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Analysis of Inflation Dynamics in Post-Communist Economies

The Case of Uzbekistan

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Abstract: This paper seeks to investigate the short-run and long-run relationship between price level and monetary, non-monetary and external factors of inflation in Uzbekistan, from January 2016 to August 2025. The Autoregressive Distributed Lag (ARDL) model is applied to examine the link between money (M), interest rate (R), exchange rate (FX), producer price index (PP), import volume (IM), global food prices and the consumer price index (CPI). The estimates of the bound test found the cointegrating associations among the variables. The alternative Johansen test confirmed the existence of such a long-run relationship. Additionally, M, FX and PP have long-run relationships with the CPI, while the elasticity of the CPI with respect to R and IM is not statistically significant in the long run. The error correction term (ECM) has a value of –0.18, which means that 18% of the deviation is corrected in each month. Moreover, R and FX have a positive and statistically significant effect on the CPI in the short run. Finally, the Toda and Yamamoto causality test established the bidirectional causality between M and the CPI in Uzbekistan.

Keywords: ARDL, bounds test, CPI, Uzbekistan

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1. Introduction

Stable inflation is a driving force in supporting macroeconomic stability and affects the overall performance of the economy. Stable inflation facilitates predictable economic planning among businesses and households; however, elevated price pressures negatively affect inflation expectations of businesses due to the uncertainty, and they impede decision-making and long-term planning. Additionally, high inflation leads to a reduction in the purchasing power of households, especially for those who have fixed income flows. Achieving low and stable inflation is therefore critical for economic well-being and reducing the financial vulnerabilities of economic agents. Hence, ensuring stable inflation should be a core mandate of the responsible authority.

The post-Soviet economies had exceptionally elevated inflation after gaining their independence, price liberalisation and monetary policy in transition being the main contributing factors thereof. These countries still administer price policies that are considered underlying causes of persistent inflation, even though the share of the administrated goods is small in the CPI basket (Atamanchuk et al., 2025). Uzbekistan, in turn, experienced pronounced inflationary pressures during the transitional period due to both internal and external factors. The exchange rate restrictions, introduced in January 1997, to protect local industries had negative welfare effects and accelerated the inflation rate through the increased import prices (Rosenberg & Zeeuw, 2000). This restriction contributed not only to inflationary pressures but also stimulated dollarisation in the economy. Therefore, Uzbekistan implemented a one-time big-bang liberalisation of the exchange rate market in 2017, and subsequently, the national currency, the Uzbek sum, depreciated relative to the U.S. dollar by 100% over the course of a single day. Simultaneously, annual inflation reached 13% in 2017. Moreover, the Covid-19 pandemic and the Russian–Ukrainian conflict caused supply-side disruptions, driving inflationary spikes in 2022, and these dynamics still have severe effects in several industries. It is important to note that some recent reforms in the energy market, such as price liberalisation, have managed to change the dynamics of inflation in Uzbekistan, though they still have secondary effects on prices. It is in this context that we are addressing the drivers of inflation in Uzbekistan.

Considering Uzbekistan's recent structural reforms, both in the real and monetary sectors, this study examines the short-run and long-run associations between monetary policy, supply disruptions and external factors of inflation in Uzbekistan. Specifically, the study aims to identify short-run and long-run relationships among interest rate, money, exchange rate, producer price index, import and global food prices in Uzbekistan using the ARDL model. Studying dynamic relationships among inflationary factors is relevant in the current transition toward an inflation-targeting regime. Additionally, Uzbekistan has started to liberalise prices, making it extremely important to understand the relationships between inflationary factors. The distinguishing feature of the study is that it attempts to estimate the short-run and long-run relationship between price level, monetary and non-monetary, and external factors of inflation using monthly data, presenting novel evidence on inflation drivers in a post-Soviet economy.

Structurally, the subsequent section is a brief literature review on the determinants of inflation. Next, the study outlines the structure of the Uzbek economy. The fourth section introduces the theories of inflation and an empirical literature review. The methodology and data are presented in section five. The sixth section introduces the results of the study, with section seven offering our conclusions.

2. Literature review on inflation dynamics

There is an exhaustive literature on the determinants of inflation; however, results vary, both in respect of a comparison between different countries and within selected, country-specific studies. Inflationary factors in wealthy countries differ significantly from those in transitional and emerging economies. As such, Kamber and Wong's (2020) study compares the drivers of inflation in various countries and suggests that oil price shocks as a driver of inflation have more pronounced effects in emerging market economies (EMEs) than in industrialised countries. Another study also identifies that oil price shocks exerted a statistically significant impact on prices in oil-importing economies, feeding into domestic headline inflation through transport, utility and food prices (Baba & Lee, 2022). Just like Mohanty and Klau (2001), who concluded that supply-side variables, external conditions and agricultural disruptions played a predominant role as drivers of inflation in emerging market economies (EMEs).

On the other hand, it has been demonstrated that demand shock had a negligible impact in emerging markets. Furthermore, Deka and Dube (2021), conducting a causality study between exchange rates and inflation in Mexico, found that exchange rates had a causal effect on inflation, suggesting strong exchange rate pass-through. In terms of Turkey, Lim and Papi (1997) argued that inflation was mostly caused by a government budget deficit. Similarly, fiscal imbalances were identified to be a principal determinant of inflation in developing countries by Catao and Terrones (2005). Applying the ARDL approach for India, Alam and Alam (2016) showed that supply-side factors were short-term drivers of inflation, while monetary growth had long-term dynamic interactions with inflation. Overall, determinants of inflation in EMEs are mostly caused by oil price shocks, supply disruptions and fiscal imbalances.

Empirical analysis of inflation dynamics is relatively limited and inconclusive in post-communist economies. Baranov and Somova (2015) studied factors of inflation in Russia and found that monetary factors, particularly money aggregate, were statistically significant determinants of inflation, whereas non-monetary factors, such as the consolidated budget, were not associated with inflation. But the wage growth also had a pronounced effect on inflation in Russia. Still, Masso and Staehr (2005) forcefully vindicated that wages did not have a significant effect on inflation in the post-Soviet Baltic states.

With respect to Uzbekistan, there is, however, considerably less literature available on inflation dynamics. There is, of course, the seminal paper of Akimov (2001) that investigated financial system reforms and stated that substantial fiscal deficit finance had inflationary pressure in the early years of transition. Ranaweera (2003) analysed the dynamic relationship among goods, money and exchange rate markets under multiple restrictions, finding a short-run association between exchange rate and inflation. Ruziev and Midmore (2014) argued that the Central Bank of Uzbekistan (CBU) restricted cash to suppress inflationary pressures, having the cash and non-cash markets emerged, where the premium was around 8–10%. Al Rasasi and Cabezon (2022) specified a vector autoregression (VAR) model to evaluate monetary policy transmission. Accordingly, the policy interest rate of the CBU had a limited effect on core inflation, but the exchange rate shock had an insignificant influence on prices. One of the empirical studies of the CBU identified three sources of inflation: aggregate demand shocks, global economic uncertainties, ongoing supply chain disruptions, and structural inefficiencies in primary sectors of the economy, such as energy and transportation (CBU, 2024). Boymirzaev (2025) empirically assessed Factor-Augmented Vector Autoregression (FAVAR) and Bayesian Vector Autoregression (BVAR) models' ability in forecasting inflation in Uzbekistan. This empirical test was facilitated to optimise the forecasting capacity of the CBU.

3. Structure of the Uzbek economy

Uzbekistan has a small open economy with a Gross Domestic Product (GDP) of approximately 115 billion USD in 2024, which is around 3.094 USD per capita income (World Bank, 2024). The economy expanded substantially, especially following structural reforms in 2017. As a result, GDP per capita rose more than two times between 2017–2024, and economic growth accounted for 6.5% in 2024. The International Monetary Fund (2024) forecasted an annual 10.8% growth of per capita income in 2025–2030, which is the highest among the former Soviet Union economies.[1]

Figure 1 indicates the sectoral composition of GDP in the given time period, in which the structure of the economy has not seen drastic changes since 2010. While the industry's share has increased marginally, the share of agriculture has declined in GDP, and manufacturing accounted for 85.1% of all industrial output in 2024. The second biggest share was allotted to the mining and quarrying sector, making up 7.6% of total industrial output. Gas extraction fell from 61.6 billion cubic meters in 2018 to 44.6 billion cubic meters in 2024, posing potential risks to the economy in the future. Uzbekistan has already started to import gas, so fluctuations in gas prices can have inflationary pressure as an external factor as well, besides being a geopolitical instrument by exporter countries. The total volume of agriculture, forestry and fishing made up 19% of total GDP in 2024, with the share of the crop and livestock production adding 96.5%, forestry accounting for 2.5% and fishing for 1% of the total agricultural sector. Due to the high demand for mortgages and the faster rise of incomes, the construction sector has increased steadily, the proportion of construction in GDP having risen from 5.7% in 2017 to 7% in 2024. The contribution of the service sector expanded due to the liberalisation of the exchange rate and prices. Additionally, the Uzbek Government has invested substantially in tourism,

[1] https://tinyurl.com/ye2a8pus

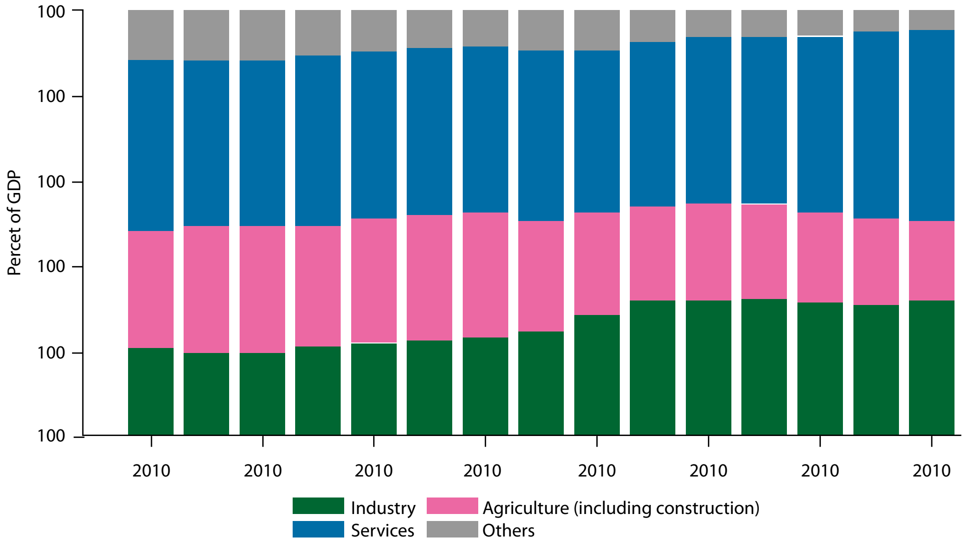

Figure 1
Composition of Gross Domestic Product by sectors
Source: Authors' calculation using World Bank Development Indicators and data from the National Statistics Committee of Uzbekistan.

transportation and infrastructure in recent years. The top three sub-sectors of services were accommodation and food services (22.4%), merchandise services (18.3%) and transportation (17.7%) in 2024.

Achieving stable inflation is complex due to several structural issues in the economy. As such, and owing to the dominant role of the state in the economy, monetary policy implementation is inefficient in controlling prices. In Uzbekistan, following the exchange market liberalisation in 2017, a supportive industrial policy is being pursued. These policies have involved granting tax incentives, providing energy subsidies and taking steps to safeguard domestic industries from imports. However, despite such incentives, price levels in those industries remain strikingly high. Limited competition because of monopolistic market structures contributes to price pressures in the transport industry and consumer durable markets, and the dominance of state ownership over the largest enterprises and banks is another substantial setback. As of 2025, nine out of the thirty-six commercial banks were state-owned, holding 65% of all bank assets and 61% of all banking system capital.[2] Thus, monetary policy is inefficient in itself because market-based instruments can hardly influence the behaviour of state enterprises and banks. Therefore, a strategic privatisation approach is highly necessary.

Additionally, a key source of distortion in Uzbekistan's inflation dynamics is the energy market. The Government of Uzbekistan subsidises the energy sector through the state budget, which has recently been placed under significant strain. For instance,

[2] https://cbu.uz/en/statistics/bankstats/2123881/

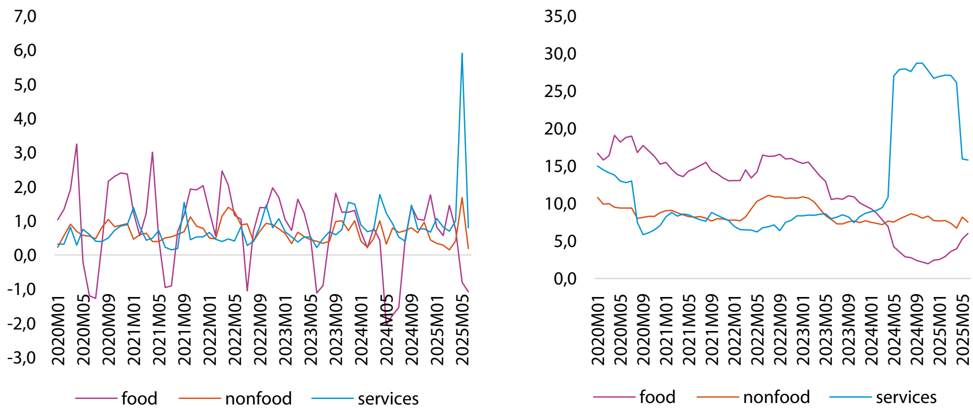

Figure 2
CPI components (% changes)
Source: Compiled by the authors using data from the National Statistics Committee of Uzbekistan.

allocated subsidies increased fivefold in just two years, rising from 5.63 trillion sums to 29.25 trillion sums (equivalent to 2.5 billion USD). Of this amount, 18 trillion sums were used to cover the difference between the cost of purchasing and selling gas, while 1.02 trillion sums were spent on geological explorations.[3] The Government of Uzbekistan has recently issued a new decree to implement market-based mechanisms in energy pricing through the gradual removal of budgetary subsidies. A new rule sets a social benchmark of 200 kWh of electricity for households, allowing subsidised tariffs up to this level and applying market rates beyond it. According to the IMF (2024), this reform is expected to serve as a key driver of future economic growth. However, such a policy initiative has considerably placed pressure on prices and delayed reaching a 5% inflation target in 2025.

The CPI basket in Uzbekistan includes overall 500 food products, non-food products and services. Figure 2 shows both the monthly and the year-on-year change of CPI components from 2020 to 2024. The left panel presents CPI compared with the previous month, while the right-hand panel presents the year-on-year CPI change.

The monthly CPI has seasonal patterns among all three components. The CPI tends to rise at the beginning of the year due to the shortage of supply in agricultural products in the winter period. However, all components usually fall in the summer period because of the harvest season that provides more supply of vegetables. Moreover, fluctuations in non-food and service components can be attributed to the liberalisation of energy prices, which significantly affected these categories. This measure cannot provide a conclusive interpretation since the CPI is measured relative to the previous month rather than a constant reference period. And the IMF issues the CPI data indexed to a fixed date. This variable offers more analytical value to examine CPI trends over time, and the indexed

[3] The data was collected from the telegram channel of the Ministry of Economy and Finance of Uzbekistan (https://t.me/minecofinuz/9021).

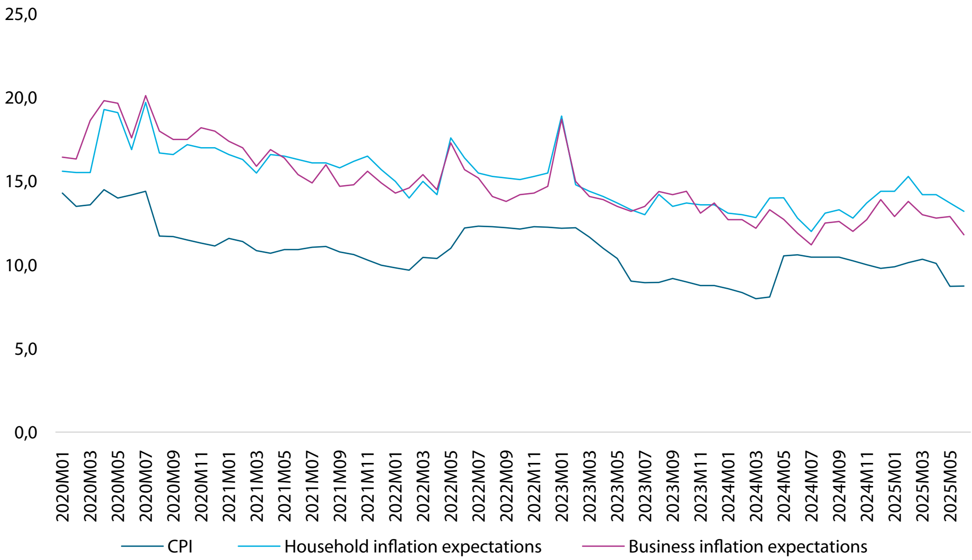

Figure 3

Inflation expectation

Source: Compiled by the authors using data from the Central Bank of Uzbekistan.

CPI with a base period of 2020 average had a constant increase in Uzbekistan during the last three years. That is why we have employed the IMF's indexed CPI in estimating the proposed model to obtain meaningful temporal comparisons.

The CBU, as a monetary policy authority, has conducted regular surveys to assess inflation expectations and perceived inflation among households and businesses since 2020. Figure 3 shows the dynamics of inflation expectations of households, businesses and the year-on-year CPI. The expectation report also includes the perceived inflation based on the subjective assessment of agents. The most recent survey, conducted in September 2025, including 3,420 respondents, reveals that household inflation expectation is largely driven by anticipated increases in utility bills (46%), energy prices (41%) and currency depreciation (22%). The proportion of depreciation expectation has been dominant among other factors since 2020. For example, the depreciation of the exchange rate accounted for 55% in December 2024 and placed third among other factors. However, it suddenly declined due to the consistent appreciation of sum against USD in the last few months. In September 2025, overall perceived inflation declined by 0.6 and made up 12.4%, marking the lowest level since December 2024. The impact of inflation was particularly pronounced in Tashkent and Qashqadaryo provinces, where residents reported a perceived inflation rate of 13.9% and 13.6% respectively. Nevertheless, the sustained rise in energy prices still has second-round effects on the broader economy. Overall, both inflation expectations of households and businesses are higher than CPI inflation due to energy prices and commodity price factors.

4. Inflation theories and empirical literature

4.1. Theories of inflation

Inflation theories are well-documented in the scholarly literature. Instead of sketching out a brief review, we are focusing exclusively on some of those influential theories that bear some relevance to the methodology and objectives of this study. As it is well-known, inflation theories provide various perspectives on the origins and mechanisms of inflation dynamics, serving as a basis for policy interventions and economic modelling.

One of the prominent theories is the Quantity Theory of Money, positing that inflation is predominantly influenced by the growth rate of money relative to the growth rate of nominal GDP. The statement of Milton Friedman (1970), that "inflation is always and everywhere a monetary phenomenon", still remains influential in developing and emerging economies. Friedman and Schwartz (1963) carried out an empirical analysis on the associations between the growth rate of money and the price index in the USA to confirm their theory.

Secondly, the Standard Phillips Curve Theory formulates a negative relationship between inflation and unemployment (Phillips, 1958). Later, this standard theory was extended by incorporating inflation expectations to explain short-run Phillips curve movements and the natural rate of unemployment to illustrate the long-run Phillips curve (Gordon, 2018). The Modern New Keynesian Phillips Curve specifies inflation as forward-looking and estimated by real marginal cost: output gap or unit labour costs (Gali & Gertler, 1999).

Finally, the Supply-Side Theory emphasises tax cuts for businesses for production and productivity (Ball & Mankiw, 1995). Complementary views include cost-push channels (commodity and wage shocks) and demand-pull pressures arising from positive output gaps.

4.2. Empirical literature

The interaction of the CPI with monetary, non-monetary and external factors of inflation has been widely studied in various countries using different models. This literature review section compares studies on transitional and developing economies, with particular emphasis on Uzbekistan.

Ghosh (1997) studies inflation dynamics in the former Soviet Union countries, suggesting that demand for money is strongly inflation elastic in the Baltic countries and Russia; therefore, conventional estimates generate a lower seigniorage – maximising inflation rate. It also emphasises the asymmetric monetisation in transitional economies, that severe inflation leads to rapid de-monetisation in these economies. For example, transitional economies tend to expand the money in circulation when inflation falls below 10%. Isakova (2010) investigates inflationary factors in Kazakhstan and Kyrgyzstan using the Johansen cointegration test and Vector Error Correction Model (VECM). The study found that lag of inflation had a statistical significance on inflation, and a strong exchange rate pass-through is observed. Both analysed countries are small, open and import-dependent economies; therefore, the exchange rate tends to have a substantial influence on prices through import prices. The study estimated the inflation equation by incorporating oil prices and dollarisation, and the results show a strong association between oil prices and inflation. As such, the central bank's independence and credibility are suggested as key policy implications to achieve stable inflation.

The most well-researched post-Soviet economy is Russia, with particular attention dedicated to inflationary factors. Most studies agree in finding monetary factors as sources of inflation in these economies (Koen & Marrese, 1995; Hoggarth, 1996; Korhonen, 1998). Nikolić (2000), for instance, observed a strong interaction between monetary aggregates (M0, monetary base, M2 and broad money) and inflation, using a finite distributed lag model in which the dependent variable, inflation in the study, depends on current and lagged values of the money growth. It concluded that money growth is a key determinant of inflation in Russia. Lissovolik (2003) analysed the dynamics of inflation by using a markup model and a money market model in Ukraine, identifying that wages and exchange rates are significant long-term drivers of inflation, whereas monetary factors play a more immediate, short-term role. In line with this, Siliverstovs and Bilan (2005) confirmed that inflation is primarily driven by devaluation expectations among economic agents in Ukraine. Rozenov (2017) assessed how exchange rate depreciation affects inflation through import prices using a VAR model. The pass-through is found to be 20–30%, which is high and consistent with other transitional and emerging economies. It suggested promoting de-dollarisation and fair competition in the goods market. Zainidinov (2021) analysed the short-run and long-run association between budget deficit and inflation using the ARDL model in Kyrgyzstan. The results show that the elasticity of inflation is 0.24% in the short-run and 0.63% in the long-run with respect to a one-percentage increase in the budget deficit.

Kuma and Gata (2023) assessed food price inflation using the ARDL model in Ethiopia. The results confirm that monetary policy variables, such as interest rate and reserve money, were the principal forces of inflation, and monetary factors had a positive and statistically significant correlation with food price fluctuations. Valogo et al. (2023) examined the threshold effect of exchange rate pass-through in Ghana. The results of the threshold model suggest that currency depreciation beyond 0.70% (threshold level) has a significant pressure on inflation. Asandului et al. (2021) investigated the link between fiscal policy and inflation in post-communist European countries using a nonlinear ARDL model. The model results reveal that fiscal policy does not have significant effects on inflation in the short run. Mihajlović and Marjanović (2020) empirically estimated the asymmetry nature of inflation in post-Soviet Baltic states using a nonlinear ARDL model. The study found that inflation is more sensitive to economic expansions than to contractions, consistent with downward price and wage rigidity. Specifically, inflation responds more strongly to a positive output gap and a negative unemployment gap. They suggested that disinflation policies relying on demand contraction impose relatively high output and employment costs. Overall, these studies emphasise the importance of monetary factors and non-monetary factors as drivers of inflation in emerging, developing and transitional economies.

5. Methodology and data

5.1. Model specification

To inflationary factors, comprehensively, we have constructed the following equation that incorporates monetary, non-monetary and external determinants of the price level.

$$CPI_t = \alpha + \beta_1 M_t + \beta_2 R_t + \beta_3 FX_t + \beta_4 PP_t + \beta_5 IM_t + \beta_6 GFP_t + D + \varepsilon_t \quad (1)$$

α is intercept term,
β_1 and β_6 are coefficients,
CPI_t is consumer price index,
M_t is broad money,
R_+ is short-term commercial bank lending rate,
FX_t is nominal exchange rate of Uzbek sum relative to USD,
PP_t is producers price index,
IM_t is import volume,
GFP_t is global food price index,
D captures two dummy variables,
ε_t is error term.

5.2. Bounds testing approach for cointegration analysis

Traditional cointegration methods of Engle and Granger (1987) and Johansen (1988) require variables to share the same integration order; however, these tests tend to produce bias and unreliable results when series are in different integration orders. Pesaran et al. (2001) address such an issue using the ARDL bounds testing approach for cointegration analysis. Hence, regressors can be a mixture of integration orders, either I(0) or I(1), but not I(2) or higher. Since the ARDL model is a single equation model, it simplifies estimation and inference and allows regressors to have different lag orders. It also enables consistent estimation of long-run relations, short-run adjustments, typically via an error-correction form. Notably, the ARDL can address the autocorrelation and endogeneity issues by selecting an appropriate lag order. If there are structural breaks or outliers in the data, incorporating dummy variables can handle such issues. Therefore, the ARDL is well-suited to examine short-run and long-run interactions between price level and monetary and non-monetary and external factors. Following Pesaran et al. (2001), the ARDL bounds test equation takes the following form.

$$\Delta CPI_t = \alpha_0 + \beta_1 CPI_{t-1} + \beta_2 M_{t-1} + \beta_3 R_{t-1} + \beta_4 FX_{t-1} + \beta_5 PP_{t-1} + \beta_6 IM_{t-1} + \beta_7 GFP_{t-1} + \sum_{i=1}^{q} \delta_1 \Delta CPI_{t-i} + \sum_{i=0}^{p} \delta_2 \Delta M_{t-i} + \sum_{i=0}^{p} \delta_3 \Delta R_{t-i} + \sum_{i=0}^{p} \delta_4 \Delta FX + \sum_{i=0}^{p} \delta_5 \Delta PP_{t-i} + \sum_{i=0}^{p} \delta_6 \Delta IM_{t-i} + \sum_{i=0}^{p} \delta_7 \Delta GFP_{t-i} + dummies + \varepsilon_t \quad (2)$$

Equation (2) has both the short-run and the long-run parts of the ARDL model. The outcome variable is the difference of CPI, coefficients from β_1 to β_7 capture the long-run part of the model, indicating how lagged level values of both CPI and other explanatory variables affect current changes of price level. The second part, which is the summation of the lagged differences of both outcome and explanatory variables, represents the short-run dynamics of the model. The short-run part has its own coefficients from δ_1 to δ_7, q and p are the number of lags.

The null hypothesis of the bounds test checks the absence of a long-term relationship or cointegration between the variables being studied. In other words, H_0: $\beta_1 = \beta_2 = \beta_7 = 0$. To evaluate the null hypothesis, it is necessary to assess the F-test, which has the following mathematical form.

$$F = \frac{(SRR_r - SRU_{ur})/p}{SRU_{ur}/(t-2p)} \quad (3)$$

Here, SRR_r is sum squares of the residuals for restricted model, SRR_{ur} is sum squares of the residuals for unrestricted model, t is the number of observations, p is the optimal lag number.

The F test results can be interpreted in three scenarios. First, if the F-statistic is higher than the upper critical bound, the null hypothesis of 'no cointegration' is rejected, confirming the existence of cointegration. Second, if the F-statistic falls below the lower critical bound, the null hypothesis is not rejected, and this is evidence of no cointegration. Finally, if the F-statistic is found between the lower and upper critical bounds, the result is inconclusive, and no definitive conclusion can be drawn.

Next, we estimate short-run parameters using the Error Correction Model (ECM). Equation (4) demonstrates the ECM representation of the ARDL model.

$$\Delta CPI_t = \alpha_0 + \sum_{i=1}^{q1} \eta \, \Delta CPI_{t-i} + \sum_{i=0}^{p1} \delta_1 \Delta M_{t-i} + \sum_{i=0}^{p2} \delta_2 \Delta R_{t-i} + \sum_{i=0}^{p3} \delta_3 \Delta FX_{t-i} + \sum_{i=0}^{p4} \delta_4 \Delta PP_{t-i} + \sum_{i=0}^{p5} \delta_5 \Delta IM_{t-i} + \sum_{i=0}^{p6} \delta_6 \Delta GFP_{t-i} + \gamma ECT_{t-1} + dummies + \varepsilon_t \quad (4)$$

ECT is an error correction term that captures the speed of adjustment or deviation from the long-run relationship with the coefficient γ. If the coefficient of the ECT is negative γ and statistically significant, it shows short-term deviations and diminish over time, and the series eventually return to the long-run equilibrium. A proportion γ of the deviations is corrected in each period, and all deviations are expected to dissipate by the end of $1/\gamma$ periods.

Following Sankaran et al. (2019), Alper et al. (2023) and Daly et al. (2024), this study applies the Toda–Yamamoto (1995) causality test due to the mixture of both stationary and non-stationary variables. The Toda–Yamamoto causality test provides a robust paradigm for checking long-term causal relationships in the case of different cointegration orders. As opposed to the traditional Granger causality test, which may produce unreliable outcomes with non-stationary series, this framework uses the level values of the variables that yield deeper insights into causal dynamics. The Toda–Yamamoto causality test does not need regular ordering among variables or the presence of a co-integration relationship; therefore, it is applicable to various data setups. Furthermore, the test adheres to an asymptotic χ^2 distribution, irrespective of whether the series are stationary, trend-stationary, or cointegrated, thereby ensuring its robustness across varied time series properties. We take three distinct steps to apply the Toda–Yamamoto causality test. First, a vector autoregression (VAR) model is specified to determine optimal lag length (p). Second, the VAR model is estimated by incorporating the highest degree of integration of the series (d_{max}) and estimate the model with ($p + d_{max}$) lags. Third, restrictions are applied to the coefficients associated with (d_{max}) and the significance of these restrictions is evaluated using the modified Wald test.

5.3. Data sources

Monthly data were collected from the National Statistics Committee of Uzbekistan, the Central Bank of Uzbekistan and the Enhanced General Data Dissemination System of the IMF, covering the time period between January 2016 and August 2025. Fiscal policy variables and output gaps are not included because the two variables are only available on a quarterly basis. The year 2016 was chosen because data for import volume and producer price index are unavailable for earlier periods. This study uses the CPI as a proxy for inflation, and the producer price index was chosen to approximate supply-side pressures. Also, the study includes the short-term lending interest rate, the broad money and the nominal exchange rate of Uzbek sums relative to the USD. Furthermore, as Uzbekistan is a small, open and import-dependent economy, the total import volume is included to reflect the impact of imports on domestic prices. The global food price index serves as an external factor affecting the domestic price level. Table 1 summarises the statistical properties of the variables. The results show that only M and GFP are positively skewed, while the other variables are negatively skewed. The Jarque–Bera probability confirms that M and IM are normally distributed.

It is essential to verify that the variables need to be integrated into an order of zero or one, but not to be two or more, in order to apply the bounds testing procedure. Therefore,

Table 1

Descriptive statistics and normality test results

	CPI	M	R	FX	PP	IM	GFP
Mean	4.60	11.63	20.52	9.04	4.51	7.60	4.70
Median	4.63	11.59	21.51	9.24	4.61	7.61	4.64
Maximum	5.10	12.66	25.73	9.46	5.25	8.36	5.06
Minimum	4.02	10.65	12.44	7.94	3.56	6.66	4.45
Std. Dev.	0.32	0.55	3.504	0.46	0.50	0.41	0.16
Skewness	–0.24	0.02	–1.00	–1.41	–0.42	–0.26	0.32
Kurtosis	1.84	1.99	2.84	3.56	1.92	2.11	1.82
Jarque–Bera	7.60	4.86	19.63	40.02	9.13	5.09	8.71
Probability	0.02	0.08	0.00	0.00	0.01	0.07	0.01
Sum	534.0	1,350.1	2,381.2	1,049.4	523.3	882.1	545.6
Sum Sq. Dev.	12.2	35.4	1,412.7	25.3	29.2	20.2	2.95
Observations	116	116	116	116	116	116	116

Source: Compiled by the authors.

Table 2

Unit root and stationarity test results

Variables	*Integration level*	ADF test		PP test		*Integration result*
		Intercept	*Trend and intercept*	*Intercept*	*Trend and intercept*	
CPI	Level	0.0960	0.9938	0.0903	0.9947	I(1)
	The first difference	0.0000	0.0000	0.0000	0.0000	
M	Level	0.9347	0.2620	0.9394	0.2720	I(1)
	The first difference	0.0000	0.0000	0.0000	0.0000	
PP	Level	0.5832	0.8498	0.4586	0.9059	I(1)
	The first difference	0.0000	0.0000	0.0000	0.0000	
GFP	Level	0.6607	0.7388	0.6716	0.7710	I(1)
	The first difference	0.0000	0.0000	0.0000	0.0000	
		Breakpoint unit root test				
		Break date		*Probability value*		
R	Level	2020m06		< 0.01		I(0)
IM	Level	2017m01		< 0.01		I(0)
FX	Level	2017m08		< 0.01		I(0)

Source: Compiled by the authors.

we confirm the stationarity of variables using the unit root; the test results are presented in Table 2. Uzbekistan has recently held substantial structural reforms that led to ups and downs of economic fundamentals, including the interest rate, exchange rate and import volume. As such, this study employed a breakpoint unit root test to assess the stationarity of R, IM and FX, considering the potential impacts of structural changes in the economy. Additionally, two dummy variables are incorporated to control those structural breaks. Specifically, the first dummy captures average shifts due to the exchange market liberalisation in September 2017, and the second dummy is included for the regime shift in 2020.[4]

6. Empirical results

The unit root test results indicated a mixture of I (0) and I (1) processes across the variables in the previous section, with no series integrated of order two. Thus, we have applied the ARDL bounds testing procedure to assess the existence of a long-run relationship. Prior to the interpretation of the main results, diagnostic tests for residual serial correlation and heteroskedasticity, as well as standard stability tests are conducted and are reported in Tables 3 and 4. According to the Breusch–Godfrey Serial Correlation LM test results, failing to reject the null of no serial correlation up to lag 2, there is no serial correlation. The Breusch–Pagan–Godfrey test results fail to reject the null hypothesis of homoskedasticity.

Table 3
Serial correlation test of residuals

Breusch–Godfrey Serial Correlation LM Test: Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	1.385249	Prob. F (2.85)	0.2559
Obs*R-squared	3.251221	Prob. Chi-Square (2)	0.1968

Source: Compiled by the authors.

Table 4
Heteroskedasticity test: Breusch–Pagan–Godfrey

Heteroskedasticity Test: Breusch–Pagan–Godfrey Null hypothesis: Homoskedasticity			
F-statistic	1.444598	Prob. F (5,110)	0.2140
Obs*R-squared	7.147633	Prob. Chi-Square (5)	0.2099
Scaled explained SS	5.743387	Prob. Chi-Square (5)	0.3320

Source: Compiled by the authors.

The ARDL bounds test result includes two elements. The first element is the F-statistic for the joint significance of the lagged level terms and a t-statistic for the coefficient on the error-correction term. The second element is the critical values of the bounds test that are compared with the F-test and t-statistic in order to make a conclusion. An important criterion is the null hypothesis of the test, that there is no cointegration

4 The dummies are constructed by taking the value of zeros before the structural break and ones thereafter.

Table 5
Cointegration results using bounds test

Null hypothesis: No levels relationship Number of cointegrating variables: 5 Trend type: Unrest. constant (Case 3) Sample size: 114						
Test statistic				Value		
F-statistic				8.1		
t-statistic				–5.6		
	10%		5%		1%	
Sample	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
			F-statistic			
Asymptotic	2.2	3.3	2.6	3.7	3.4	4.6
			t-statistic			
Asymptotic	–2.5	–3.8	–2.8	–4.1	–3.4	–4.7
* I (0) and I (1) are respectively the stationary and non-stationary bounds						

Source: Compiled by the authors.

among selected variables. To assess this hypothesis, we compare estimated statistics with critical values in Table 5.

The cointegration results are generated relying on Case 3, which is unrestricted constant (no deterministic trend). This study examines the null hypothesis of no levels relationship among variables using 114 monthly observations. The estimated F-statistic is 8.1, which is higher than the upper critical value at 1%, 5% and 10%. Moreover, the t-statistic results offer further robustness for cointegration analysis. The absolute values of the t-statistics are 4.7 and 4.1 at one percent and five percent confidence intervals, respectively, and the estimated t-statistic is 5.6 at the absolute term, which is higher than both intervals of critical values. Thus, the null hypothesis is rejected based on the t-statistic, further confirming the existence of cointegration among the variables. This result confirms the theoretical framework of Pesaran et al. (2001), who employed to test cointegration between variables in the case of stationary and non-stationary series. We also checked the robustness of the F-test, using the Johansen cointegration test; its results are presented in Table 6. The test results confirmed the cointegration results of the bounds test approach. It showed at least two cointegration relationships among the variables.

Once cointegration is determined using the ARDL bounds testing procedure, the corresponding ARDL–ECM is estimated to obtain long-run effects alongside short-run dynamics. Table 7 presents the long-run coefficients of the ARDL model under an unrestricted constant specification (Case 3). Three variables (M, lag of FX and PP) have statistically significant long-run associations with the CPI. The directions of the relations are consistent with expectations of conventional wisdom. For example, the first row shows the positive elasticity of the CPI with respect to M at 0.18, which means that 1% increase in broad money leads to a rise in the price level of around 0.2%. This aligns with the findings of Friedman and Schwartz (1963), who identified money-price co-movement in

Table 6
Johansen cointegration test

Hypothesised No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical value	Prob.** Critical value
None *	0.861560	307.8213	95.75366	0.0000
At most 1 *	0.366913	88.33888	69.81889	0.0008
At most 2	0.182590	37.59556	47.85613	0.3199
At most 3	0.105858	15.21630	29.79707	0.7659
At most 4	0.015297	2.796468	15.49471	0.9753
At most 5	0.009731	1.085400	3.841465	0.2975

Source: Compiled by the authors.

Table 7
Cointegrating coefficients

Outcome variable: CPI				
Variable *	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
M	0.182399	0.021101	8.643890	0.0000
R (–1)	–0.290968	0.201516	–1.443893	0.1516
FX (–1)	0.330364	0.052238	6.324245	0.0000
IM	0.004462	0.016116	0.276849	0.7824
PP (–1)	0.271735	0.037501	7.245987	0.0000

Source: Compiled by the authors.

the long run. The lag of R enters with a negative coefficient, and it is not statistically significant. Specifically, 1% rise in R in the previous month is associated with negative 0.29% lower CPI in the long run. Such an association can be explained by the traditional interest rate channel through contraction of aggregate demand. It is important to note that ARDL models identify associations and long-run cointegration but do not establish causality.

Next, FX in a given month reveals a positive coefficient, which means that 1% depreciation of the Uzbek sum corresponds to a 0.33% high CPI in the subsequent month. Notably, this effect is statistically significant at the 5% level and should be interpreted via exchange rate pass-through. The literature identified similar interactions of FX and CPI, such as studies by Deka and Dube (2021) in Mexico and Malec et al. (2024) in Ethiopia. Moreover, there is no statistically significant level relationship between import volume and price level in the long run between 2016–2025, indicating very marginal elasticity of 0.004%. The lag of PP shows a moderately highly significant association (0.27), consistent with pass-through from upstream costs to consumer prices. Overall, the price level has significant integration with money, exchange rate and producer prices in the long run.

The short-run association among variables is assessed using the short-run form of the ARDL model. Table 8 presents the model results, focusing on ECT and elasticity coefficients. The ARDL (4,0,4,4,0,2) is selected via Akaike Information Criterion (AIC).

Table 8
Error correction model results

Outcome variable: ΔCPI				
Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
ECT	–0.18	0.02	–7.16	0.0000
ΔR	0.06	0.03	1.96	0.0525
ΔR (–1)	0.08	0.03	2.20	0.0300
ΔFX	0.05	0.01	5.47	0.0000
ΔFX (–1)	0.02	0.00	–4.13	0.0001
ΔPP	0.09	0.01	4.93	0.0000
GFP	0.011	0.33	3.50	0.0007
D1	–4.12	0.58	–7.02	0.0000
D2	0.05	0.12	0.42	0.6710
C	–33.35	4.90	–6.80	0.0000

Source: Compiled by the authors.

ECT had a statistically significant negative coefficient of 0.18, implying that approximately 18% of the previous month's disequilibrium between the CPI and the long-run covariates is offset each month. This suggests a stable association between the price level and the selected variables over the sample. Contemporaneous change of commercial bank lending rate is statistically linked to monthly CPI, and the elasticity constituted 0.06% in the short run. Also, the lagged value of R has a positive association with price level. This signals the efficiency in the second stage of the monetary policy transmission mechanism. The transmission from market interest rates to inflation operates through investment, consumption and the output gap (Mishkin, 1995). The CBU started targeting the interest rate rather than the monetary aggregate since the transition to inflation targeting. Such a regime shift can explain the association of R and CPI. Next, depreciation of the Uzbek sum relative to USD tends to coincide with a higher price level. For example, 1% depreciation is associated with 0.05% higher prices in the short run. The magnitude of elasticity is larger in the long-term than in the short-term. Both current and lag value of FX are linked with CPI in a consistent manner with theoretical expectations, without any puzzles. Next, PP shows a similar pattern: 1% producer price is associated with 0.09% higher CPI inflation. The last variable is global food prices, which showed a marginal interaction in terms of magnitude. Specifically, 1% change in global food prices corresponds to a 0.011% higher CPI in the short run, and such a relationship between global food prices and the CPI is widely documented in empirical studies (Al-Eyd, 2012; Atamanchuk et al., 2025). Hence, the short-run model results suggest that CPI is associated with commercial bank interest rate, exchange rate, producer prices and global food prices in the short run.

The traditional VECM and Engle and Granger causality tests are limited when applied to a short sample and with a mixture of integration of variables. That is why Toda and Yamamoto (1995) suggested an alternative approach when the variables are integrated into different orders. They demonstrated that the modified Wald test follows an asymptotic

Table 9

Toda–Yamamoto causality test results

VAR Granger Causality – Block Exogeneity Wald Tests			
Dependent variable: CPI			
Excluded	*Chi-sq*	*df*	*Prob.*
M	9.2	3	0.0256
R	1.4	3	0.6855
FX	7.3	3	0.0608
IM	1.1	3	0.7763
PP	0.6	3	0.8948
All	20.4	15	0.1551
Dependent variable: M			
CPI	10.2	3	0.0165
R	11.2	3	0.0103
FX	88.2	3	0.0000
IM	5.7	3	0.1242
PP	0.7	3	0.8551
All	130.8	15	0.0000

Source: Compiled by the authors.

chi-squared distribution regardless of the integration or cointegration properties of the series.

In the context of this study, the procedure is as follows: we initially estimated a reduced-form VAR with seven variables and identified a lag of two relying on AIC information criteria. Then, we estimated a new VAR system with three lags (d_{max}). After all, all endogenous variables are entered as exogenous with lag number three, and then the VAR Granger Causality – Block Exogeneity Wald Tests are employed to identify causality (Wolde-Rufael, 2010). Table 9 summarises the causality results with χ^2 and p values. We only presented two cases when CPI and M are outcome variables. In the first case, money ($\chi^2 = 9.2$, $p = 0.0256$) significantly Granger-cause CPI at the 5% significance level. This indicates that past values of money improve forecasts of the consumer price index. However, the remaining variables (R, FX, IM and PP) do not significantly Granger-cause CPI, as their p-values exceed the 5% threshold level. The joint test for all variables made up χ^2 value of 130.8 with 15 degrees of freedom and a p-value of 0.0000. This suggests that the combined lagged effects of all variables significantly influence forecasts of the CPI. When money is the outcome variable in the second case, CPI, R and FX have Granger cause on M, which means that there is a bidirectional causal relationship between the CPI and M. The bidirectional causality aligns with money-led movements in aggregate demand. To be more precise, the faster growth is followed by a higher price level. In all other cases, we could not find any casualty relationship between the CPI and other variables. All in all, money still has predictive power to explain changes in prices in Uzbekistan.

7. Conclusion

Substantial structural reforms have been undertaken in Uzbekistan in order to accelerate the transition process. The liberalisation of the foreign exchange market and the administrated prices in the energy market have catalysed broader transformations in recent years. However, depreciation of the domestic currency and high inflation pose constraints not only on the financial system but also on macroeconomic stability. This study, therefore, investigated how to identify short-run and long-run factors of inflation using the ARDL bounds testing approach. The present analysis used monthly data from January 2016 to August 2025, and the study limited the sample due to the absence of data for some variables prior to 2016. The empirical design is threefold. First, given the mixture of integration in selected variables, the ARDL bound test procedure is applied to verify cointegration among variables. Second, we identified cointegration; therefore, the ARDL regression is specified to recover short-run and long-run associations. Third, the Toda and Yamamoto causality test is employed, considering a small sample and mixed order of integration.

The cointegration relationship is identified using the ARDL bounds test; the computed F-statistic of 8.1 exceeds the upper critical value of 4.6 at 1% significance level. Also, the absolute value of the t-statistic (5.6) is beyond the 1% critical bound. Hence, both tests rejected the null of no level relationship among variables so confirming a stable long-run cointegrating relationship. Additionally, the ARDL estimates show that money and exchange rate, and producer prices have economically and statistically significant long-run interactions with the CPI. Specifically, the elasticity of inflation with respect to money and exchange rate, and producer prices accounted for 0.18 and 0.33, and 0.27 in the long term. However, interest rate and import volume are not significantly associated with the CPI over the long run.

The short-run error-correction coefficient is negative and significant (ECM = –0.18), indicating approximately 18% of the deviation from long-run equilibrium is corrected in each month. The interest rate, exchange rate and producer prices, and global food prices are found to have interactions with the CPI in the short-term, and such interactions are statistically significant, though the magnitude of elasticity is small. Also, the Toda and Yamamoto causality test identified bidirectional causality between money and the CPI; however, other variables did not exhibit predictive power with the CPI.

The findings of the study are policy-relevant. Since inflation rises persistently above the target, a clearer understanding of the dynamic associations between the price level and monetary, non-monetary and external factors strengthens policy design and calibration. Empirical results related to the dynamic relationship between the CPI and drivers of inflation over the short and long term inform the coordination of interest rate, exchange rate and broader macroeconomic policies.

This study has certain limitations that are recommended for further investigation. The output and fiscal expenditures are not selected due to data availability constraints, as these indicators are reported quarterly, while the estimation is made on a monthly basis. Hence, the incorporation of output and fiscal policy variables is quite relevant. Additionally, structural VAR specification can better capture and identify structural causality.

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