenia (2006–present)<br>• Georgia (2009–present)<br>• Kazakhstan (2015–present) | |

Source: International Monetary Fund (2023).

These regime differences influence inflation expectations in ways that are directly relevant for the hybrid NKPC. Economies with credible inflation targeting, such as Armenia, Georgia, and Kazakhstan, are more likely to exhibit stronger forward-looking components in the NKPC, while those with less flexible regimes, such as Kyrgyzstan, Tajikistan, and Turkmenistan, tend to display inflation persistence driven by backward-looking expectations.

An important structural feature, particularly in Uzbekistan and Turkmenistan, has been the extensive use of administrative price controls on key goods and services. In Uzbekistan, such controls were progressively dismantled following the 2017 foreign exchange liberalisation, with substantial removal completed by early 2021.[2] Nevertheless, they play a decisive role in the sample period of 1992–2023. While these measures can temporarily suppress measured CPI volatility, they also distort relative prices, delay adjustment to shocks, and weaken the observed link between marginal costs and inflation. Over time, they may introduce structural breaks in the inflation series, complicating econometric estimation and potentially biasing forward-looking NKPC coefficients downward. They can also affect cross-country comparability if some regimes systematically understate inflation persistence due to administratively induced stability. Consequently, NKPC results for these economies should be interpreted with caution.

Table 1 underscores the diversity and persistence of monetary regimes across the CCA region. Fixed and crawl-like pegs dominate in some economies, while others have sustained inflation-targeting frameworks for over a decade. These institutional differences shape the relative weight of rational versus adaptive expectations in price setting, making the hybrid NKPC a suitable tool for capturing regime-specific dynamics. Despite substantial disinflation since the transition period, inflation inertia remains a central policy

challenge, sustained by a combination of backward-looking expectations, slow price adjustment, and continued exposure to volatile external conditions.

This study builds on this contextual understanding by employing a hybrid NKPC specification to quantify the structural parameters of price-setting behaviour in the CCA region and to assess how regime type, external shocks, and administrative interventions shape inflation dynamics.

## 3. Literature review

### 3.1. Theoretical background

The hybrid NKPC, as formalised by Gali and Gertler (1999), synthesises forward-looking price-setting behaviour from Calvo's (1983) staggered contracts model with a backward-looking component that captures indexation to past inflation. In its canonical form, current inflation $\pi_t$ is expressed as a weighted average of expected future inflation $E_t[\pi_{t+1}]$ and lagged inflation $\pi_{t-1}$, augmented by a term reflecting the real marginal costs gap $\widehat{mc}_t$:

$$\pi_t = \alpha_b \pi_{t-1} + \alpha_f E_t[\pi_{t+1}] + \lambda \widehat{mc}_t + \varepsilon_t \tag{2}$$

where $\alpha_b$ and $\alpha_f$ are the backward- and forward-looking weights, respectively, and $\lambda$ denotes the slope parameter linking inflation to marginal costs. The error in estimation of $E_t[\pi_{t+1}]$ is assumed to be uncorrelated with information periods $t$ and $t-1$, under a rational expectation assumption. This formulation provides the following orthogonal conditions for the reduced form of the hybrid NKPC:

$$E_t\left\{\left(\pi_t - \alpha_b \pi_{t-1} - \alpha_f \pi_{t+1} - \lambda \widehat{mc}_t\right) z_t\right\} = 0 \tag{3}$$

$$E_t\left\{\left(\pi_t - \omega\phi^{-1}\pi_{t-1} - \theta\beta\phi^{-1}\pi_{t+1} - (1-\omega)(1-\theta)(1-\beta\theta)\phi^{-1}\widehat{mc}_t\right) z_t\right\} = 0 \tag{4}$$

where $\alpha_b = \omega\phi^{-1}$, $\alpha_f = \theta\beta\phi^{-1}$, and $\lambda = (1-\omega)(1-\theta)(1-\beta\theta)\phi^{-1}$. The $z_t$ is a vector of instruments, $\omega$ is degree of backwardness, $\theta$ is price stickiness, $\beta$ is a subjective discount factor, and $\phi = \theta + \omega(1-\theta(1-\beta))$.

The equation (2) specification represents a closed economy version of NKPC as the real marginal cost comprises only domestic costs ignoring imported inflation costs. In open-economy extensions of the NKPC (Batini et al., 2005; Clarida et al., 2001; Gali & Monacelli, 2005), marginal costs incorporate imported inflation through terms-of-trade fluctuations, imported intermediate goods, and exchange rate pass-through as:

$$\pi_t = \alpha_b \pi_{t-1} + \alpha_f E_t[\pi_{t+1}] + \lambda^H \widehat{mc}_t + \lambda^F \Delta \mathrm{T_t} + \mathrm{e_t} \tag{5}$$

where $\lambda^H = (1-\gamma)$ and $\lambda^F = \gamma$ represent share of domestic and foreign real marginal costs on the current inflation. The parameter $\gamma$ reflects the proportion of imported (final) goods in the domestic consumption basket and, consequently, serves as an indicator of the degree of foreign dependency or economic openness. In the closed economy version given in Equation (2), the influence of open-economy factors on inflation dynamics is embedded within the decomposition of real marginal costs. This decomposition represents the summation of domestic real costs and imported real costs through terms of

trade ($\Delta T_t$), weighted by $\gamma$. This makes the framework particularly well suited to small, open, and commodity-dependent economies such as those in the CCA region.

Equation (5) assumes the perfect exchange rate pass-through, the law of one price (LOOP) holds continually, as $q_t = (1-\gamma)\Delta T_t$ where $q_t$ is the real exchange rate. Monacelli (2005) concerns this assumption arguing that LOOP is imperfect in empirical data for imported prices in the short-run (even though it continues to hold for export prices). The degree of pass-through can be unitary only under three scenarios. First, if the elasticity of demand is constant and independent of the market shares, the demand curve faced by the foreign firms is stable and unchanging, regardless of their dominance in the market or pricing decisions. In such cases, foreign exchange rate passes fully into domestic prices. Second, the power of foreign firms to affect domestic prices is negligibly nil when number of goods in the consumption basket is infinitive. Third, if the share of foreign goods in the domestic consumption basket is 100% (complete foreign domination in the domestic market), they can pass-through any exchange rate movement into domestic prices without losing market share.

Monacelli (2005) assumes a fixed openness index, $\gamma = 0.4$, and incorporates the pass-through as:

$$\pi_t = \alpha_b \pi_{t-1} + \alpha_f E_t[\pi_{t+1}] + \lambda^H \widehat{mc}_t + \rho \Delta T_t + e_t \tag{6}$$

where $\rho$ is degree of pass-through. In the methodology section, we relax the restriction on openness, using a time-varying proxy based on empirical data, measured as the ratio of imports to GDP.

### 3.2. Empirical results

While the hybrid NKPC provides a theoretically consistent framework for capturing both forward- and backward-looking inflation dynamics, empirical findings vary substantially across countries and methodological choices. For instance, Gali and Gertler (1999) utilise GMM methodology to address endogeneity concerns, with robust instruments such as lags in real labour costs, interest rates, the output gap, wage inflation, and commodity prices. Their empirical results for the US suggest that $\alpha_f$ ranges between 0.62 and 0.88, indicating a dominant forward-looking component, alongside some inflation persistence from the backward-looking component. This finding is consistent with several other studies (e.g. Fidrmuc & Daniskova, 2019; Gali et al., 2005; Kozicki & Tinsley, 2002; Sbordone, 2005). In contrast, Linde (2005) and Rudd and Whelan (2005) argue that backward-looking dynamics are more persistent than predicted by the original framework. Cogley and Sbordone (2008) attribute part of this discrepancy to shifts in long-run inflation trends linked to changes in monetary policy regimes, which can materially alter the estimated coefficients on lagged inflation.

In the context of post-Soviet economies, evidence is limited but instructive. While some studies have examined the hybrid NKPC in other post-Soviet nations, such as Russia, Estonia, Latvia, and Lithuania, there is a noticeable gap in research focusing specifically on the CCA countries. For instance, Dabusinskas and Kulikov (2007) analyse the hybrid NKPC in Estonia, Latvia, and Lithuania during 1996–2005, revealing that Estonia exhibits a greater backward-looking inflation expectation (0.54) with a high degree of backwardness ($\omega = 0.79$) and price stickiness ($\theta =$

0.68), while Latvia and Lithuania are more forward-looking (0.54 and 0.75, respectively), with lower values for backwardness and price stickiness. In contrast, Basarac et al. (2011) find significantly larger estimates for the backward-looking component in these three post-Soviet Baltic states (Estonia 0.83, Latvia 0.85, Lithuania 0.88) during 2002–2009. Sokolova (2014) applies the hybrid NKPC to Russia (1999–2013) and finds that inflation expectations are predominantly backward-looking, consistent with Melihovs and Zasova's (2007) results for Latvia (0.56), which highlights the model's superiority over purely forward-looking formulations in capturing inflation inertia. Sovbetov and Kaplan (2019a, 2019b) further show that while emerging and frontier economies tend to be more backward-looking, Russia's forward-looking component increased from 0.41 during 1990–2016 to 0.57 during 2000–2016, with the backward-looking component declining from 0.64 to 0.54, indicating that credible monetary policy frameworks can gradually shift expectation formation towards anticipated prices.

More recent work has expanded the empirical scope to the CCA. Atamanchuk et al. (2025) estimate an augmented Phillips curve, a panel VAR, and a local projections model for the region (excluding Turkmenistan), finding that global factors, particularly foreign inflation and food prices, are dominant drivers of domestic inflation, with substantial exchange rate pass-through and notable persistence. Domestic demand conditions and inflation expectations also play statistically significant, though smaller, roles. Importantly, they find that monetary policy can mitigate external shocks, especially when accompanied by exchange rate appreciation, underscoring the importance of policy credibility and exchange rate flexibility. The significance of heterogeneous import exposure for pass-through dynamics is further illustrated by Ybrayev et al. (2024), who decompose Kazakhstan's inflation into high- and low-import-content goods, showing that high-import-content categories exhibit markedly stronger and faster responses to exchange rate changes, thereby reinforcing imported inflation channels in small open economies.

Poghosyan (2020) focuses specifically on exchange rate pass-through (ERPT) in the CCA (also excluding Turkmenistan), estimating an average pass-through of about 10% on impact and 25% after one year, with no significant asymmetries by regime type or shock size. The findings imply that transitions from fixed to floating regimes need not entail substantial inflationary costs, and that maintaining a low inflation environment reduces ERPT over time. This is directly relevant to open-economy NKPC specifications, where ERPT interacts with the foreign marginal cost term to shape inflation dynamics.

Despite these contributions, there remains a notable gap in empirical research applying the hybrid NKPC to the full set of CCA economies. Existing studies either focus on single countries or subgroups, or employ reduced-form Phillips curve models without jointly estimating the structural NKPC parameters. This paper addresses this gap by providing the first systematic, multi-country estimation of the hybrid NKPC for Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, explicitly considering both closed- and open-economy specifications with perfect and imperfect pass-through. In doing so, it integrates insights from the broader literature on inflation persistence, external shock transmission, and monetary policy credibility, while offering region-specific estimates that can inform policy design.

## 4. Data and methodology

### 4.1. Data

This study employs quarterly data from Q1 1996 to Q4 2023, sourced from LSEF Refinitiv Datastream (formerly Thomson Reuters Eikon) and the World Bank databases.[3] The data encompasses key economic variables: GDP deflator (DEF), Consumer Price Index (CPI), output gap (Y), the net barter terms of trade (TOT), share of imports in GDP (IMP), real interest rates (RIR), real exchange rates (REEX), and the oil price index (OIL). While many of these variables are not explicitly modelled in the equations, they serve as instrumental variables for Generalized Method of Moments (GMM) estimation to address endogeneity concerns. Table 2 summarises their role and sources.

Inflation is measured through two complementary indicators: the GDP deflator and the CPI. The GDP deflator is calculated as the ratio of current-price GDP to constant-price GDP, serving as a broad price measure across the entire economy, whereas the CPI reflects consumer-level price changes. The net barter terms of trade are derived as the logarithmic difference between the import price index and export price index, both expressed in domestic currency. The share of imports in GDP serves as a time-varying proxy for economic openness. Remaining variables are used as instruments.

The output gap is derived by de-trending the natural logarithm of the real GDP variable using the Hodrick–Prescott (HP) filter which decomposes a time series $y_t$ into a trend component $\tau_t$ and a cyclical component $c_t$. The trend component, $\tau_t$, represents the potential long-run output which is obtained by minimizing the following expression:

$$\min_{\tau_t}\left[\sum_{t=1}^{T}(y_t-\tau_t)^2+\lambda\sum_{t=2}^{T-1}\left[(\tau_{t+1}-\tau_t)-(\tau_t-\tau_{t-1})^2\right]\right]$$

where $\lambda$ is the smoothing parameter that controls the trade-off between the smoothness of the trend component and the flexibility of the cyclical component. For our annual data, $\lambda$ is set to 1600, which is a commonly used baseline smoothing parameter in macroeconomic applications (Ravn & Uhlig, 2002). The $c_t$ is the output gap which is derived by $c_t = y_t - \tau_t$.

**Table 2.** Data role and sources.

| Variable | Proxy | Role | Sources |
|---|---|---|---|
| DEF | Implicit GDP Deflator | Dependent, Independent, Instrumental | World Bank |
| CPI | Consumer Price Index | Dependent, Independent, Instrumental | World Bank |
| $Y^{GAP}$ | Output Gap ($GDP - GDP^{POTENTIAL}$) | Independent, Instrumental | World Bank |
| TOT | Net Barter Terms of Trade ($\frac{ExportPriceIndex}{ImportPriceIndex} \times 100$) | Independent, Instrumental | World Bank |
| IMP | Imports of Goods and Services (% GDP) | Independent, Instrumental | World Bank |
| UNE | Unemployment Rate | Instrumental | World Bank, LSEG Refinitiv |
| RIR | Real Interest Rate | Instrumental | World Bank, LSEG Refinitiv |
| REEX | Real Effective Exchange Rate | Instrumental | World Bank, LSEG Refinitiv |
| OIL | Oil Price Index | Instrumental | World Bank, LSEG Refinitiv |

Note: The missing data quarters are obtained by linear interpolation methodology.

A critical consideration in this analysis is the uneven quality of official statistics across the sample. While the World Bank and LSEG Refinitiv provide internationally harmonised data, academic and institutional studies (e.g. Atamanchuk et al., 2025; International Monetary Fund, 2023) highlight persistent concerns in certain economies – most notably Turkmenistan, and to a lesser extent Tajikistan and Uzbekistan – arising from restricted independence of statistical agencies, administrative opacity, and the prevalence of government-directed price controls. Such practices can suppress measured inflation volatility and distort cost indicators, with administrative controls in particular dampening volatility and distorting the inflation process, making $\omega$ less reflective of genuine inflation inertia. In some cases, these effects may lead to attenuated estimates of the backward-looking inflation coefficient ($\omega$) and weaker observed links between marginal costs and inflation ($\lambda$ parameters). For example, if wage adjustments in state-dominated sectors are delayed or administratively fixed, real unit labour costs may understate true marginal costs, biasing interpretations of price stickiness and pass-through. These risks are most acute in country-specific estimations; pooling in the panel framework helps mitigate the impact of country-level mismeasurement by exploiting cross-sectional variation, but does not eliminate the underlying data quality concerns. Consequently, while the qualitative patterns we document are robust, the magnitude of some country-level coefficients should be interpreted with caution, especially where institutional constraints on statistical independence are well documented.

A few quarterly observations are missing for some variables, particularly instrumental variables such as the real interest rate (RIR) and the real effective exchange rate (REEX). To preserve temporal consistency and avoid dropping countries from the estimation, these gaps are filled using linear interpolation, a transparent and widely accepted approach in macroeconomic panel work. Because these variables enter the model only as instruments rather than core dependent or independent variables in the NKPC equations, the potential bias from interpolation is likely to be minimal. Nevertheless, if gaps coincide with high-volatility episodes (e.g. post-Soviet hyperinflation, the 1998 Russian financial crisis, Uzbekistan's 2017 exchange rate liberalisation), interpolation may still understate the true variance of these series.

Table 3 summarises data for each country, revealing several noteworthy patterns that provide important context for the empirical analysis. In Armenia, average inflation is moderate but accompanied by relatively high volatility in both the GDP deflator and CPI, with skewness and kurtosis statistics indicating occasional large shocks. The import share in GDP is close to 50%, suggesting that imported inflation channels are likely to play a significant role in its open-economy NKPC specification. Georgia exhibits the highest GDP deflator volatility in the sample, reflecting the combined effects of post-Soviet transition instability and sensitivity to global commodity prices. Its CPI variation is similarly elevated, and trade openness exceeds 50%, increasing the economy's exposure to terms-of-trade fluctuations and exchange rate pass-through.

The two largest commodity exporters in the region, Kazakhstan and Azerbaijan, register lower average inflation rates yet remain strongly influenced by global energy price cycles, as reflected in the variability of their terms-of-trade measures. Kyrgyzstan stands out for its exceptionally high trade openness, with imports accounting for nearly 68% of GDP on average, implying that imported cost shocks are likely to exert a pronounced effect on the estimated $\lambda^F$ coefficients. Turkmenistan records the highest

**Table 3.** Descriptive statistics.

| Country | Variable | Mean | Median | Max. | Min. | Std. Dev. | Skewness | Kurtosis | Obs. |
|---|---|---|---|---|---|---|---|---|---|
| *Armenia* | DEF | 2.0077 | 0.0498 | 41.0729 | −0.4549 | 7.5944 | 24.3429 | 4.8031 | 128 |
| | CPI | 3.1765 | 0.0550 | 35.1500 | −0.0063 | 9.6979 | 2.8138 | 8.9948 | 128 |
| | $Y^{GAP}$ | 0.0000 | 0.0212 | 0.7708 | −0.7358 | 0.3123 | −0.173 | 3.9506 | 128 |
| | ΔTOT | 0.0123 | 0.0080 | 0.1608 | −0.1235 | 0.0458 | 0.2275 | 4.4489 | 112 |
| | IMP | 0.4990 | 0.4898 | 0.7310 | 0.3878 | 0.0811 | 0.8273 | 0.5166 | 128 |
| *Azerbaijan* | DEF | 1.2459 | 0.1174 | 13.8607 | −0.1885 | 3.3223 | 2.7802 | 9.5728 | 128 |
| | CPI | 1.5302 | 0.0668 | 16.6222 | 0.0107 | 4.2910 | 2.7950 | 9.2333 | 128 |
| | $Y^{GAP}$ | 0.0000 | 0.0091 | 0.8197 | −1.001 | 0.4033 | −0.4258 | 3.582 | 128 |
| | ΔTOT | 0.0510 | 0.1207 | 0.6674 | −0.4610 | 0.23336 | −0.1072 | 3.7109 | 112 |
| | IMP | 0.3809 | 0.3704 | 0.7271 | 0.2068 | 0.1349 | 0.8690 | 3.1612 | 128 |
| *Georgia* | DEF | 7.2832 | 0.0784 | 154.442 | −0.5816 | 28.9514 | 4.7169 | 23.2728 | 128 |
| | CPI | 4.5289 | 0.0522 | 74.879 | −0.0051 | 16.1527 | 3.6754 | 15.0966 | 128 |
| | $Y^{GAP}$ | 0.0000 | 0.0125 | 0.5415 | −0.6861 | 0.2979 | −0.6046 | 3.5262 | 128 |
| | ΔTOT | 0.0141 | 0.0116 | 0.2097 | −0.1257 | 0.0554 | 0.8784 | 4.9452 | 112 |
| | IMP | 0.5298 | 0.5409 | 1.0913 | 0.3141 | 0.1402 | 1.8513 | 7.1684 | 128 |
| *Kazakhstan* | DEF | 1.4969 | 0.1378 | 15.4673 | 0.0182 | 4.1819 | 2.8128 | 9.0476 | 128 |
| | CPI | 2.0301 | 0.0840 | 21.5000 | 0.0520 | 5.9198 | 2.7927 | 8.8655 | 128 |
| | $Y^{GAP}$ | 0.0000 | 0.0395 | 0.7541 | −1.0411 | 0.3743 | −0.7795 | 4.4653 | 112 |
| | ΔTOT | 0.0410 | 0.0631 | 0.3708 | −0.3520 | 0.1523 | −0.6824 | 3.7979 | 112 |
| | IMP | 0.3421 | 0.3191 | 0.4909 | 0.2442 | 0.0837 | 0.3576 | 1.6024 | 128 |
| *Kyrgyzstan* | DEF | 0.6713 | 0.0960 | 8.3011 | 0.0203 | 1.9304 | 3.4868 | 13.4892 | 128 |
| | CPI | 1.5511 | 0.0978 | 18.5000 | 0.0213 | 4.3175 | 3.0194 | 10.9381 | 128 |
| | $Y^{GAP}$ | 0.0000 | 0.0225 | 0.5476 | −0.838 | 0.3108 | −0.832 | 3.9707 | 128 |
| | ΔTOT | 0.0480 | 0.0396 | 0.1931 | −0.0620 | 0.0669 | 0.3368 | 2.4322 | 112 |
| | IMP | 0.6756 | 0.6681 | 0.9527 | 0.3702 | 0.1746 | −0.0362 | 1.7368 | 128 |
| *Tajikistan* | DEF | 1.0173 | 0.1538 | 12.0721 | 0.0054 | 2.4200 | 3.4349 | 15.1325 | 128 |
| | CPI | 2.1155 | 0.1268 | 23.0000 | 0.0840 | 5.6596 | 2.8673 | 9.9039 | 128 |
| | $Y^{GAP}$ | 0.0000 | 0.0259 | 0.7924 | −1.0091 | 0.3652 | −0.6051 | 4.0855 | 128 |
| | ΔTOT | 0.0280 | 0.0477 | 0.1476 | −0.159 | 0.0790 | −0.6495 | 2.7566 | 112 |
| | IMP | 0.6294 | 0.6242 | 0.9966 | 0.3842 | 0.1814 | 0.2568 | 2.0510 | 128 |
| *Turkmenistan* | DEF | 2.2643 | 0.1101 | 30.8915 | −0.0515 | 6.1260 | 3.5529 | 16.2229 | 128 |
| | CPI | 1.9401 | 0.1110 | 21.0000 | 0.0701 | 5.1520 | 2.7523 | 9.3430 | 128 |
| | $Y^{GAP}$ | 0.0016 | 0.0314 | 0.8497 | −1.1251 | 0.4435 | −0.744 | 3.9043 | 128 |
| | ΔTOT | 0.0520 | 0.0651 | 1.2205 | −0.417 | 0.2993 | 1.7776 | 9.3211 | 112 |
| | IMP | 0.3712 | 0.3862 | 0.6659 | 0.1249 | 0.1621 | 0.0942 | 1.8446 | 128 |
| *Uzbekistan* | DEF | 1.3031 | 0.2268 | 12.3860 | 0.0893 | 3.0212 | 2.8439 | 9.7523 | 128 |
| | CPI | 1.7322 | 0.1299 | 19.5000 | 0.0733 | 4.5747 | 2.9459 | 10.5639 | 128 |
| | $Y^{GAP}$ | 0.0000 | 0.0129 | 0.8506 | −0.9303 | 0.3419 | 0.1553 | 4.6734 | 128 |
| | ΔTOT | 0.0700 | 0.0666 | 0.4196 | −0.149 | 0.1127 | 0.7232 | 4.5449 | 112 |
| | IMP | 0.2977 | 0.2906 | 0.4436 | 0.1685 | 0.0841 | 0.2093 | 2.0621 | 128 |

GDP deflator volatility in the dataset, although persistent concerns about the reliability of official statistics mean that the true magnitude of such variation should be interpreted cautiously. Uzbekistan shows the lowest openness ratio in the sample but has undergone significant structural transformation since the 2017 exchange rate liberalization, a development that is likely to affect both the stability and magnitude of its estimated NKPC parameters.

Given the potential for seasonality in quarterly macroeconomic series, particularly inflation, the dataset undergoes rigorous seasonal adjustment. We employ the additive decomposition form of the X-13 procedure developed by the U.S. Census Bureau[4] (Findley et al., 1998). This choice reflects the fact that seasonal fluctuations in series tend to be relatively constant in magnitude over time, making additive adjustment more appropriate than multiplicative. The procedure combines autoregressive integrated moving average (ARIMA) modelling with signal extraction techniques to pre-adjust and decompose the series.

Formally, the observed series $y_t$ is first modelled as an ARIMA process to extend the series and stabilise its variance, and then decomposed into three orthogonal components:

$$y_t = T_t + S_t + I_t$$

where $T_t$ is the trend-cycle component, $S_t$ is the seasonal component, and $I_t$ is the irregular (noise) component. The seasonally adjusted series is obtained as:

$$y_t^{SA} = y_t - S_t$$

The underlying ARIMA model is specified as $ARIMA(p,d,q)(P,D,Q)_4$ to capture both regular and seasonal dynamics in quarterly data, with the SEATS module extracting mutually orthogonal components. This method is widely regarded in applied macroeconomics for its ability to isolate seasonal effects with minimal distortion to the underlying trend. Its advantages include flexibility in handling irregular seasonal patterns and robustness to structural breaks, while limitations include the potential removal of cyclical components if the model is mis-specified. Applying X-13ARIMA-SEATS ensures that the inflation series align with the NKPC framework's assumption of seasonally adjusted data.

Finally, we report individual and panel (Pesaran CIPS) unit root tests to confirm stationarity of the series, given in Table 4.

### 4.2. Methodology

The model specification centres on the hybrid New Keynesian Phillips Curve (NKPC), as shown in the Equation (2) for closed economy and Equation (5) for open economy perfect pass-through. Following, Monacelli (2005), we also consider open economy with low pass-through. Instead of utilizing a fixed openness index as proposed in Monacelli (2005), we employ a time-varying proxy based on empirical data, measured as the ratio of imports to GDP. Thus, we model open economy NKPC with imperfect pass-through as:

$$\pi_t = \alpha_b \pi_{t-1} + \alpha_f E_t[\pi_{t+1}] + \lambda^H \widehat{mc}_t + \lambda^F \Delta \mathrm{T_t} + \mathrm{e_t} \tag{7}$$

where $\lambda^H = (1-\rho\gamma)$ and $\lambda^F = \rho\gamma$ and $\rho$ is degree of exchange rate pass-through. Note that this equation nests all other equations making them special cases of it. When $\rho$ is a unitary, Equation (7) reduces to Equation (5), the case of open economy full pass-through. When either $\gamma$ or $\rho$ is zero, the model becomes the closed economy version given in Equation (2). Further, the structural parameters can be derived as:

- $\alpha_b = \omega\phi^{-1}$
- $\alpha_f = \theta\beta\phi^{-1}$
- $\lambda^H = (1-\rho\gamma)(1-\omega)(1-\theta)(1-\beta\theta)\phi^{-1}$
- $\lambda^F = \rho\gamma(1-\omega)(1-\theta)(1-\beta\theta)\phi^{-1}$

Note that the higher $\gamma$ indicates a greater role of imported inflation in current inflation under perfect pass-through ($\rho = 1$). The stronger sticky prices ($\theta$) reduce the role of imported inflation, as adjustments to $\Delta \mathrm{T_t}$ are slower. The higher backwardness ($\omega$) also reduces the role of imported inflation because it shifts the focus of inflation dynamics away from structural drivers like $\Delta \mathrm{T_t}$ towards past inflation. This reflects an inflation

**Table 4.** ADF unit root tests.

| | Level | | | First-Difference | | | | |
|---|---|---|---|---|---|---|---|---|
| | DEF | CPI | $Y^{GAP}$ | ΔTOT | ΔRIR | ΔREEX | ΔIMP | ΔOIL |
| Armenia | −3.819*** | −3.104** | −6.040*** | −5.0809*** | −3.482** | −4.2901*** | −5.110*** | −3.592** |
| | [0.007] | [0.036] | [0.000] | [0.000] | [0.018] | [0.002] | [0.000] | [0.013] |
| Azerbaijan | −3.349** | −3.752*** | −5.743*** | −4.483*** | −3.638*** | −3.647*** | −4.431*** | |
| | [0.021] | [0.008] | [0.000] | [0.001] | [0.011] | [0.010] | [0.002] | |
| Georgia | −3.6178** | −2.905** | −6.343*** | −5.7288*** | −3.6204*** | −4.6422*** | −7.050*** | |
| | [0.011] | [0.056] | [0.000] | [0.000] | [0.009] | [0.000] | [0.000] | |
| Kazakhstan | −3.794*** | −4.105*** | −5.695*** | −4.473*** | −3.354** | −3.790*** | −9.558*** | |
| | [0.007] | [0.003] | [0.000] | [0.001] | [0.021] | [0.007] | [0.000] | |
| Kyrgyzstan | −6.119*** | −10.778*** | −6.514*** | −8.017*** | −3.802*** | −3.576** | −4.238*** | |
| | [0.000] | [0.000] | [0.000] | [0.000] | [0.007] | [0.014] | [0.003] | |
| Tajikistan | −11.434*** | −3.945*** | −5.882*** | −4.462*** | −3.261** | −2.957** | −5.173*** | |
| | [0.000] | [0.006] | [0.000] | [0.002] | [0.032] | [0.050] | [0.000] | |
| Turkmenistan | −10.540*** | −6.285*** | −5.809*** | −5.177*** | −3.078** | −5.091*** | −3.951*** | |
| | [0.000] | [0.000] | [0.000] | [0.000] | [0.037] | [0.000] | [0.005] | |
| Uzbekistan | −4.864*** | −8.227*** | −5.998*** | −3.606** | −3.295** | −3.658*** | −4.831*** | |
| | [0.001] | [0.000] | [0.000] | [0.012] | [0.028] | [0.009] | [0.001] | |
| **PANEL (Pesaran CIPS)** | −7.105*** | −4.129*** | −6.233*** | −4.408*** | −5.054*** | −5.099*** | −3.711*** | |
| | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | |

Notes: Table reports MacKinnon (1996) one-sided *p*-values for the ADF unit root test in levels and first differences, including an intercept and with automatic lag length selection based on the SIC, with a maximum of four lags. For the panel case, Pesaran's CIPS cross-section-dependent unit root test is applied, using a deterministic constant and a maximum of four lags based on the SIC. *P*-values are in brackets and asterisks follow: ***$p<0.01$, **$p<0.05$, *$p<0.10$.

process dominated by inertia, where external shocks like terms of trade changes play a smaller role in influencing current inflation.

Finally, we derive the following orthogonal conditions for the reduced form of the open economy imperfect pass-through NKPC:

$$E_t\left\{\left(\pi_t - a_b\pi_{t-1} - a_f\pi_{t+1} - \lambda^H\widehat{mc}_t - \lambda^F\Delta \mathrm{T_t}\right)z_t\right\} = 0 \tag{8}$$

$$E_t\left\{\begin{pmatrix}\pi_t - \omega\phi^{-1}\pi_{t-1} - \theta\beta\phi^{-1}\pi_{t+1} - (1-\rho\gamma)(1-\omega)(1-\theta)(1-\beta\theta)\phi^{-1}\widehat{mc}_t \\ -\rho\gamma(1-\omega)(1-\theta)(1-\beta\theta)\phi^{-1}\Delta \mathrm{T_t}\end{pmatrix}z_t\right\} = 0 \tag{9}$$

Consistent with the literature, inflation expectations are proxied using variables such as past inflation rates, output gaps, real interest rates, real exchange rates, and oil prices. These variables serve as instruments in the GMM estimation, circumventing the need to explicitly model inflation expectations. The study employs the continuously updating GMM (CUE) estimator, which provides lower small-sample bias and robust Hansen's J-test performance[5] compared to the two-step GMM technique. Heteroskedasticity and auto-correlation-consistent (HAC) standard errors are applied, using spectral quadratic kernels and automatic bandwidth selection as per Wilhelm's (2015)guidelines.

## 5. Results

### 5.1. Reduced hybrid NKPC results

The results of the study, presented in Table 5, offer valuable insights into inflation dynamics in the CCA economies. The hybrid NKPC model is estimated by continuously

**Table 5.** Hybrid NKPC results.

| | | Armenia | Azerbaijan | Georgia | Kazakhstan | Kyrgyzstan | Tajikistan | Turkmenistan | Uzbekistan |
|---|---|---|---|---|---|---|---|---|---|
| **Panel A: Closed Hybrid NKPC** | | | | | | | | | |
| DEF | $\pi_b$ | 0.482*** | 0.562*** | 0.466*** | 0.514*** | 0.575*** | 0.630*** | 0.612*** | 0.548*** |
| | | (0.113) | (0.109) | (0.098) | (0.109) | (0.103) | (0.142) | (0.136) | (0.122) |
| | $\pi_f$ | 0.507*** | 0.435*** | 0.517*** | 0.478*** | 0.417*** | 0.368*** | 0.384*** | 0.447*** |
| | | (0.081) | (0.078) | (0.084) | (0.086) | (0.063) | (0.083) | (0.087) | (0.100) |
| | $\lambda^H$ | 0.070** | 0.069*** | 0.061** | 0.059*** | 0.055*** | 0.044*** | 0.036*** | 0.068*** |
| | | (0.035) | (0.014) | (0.028) | (0.017) | (0.016) | (0.013) | (0.009) | (0.019) |
| | $\lambda^F$ | – | – | – | – | – | – | – | – |
| | J-Stats. | 5.26 | 5.44 | 6.05 | 8.73 | 13.04 | 14.92 | 9.41 | 10.93 |
| | | [0.26] | [0.63] | [0.11] | [0.78] | [0.45] | [0.29] | [0.74] | [0.62] |
| | Cragg-Donald | 16.19 | 14.81 | 17.05 | 22.19 | 18.74 | 16.06 | 12.69 | 24.31 |
| **Panel B: Open Economy Hybrid NKPC (Perfect Pass-Through)** | | | | | | | | | |
| CPI | $\pi_b$ | 0.478*** | 0.530*** | 0.462*** | 0.505*** | 0.564*** | 0.603*** | 0.601*** | 0.532*** |
| | | (0.124) | (0.095) | (0.101) | (0.092) | (0.108) | (0.118) | (0.118) | (0.106) |
| | $\pi f$ | 0.516*** | 0.461*** | 0.527*** | 0.486*** | 0.425*** | 0.389*** | 0.395*** | 0.446*** |
| | | (0.104) | (0.076) | (0.096) | (0.085) | (0.081) | (0.080) | (0.072) | (0.074) |
| | $\lambda h$ | 0.041** | 0.042*** | 0.041** | 0.039*** | 0.027*** | 0.024*** | 0.027** | 0.051*** |
| | | (0.020) | (0.011) | (0.019) | (0.009) | (0.009) | (0.007) | (0.013) | (0.016) |
| | $\lambda F$ | 0.031** | 0.021** | 0.029** | 0.027*** | 0.032*** | 0.026*** | 0.012* | 0.026*** |
| | | (0.014) | (0.010) | (0.015) | (0.007) | (0.010) | (0.008) | (0.007) | (0.008) |
| | J-Stats. | 5.11 | 7.91 | 5.49 | 9.40 | 13.17 | 15.93 | 9.93 | 9.04 |
| | | [0.40] | [0.85] | [0.36] | [0.75] | [0.54] | [0.25] | [0.72] | [0.78] |
| | Cragg-Donald | 17.22 | 19.60 | 18.44 | 21.87 | 19.33 | 15.47 | 16.68 | 25.92 |
| **Panel C: Open Economy Hybrid NKPC (Imperfect Pass-Through)** | | | | | | | | | |
| CPI | $\pi b$ | 0.480*** | 0.542*** | 0.464*** | 0.510*** | 0.571*** | 0.617*** | 0.606*** | 0.541*** |
| | | (0.124) | (0.093) | (0.103) | (0.105) | (0.106) | (0.118) | (0.125) | (0.103) |
| | $\pi b$ | 0.511*** | 0.453*** | 0.507*** | 0.482*** | 0.421*** | 0.379*** | 0.390*** | 0.445*** |
| | | (0.099) | (0.052) | (0.093) | (0.073) | (0.061) | (0.058) | (0.067) | (0.062) |
| | $\lambda H$ | 0.034** | 0.037*** | 0.036** | 0.042*** | 0.021*** | 0.018*** | 0.026*** | 0.046*** |
| | | (0.016) | (0.012) | (0.018) | (0.013) | (0.007) | (0.006) | (0.007) | (0.015) |
| | $\lambda F$ | 0.034** | 0.023*** | 0.040** | 0.029*** | 0.043*** | 0.032*** | 0.015** | 0.030*** |
| | | (0.015) | (0.009) | (0.019) | (0.009) | (0.014) | (0.009) | (0.007) | (0.008) |
| | J-Stats. | 4.94 | 4.30 | 4.60 | 8.79 | 13.26 | 15.51 | 9.36 | 10.95 |
| | | [0.29] | [0.86] | (0.33) | [0.79] | [0.43] | [0.21] | [0.74] | [0.62] |
| | Cragg-Donald | 15.39 | 18.52 | 19.44 | 20.80 | 17.45 | 11.98 | 12.36 | 22.47 |

Notes: The table reports hybrid NKPC estimates obtained by continuously updating GMM (CUE). Instruments include one or two lags of inflation (GDP deflator in the closed specification; CPI in the open specifications), the output gap, real unit labour costs, the terms of trade, and the import share, plus up to four lags of the real interest rate, the real effective exchange rate, and the oil price. HAC-robust standard errors are shown in parentheses; significance levels are ***$p < 0.01$%, **$p < 0.05$, and *$p < 0.10$. Hansen J-statistics are reported with $p$-values in parentheses, and Cragg-Donald F-statistics are provided for weak-instrument diagnostics.

updating GMM using one to two lags of inflation, the output gap, terms of trade, and the import share in GDP, together with up to four lags of real interest rates, real effective exchange rates, and oil prices as instruments. Panel A uses the GDP deflator under the closed-economy specification, whereas Panels B and C use the CPI, which also captures imported price pressures under the open-economy specifications. Across all models, Hansen's J statistics do not reject the overidentifying restrictions, and Cragg-Donald F statistics indicate no weak-instrument concerns.

Both backward-looking and forward-looking components are statistically significant at the 1% level in every country and specification, confirming the empirical relevance of the hybrid NKPC. In the closed-economy model, the backward-looking weight ($\pi_b$) ranges from 0.466 in Georgia to 0.630 in Tajikistan, while the forward-looking weight ($\pi_f$) spans from 0.368 in Tajikistan to 0.517 in Georgia. Georgia records the most forward-oriented inflation process in the sample, followed closely by Armenia ($\pi_f = 0.507$), whereas Kazakhstan exhibits a balanced profile with $\pi_b = 0.51$ and $\pi_f = 0.48$. Uzbekistan and Azerbaijan are more backward-looking, and the strongest persistence appears in Tajikistan and Turkmenistan ($\pi_b = 0.63$ and $\pi_b = 0.61$, respectively). Using the GDP-deflator in the closed-economy specification isolates domestic price dynamics and underscores the central role of inertia in the region.

The open-economy specifications (Panels B and C), reveal a consistent pattern: as openness and exchange rate channels are introduced, the backward-looking weight declines while the forward-looking component rises. Under perfect pass-through, $\pi_f$ exceeds its closed-economy value for nearly all countries, indicating that external exposure tends to amplify the role of expectations. In the imperfect pass-through model, backward-looking weights are slightly higher than in the perfect pass-through case, yet still lower than in the closed-economy setting. This implies that even with partial insulation from external shocks, forward-looking expectations retain a central role in the price formation of open economy specification.

The cost slopes provide additional structure. In the closed model, the slope on domestic real marginal costs ($\lambda^H$) ranges from 0.036 in Turkmenistan to 0.070 in Armenia. In the open models, the closed-economy cost term decomposes into domestic ($\lambda^H$) and external ($\lambda^F$) components. Domestic costs generally exert the larger influence, though notable exceptions remain. Kyrgyzstan and Tajikistan load more heavily on external costs, indicating greater sensitivity to imported price shocks, whereas Turkmenistan records the lowest $\lambda^F$, suggesting that its inflation is predominantly driven by internal cost pressures. These contrasts underscore substantial heterogeneity in inflation transmission across countries.

We compute the domestic and external cost shares as $\frac{\lambda^H}{\lambda^H+\lambda^F}$ and $\frac{\lambda^F}{\lambda^H+\lambda^F}$, using the imperfect pass-through specification (Panel C). The resulting shares indicate that domestic costs dominate in most cases: Azerbaijan 61.67% domestic and 38.33% external, Kazakhstan 59.15 and 40.85, Turkmenistan 63.41 and 36.59, and Uzbekistan 60.53 and 39.47. By contrast, external costs exceed domestic costs in Georgia 47.37 and 52.63, Kyrgyzstan 32.81 and 67.19, and Tajikistan 36.00 and 64.00. Armenia is approximately balanced at 50 and 50. Taken together, these patterns imply that imported inflation channels are especially salient in Kyrgyzstan and Tajikistan, material in Georgia, and comparatively less influential in Azerbaijan, Kazakhstan, Turkmenistan, and Uzbekistan, a configuration that is consistent with the countries' differing degrees of openness and exposure to terms-of-trade and exchange-rate movements.

### 5.2. Structural hybrid NKPC results

Table 6 reports the structural parameters implied by the hybrid NKPC under three environments: a closed economy (Panel A); an open economy with perfect pass-through (Panel B); and an open economy with imperfect pass-through (Panel C). For each panel we present two calibrations, one where the discount factor is estimated and lies below unity, and one where it is fixed at unity. Reading across countries and panels yields a coherent set of patterns that aligns with the institutional context documented earlier.

The degree of backwardness, $\omega$, is high in most CCA economies, yet it responds systematically to the modelling of external channels. In the closed economy with

**Table 6.** Structural parameters for the hybrid NKPC.

| | | Armenia | Azerbaijan | Georgia | Kazakhstan | Kyrgyzstan | Tajikistan | Turkmenistan | Uzbekistan |
|---|---|---|---|---|---|---|---|---|---|
| **Panel A: Closed Hybrid NKPC** | | | | | | | | | |
| (1) | $\omega$ | 0.541 | 0.658 | 0.538 | 0.589 | 0.692 | 0.788 | 0.792 | 0.638 |
| | $\theta$ | 0.603 | 0.541 | 0.623 | 0.601 | 0.553 | 0.511 | 0.541 | 0.543 |
| | $\beta$ | 0.942 | 0.943 | 0.958 | 0.951 | 0.922 | 0.902 | 0.930 | 0.930 |
| | $\gamma$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | $\rho$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | $D$ | 2.52 | 2.18 | 2.65 | 2.51 | 2.24 | 2.05 | 2.18 | 2.19 |
| (2) | $\omega$ | 0.541 | 0.659 | 0.488 | 0.605 | 0.678 | 0.743 | 0.726 | 0.656 |
| | $\theta$ | 0.563 | 0.502 | 0.543 | 0.586 | 0.490 | 0.455 | 0.455 | 0.517 |
| | $\beta$ | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | $\gamma$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | $\rho$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | $D$ | 2.29 | 2.01 | 2.19 | 2.42 | 1.96 | 1.77 | 1.84 | 2.07 |
| **Panel B: Open Economy Hybrid NKPC (Perfect Pass-Through)** | | | | | | | | | |
| (1) | $\omega$ | 0.542 | 0.621 | 0.518 | 0.581 | 0.670 | 0.747 | 0.774 | 0.608 |
| | $\theta$ | 0.618 | 0.576 | 0.610 | 0.586 | 0.560 | 0.528 | 0.544 | 0.538 |
| | $\beta$ | 0.938 | 0.939 | 0.949 | 0.945 | 0.906 | 0.915 | 0.935 | 0.947 |
| | $\gamma$ | 0.498 | 0.328 | 0.504 | 0.415 | 0.545 | 0.516 | 0.306 | 0.338 |
| | $\rho$ | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | $D$ | 2.62 | 2.36 | 2.57 | 2.42 | 2.27 | 2.12 | 2.19 | 2.17 |
| (2) | $\omega$ | 0.537 | 0.615 | 0.510 | 0.598 | 0.656 | 0.711 | 0.709 | 0.624 |
| | $\theta$ | 0.576 | 0.536 | 0.571 | 0.572 | 0.497 | 0.459 | 0.467 | 0.523 |
| | $\beta$ | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | $\gamma$ | 0.511 | 0.335 | 0.524 | 0.524 | 0.562 | 0.534 | 0.312 | 0.358 |
| | $\rho$ | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | $D$ | 2.36 | 2.16 | 2.33 | 2.34 | 1.99 | 1.85 | 1.87 | 2.10 |
| **Panel C: Open Economy Hybrid NKPC (Imperfect Pass-Through)** | | | | | | | | | |
| (1) | $\omega$ | 0.559 | 0.640 | 0.516 | 0.589 | 0.673 | 0.760 | 0.775 | 0.621 |
| | $\theta$ | 0.603 | 0.573 | 0.598 | 0.569 | 0.542 | 0.509 | 0.533 | 0.536 |
| | $\beta$ | 0.931 | 0.935 | 0.944 | 0.947 | 0.917 | 0.918 | 0.932 | 0.942 |
| | $\gamma$ | 0.504 | 0.386 | 0.523 | 0.413 | 0.672 | 0.636 | 0.367 | 0.395 |
| | $\rho$ | 0.932 | 0.848 | 0.956 | 0.935 | 0.811 | 0.812 | 0.803 | 0.943 |
| | $D$ | 2.52 | 2.34 | 2.49 | 2.32 | 2.19 | 2.04 | 2.14 | 2.16 |
| (2) | $\omega$ | 0.552 | 0.629 | 0.502 | 0.614 | 0.667 | 0.726 | 0.718 | 0.642 |
| | $\theta$ | 0.554 | 0.526 | 0.548 | 0.561 | 0.493 | 0.446 | 0.461 | 0.520 |
| | $\beta$ | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | $\gamma$ | 0.518 | 0.394 | 0.515 | 0.422 | 0.698 | 0.661 | 0.382 | 0.402 |
| | $\rho$ | 0.941 | 0.860 | 0.948 | 0.941 | 0.833 | 0.836 | 0.848 | 0.934 |
| | $D$ | 2.24 | 2.11 | 2.22 | 2.28 | 1.98 | 1.81 | 1.85 | 2.08 |

Notes: Numbers in the table are estimates of hybrid New Keynesian Phillips Curve that is derived by continuously updating GMM methodology using instruments of one to two lags of inflation (CPI and GDP deflator), output gap, terms of trade, and share of imports in GDP, as well as up to four lags of real interest rates, real exchange rates, and changes in oil prices. The $\omega$ denotes degree of backwardness; $\theta$ represents price stickiness; $\beta$ is beta discount factor; $\gamma$ is degree of openness, $\rho$ is degree of pass-through. The $D$ is price duration which is manually calculated in quarterly basis periods by $1/(1-\theta)$.

estimated $\beta$ (Panel A, model 1), $\omega$ ranges from 0.538 in Georgia and 0.541 in Armenia to 0.788 in Tajikistan and 0.792 in Turkmenistan. Introducing openness with perfect pass-through (Panel B, model 1) lowers $\omega$ almost everywhere, for example from 0.658 to 0.621 in Azerbaijan, from 0.538 to 0.518 in Georgia, and from 0.638 to 0.608 in Uzbekistan. Allowing for imperfect pass-through (Panel C, model 1) nudges $\omega$ back up slightly in most cases, consistent with partial insulation of domestic prices from external shocks. These shifts indicate that modelling imported inflation explicitly reallocates some of the persistence that would otherwise be absorbed by backward-looking terms, while incomplete pass-through restores a portion of that persistence.

Price stickiness, $\theta$, is moderate and remarkably stable across environments, implying relatively short price durations. With estimated $\beta$ in the closed economy (Panel A, model 1), $\theta$ lies between 0.511 in Tajikistan and 0.623 in Georgia, corresponding to price durations $D = 1/(1-\theta)$ between roughly 2.05 and 2.65 quarters. Open-economy specifications deliver similar magnitudes, for example $\theta = 0.618$ in Armenia and 0.610 in Georgia under perfect pass-through (Panel B, model 1), and $\theta = 0.603$ and 0.598 in the same countries under imperfect pass-through (Panel C, model 1). Fixing $\beta$ at unity lowers $\theta$ and shortens price duration uniformly across countries, as seen for Tajikistan where $\theta$ falls from 0.511 to 0.455 and $D$ from 2.05 to 1.77 quarters. This is the expected identification trade-off between intertemporal discounting and nominal rigidity.

The openness parameter, $\gamma$, is economically meaningful and lines up with the descriptive evidence. Under perfect pass-through with estimated $\beta$ (Panel B, model 1), $\gamma$ is highest in Kyrgyzstan at 0.545 and Tajikistan at 0.516, and lowest in Turkmenistan at 0.306 and Azerbaijan at 0.328. Under imperfect pass-through (Panel C, model 1), the ranking persists and the dispersion widens: Kyrgyzstan 0.672 and Tajikistan 0.636 at the top, Turkmenistan 0.367 and Azerbaijan 0.386 at the bottom. These values corroborate the earlier decomposition of marginal costs, where external cost shares were largest for Kyrgyzstan and Tajikistan and comparatively small for Turkmenistan and Azerbaijan.

Pass-through, $\rho$, is high but clearly incomplete in the imperfect pass-through setting. With estimated $\beta$ (Panel C, model 1), $\rho$ ranges from 0.803 in Turkmenistan and 0.811–0.812 in Kyrgyzstan and Tajikistan to 0.932 in Armenia and 0.956 in Georgia, with Kazakhstan and Uzbekistan also near the top at 0.935 and 0.943. Fixing $\beta$ at unity (Panel C, model 2) lifts $\rho$ modestly across countries. The pattern suggests that exchange-rate and foreign-price shocks transmit strongly to domestic prices in the inflation-targeting economies of Armenia and Georgia, and to a lesser degree in Kazakhstan and Uzbekistan, while transmission is more muted where pricing is more regulated or tradability is lower.

Two cross-country regularities merit emphasis. First, the three inflation-targeting economies generally sit at the lower end of $\omega$ and at the upper end of $\rho$, for example Georgia with $\omega = 0.518$ and $\rho = 0.956$ when $\beta$ is estimated, which is consistent with better anchored expectations and clearer transmission from external prices to domestic inflation. Second, the countries with the highest openness $\gamma$ also tend to display larger external cost shares and higher sensitivity to imported shocks, as reflected in Kyrgyzstan and Tajikistan, even though their pass-through coefficients are not the largest. That combination points to imported inflation channels operating primarily through quantities and cost structures, with administrative features and market structure tempering immediate price pass-through.

Overall, the structural parameters portray an inflation process that remains persistence-laden, with $\omega$ typically between 0.5 and 0.8, nominal rigidities that imply price resetting roughly every two to two and a half quarters, and external channels that matter materially in the more open economies. The movement of $\omega$ across Panels A to C confirms that part of what is often measured as inertia in closed-economy specifications is in fact imported through terms of trade and exchange-rate channels.

### 5.3. Panel hybrid NKPC results

Table 7 reports panel fixed-effects GMM estimates that pool the CCA economies to recover region-wide regularities while absorbing time-invariant country heterogeneity. In the reduced-form results (Panel A), the closed-economy specification yields a backward-looking weight of 0.553 and a forward-looking weight of 0.422, confirming substantial persistence alongside a meaningful role for expectations. Introducing openness with perfect pass-through tilts the balance towards expectations, with $\pi_b = 0.538$ and $\pi_f = 0.453$. Allowing for imperfect pass-through produces intermediate values $\pi_b = 0.546$ and $\pi_f = 0.446$. Hansen J-statistics display comfortable $p$-values in all three cases, indicating absence of overidentification problems.

Cost slopes point to a material contribution from imported pressures once external channels are modelled. In the closed specification, the slope on domestic real marginal costs is 0.058. In the open specifications both cost terms are significant. Under perfect pass-through, $\lambda^H = 0.034$ and $\lambda^F = 0.029$, implying a domestic share of about 54%. Under imperfect pass-through, $\lambda^H = 0.036$ and $\lambda^F = 0.025$, yielding a domestic share near 59%. This shift toward a lower external share when $\rho < 1$ is consistent with the decomposition in Equation (7), where $\lambda^F \propto \rho\gamma$ and $\lambda^H \propto 1 - \rho\gamma$ holding other parameters fixed. The change is modest and should be interpreted as consistent with the model's mapping rather than as strong causal evidence, since $\omega$, $\theta$, and $\rho$ are jointly estimated.

The structural parameters in Panel B are internally coherent and track the reduced-form movements. The degree of backwardness remains high across environments,

**Table 7.** Panel fixed-effect GMM estimates.

| | $\pi_b$ | f | $\lambda^H$ | $\lambda^F$ | J-Stats. | Effect |
|---|---|---|---|---|---|---|
| **Panel A: Reduced Hybrid NKPC** | | | | | | |
| Closed Hybrid NKPC (No Pass-Through) | 0.553*** | 0.422*** | 0.058*** | – | 3.12 | Country Fixed |
| | (0.092) | (0.078) | (0.021) | | [0.54] | |
| Open Hybrid NKPC (Perfect Pass-Through) | 0.538*** | 0.453*** | 0.034*** | 0.029*** | 3.84 | Country Fixed |
| | (0.087) | (0.081) | (0.011) | (0.010) | [0.47] | |
| Open Hybrid NKPC (Imperfect Pass-Through) | 0.546*** | 0.446*** | 0.036*** | 0.025*** | 4.18 | Country Fixed |
| | (0.091) | (0.080) | (0.013) | (0.009) | [0.39] | |
| | $\omega$ | $\theta$ | β | γ | ρ | D |
| **Panel B: Structural Hybrid NKPC** | | | | | | |
| Closed Hybrid NKPC (β relaxed) | 0.673 | 0.547 | 0.938 | 0 | 0 | 2.21 |
| Closed Hybrid NKPC (β restricted) | 0.665 | 0.506 | 1 | 0 | 0 | 2.02 |
| Open Hybrid NKPC (Perfect) (β relaxed) | 0.664 | 0.561 | 0.938 | 0.398 | 1 | 2.28 |
| Open Hybrid NKPC (Perfect) (β restricted) | 0.653 | 0.525 | 1 | 0.414 | 1 | 2.11 |
| Open Hybrid NKPC (Imperfect) (β relaxed) | 0.658 | 0.552 | 0.942 | 0.395 | 0.871 | 2.23 |
| Open Hybrid NKPC (Imperfect) (β restricted) | 0.660 | 0.514 | 1 | 0.489 | 0.873 | 2.06 |

Note: Panel GMM employs country-fixed effects. J-statistics are reported for overidentification concerns with $p$-values in brackets.

ranging from 0.665 to 0.673 in the closed case and settling between 0.653 and 0.664 in the open case with perfect pass-through, and around 0.658–0.660 in the imperfect pass-through case. Price stickiness is moderate, with $\theta$ between 0.506 and 0.561 and implied price durations $D = 1/(1-\theta)$ between 2.02 and 2.28 quarters. Openness is economically meaningful, with $\gamma$ around 0.40 in the perfect pass-through model and between 0.395 and 0.489 in the imperfect model, in line with the descriptive evidence on import penetration. Estimated pass-through is high but incomplete in the imperfect case, with $\rho \approx 0.87$ whether $\beta$ is relaxed or fixed at unity. Fixing $\beta$ systematically lowers $\theta$ and shortens $D$, which is the expected trade-off between intertemporal discounting and nominal rigidity and serves as a specification check.

Pooling delivers robustness along two margins that are salient for this region. Country fixed effects absorb persistent differences in statistical coverage and the long-run intensity of administrative pricing, while the panel structure raises precision by exploiting cross-sectional variation in instruments and cost terms. These features mitigate concerns that country-specific practices, such as extensive administrative controls in Turkmenistan and earlier in Uzbekistan, unduly drive the results. The fact that panel estimates attribute roughly one half of total cost pressure to external sources under imperfect pass-through, while preserving forward-looking weights close to 0.45, indicates that the principal regional conclusions are not artefacts of any single data regime. Overall, the panel results generalise the country findings: inflation in the CCA region remains persistence-laden, prices reset on average every two to two and one-half quarters, and external channels are quantitatively important, particularly when openness and pass-through are modelled explicitly.

## 6. Conclusion

This paper provides the first multi-country estimation of the hybrid New Keynesian Phillips Curve for the post-Soviet economies of Central Asia and the South Caucasus. Using quarterly data over 1996–2023, we document that inflation in the region reflects a combination of backward-looking inertia and forward-looking expectations. In country estimations, the backward-looking weight is generally larger than the forward-looking weight in the closed-economy specification, with the most pronounced persistence in Tajikistan and Turkmenistan. Georgia and Armenia display relatively stronger forward-looking components, and Kazakhstan is close to balanced. When open-economy channels are introduced, the forward-looking term gains importance for nearly all countries, which indicates that external exposure strengthens the role of expectations in price setting.

Structural parameters reinforce these conclusions. The degree of backwardness typically lies between 0.5 and 0.8, while price stickiness implies average price durations of about two to two and a half quarters. Openness is highest in Kyrgyzstan and Tajikistan and lowest in Turkmenistan and Azerbaijan, which aligns with the cost decomposition from the reduced-form estimates. Pass-through is high but incomplete in the imperfect pass-through specification, with the largest values in Georgia and Armenia and smaller values in the more regulated or less tradable economies. These features are consistent with institutional differences across the region, including the adoption of inflation targeting in Armenia and Georgia and more managed regimes elsewhere.

Pooling the sample in a panel fixed-effects GMM framework yields region-wide regularities that both validate and qualify the country results. The panel attributes roughly 0.55 of current inflation to backward-looking behaviour and about 0.45 to forward-looking expectations in the open-economy models. Cost slopes indicate a material external contribution once openness is modelled explicitly. Under perfect pass-through, domestic costs account for about 54% of the total cost slope, while under imperfect pass-through the domestic share rises to about 59%. These patterns confirm the quantitative role of imported inflation, while also showing that domestic cost pressures remain the primary driver for the region as a whole.

Two policy implications follow. First, where credible inflation-targeting frameworks are in place, forward-looking behaviour is stronger and pass-through is more complete. This suggests that continued investment in transparent policy frameworks, clear communication, and the development of financial markets that transmit policy signals can gradually shift expectations towards an anticipatory basis. Second, in the more open and import-dependent economies, external cost shocks transmit appreciably to domestic inflation. Exchange rate flexibility, prudent reserve management, and targeted social protection can improve the trade-off faced by monetary authorities when global prices move sharply.

The analysis also highlights important caveats. Data quality is uneven across countries, particularly in environments with extensive administrative pricing and limited statistical independence. While our panel strategy with country fixed effects helps to mitigate country-specific measurement issues, it does not eliminate them. In addition, a small number of quarterly observations were linearly interpolated, mainly for instrument variables such as real interest rates and real effective exchange rates. Because these series enter as instruments rather than as dependent variables, the impact on coefficient estimates should be limited, yet periods of crisis or regime change can still make interpolation conservative with respect to volatility. Finally, the hybrid NKPC does not model discrete shocks explicitly. The open-economy specification captures transmission through terms of trade and exchange rate pass-through, but the effects of events such as the Global Financial Crisis, the COVID-19 pandemic, and the repercussions of Russia's invasion of Ukraine are absorbed into parameters rather than identified as separate disturbances.

These limitations point to several avenues for future work. Combining the present approach with survey-based measures of inflation expectations would allow a cleaner separation of adaptive and rational components. Micro price data and sectoral disaggregation could clarify the role of administered prices, exchange rate pass-through heterogeneity, and state dependence in price adjustment. Time-varying or regime-switching versions of the hybrid NKPC could capture shifts in credibility and policy frameworks more directly. Finally, explicit identification of external shocks using local projections or external instruments would complement the structural approach and help quantify how openness and pass-through interact with policy in real time.

Taken together, the results indicate that inflation in the CCA region remains persistence-laden but responsive to policy credibility and external conditions. Prices reset relatively frequently, imported cost channels are quantitatively important in the more open economies, and credible monetary frameworks can tilt expectations towards a forward-looking basis. These findings provide a consistent empirical foundation for policy design in a region where domestic structures, openness, and institutional reforms jointly shape the inflation process.

## Notes

1. See Figure A1 in the Appendix for log-transformed GDP trajectories of the eight CCA economies, annotated with key crises and conflict periods.
2. https://www.worldbank.org/en/results/2024/07/16/helping-uzbekistan-undertake-a-historic-social-and-economic-transformation.
3. https://databank.worldbank.org/source/world-development-indicators.
4. X-13ARIMA-SEATS Reference Manual, Version 1.1. US Bureau of the Census, Washington, DC. http://www.census.gov/ts/x13as/docX13ASHTML.pdf.
5. See Hansen et al. (1996).

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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## References

Atamanchuk, M., Hajdenberg, A., Kadissi, D., Lisi, G., & Rao, N. (2025). *Drivers of inflation in the Caucasus and Central Asia* (IMF Working Paper No. 25/3). International Monetary Fund.

Basarac, M., Skrabic, B., & Soric, P. (2011). The hybrid Phillips curve: Empirical evidence from transition economies. *Czech Journal of Economics and Finance*, *61*(4).

Batini, N., Jackson, B., & Nickell, S. (2005). An open-economy new Keynesian Phillips curve for the UK. *Journal of Monetary Economics*, *52*(6), 1061–1071. https://doi.org/10.1016/j.jmoneco.2005.08.003

Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics*, *12*(3), 383–398. https://doi.org/10.1016/0304-3932(83)90060-0

Clarida, R., Gali, J., & Gertler, M. (2001). Optimal monetary policy in open versus closed economies: An integrated approach. *American Economic Review*, *91*(2), 248–252. https://doi.org/10.1257/aer.91.2.248

Cogley, T., & Sbordone, A. M. (2008). Trend inflation, indexation, and inflation persistence in the New Keynesian Phillips curve. *American Economic Review*, *98*(5), 2101–2126. https://doi.org/10.1257/aer.98.5.2101

Dabusinskas, A., & Kulikov, D. (2007). *New Keynesian Phillips curve for Estonia, Latvia and Lithuania* (Bank of Estonia Working Paper 2007–07). Bank of Estonia.

Fidrmuc, J., & Daniskova, K. (2019). Meta-analysis of the new Keynesian Phillips curve in developed and emerging economies. *Emerging Markets Finance & Trade*, *56*(1), 10–31. https://doi.org/10.1080/1540496X.2019.1590700

Findley, D. F., Monsell, B. C., Bell, W. R., Otto, M. C., & Chen, B. C. (1998). New capabilities and methods of the X-12-ARIMA seasonal adjustment program. *Journal of Business and Economic Statistics*, *16*(2), 127–177. https://doi.org/10.1080/07350015.1998.10524743

Gali, J., & Gertler, M. (1999). Inflation dynamics: A structural econometric analysis. *Journal of Monetary Economics*, *44*(2), 195–222. https://doi.org/10.1016/S0304-3932(99)00023-9

Gali, J., Gertler, M., & Lopez-Salido, J. D. (2005). Robustness of the estimates of the hybrid New Keynesian Phillips curve. *Journal of Monetary Economics*, *52*(6), 1107–1118. https://doi.org/10.1016/j.jmoneco.2005.08.005

Gali, J., & Monacelli, T. (2005). Monetary policy and exchange rate volatility in a small open economy. *Review of Economic Studies*, *72*(3), 707–734. https://doi.org/10.1111/j.1467-937X.2005.00349.x

Hansen, L. P., Heaton, J., & Yaron, A. (1996). Finite m-sample properties of GMM estimators. *Journal of Business and Economic Statistics*, *14*(3), 262–280. https://doi.org/10.1080/07350015.1996.10524656

Hubert, P., & Mirza, H. (2019). The role of forward- and backward-looking information for inflation expectations formation. *Journal of Forecasting*, *38*(8), 733–748. https://doi.org/10.1002/for.2596

International Monetary Fund. (2023). *Annual report on exchange arrangements and exchange restrictions 2023 (AREAER)*. https://www.elibrary.imf.org/downloadpdf/display/book/9798400260391/9798400260391.pdf

Kozicki, S., & Tinsley, P. A. (2002). *Alternative sources of lag dynamics of inflation* (Research Working Paper RWP 02-12). Federal Reserve Bank of Kansas City.

Linde, J. (2005). Estimating new-Keynesian Phillips curves: A full information maximum likelihood approach. *Journal of Monetary Economics*, *52*(6), 1135–1149. https://doi.org/10.1016/j.jmoneco.2005.08.007

MacKinnon, J. G. (1996). Numerical distribution functions for unit root and cointegration tests. *Journal of Applied Econometrics*, *11*(6), 601–618. https://www.jstor.org/stable/2285154

Mankiw, N. G., & Reis, R. (2002). Sticky information versus sticky prices: A proposal to replace the New Keynesian Phillips curve. *Quarterly Journal of Economics*, *117*(4), 1295–1328. https://www.jstor.org/stable/4132479

Melihovs, A., & Zasova, A. (2007). *Estimation of the Phillips curve for Latvia*. Bank of Latvia.

Monacelli, T. (2005). Monetary policy in a low pass-through environment. *Journal of Money, Credit, and Banking*, *37*(6), 1047–1066. https://www.jstor.org/stable/3839027

Norkute, M., & Westerlund, J. (2024). A factor-augmented New Keynesian Phillips curve for the European Union countries. *Oxford Bulletin of Economics and Statistics*, *86*(4), 794–810. https://doi.org/10.1111/obes.12614

Poghosyan, T. (2020). *Exchange rate pass-through in the Caucasus and Central Asia* (IMF Working Paper No. 20/154).

Ravn, M. O., & Uhlig, H. (2002). On adjusting the Hodrick-Prescott filter for the frequency of observations. *Review of Economics and Statistics*, *84*(2), 371–376. https://doi.org/10.1162/003465302317411604

Roberts, J. M. (1995). New Keynesian economics and the Phillips curve. *Journal of Money, Credit, and Banking*, *27*(4), 975–984. https://doi.org/10.2307/2077783

Rudd, J., & Whelan, K. (2005). New tests of the new-Keynesian Phillips curve. *Journal of Monetary Economics*, *52*(6), 1167–1181. https://doi.org/10.1016/j.jmoneco.2005.08.006

Sbordone, A. M. (2002). Prices and unit labor costs: A new test of price stickiness. *Journal of Monetary Economics*, *49*(2), 265–292. https://doi.org/10.1016/S0304-3932(01)00111-8

Sbordone, A. M. (2005). Do expected future marginal costs drive inflation dynamics? *Journal of Monetary Economics*, *52*(6), 1183–1197. https://doi.org/10.1016/j.jmoneco.2005.08.010

Sokolova, A. (2014). Are inflation expectations in Russia forward-looking? *International Journal of Computational Economics and Econometrics*, *4*(1/2), 254–268. https://doi.org/10.1504/IJCEE.2014.060292

Sovbetov, Y., & Kaplan, M. (2019a). Causes of failure of the Phillips curve: Does tranquillity of economic environment matter? *The European Journal of Applied Economics*, *16*(2), 139–154. https://doi.org/10.5937/EJAE16-21569

Sovbetov, Y., & Kaplan, M. (2019b). Empirical examination of the stability of expectations-augmented Phillips curve for developing and developed countries. *Theoretical and Applied Economics*, *26*(2/619), 63–78.

Wilhelm, D. (2015). Optimal bandwidth selection for robust generalized method of moments estimation. *Econometric Theory*, *31*(5), 1054–1077. https://doi.org/10.1017/S026646661400067X

Ybrayev, Z., Shamar, B., & Mamatova, K. (2024). Domestic inflation decomposition in a small open economy: Evidence from import price dynamics in Kazakhstan. *Central Bank Review*, *24*(4), 100179. https://doi.org/10.1016/j.cbrev.2024.100179

## Appendix

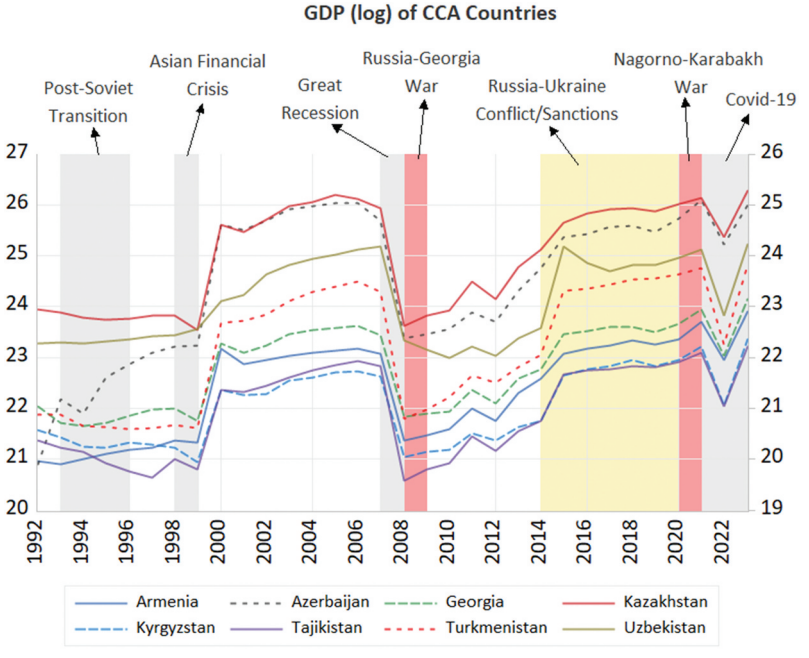


**Figure A1.** GDP (log-transformed) across the CCA Countries.