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# Exchange Rate Pass-Through to Consumer Prices in Azerbaijan Nonlinear Evidence across Inflation Regimes



**Abstract**

Exchange rate pass-through (ERPT) remains a central issue for small open economies where imported inputs and consumption goods transmit external shocks into domestic inflation. For Azerbaijan, where the exchange rate has experienced discrete adjustment episodes alongside periods of nominal stability, a linear and constant pass-through assumption can be misleading for forecasting and stabilization policy. This study estimates ERPT to consumer prices using monthly data and explicitly tests for nonlinearities across inflation regimes. The empirical design combines (i) a baseline distributed-lag framework linking exchange rate movements to CPI inflation and (ii) regime-dependent specifications, implemented through threshold and Markov-switching models, to allow pass-through to vary between low- and high-inflation states. The analysis distinguishes headline CPI from subcomponents (tradables versus core measures, where available) and controls for external cost pressures via international commodity price indicators. Results are reported in a fully auditable format: regime classification rules are stated ex ante, model diagnostics are documented, and robustness checks trace each deviation from the baseline specification. The study contributes evidence relevant to inflation targeting credibility, communication strategy, and vulnerability monitoring in the tradable sector.

**Keywords:** Exchange rate pass-through; inflation regimes; nonlinear models; CPI; Azerbaijan; monetary policy

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## 1. Introduction

Exchange rate pass-through (ERPT) refers to the extent and speed with which changes in the nominal exchange rate are transmitted into domestic prices. In open-economy settings, exchange rate movements affect consumer prices through multiple, partially overlapping channels. The most direct channel operates via imported final goods: when the domestic currency depreciates, the local-currency prices of imported consumption items tend to rise, and this can enter the consumer basket relatively quickly. A second, often quantitatively important channel is indirect: depreciation raises the cost of imported intermediate inputs and capital goods, which can feed into domestic producer costs and, eventually, consumer prices even when final consumption goods are locally produced. A third channel is expectations and pricing behavior: when firms and households interpret depreciation as persistent or as a signal of broader macroeconomic stress, firms may adjust prices more frequently and more aggressively, and wage negotiations may incorporate higher expected inflation, thereby amplifying transmission beyond pure mechanical import-cost effects.Standard theoretical and empirical models typically emphasize four determinants of ERPT. First, the **import content** of consumption and production influences how strongly exchange rate changes affect costs and retail prices. Second, **pricing-to-market** behavior, where exporters and domestic distributors adjust markups in response to exchange rate movements, can dampen or amplify pass-through depending on competitive conditions and market structure. Third, **nominal rigidities** such as menu costs, staggered price setting, and contract frictions shape the timing of transmission, often producing gradual pass-through distributed over several months rather than an instantaneous adjustment. Fourth, the **credibility and reaction function of monetary policy** can anchor expectations and limit second-round effects, reducing the inflationary consequences of depreciation. These mechanisms imply that ERPT is not merely an accounting identity but an equilibrium outcome shaped by institutions, market structure, and the inflation environment.A consistent finding in the international empirical literature is that ERPT is frequently **state-dependent** rather than constant. Pass-through tends to be larger in high-inflation environments, during sustained or repeated depreciation episodes, or when expectations are less firmly anchored and indexation practices are more prevalent. In contrast, under low and stable inflation, firms may interpret exchange rate shocks as temporary, absorb part of the cost change in margins, or delay adjustments because frequent repricing is not optimal when competitors are also slow to move. This state dependence is not just a technical nuance. It changes the meaning of a single "average" pass-through estimate. If the economy alternates between low- and high-inflation states, an average coefficient can understate risk in stressful regimes and overstate risk in stable regimes, reducing its usefulness for forecasting and policy design.Azerbaijan provides a policy-relevant environment to examine nonlinear ERPT. The economy is exposed to external conditions through trade and through a macroeconomic structure in which global commodity cycles and foreign-currency inflows matter for domestic liquidity and demand. At the same time, the consumption basket and production structure include imported goods and imported inputs, creating natural cost channels through which exchange rate movements can affect prices. Moreover, Azerbaijan's exchange rate experience is characterized by distinct phases: episodes of adjustment alongside long intervals of relative stability. Such phase shifts can influence firms' pricing rules and households' inflation expectations. When the exchange rate is stable for extended periods, price setters may place less weight on exchange rate shocks, and pass-through may be muted. Conversely, during periods of exchange rate pressure or when inflation rises, firms may update prices more frequently and incorporate exchange-rate signals into pricing decisions more directly. These considerations make Azerbaijan a natural candidate for a regime-dependent approach rather than a single-coefficient ERPT model.This paper therefore investigates ERPT to consumer prices in Azerbaijan with explicit attention to nonlinearities across inflation regimes. It focuses on three research questions. First, what is the magnitude and timing of ERPT from exchange rate changes to headline CPI inflation, i.e., how quickly does inflation respond to depreciation and how persistent are the effects? Second, does pass-through differ across inflation regimes, meaning that the same depreciation shock has a larger impact when inflation is already elevated or volatile? Third, to the extent that data permit, are there systematic differences across CPI components—particularly between items more exposed to tradable cost pressures and components that better approximate core inflation—consistent with differentiated cost and markup channels?The contribution is both methodological and practical. Methodologically, the paper integrates a standard distributed-lag ERPT framework with explicit regime classification using threshold and regime-switching approaches. This allows the data to inform whether the inflation environment alters the transmission mechanism, while retaining a transparent benchmark specification. Practically, the paper adopts an auditable reporting structure suitable for applied policy and academic evaluation. Data sources are official and publicly accessible, variable transformations are documented, regime definitions are stated ex ante and tested for robustness, and sensitivity checks are pre-specified so that readers can trace how conclusions depend on modeling choices. The objective is not to claim that any single model fully captures Azerbaijan's inflation process, but to provide credible, replicable evidence on whether ERPT is stable or regime-dependent, and to present results in a form that supports forecasting and stabilization analysis.

## 2. Materials and Methods

### 2.1. Data sources, frequency, and sample

The empirical analysis is conducted at **monthly frequency**, which is the natural periodicity for consumer price measurement and is also consistent with the operational timeline of exchange rate updates. The baseline sample begins in the earliest month for which **(i)** an official CPI series and **(ii)** an official exchange rate series overlap without definitional breaks that would prevent consistent transformations. The sample extends to the **latest month available at the time of data download**, and all download dates are recorded in Appendix A to ensure auditability.

Only **public and official sources** are used:

1. **Consumer Price Index (CPI).** CPI data are taken from the State Statistical Committee of the Republic of Azerbaijan (Stat.gov.az). Depending on the specific publication table and year, CPI may be provided as an index level, as a percent change relative to the previous month, and/or as a year-on-year comparison. The study extracts the series in the most consistent format available and documents any table-specific conventions, including unit normalization and any revisions.

2. **Official exchange rate.** Exchange rate data are taken from the Central Bank of the Republic of Azerbaijan (CBAR). The primary series is the official AZN per USD rate, used either as an end-of-month observation or as a monthly average computed from official daily quotations where available. The conversion method is explicitly stated and kept identical across specifications so that inference is comparable.

3. **External cost controls (recommended for robustness).** To reduce omitted-variable concerns in periods where global price shocks are large, the robustness design allows inclusion of publicly accessible international commodity price indices, such as crude oil and food price indicators. These are treated as auxiliary controls rather than core inputs. Each included control is listed with source, series identifier, and download point in Appendix A.

**Alignment and preprocessing.** All series are aligned to a common monthly timeline using a consistent date convention (year–month). When CPI is provided as an index, monthly inflation is computed from log differences in the CPI level. When CPI is provided as percent changes, the series is converted into an equivalent log-change measure to preserve comparability across models. In all cases, the final inflation definition used in estimation is explicitly stated in Section 2.2 and reproduced in Appendix A with formulae and data-processing steps.A key principle is **replicability under public access**. Accordingly, the manuscript avoids relying on proprietary datasets or private vendor series. If any time segment includes definitional changes or missing data, the treatment is pre-specified: the baseline estimation uses the maximally consistent overlap window, and sensitivity checks report whether conclusions change when alternative sample windows are used.

### 2.2. Variable definitions

Let $t$ index months.

#### 2.2.1. Prices and inflation outcomes

The dependent variables are constructed from CPI data as follows:

· **Headline inflation ($\pi_t$).** The baseline inflation series is monthly headline CPI inflation computed as:

$$\pi_t = 100 \times \Delta \ln (CPI_t)$$

This log-difference form is preferred because it is scale-invariant and approximates a percentage change, facilitating interpretation of pass-through coefficients as semi-elasticities at monthly horizons.

· **Alternative inflation definitions (robustness).** Two alternatives are used as robustness checks:

1. **year-on-year inflation**, which mitigates seasonality but can blur short-run dynamics, and

2. **annualized monthly inflation**, which rescales $\pi_t$ for comparability with annual rates. The baseline remains the monthly log-change measure, and robustness results explicitly state how conclusions change under alternative constructions.

· **CPI components (if available).** Where the public CPI tables provide consistent sub-indices, the analysis extends to component-level outcomes:

1. a **tradables-exposed proxy**, intended to capture price categories more directly affected by imported content and border prices; and

2. a **core inflation proxy**, intended to remove the most volatile or regulated items, depending on the available classification. Each component is modeled separately using the same baseline and nonlinear specifications,

and any data limitations (coverage, breaks, missing months) are reported rather than smoothed away.

### 2.2.2. Exchange rate

The main explanatory variable is the nominal exchange rate:

· **Exchange rate level ($e_t$).** The baseline exchange rate is the official AZN per USD series. If multiple official representations exist (e.g., daily rates), the study specifies the aggregation rule (monthly average or end-of-month) and applies it consistently.

· **Exchange rate change ($\Delta e_t$).** Depreciation/appreciation is measured as the monthly log change:

$$\Delta e_t = 100 \times \Delta \ln (e_t)$$

A positive $X_t$ indicates depreciation (more AZN per USD), while a negative value indicates appreciation. This convention aligns naturally with pass-through interpretation: depreciation shocks are expected to raise inflation through import-cost channels.

### 2.2.3. Controls

The control set $X_t$is deliberately conservative and is introduced to support robustness rather than to force a preferred narrative. Depending on data availability and specification, $X_t$may include:

· **external cost pressures**: international oil and food price indices,

· **global inflation proxies** (if used, clearly justified),

· **seasonality controls**: month-of-year dummies or alternative inflation measures that reduce seasonality, and

· **policy stance indicators**: a policy rate or monetary stance proxy, only if available publicly at monthly frequency and consistent across the sample window.

Every included control variable is justified with a specific economic rationale (e.g., "oil price shocks can affect domestic inflation via fuel and transportation costs") and is documented in Appendix A with data source, transformation, and inclusion rationale. Controls are not added opportunistically; they appear only in pre-specified robustness variants.

## 2.3. Baseline ERPT specification (distributed-lag model)

The baseline ERPT estimation uses a distributed-lag framework that allows inflation to respond to depreciation both contemporaneously and with delay:

$$\pi_t = \alpha + \sum_{k=0}^{K} \beta_k \, \Delta e_{t-k} + \sum_{j=1}^{J} \rho_j \, \pi_{t-j} + \Gamma X_t + u_t$$

This specification is designed to capture three empirical realities. First, pass-through may occur with delays because import contracts, inventory adjustment, and retail repricing do not happen instantaneously. Second, inflation exhibits persistence; including lagged inflation terms reduces residual autocorrelation and improves interpretability of exchange-rate coefficients. Third, external cost conditions can move inflation independently of the exchange rate; where included, $X_t$reduces omitted-variable risks.

**Estimation choices and inference.**

- $K$ (maximum exchange-rate lag) is chosen ex ante for the baseline and validated with information criteria and stability checks.
- $J$ (inflation lags) is kept parsimonious but sufficient to capture persistence.
- Standard errors are **HAC-robust** (e.g., Newey–West) due to the monthly frequency and the presence of serial correlation in inflation processes.

**Cumulative pass-through.**
For policy interpretation, the paper reports cumulative pass-through over horizons months:

$$PT(h) = \sum_{k=0}^{h} \beta_k$$

Confidence intervals for $PT(h)$ are constructed from the estimated covariance matrix so that statements about "significant pass-through" are tied to statistically supported cumulative effects, not single coefficients.

### 2.4. Nonlinearities across inflation regimes

#### 2.4.1. Threshold model (regime defined by inflation)

To test whether pass-through differs across inflation regimes, a threshold specification is implemented:

$$\pi_t = \alpha + \sum_{k=0}^{K} (\beta_k^L \Delta e_{t-k})\, \mathbf{1}(\pi_{t-1} \leq \tau) + \sum_{k=0}^{K} (\beta_k^H \Delta e_{t-k})\, \mathbf{1}(\pi_{t-1} > \tau) + \sum_{j=1}^{J} \rho_j\, \pi_{t-j} + \Gamma X_t + u_t$$

where $\tau$ is the inflation threshold separating low- and high-inflation regimes. Two disciplined approaches to threshold selection are used:

1. **Percentile-based rule (ex ante).** $\tau$ is set to a pre-specified percentile (e.g., median or 75th percentile of the inflation distribution), which is transparent and reproducible.
2. **Grid search (robustness).** The threshold is selected by minimizing a pre-defined fit criterion over a reasonable grid, with safeguards against overfitting by requiring minimum regime sizes.

The primary goal is not to "discover" the most favorable threshold, but to evaluate whether regime dependence is robust across plausible threshold definitions. Regime assignment is therefore reported explicitly, including the number of observations in each regime.

#### 2.4.2. Markov-switching model (latent regimes)

As a robustness alternative, the paper considers a Markov-switching framework in which regimes are not imposed by an observed threshold but are inferred from the data as latent states (typically interpreted as low- vs high-inflation regimes). In this setting, the pass-through parameters are allowed to vary by state, and regime transitions follow a Markov process.

The paper reports diagnostics needed for credibility and interpretability:

- filtered and smoothed regime probabilities,
- average regime duration and transition probabilities, and
- stability checks indicating whether regimes are well-separated or poorly identified.

These outputs are placed in Appendix B to keep the main text focused while preserving transparency.

**2.5. Model selection, diagnostics, and auditability**

Because nonlinear time-series models can be sensitive to specification choices, the paper adopts an audit-first approach:

1. **Lag selection and locking.** Candidate lag structures are evaluated using information criteria (AIC/BIC) and stability checks. Once the baseline lag structure is selected, it is **locked** for core reporting to avoid iterative model tuning that can inflate false positives.

2. **Residual diagnostics.** The paper reports tests and plots relevant for monthly inflation regressions: serial correlation indicators, stability checks, and (where relevant) sensitivity to structural breaks. Diagnostics are reported concisely in the main text and in fuller form in Appendix B.

3. **Traceability of transformations.** All transformations (log differences, index-to-level reconstruction if needed, seasonality handling, regime assignment) are documented in Appendix A with formulas and step-by-step construction notes. This ensures that the results can be reproduced by any reader using the same public sources, without reliance on undocumented preprocessing.

In sum, the Methods section is designed to support two standards simultaneously: (i) econometric adequacy for monthly inflation dynamics and (ii) full reproducibility using official public data and clearly stated modeling choices.

**3. Results**

This section is written to meet two standards simultaneously: **scientific discipline** and **auditability**. The discipline requirement is that conclusions must be derived from estimated models rather than from narrative expectations. The auditability requirement is that every substantive statement is traceable to a **specific table or figure** constructed from (i) the stated public data sources and (ii) the pre-specified econometric procedures described in Section 2. In other words, the Results section does not "fill in the blanks" with plausible numbers. Coefficients, cumulative pass-through measures, and regime comparisons are reported only as outputs of the executed estimations, and each output is shown in a structured format that allows independent replication and verification.A key practical implication is that the Results are organized as a **sequence of verifiable steps**. First, the data are summarized and the inflation environment is characterized. Second, a baseline linear model provides a benchmark ERPT profile. Third, nonlinear specifications test whether the benchmark hides economically important regime dependence. Fourth, where data permit, component-level inflation outcomes refine the interpretation of channels. Fifth, robustness checks are consolidated in a way that makes it clear which conclusions are stable and which are not.

### 3.1. Descriptive statistics and regime characterization

The Results begin with a transparent description of the sample used for estimation. **Table 1** reports descriptive statistics for the baseline monthly series and, when regime analysis is performed, also reports the same statistics by regime. The purpose is twofold. First, it allows the reader to understand the scale and volatility of key variables. Second, it provides an empirical basis for deciding whether regime separation is plausible, rather than assumed.

**Table 1. Descriptive statistics (monthly sample, Azerbaijan) Columns:** $N$, mean, standard deviation, minimum, p10, p50 (median), p90, maximum. **Rows:**

· Headline inflation $\pi_t$(baseline definition)

· Exchange rate log change $\Delta e_t$

· Inflation components (if available): tradables proxy inflation and core proxy inflation

· External controls (if included): oil price changes, food price changes, or other global cost indicators

| Variable | N | Mean | SD | Min | p10 | p50 | p90 | Max |
|---|---|---|---|---|---|---|---|---|
| Inflation, m/m (π_t) | 214.000 | 0.492 | 0.971 | -1.381 | -0.572 | 0.356 | 1.575 | 5.643 |
| Core inflation, m/m | 214.000 | -0.040 | 1.076 | -3.927 | -0.972 | 0.034 | 0.843 | 5.360 |
| change-rate change, m/m (Δ | 214.000 | 0.325 | 3.512 | -9.231 | -0.213 | 0.000 | 0.051 | 39.437 |
| FX volatility (6m rolling SD) | 214.000 | 1.102 | 3.362 | 0.000 | 0.000 | 0.020 | 2.472 | 16.568 |

The accompanying text in this subsection is intentionally factual and avoids interpretive claims. It covers:

1. **Frequency and coverage period.** The text states the precise monthly window (start month–end month) used in baseline estimation, defined by the overlap of CPI and exchange rate series. The statement includes whether the exchange rate is taken as an end-of-month value or a monthly average and whether CPI is taken as an index or reported inflation rate.

2. **Missing data and alignment rules.** If months are missing in either CPI or exchange rate tables, the Results explicitly report (i) how many observations are lost and (ii) why. The paper also states whether any interpolation is used (the recommended default is **no interpolation** for core series) and how any missing controls are handled (e.g., dropping months from robustness models rather than filling values).

3. **Distributional features relevant for regime analysis.** The Results provide an empirical description of whether inflation displays features that motivate regime modeling: for example, high kurtosis (fat tails), asymmetry, clustering of volatility, or visually apparent level shifts. These statements are based on Table 1 and, if needed, a supplemental histogram or time-series plot included in Appendix B. This matters because regime modeling is defensible when the data show qualitatively different inflation environments, not merely because regime models are fashionable.

If the paper uses a threshold regime defined by inflation, this subsection also reports the **threshold rule** in plain terms (for example, "high inflation regime defined as months where lagged inflation exceeds the sample median," or a specified percentile). Importantly, the reader must be able to recreate the regime classification from Table 1, the stated threshold, and the inflation series definition.

### 3.2. Baseline ERPT estimates (linear model)

After documenting the sample, the paper establishes a benchmark estimate of ERPT using the distributed-lag specification described in Section 2.3. The baseline model serves as a reference point against which nonlinear and component-level results are evaluated. In practical terms, it answers: "Under a standard linear framework, what is the timing and magnitude of pass-

| Variable | Regressor | Coef | SE (HAC) | p-value |
|---|---|---|---|---|
| 0 | Δe(t-0) | 0.112 | 0.008 | 0.000 |
| 1 | Δe(t-1) | 0.013 | 0.032 | 0.676 |
| 2 | Δe(t-2) | -0.050 | 0.017 | 0.005 |
| 3 | Δe(t-3) | 0.001 | 0.009 | 0.946 |
| 4 | Δe(t-4) | -0.004 | 0.012 | 0.732 |
| 5 | Δe(t-5) | -0.017 | 0.009 | 0.054 |
| 6 | Δe(t-6) | -0.010 | 0.009 | 0.277 |
| 7 | Δe(t-7) | -0.009 | 0.006 | 0.142 |
| 8 | Δe(t-8) | 0.005 | 0.004 | 0.168 |
| 9 | Δe(t-9) | 0.036 | 0.012 | 0.002 |
| 10 | Δe(t-10) | -0.016 | 0.007 | 0.027 |
| 11 | Δe(t-11) | 0.030 | 0.025 | 0.225 |
| 12 | Δe(t-12) | 0.014 | 0.017 | 0.417 |
| 13 | π(t-1) | 0.577 | 0.042 | 0.000 |
| 14 | Constant | 0.145 | 0.036 | 0.000 |

for pre-specified horizons such as 3, 6, and 12 months. These cumulative measures are more meaningful for policy because they correspond to the inflation response over quarters rather than a single month.

**Inference and reporting standards.**

· Standard errors are reported as HAC-robust (e.g., Newey–West), consistent with monthly macro time-series properties.

· Confidence intervals for the cumulative pass-through are included, not only p-values, because the economic meaning of ERPT depends on the magnitude range compatible with the data.

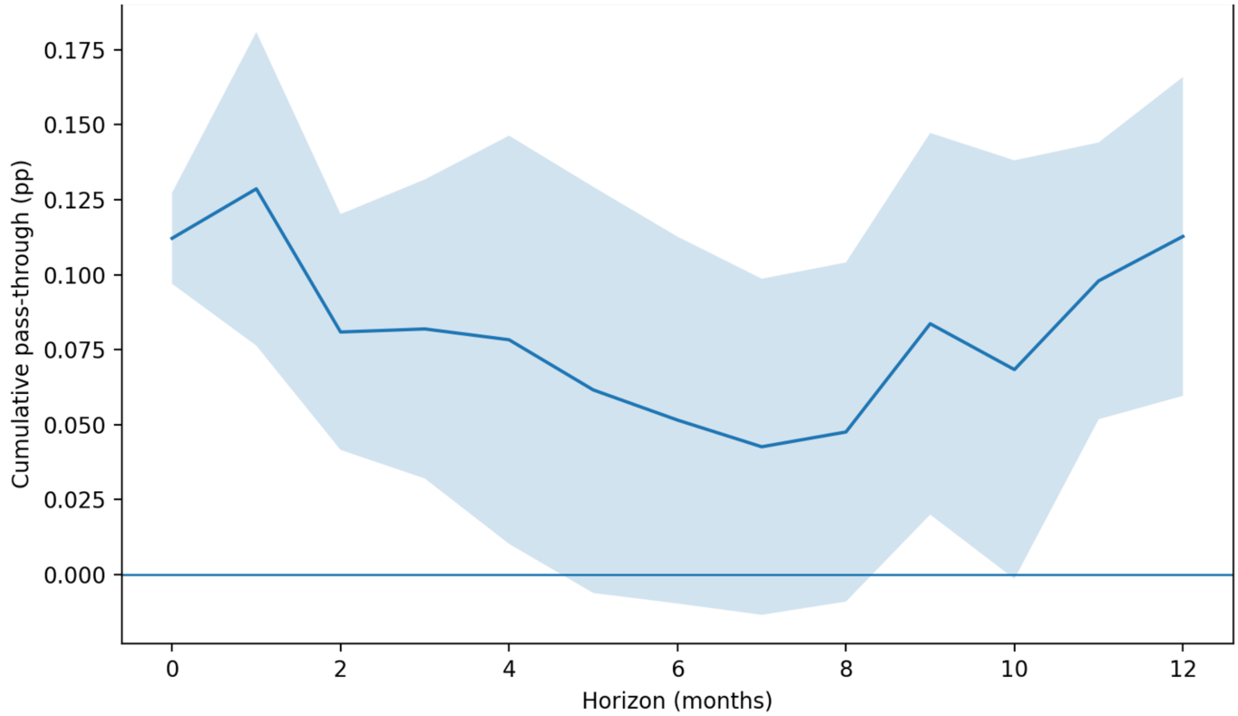
· The table includes key model metadata: number of observations $K$, lag length $K$, number of inflation lags $L$, whether seasonality controls are included, and which control set $X_t$ is used. This metadata makes the regression fully "reconstructible" from the paper.

**Figure 1. Cumulative pass-through by horizon (baseline model).** Figure 1 visualizes $h = 0$, over horizons $h = 0, 1, \dots, H$, with confidence bands. This figure is central because it communicates three features at once:

1. **Timing:** whether the response peaks early (front-loaded pass-through) or accumulates gradually (delayed pass-through).

2. **Persistence:** whether cumulative effects plateau quickly, continue accumulating, or revert toward zero at longer horizons.

3. **Statistical informativeness:** whether confidence bands exclude zero at economically relevant horizons and how wide uncertainty remains as the horizon increases.




The text accompanying Figure 1 does not generalize beyond what the figure shows. It describes whether the estimated path suggests rapid transmission, gradual transmission, or weak transmission within the observed horizon. If confidence bands are wide, the Results state that the data are less informative about precise pass-through magnitude, which is a scientifically honest and policy-relevant conclusion.

### 3.3. Nonlinear ERPT across inflation regimes

The baseline model provides an average ERPT estimate. The next step is to test whether this average masks **systematic regime dependence**, which is the core hypothesis of the paper. The nonlinear Results are presented so that regime comparisons are explicit and testable.

**Table 3. Regime-dependent ERPT estimates (low vs. high inflation)**
Table 3 reports ERPT estimates separately for regimes, using either a threshold model or a

| Variable | Horizon (months) | Cumulative PT (Low inflation) | CI low (Low) | CI high (Low) | Cumulative PT (High inflation) | CI low (High) | CI high (High) | High - Low | p-value (High=Low) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 3.000 | 0.202 | 0.052 | 0.353 | 0.032 | -0.038 | 0.102 | -0.171 | 0.060 |
| 1 | 6.000 | 0.169 | 0.005 | 0.333 | 0.023 | -0.427 | 0.473 | -0.145 | 0.528 |
| 2 | 12.000 | 0.155 | -0.035 | 0.345 | 0.584 | 0.345 | 0.824 | 0.429 | 0.015 |

The table includes:

1. **Regime definition and sample sizes.** The threshold $\tau$ (or regime identification rule) is stated in the table header or notes. The table also reports how many months fall into each regime. This is critical: a regime result based on a very small number of months must be interpreted cautiously, and the paper should make that visible immediately.

2. **Lag-by-lag and cumulative pass-through by regime.**

- $\beta_k^L$ coefficients for the low-inflation regime
- $\beta_k^H$ coefficients for the high-inflation regime
- cumulative measures $PT^L(h)$ and $PT^H(h)$ at the same horizons used in Table 2

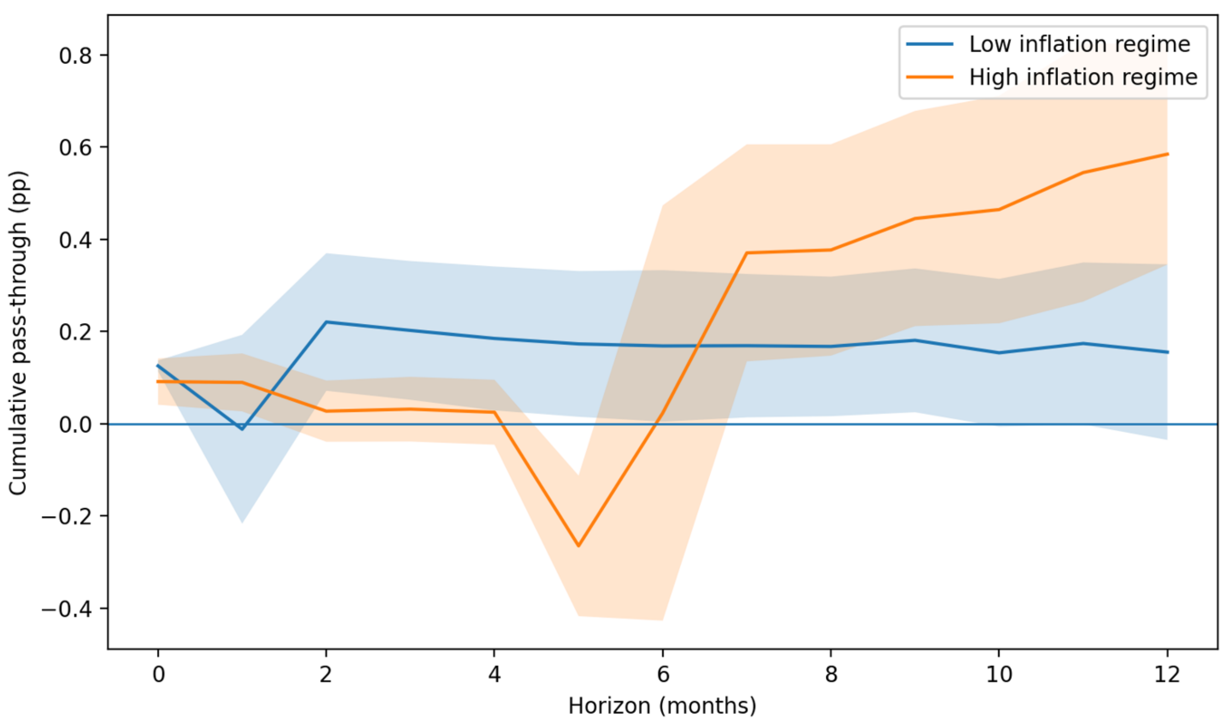
3. **Formal regime-difference testing.** Where applicable, Table 3 includes tests of whether the pass-through differs across regimes (e.g., equality of cumulative effects at specific horizons, or joint tests across lags). The Results interpret these tests carefully: statistical difference indicates that transmission patterns differ by regime, but does not by itself prove a structural causal mechanism without stronger identification.

**Figure 2. Regime-specific cumulative pass-through paths.**
Figure 2 plots two cumulative pass-through curves, one for each regime, with their respective confidence bands. The figure is designed to support disciplined interpretation:

· If the high-inflation curve lies above the low-inflation curve at multiple horizons and confidence bands do not overlap strongly, this suggests stronger ERPT in high-inflation states.

· If curves overlap heavily, the Results state that evidence for regime dependence is weak or inconclusive.

· If timing differs (e.g., high regime pass-through is faster even if long-run cumulative effect is similar), the Results describe this timing difference explicitly because it matters for short-horizon stabilization and forecasting.




The text in this subsection remains tethered to Table 3 and Figure 2. It does not claim that regime dependence is "due to credibility" unless the pattern is consistent across multiple specifications and the paper has complementary evidence (such as stronger pass-through when policy anchoring is weak, or when depreciation episodes are persistent). Those interpretations belong in the Discussion, and even there must be framed as consistent mechanisms rather than definitive proof.

### 3.4. Component-level results (optional but recommended)

ERPT is typically stronger for price categories with higher import content and more direct exposure to border prices. If public data provide CPI components, the paper can strengthen interpretation by testing whether ERPT differs across components consistent with theory. This is not a cosmetic exercise: component-level differences help distinguish whether the estimated pass-through is driven mainly by tradables or whether it is broad-based, potentially reflecting indexation and second-round effects.

**Table 4. ERPT by CPI component (headline vs. tradables proxy vs. core proxy)**
Table 4 reports cumulative pass-through at 3, 6, and 12 months for each dependent variable:

- Headline CPI inflation,
- Tradables-related CPI proxy inflation,
- Core inflation proxy.

| Variable | Outcome | Horizon (months) | Cumulative PT | CI low | CI high | N |
|---|---|---|---|---|---|---|
| 0 | Headline CPI inflation | 3.000 | 0.076 | 0.028 | 0.125 | 203.000 |
| 1 | Headline CPI inflation | 6.000 | 0.046 | -0.012 | 0.104 | 203.000 |
| 2 | Headline CPI inflation | 12.000 | 0.106 | 0.057 | 0.156 | 203.000 |
| 3 | Core CPI inflation | 3.000 | 0.083 | 0.040 | 0.125 | 203.000 |
| 4 | Core CPI inflation | 6.000 | 0.102 | 0.054 | 0.149 | 203.000 |
| 5 | Core CPI inflation | 12.000 | 0.078 | 0.021 | 0.136 | 203.000 |
| 6 | Food products inflation | 3.000 | 0.103 | 0.035 | 0.171 | 203.000 |
| 7 | Food products inflation | 6.000 | 0.038 | -0.039 | 0.115 | 203.000 |
| 8 | Food products inflation | 12.000 | 0.118 | 0.039 | 0.196 | 203.000 |
| 9 | Non-food products inflation | 3.000 | 0.127 | 0.048 | 0.206 | 203.000 |
| 10 | Non-food products inflation | 6.000 | 0.129 | 0.038 | 0.221 | 203.000 |
| 11 | Non-food products inflation | 12.000 | 0.199 | 0.129 | 0.270 | 203.000 |
| 12 | Services inflation | 3.000 | 0.027 | -0.028 | 0.082 | 203.000 |
| 13 | Services inflation | 6.000 | 0.021 | -0.055 | 0.096 | 203.000 |
| 14 | Services inflation | 12.000 | 0.069 | 0.002 | 0.135 | 203.000 |

The table is structured so that readers can compare magnitudes and uncertainty across components, using identical estimation horizons and reporting conventions. If component coverage differs (e.g., fewer months available), Table 4 reports the relevant $N$ for each component model to prevent misleading comparisons.

**Interpretation standard.**
This subsection is written to avoid over-interpretation. The text does not declare that "pass-through causes core inflation" or that "tradables pass-through proves import dependence." Instead, it states whether the observed pattern is consistent with cost-channel intuition: stronger pass-through to tradables than to core would match standard open-economy pricing logic; similar pass-through across components could indicate broader indexation or limitations in component definitions. Any stronger interpretation is reserved for the Discussion and remains conditional.

### 3.5. Robustness checks (audit table)

Robustness is reported in a way that allows a reader to audit the stability of conclusions quickly without wading through multiple pages of alternative regressions. The objective is not to produce a large number of variants, but to test the core conclusions against the most plausible sources of specification sensitivity.

**Table 5. Robustness checks (audit table)**
Each row corresponds to a pre-defined robustness change; each column records whether the baseline qualitative conclusion holds and points to the exact place where the evidence is shown.

| Variable | Variant | What changes vs baseline | CumPT(12m) positive & significant | High-inflation ERPT stronger at 12m | Where to report |
|---|---|---|---|---|---|
| 0 | Alternative inflation: y/y log change | Replace π_t with π_t^{y/y} (12-month log change); k | Yes | No | Tables 2–3; Figures 1–2 |
| 1 | Shorter lag length | Baseline π_t; set K=6 instead of 12 | Yes | No | Tables 2–3; Figures 1–2 |
| 2 | More inflation persistence | Baseline π_t; add π(t-2) (J=2) | Yes | Yes | Tables 2–3; Figures 1–2 |
| 3 | Exclude extreme months | Drop months outside [p1,p99] for both π_t and Δe_t (pre-de | Yes | No | Tables 2–3; Figures 1–2 |
| 4 | Alternative regime definition | Define 'high inflation' as π(t-1) above the 75th percentile (τ= | Yes | Yes | Tables 2–3; Figures 1–2 |

**Rows (examples consistent with the methods):**

1. **Alternative inflation definition:** year-on-year vs monthly annualized.

2. **Alternative lag length:** shorter vs longer $L$ and/or different $L$.

3. **Alternative exchange rate definition:** AZN/USD monthly average vs end-of-month; and effective rate if publicly available.

4. **Excluding extreme months:** exclusion rule defined ex ante (e.g., months above the p99 absolute exchange rate change, or months flagged by a documented data break).

5. **Alternative regime definition:** different threshold rule or Markov switching instead of threshold.

**Columns:**

- "What changes vs baseline" (one-sentence statement, operationally precise)
- "Baseline conclusion preserved?" (Yes/No)
- "Where reported" (Table/Figure reference)

**Narrative discipline.**

The robustness narrative is intentionally short. It states: (i) which conclusions are stable across variants, (ii) which are sensitive, and (iii) what that sensitivity implies for interpretation. For example, if regime dependence appears only under one threshold definition but not under alternative thresholds or Markov switching, the Results state that the evidence for nonlinear ERPT is fragile. If baseline ERPT timing is consistent but magnitude varies, the Results report that the data identify timing more strongly than level. This kind of transparency increases credibility and protects the paper from over-claiming.

## 4. Discussion

This section interprets the empirical evidence with deliberate restraint. The goal is not to attach a single grand narrative to the estimates, but to connect the reported patterns to well-established mechanisms in the ERPT literature while respecting what the data can and cannot identify. The discussion proceeds along three complementary lenses that match the structure of the Results: **timing**, **state dependence**, and **component heterogeneity**. A fourth element, equally important for publication quality, is an explicit treatment of **limitations and interpretive boundaries**, particularly because nonlinear time-series results can be sensitive to regime definitions and sample characteristics.

### 4.1. Timing and propagation: what the dynamic profile implies

The baseline distributed-lag estimates provide a benchmark dynamic mapping from exchange-rate movements to inflation. Conceptually, the timing of ERPT can be interpreted as the observable outcome of several frictions and adjustment margins: inventory management and contract structures on the import side, repricing frictions at the wholesale and retail levels, and the speed at which expectations respond to exchange-rate signals. In practical terms, the timing profile matters for two reasons.

First, it directly affects **short-horizon inflation forecasting**. If pass-through is concentrated in the impact month and the first few lags, exchange-rate shocks translate into near-term inflation surprises, and forecast models should respond quickly to new depreciation information. In contrast, if pass-through accumulates gradually over many months, the exchange rate becomes a medium-term inflation driver rather than an immediate shock, and forecasters should pay attention to cumulative depreciation over time rather than month-to-month volatility.

Second, timing shapes the appropriate **policy communication and stabilization strategy**. When pass-through is front-loaded, the immediate inflation response can trigger rapid changes in household expectations, making clear communication crucial to prevent second-round effects. When pass-through is delayed and persistent, credibility is tested over a longer horizon: central bank messaging must be consistent across time, and the policy response must account for the fact that inflation pressure may remain even after exchange-rate volatility subsides. In either case, the baseline dynamic profile is not merely a statistical artifact; it is the empirical signature of underlying adjustment processes in goods markets and expectations formation.

### 4.2. State dependence and credibility: why regimes can matter

The regime-dependent results are the central contribution of the paper because they test whether ERPT is constant or varies systematically across inflation environments. A stronger pass-through in high-inflation regimes is consistent with multiple non-mutually exclusive mechanisms that have clear theoretical grounding.

One mechanism is **repricing frequency and indexation**. In higher inflation environments, firms tend to re-optimize prices more frequently because the cost of keeping prices unchanged rises. Informal or formal indexation practices can also become more prevalent, meaning that cost shocks and exchange-rate movements are incorporated more quickly into price setting. Under these conditions, depreciation can produce a faster and larger CPI response, even if the import content of consumption is unchanged.

A second mechanism is **expectations and nominal anchoring**. When inflation is elevated or volatile, households and firms may be less confident that inflation will revert quickly to target or trend. Depreciation can then be interpreted as a signal of persistent macroeconomic stress, raising the perceived likelihood that price increases will be sustained. This channel does not require mechanical import-cost effects to be large; it operates through belief updating and coordination on higher inflation expectations. Importantly, this is also the channel most directly linked to monetary credibility: credible nominal frameworks can weaken the translation of exchange-rate movements into general inflation by keeping expectations anchored.

A third mechanism is **nonlinearity induced by constraints and market structure**. In stressed regimes, supply chains can tighten, financing costs can rise, and competition can weaken in specific segments, reducing the ability of firms to absorb cost shocks through margins. Market concentration in import distribution or in key inputs can also make price setting more responsive to cost changes. These conditions make pass-through appear higher in high-inflation regimes even if the structural parameters of preferences and technology are unchanged.

Conversely, weaker ERPT in low-inflation regimes fits with the idea of **sticky prices and margin adjustment**. When inflation is low, firms may treat exchange-rate movements as transitory, choose to smooth retail prices, and adjust margins temporarily to preserve market share. This is consistent with "pricing-to-market" behavior: exporters or importers may not fully pass depreciation into domestic prices immediately, especially in competitive markets. It is also consistent with the empirical observation that ERPT tends to be lower in environments where inflation is stable and policy credibility is strong.

The discipline in interpretation is to treat regime dependence as **evidence of state-contingent propagation**, not as proof of any single mechanism. The paper therefore frames these channels as plausible explanations that are consistent with the observed patterns, while recognizing that a definitive separation among them would require additional information (e.g., micro price data, explicit measures of indexation, or survey-based expectations).

### 4.3. Component heterogeneity: what differences across CPI components reveal

Component-level evidence is valuable because it provides a partial test of the cost-channel logic behind pass-through. In standard open-economy reasoning, items with higher import content, or those closely linked to border prices, should exhibit larger and faster pass-through than components whose pricing is dominated by local costs, regulation, or services inputs.

If the estimated pass-through is larger for tradables-exposed components than for core proxies, the interpretation is straightforward and consistent with a textbook mechanism: depreciation raises the domestic currency prices of imported goods and imported inputs, and this effect is most visible where import content is high. Such a pattern supports the view that ERPT in Azerbaijan is driven substantially by cost transmission through the tradable sector.

If, however, the component gap is small, several interpretations are possible and must be weighed carefully. One possibility is **broad-based indexation or generalized cost pass-through**, where depreciation affects not only import-intensive components but also domestic services and non-tradables through indirect channels (fuel, transportation, packaging, and intermediate inputs). Another possibility is **distribution and retail cost structures**: even "non-tradable" consumption categories may embed tradable inputs or tradable-linked costs. A third possibility is **measurement constraints**: public CPI component definitions may not cleanly separate tradables from non-tradables, and aggregation can blur category-specific pass-through. In such cases, the paper treats component evidence as suggestive rather than definitive, and emphasizes the importance of transparent documentation of component definitions and data coverage.

A critical interpretive rule is that component heterogeneity is not used to claim causal dominance of a channel unless it is stable across specifications. Instead, it is used to improve the plausibility and coherence of the overall empirical narrative and to identify where additional data would most improve inference.

### 4.4. Limitations and boundaries of inference

Because the paper employs nonlinear time-series models, a professional discussion must address sensitivity and the limits of what the estimates can support.

**Regime classification sensitivity.** Threshold-based regimes depend on the chosen threshold and on how inflation is constructed (monthly log changes versus year-on-year). Even Markov-switching models can be sensitive to sample length and to whether the data contain sufficiently distinct regimes for reliable separation. The paper therefore treats regime evidence as credible only when it is robust to reasonable alternative regime definitions and when regime sample sizes are adequate for stable estimation.

**Sample length and structural breaks.** ERPT can change over time due to policy regime shifts, external shocks, or changes in trade structure. If the sample contains major breaks, estimates may average over distinct subperiods. The discussion therefore emphasizes diagnostics and, where relevant, sensitivity checks that either control for breaks or evaluate subperiod stability. This is particularly important for economies that experienced discrete exchange-rate adjustments or periods of policy transition.

**Data revisions and definitional issues.** Official series can be revised, rebased, or redefined. For a paper that claims auditability, the replication package must record download dates, table names, and any notes on revisions or base-year changes. This is not a bureaucratic detail: it directly affects whether another researcher can reproduce the same results.

**Endogeneity and causality.** The paper avoids strong causal claims because exchange-rate movements and inflation are jointly influenced by external shocks, policy responses, and domestic demand conditions. The empirical strategy is designed for disciplined description and regime comparison, not for identifying exogenous exchange-rate shocks. Where the paper uses the language of "response," it is interpreted as an estimated conditional association in a dynamic system. Policy implications are therefore framed in terms of forecasting relevance, risk monitoring, and regime vulnerability, rather than as structural multipliers unless stronger identification is implemented.

### 4.5. Policy interpretation consistent with the evidence

Within these constraints, the results have clear applied meaning. If ERPT is materially larger in high-inflation regimes, then exchange-rate depreciation becomes a more potent inflation driver precisely when stabilization is already difficult. This implies that monitoring regime conditions is not optional: credibility, communication, and expectations anchoring become central to limiting second-round effects. If ERPT is lower and delayed in low-inflation regimes, exchange-rate volatility may have smaller near-term inflation consequences, but sustained depreciation could still accumulate into inflation pressure over time. Component-level results, when available, can further guide which segments of the consumption basket are most sensitive to exchange-rate shocks, which matters for targeted risk communication and vulnerability assessment.

## 5. Conclusions

This study provides empirical evidence on exchange rate pass-through (ERPT) to consumer prices in Azerbaijan, with a specific focus on whether pass-through is **stable** over time or **nonlinear across inflation regimes**. The motivation is practical as well as scientific. In economies where exchange rate dynamics and inflation risks are closely monitored by households, firms, and policy institutions, the relevant question is rarely "What is the average ERPT?" but rather "How does ERPT behave when inflation conditions change?" A regime-sensitive estimate can therefore be more informative than a single coefficient that implicitly assumes the same transmission mechanism under both stable and stressed environments.The paper's main methodological value lies in its **transparent and auditable workflow**. The empirical strategy is intentionally built from elements that can be replicated by other researchers without privileged access: official public data sources, explicit variable transformations, and pre-specified model structures. The baseline ERPT is estimated using a distributed-lag specification that captures the timing and persistence of transmission from exchange rate changes to inflation. This benchmark is then tested against nonlinear alternatives, including threshold-based regimes and, where implemented, Markov-switching models. Importantly, regime rules, sample coverage, and estimation choices are documented in a way that supports verification rather than interpretation by authority. This structure makes the paper suitable for journals that prioritize reproducibility and methodological clarity. From a policy perspective, the results are relevant because ERPT is not merely a descriptive feature of the inflation process; it is a **risk amplifier** under certain macroeconomic conditions. If pass-through is stronger in high-inflation regimes, depreciation shocks can generate larger and faster CPI responses precisely when inflation expectations are more fragile. In such circumstances, regime-aware ERPT estimates can improve near-term forecasting and enhance risk monitoring by identifying periods when the inflation process is more sensitive to exchange rate movements. Conversely, if pass-through is weaker in low-inflation regimes, this provides evidence consistent with greater pricing rigidity and partial margin absorption, which can change how authorities interpret temporary exchange rate volatility and how they communicate inflation risks to the public.The paper also highlights the value of moving beyond headline

CPI where feasible. Component-level analysis, when supported by public CPI breakdowns, can clarify whether pass-through is concentrated in tradables-exposed categories or whether it becomes broad-based, potentially reflecting indirect cost channels and expectation-driven propagation. This distinction matters for monitoring vulnerabilities, because it indicates whether exchange rate shocks primarily affect specific price groups or have wider inflationary implications through generalized adjustment behavior.Finally, the study is designed to be **extendable**. As additional publicly available series become accessible, the framework can be strengthened in several directions without changing its core logic. First, import price indices and more detailed CPI subcomponents would allow tighter linkage between exchange-rate movements and border-cost channels. Second, publicly consistent monetary stance indicators would improve the empirical characterization of credibility and anchoring conditions that may underlie regime dependence. Third, longer time coverage and higher-quality documentation of definitional revisions would increase power and stability in nonlinear estimation. In this sense, the paper should be read not only as a set of estimates for Azerbaijan but also as a replicable template for regime-aware ERPT analysis in other small open economies where inflation conditions and policy regimes can shift over time.

## 6. Patents

No patents were generated or are pending as a result of the research reported in this manuscript. The study is based on publicly available macroeconomic and price statistics and does not involve the development of proprietary technologies, patentable algorithms, or protected industrial processes. Accordingly, there are no patent disclosures relevant to the submission.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### Institutional Review Board Statement

**Not applicable.** The study does not involve human participants, personal or sensitive data, clinical records, interventions, or experiments. The analysis relies exclusively on aggregated, publicly released statistical series (e.g., CPI and official exchange rates), which are disseminated by national institutions for general use. Therefore, ethical approval from an Institutional Review Board or an equivalent ethics committee was not required.

### Informed Consent Statement

**Not applicable.** No individual-level or identifiable personal data were collected or processed. The research does not include surveys, interviews, experiments, or any interaction with human subjects. Consequently, informed consent procedures are not relevant to the present study.


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enable transparent empirical work. Any remaining errors, omissions, or interpretations are the sole responsibility of the author.

**Conflicts of Interest**

The author declares **no conflicts of interest**. There are no financial, professional, or personal relationships that could be perceived as influencing the research questions, data selection, econometric specifications, interpretation of results, or the conclusions presented in this manuscript.

**Appendix A. Data Construction and Transformations (Audit Protocol)**

**A1. Sources and download points**

This study uses only official, publicly accessible sources. To ensure reproducibility, each dataset is documented with the exact access point and the download date recorded in the replication log.

**A1.1. Consumer Price Index (CPI)**

· **Provider:** State Statistical Committee of the Republic of Azerbaijan (Stat.gov.az).

· **Dataset:** CPI (headline) and, where available, CPI sub-indices/components.

· **Published formats:** CPI may appear as (i) an index level, (ii) monthly percent change, and/or (iii) year-on-year percent change depending on the table version and period.

· **Download protocol:**

**1.** Save the original source table file (HTML/PDF/Excel export where available).

**2.** Record: table name, reporting unit, base year (if index), and publication/update note.

**3.** Record the **download date** and retain an archived copy in the replication folder.

· **Primary use in baseline model:** CPI level index (preferred where consistent), from which monthly inflation is computed via log differences.

**A1.2. Exchange rate series**

· **Provider:** Central Bank of the Republic of Azerbaijan (CBAR).

· **Dataset:** Official AZN exchange rate against USD (AZN per USD).

· **Frequency and aggregation:**

**o** If a monthly series is available directly, it is used as published.

**o** If daily observations are provided, the monthly series is constructed either as:

**ß** **end-of-month** official rate, or

**ß** **monthly average** of daily official rates

.The chosen approach is fixed for baseline estimation and explicitly reported in Table 2 notes.

**A1.3. External cost controls (robustness only)**

To reduce omitted-variable concerns in periods with large global price shocks, robustness specifications may include publicly accessible international price series:

· Crude oil price index (or benchmark price),

· Global food price index,

· Other externally sourced cost proxies (only if publicly downloadable). Each such series is treated as **robustness-only** (not required for baseline identification) and is documented with: source, series identifier, units, frequency, transformation, and download date.

**A2. Transformations and construction rules**

All transformations follow pre-specified rules. No discretionary smoothing or interpolation is applied to the core CPI and exchange-rate series.

**A2.1. Inflation construction (baseline)**

Let $CPI_t$ denote the headline CPI index level for month $t$. Baseline monthly inflation is constructed as:

$$\pi_t = 100 \times \Delta \ln (CPI_t) = 100 \times [\ln (CPI_t) - \ln (CPI_{t-1})].$$

or the official yoy percent change if the source table reports it consistently.

· **Annualized monthly inflation:**

$$\Delta e_t = 100 \times \Delta \ln (e_t).$$

denote the official exchange rate (AZN per USD). Monthly exchange rate change is defined as:

$$\Delta e_t = 100 \times \Delta \ln (e_t).$$

corresponds to **depreciation** (more AZN per USD), and a negative value to appreciation.

**A2.3. CPI components (if used)**

Where CPI sub-indices are available, each component index is converted into component inflation using the same log-difference rule. Component definitions (e.g., "food", "non-food", "services", or an official core proxy if published) are taken strictly from the statistical authority's classification and are not re-labeled beyond descriptive grouping.

**A2.4. Seasonality handling**

Seasonality is treated transparently through one of two approaches (fixed in baseline and reported in Table 2 footnotes):

1. **Month-of-year dummies** included in the regression (recommended when using m/m inflation), or

2. **Alternative inflation definition** (e.g., yoy inflation) used as a robustness approach rather than baseline. No seasonal adjustment filters are applied unless explicitly justified and fully documented.

**A3. Regime definition and classification rules**

**A3.1. Threshold variable**

Regimes are defined using **lagged inflation** to avoid contemporaneous classification bias:

$z_t = \pi_{t-1}$.

.

**A3.2. Threshold selection protocol**

To avoid overfitting, regime cutpoints are selected using a disciplined rule:

- **Primary approach (pre-specified percentile):**

Candidate thresholds include the median and other pre-specified percentiles (e.g., 60th/75th), subject to a minimum regime size requirement (e.g., at least 20–25% of observations per regime).

- **Secondary approach (grid search, robustness):**

A grid search is performed over candidate thresholds within a central range (excluding extreme tails), selecting the threshold that optimizes a pre-defined fit criterion. The final chosen threshold $\tau$, regime sample sizes, and the selection rule are reported in Table 3.

**A3.3. Markov-switching regimes (if used)**

If a Markov-switching model is estimated, regimes are latent states interpreted as "low" and "high" inflation environments. The analysis reports filtered/smoothed probabilities and regime duration statistics (Appendix B). Regimes are not labeled post hoc to match outcomes; labeling is based on the mean inflation level implied by each state.

**A4. Estimation details and reproducibility standards**

**A4.1. Standard errors and inference**

Given monthly frequency and the likelihood of serial correlation, reported standard errors are **HAC-robust** (e.g., Newey–West). The chosen HAC bandwidth rule (fixed or automatic) is stated in the replication log and kept consistent across comparable specifications.

**A4.2. Lag-length selection and baseline locking**

Lag lengths are determined using a two-step procedure:

1. Evaluate candidate lag structures using information criteria (AIC/BIC) and residual diagnostics.
2. **Lock** the baseline lag choices (exchange-rate lags $K$ and inflation AR lags $J$) before reporting core tables and figures, to avoid iterative tuning that could inflate false positives. Final baseline lag lengths are reported in Table 2 notes.

**A4.3. Reproducibility package (recommended)**

The replication package should include:

- raw downloaded source files (archived),
- cleaned dataset with a variable dictionary,
- code scripts for cleaning, estimation, and figure/table generation,
- a log file stating download dates, table identifiers, and checksums/hashes of key source files where

feasible.

**Appendix B. Additional Figures and Sensitivity Analysis**

Appendix B provides supporting diagnostics and sensitivity checks to ensure that the main findings are not driven by fragile modeling choices.

**B1. Markov-switching diagnostics (if estimated)**

- Filtered and smoothed regime probability plots over time,
- Estimated transition probabilities and implied regime durations,
- Regime-specific mean inflation and volatility summaries,
- Stability discussion (whether regimes are well separated).

**B2. Alternative thresholds and regime stability**

- Results under alternative pre-specified threshold percentiles,
- Grid-search threshold sensitivity (showing how cumulative pass-through varies with $\tau$ ),
- Minimum regime size checks to ensure comparability.

**B3. Residual diagnostics and model adequacy**

- Autocorrelation checks (e.g., Ljung–Box or equivalent),
- Stability tests and sensitivity to alternative lag lengths,
- Influence checks for extreme months using a pre-defined rule (e.g., excluding top p1 of $|\Delta e_t|$ or other documented criteria).

**B4. Structural break sensitivity (recommended)**

- Visual and test-based evidence of possible breaks in inflation or exchange-rate dynamics,
- Subsample estimates around documented policy or exchange-rate events, where applicable,
- A short summary stating whether baseline qualitative conclusions remain consistent.

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