Post-COVID-19 Inflation Dynamics in Bangladesh

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Research Article

Abstract

Purpose: *Bangladesh's economy has recently experienced elevated inflationary pressures, which significantly affect economic stability and growth. This study analyzes the factors driving inflation in Bangladesh and determines whether supply-side factors or demand-side pressures primarily influence it.*

Methods: *The ARDL approach is used in this study's estimating process to use monthly secondary data from January 2015 to September 2024, available from different sources like Bangladesh Bank (BB) and Bangladesh Bureau of Statistics (BBS). This study utilized three separate models for scenario analysis to determine whether inflation dynamics are the same for the pre-COVID and post-COVID periods or over the entire period and whether supply-side or demand-side phenomena drive inflation. The rate of inflation is the dependent variable in the model; industrial production, import, inward remittance, exchange rate, and central bank policy rates (repo, reverse repo) are our independent variables, and the broad money supply is included as a control variable. A correlation matrix is also used to observe the connection among the variables.*

Results: *This study's findings reveal a long-run relationship among industrial production, lag value of inflation, import, lag values of exchange rate, and broad money supply, but the central bank policy rates have no statistical significance for Bangladesh. This revealed that the channels through which monetary policy influences inflation may be weak or ineffective, or inflation may be driven more by supply-side factors than demand-side ones, reducing the effectiveness of monetary policy.*

Implications: *The finding informs policymakers or experts that the recent inflationary trend is a supply-side phenomenon and will be adjusted over time.*

Originality: *This study offers a story contribution by systematically analyzing the post-COVID-19 inflation dynamics in Bangladesh, distinguishing between supply-side and demand-side drivers. Unlike previous studies, which primarily focus on pre-pandemic inflation trends or general macroeconomic conditions, this paper examines explicitly the structural shifts in inflationary pressures caused by the pandemic's aftermath.*

Limitations: *Inflation is a multivariate variable, and while fiscal deficits may directly influence inflation, their data are only available annually. Therefore, we cannot include this variable in our article.*

Keywords: Inflation, ARDL, Supply-side impact, Post-COVID-19, Bangladesh.

1. Introduction

Inflation is a significant and ongoing problem that impacts the country's economic stability and the welfare of its people. The persistent rise in prices reduces purchasing power, particularly for low-income

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households, discourages investment, and hinders sustainable growth. This persistent inflation also exacerbates income inequality. Over the past two years, the inflation rate has remained close to double digits, while average monthly wages have not increased significantly enough to keep pace with the rising cost of living. Because of this, many households find it difficult to cover their basic needs, and the gap between income groups continues to widen. Small and medium-sized businesses also experience growing operational costs, threatening their sustainability. Therefore, it is crucial to understand the underlying factors driving inflation to implement effective policies that promote sustained economic growth and ensure price stability.

A blend of demand-pull and cost-push factors, inflation expectations, and external influences drive the inflationary dynamics in Bangladesh. Demand-pull inflation arises from heightened consumer demand due to increased money supply, government expenditure, and economic expansion. Conversely, cost-push inflation results from supply-side disruptions, such as rising production costs and global price volatility. The main contributor to the hike in inflation was the significant increase in food inflation. The increasing food inflation in Bangladesh has been deepened by multiple factors, including supply chain disruptions caused by severe floods, adverse weather conditions, rising input costs, and global price hikes for essential food items. Inadequate logistics systems and artificial shortages created by market syndicates have further compounded the crisis. Additionally, currency depreciation and surging energy costs have amplified inflationary pressures, affecting both food and non-food sectors. According to Khan, R. E. A., and Gill, A. R. (2010), CPI, WPI, SPI, and GDP deflator have all increased due to the exchange rate depreciation and the rise in import values.

Many factors can influence the level of inflation, either directly or indirectly. However, focusing on the dynamics of industrial production, imports, inward remittances, the exchange rate, central bank policy rates, and money supply provides a comprehensive examination of key drivers in the economic system. Industrial production affects inflation through supply dynamics, with increased production lowering prices by boosting supply, while decreased production creates shortages that drive prices up. Imports play a significant role, as cheaper imports help reduce inflation by increasing supply, whereas costlier imports, due to global price hikes or a weaker Taka, raise production costs and consumer prices. Meanwhile, inward remittances constitute a significant portion of Bangladesh's foreign exchange earnings. It boosts household income and consumption, potentially driving demand-pull inflation if supply cannot keep pace. Roy, R., & Rahman, M. M. (2014) demonstrated that remittance inflows in Bangladesh contribute to inflationary pressures, with a more distinct impact on food inflation, which is 2.5 times higher than general inflation. Other variables like the industrial production index reduce inflation, while the exchange rate increases both general and food inflation. Broad money supply shows no significant impact, indicating monetary neutrality during the study period. The exchange rate is critical, as the depreciation of the Taka raises import costs, contributing to cost-push inflation, while money supply growth can exacerbate inflation by increasing liquidity. Salim, N. J., Leng, et al. revealed that money supply (MS) and interest rate (IR) are significant determinants of inflation in the selected Asian countries, with both showing a negative relationship. Consequently, effective forecasting and identifying the sources of price shock are essential for timely and accurate policy responses (Buddhari &Varapat, 2003).

By focusing on the time-varying nature of inflation, the drivers of inflation enable a more precise approach to achieving price stability and promoting sustainable economic growth. Relying solely on monetary policy is not sufficient for controlling inflation. This approach has had a limited impact on addressing supply-driven inflation, particularly in the food sector. Structural issues, such as inefficiencies in market mechanisms and supply chain constraints, disrupt the balance between supply and demand, contributing to price volatility. Thus, a coordinated approach that integrates monetary policies with supply-side adjustment and improvement in market mechanisms is essential for effective inflation control. Jarsulic, M. (2022) emphasized the importance of it promoting combining supply-side measures with monetary policy.

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For Bangladesh, particularly in the post-COVID-19 period, where global economic disruptions, supply chain congestion, and changes in remittance flows have had profound implications. The pandemic-induced economic shock led to unique monetary and fiscal policy responses to stabilize the economy. However, these interventions also carried inflationary risks with intensified supply-side disruptions. This study aimed to analyze the determinants of inflation in Bangladesh using an ARDL framework, considering pre-COVID, post-COVID, and overall economic scenarios. By incorporating variables such as industrial production, foreign exchange rate, broad money supply, and policy rates, this study's goal is to empirically examine the primary drivers of inflation in different periods and determine whether inflationary dynamics differ between the pre-COVID and post-COVID periods or remain consistent over the entire period in Bangladesh. However, for this purpose, the ARDL (Auto-Regressive Distributed Lag) models are used to analyze secondary data from various sources and determine the short- and long-term relationships between inflation and important economic variables like industrial production, imports, inward remittances, repo, reverse repo, call money rate, exchange rates, and money supply in Bangladesh. By investigating these relationships, the paper pursued to offer valuable insights into the dynamics of inflation and provide evidence-based policy recommendations.

The paper is organized in the following manner. The introductory section is followed by a brief review of relevant literature in Section 2. Section 3 provides a brief overview of the current inflation scenario in Bangladesh to understand the magnitude of the problem. Section 4 is devoted to data and methodology. By using the ARDL (Auto-Regressive Distributed Lag) procedure, empirical results, and discussions are presented in Section 5. Finally, section 6 concludes with the study's findings and suggests some policy implications based on the results of the econometric model in Section 6.

2. Literature review

Many studies have been conducted on determinants of inflation for individual countries or regions, but very limited literature addresses the pandemic-induced scenario analysis. This study will explore the different components of inflation and incorporate the macroeconomic factors along with pre-COVID and post-COVID scenario analysis, which have yet to be investigated. In the following segment, we reviewed some existing literature.

Zhang and Dai (2020) analyzed the relative importance of trend inflation and monetary policy in explaining macroeconomic stability in Australia. They examined pre-inflation targeting (Pre-IT, from 1983Q1 to 1993Q1) and inflation targeting (IT from 1993Q2 to 2018Q4) by implementing a small open economy model combined with Bayesian estimation. The results indicated that during the pre-IT period, monetary policy was not sufficiently responsive, which resulted in economic volatility and indeterminacy caused by self-fulfilling inflation expectations. In contrast, the IT regime eliminated indeterminacy and enhanced stability by making monetary policy more aggressive toward inflation deviations. Using a regime-switching model with a hybrid New Keynesian Phillips Curve, Behera and Patra (2022) found that despite Phillips curve flattening and positive production gaps, trend inflation decreased during the FIT period, indicating that monetary policy helped to stabilize inflation expectations. Additionally, inflation's tendency and volatility have decreased, indicating increased welfare gains over the FIT time frame.

Nguyen et al. used a Global VAR (GVAR) model to analyze inflation dynamics in Sub-Saharan Africa (SSA) and evaluate the contributions of domestic, regional, and global factors. The results indicated that inflation has primarily been driven by domestic supply shocks, along with fluctuations in exchange rates and monetary variables. However, in recent years, the influence of these factors has diminished. Instead, domestic demand pressures and global shocks, particularly output-related shocks, have become more significant in shaping inflation trends over the last decade. The study suggested improving policy

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instruments and implementing forward-looking monetary frameworks to control inflation and promote economic growth successfully.

The study by Dhakal et al. (1994) investigated the determinants of inflation in the U.S. using a vector autoregressive (VAR) model. Key findings revealed that the money supply has a significant and long-lasting impact on inflation. However, non-monetary factors like wage rates, energy prices, and budget deficits also significantly impact inflation, challenging the sole focus on monetary causes. The analysis supported that the Federal Reserve accommodates supply shocks, which indirectly link monetary changes to inflation. In order to effectively manage inflation, the study emphasized the significance of addressing both monetary and non-monetary components.

Mohanty and John (2015) used structural and time-varying parameter econometric models to examine the factors influencing inflation in India between 1996 and 2014. It determined that the output gap, monetary and fiscal policies, and crude oil prices were important determinants of inflation. Crude oil prices affected inflation instantly, but fiscal policy had a longer-term effect and gained prominence after 2008 due to fiscal stimulus programs. The impact of the output gap was limited, and monetary policy continued to have a steady influence.

Lim and Sek (2015) explored the determinants of inflation in high and low-inflation countries using ARDL and ECM models. The study found that the long-run impact of high-inflation countries' national expenditure implies a positive impact on inflation, but money supply implies a negative impact on inflation. In low-inflation countries, GDP growth has a negative impact on inflation, and imports of goods and services have a positive impact on inflation. The finding also showed no short-run relationship between inflation and variables for high-inflation countries. However, money supply, imports, and GDP growth have a short-run impact on inflation in low-inflation countries.

Iya and Aminu (2014) studied inflation determinants in Nigeria from 1980 to 2012 using time series data and various econometric methods. They found that money supply and interest rates positively impacted inflation, while government expenditure and exchange rates negatively impacted it. The Johansen co-integration test revealed long-term relationships among these variables. Granger causality tests showed one-way causality between inflation and money supply and between exchange rate and money supply. The VEC error correction model confirmed a long-run relationship, with money supply and exchange rate influencing interest rates.

Using co-integration and error correction techniques, Kahssay (2017) examined the determinants of inflation in Ethiopia over a period of 40 years. The results showed that, in the long run, broad money supply and GDP positively influence inflation, while imports and gross national savings (GNS) reduce it. Credit facilities and exports did not have any significant effect. Conversely, the error correction model suggested that 26% of the adjustment toward long-run equilibrium was made annually in the short run. At the same time, the broad money supply had a more substantial positive effect on inflation compared to GDP and GNS. The study concluded that demand-side and supply-side factors influence inflation, with money supply and GDP being key drivers.

Setiartiti and Hapsari (2019) analyzed factors affecting inflation in Indonesia from 2010 to 2017, finding that the money supply significantly influenced inflation in the short run, while exchange rates, BI rates as the interest rate, and GDP showed no significant effects in either the short or long run. Arif and Ali (2012) examined inflation in Bangladesh from 1978 to 2010 using cointegration and error correction methods. They found that, in the long run, inflation is positively influenced by broad money, government expenditure, and imports, while government revenue and exports have adverse effects. In the short run, inflation adjusts slowly (4% annually) toward equilibrium, with government expenditure and money supply having the most substantial impact. The study recommended implementing balanced fiscal and monetary policies, managing spending, and aligning money supply with real sector performance to control inflation.

Hossain and Islam (2010) tried to investigate the determinants of inflation in Bangladesh using data from 1990 to 2010. Through an Ordinary Least Squares (OLS) method, the study found that money supply and

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one-year lagged interest rates positively and significantly impact inflation, while lagged money supply and fiscal deficit have a negative effect. To mitigate inflation, the study recommends controlling the money supply, reducing the prior year's interest rate, increasing production, managing wages, importing essential goods, addressing population growth, and curbing the influence of middlemen. These measures are highlighted as essential for effective inflation management.

Uddin et al. (2014) have applied the Autoregressive Distributed Lagged (ARDL) Model to find results. The analysis concludes that both domestic and external factors drive inflation in Bangladesh. Key variables like GDP growth, money supply, and interest rates correlate positively with inflation; the real exchange rate and the past year's money supply negatively affect inflation. The study suggested that inflation results from both demand-pull and cost-push factors, and controlling these variables is essential to managing inflation.

Salma (2021) employs the Ordinary Least Squares (OLS) method to examine the relationship between inflation and broad money supply, FDI, GDP growth, foreign exchange rates, and trade balance. The study revealed that broad money supply and trade balance positively and significantly influence inflation. Foreign direct investment also has a slight positive but significant impact on inflation. GDP growth shows a negative and insignificant relationship, while foreign exchange rates have a positive but insignificant impact on inflation.

Nguyen et al. (2017) investigate inflation dynamics in Sub-Saharan Africa (SSA), emphasizing the changing roles of supply and demand shocks in recent decades. Using a Global VAR (GVAR) model, the analysis highlights that domestic supply shocks, exchange rates, and monetary variables historically drove inflation. However, global shocks, particularly from output and demand, have gained prominence recently, suggesting an increasing role for modern monetary policy frameworks in SSA.

The study identified those distinct inflation determinants across Pakistan, India, and Bangladesh. Employing an ARDL (autoregressive distributed lag) approach, the study findings by Siddiqui et al. (2024) demonstrated that the study found that Pakistan's inflation is driven by exports, money supply, exchange rate, and oil rents, while GDP has a negative impact. In India, inflation is influenced by exports, money supply, and oil rents. For Bangladesh, GDP and oil rents positively affect inflation, while the exchange rate has a significant negative impact. This study recommended that policymakers should focus on renewable energy investments and enhance monetary policy coordination to manage inflation.

Gyebi and Boafo (2013) examined the macroeconomic factors influencing inflation in Ghana from 1990 to 2009, identifying key macroeconomic factors influencing price levels. It found that money supply and actual output significantly drive inflation, while exchange rate depreciation and Economic Recovery Program (ERP) policies help reduce it. The study used time series econometric models to reveal that fiscal mismanagement and monetary expansion are critical contributors to inflation.

Khatun and Ahamad (2012) estimated the unrestricted error correction model (UECM) version of the ARDL model, revealing that rice production has a significant negative impact on inflation in the short and long run. However, petroleum prices and broad money supply have positive but relatively inelastic effects. The study recommended that policies focus on enhancing rice production and maintaining adequate food grain stocks, particularly rice, to prevent inflation during periods of shortage. Rationalizing petroleum prices and strengthening monetary policies to curb excessive money supply are also recommended.

Ahmed and Islam (2016) examined the determinants of inflation in Bangladesh using an ARDL-bound F-test. They found that petroleum prices significantly drive long-term inflation, while real GDP has a notable short-term positive effect. However, in the short term, broad money supply, domestic petroleum prices, and private-sector credit were found to have insignificant impacts on inflation. The study recommended that the government promote local substitutes like natural gas and focus on improving productivity in goods and services to mitigate inflationary pressures.

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Dahiru and Sulong (2017) demonstrated the existence of a positive long-run relationship between the exchange rate, broad money supply, oil price, and inflation, but negatively related to financial instability, interest rate, gross domestic product, and broad money supply, nominal effective exchange rate irritation term. The study recommended that Nigeria should prioritize monetary policy and exchange rate stabilization in order to manage inflation, while promoting economic diversification to reduce dependency on imports and control inflationary pressures.

3. A Brief Overview of the Current Inflation Scenario in Bangladesh

Inflation in Bangladesh, particularly food inflation, has significantly impacted people's economic access to food. All income groups have experienced increased food expenditures, with lower—and lower-middle-income groups being most severely affected. The lower-income group spends the maximum of their income on food, while the upper-middle-income group spends more than one-third of their income on food. The Russia-Ukraine war, inefficient domestic policies, syndicate activities, and a weak domestic production framework were key contributors to inflation. (Uddin & Anika, 2024).

In urban areas, higher-income households initially experienced greater non-food inflation. However, as rates exceeded double digits, poorer households became more affected, highlighting a nonlinear inflationary trend in urban areas (Hossain, Mujeri& Chowdhury2013).

Fig. 1: The trend of Inflation

(Base Index 2021-22 =100) Food and Non-Food Inflation

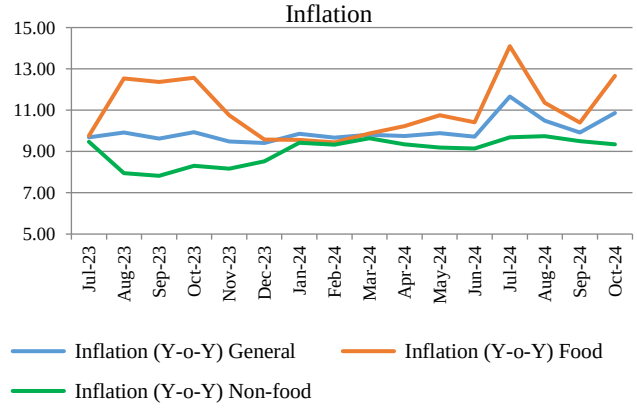
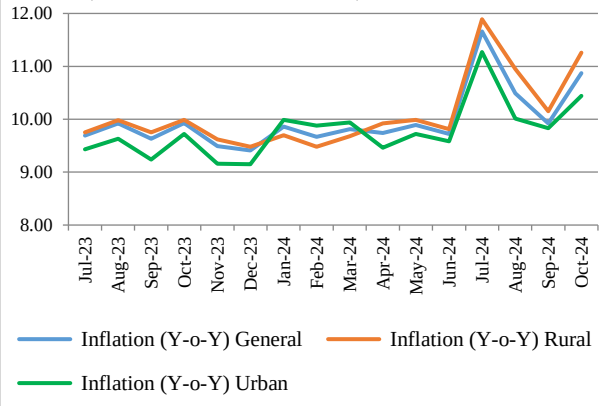


Fig. 2: The trend of Inflation

(Base Index 2021-22 =100) Urban and Rural



Sources: Bangladesh Bureau of Statistics and Bangladesh Bank

According to Figure 1, from January 2023 to October 2024, food inflation in Bangladesh remained a major concern, consistently exceeding non-food inflation rates. Supply chain disruptions also played a role in keeping food inflation persistently high. At its peak, food inflation reached 14.10 percent in July 2024 before moderating slightly to 11.36 percent by August 2024 and 10.40 percent in September 2024, reflecting some stabilization in supply chains and a gradual easing of price pressures. However, in October 2024, food inflation increased 12.66 percent. Food items, including rice and vegetables, were primary contributors to inflation, with prices rising sharply. October's inflation rise was influenced by several factors, such as supply chain disruptions from floods that raised egg prices and reduced fish stocks, along with wage increases following the July-August protests.

Non-food inflation in Bangladesh from January 2023 to October 2024 remained significant, though consistently lower than food inflation. Rising housing, transportation, utilities, and healthcare costs primarily drove it. Global fuel price hikes, along with the depreciation of the Bangladeshi Taka, led to higher production and transportation costs, contributing to rising non-food prices. Peaks in non-food inflation were observed in the first half of 2024, reaching around 10 percent, especially in urban areas where transportation and utility costs are higher. In September and October 2024, non-food inflation slightly

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improved, settling at 9.50 percent and 9.34 percent, respectively. Transportation, health, and utilities are responsible for reducing this inflation.

Figure 2: Rural inflation in Bangladesh from January 2023 to October 2024 was heavily influenced by food inflation, as rural households are more vulnerable to fluctuations in food prices. . Food inflation in urban areas stood at 12.53% in October, while it was higher in rural areas at 12.75%. Prices for essential items such as rice, wheat, and vegetables remained elevated. However, a gradual decline in food inflation in rural areas brought September to 10.38 percent, but in October 2024, inflation rose to 11.26 percent due to rising food inflation. Market inefficiencies and logistical bottlenecks exacerbate supply-side constraints. Artificial shortages orchestrated by syndicates and inefficiencies in the agricultural supply chain amplify price instability, disproportionately affecting rural households. Urban inflation in Bangladesh from January 2023 to October 2024 remained notably high, driven by increased transportation, housing, and utilities costs. Rising global fuel prices and the depreciation of the Bangladeshi Taka compounded these costs, particularly affecting urban dwellers relying heavily on energy and transportation services. Notably, the trend of rural and urban inflation is going in the same direction as the overall year-on-year national inflation rate, which began to show signs of easing in the latter half of 2024.

4. Data and Methodology

In this study, we employed a three-stage empirical analysis. In the first stage, we estimated a correlation matrix to identify the interlinkages among the variables. To assess the stationarity of the variables, we applied the traditional Augmented Dickey-Fuller (ADF) test and the Perron (1989) test. Subsequently, we conducted ARDL Bound tests for pre- and post-COVID periods. Finally, we used the error correction model to examine any short-run relationships among the variables over time. Using the following variables as dependent variables, we acquired monthly data from January 2015 to May 2024: the foreign exchange rate at month's end (BDT per US dollar), industrial production (Index, 2015-16=100), imports (USD million), inward remittances (USD million), Repo rate, Reverse Repo rate, Inter-bank Call Money rate and the broad money supply (m2). The monthly data was collected from the Bangladesh Bureau of Statistics (BBS) and the Bangladesh Bank (BB) website.

The variables need to be log-transformed as the econometric analysis, and we have used this method appropriately. Evaluating the data's stationarity is essential for time series data analysis. However, the ARDL approach has been widely utilized in various fields of economic research (Laourari & Abderrahim, 2022). Benabdallah and Oulddali (2024) employed the method to uncover Algeria's primary drivers of inflation. The key objective is establishing a robust empirical framework to understand the long-run inflationary patterns. Similarly, Alwis and Dewasiri (2022) focused on the supply-driven determinants of inflation in Sri Lanka from 1977 to 2019 using the ARDL bounds testing approach. These studies showed the method's effectiveness in capturing both short- and long-run dynamics in inflationary studies.

The Augmented Dickey-Fuller (ADF) and The Phillips-Perron (PP) tests were used in this study. Before conducting these unit root tests, a correlation matrix test was performed as a standard preliminary check. Then, the long-term relationship and dynamic interactions among the variables of interest were estimated using the bound testing or ARDL (Auto-Regressive Distributed Lag) approach introduced by Pesaran et al. (2001). The ARDL co-integration approach is particularly suitable when the variables have a mixed order of integration, such as I (0) and I(1).

The long-run relationship between inflation and its determinants is estimated by using the ARDL approach as follows:

$$Infl\_rate = f\ (inf_{t-1}, lipi, cm, repo, rrepo, lremii, exch, limp, lm2) \ldots\ldots\ldots\ (1)$$

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Where, Infl_rate= Rate of inflation;
inf_{t-1}= lag value of the rate of inflation;
Lipi= log of Industrial Production;
Limp_usd= log of import;
Lrem= log of Inward Remittance;
Exch= Foreign Exchange Rate;
Lm2= log of Broad money supply;
Repo = central banks' policy rate
RRepo = Reverse Repo rate
Cm = Inter-bank Call Money rate
The ARDL equation of this analysis is:

$$Inf_t = \delta_0 + \sum_{t=1}^{n} \delta_{1i} Inf_{t-i} + \sum_{t=0}^{n} \delta_{2i}\, Lipi_{t-i} + \sum_{t=0}^{n} \delta_{3i}\, cm\_u_{t-i} + \sum_{t=0}^{n} \delta_{4i}\, repo\_u_{t-i} + \sum_{t=0}^{n} \delta_{5i}\, rrepo\_u_{t-i} + \sum_{t=0}^{n} \delta_{6i}\, Lremii\_u_{t-i} + \sum_{t=0}^{n} \delta_{7i}\, exch_{t-i} + \sum_{t=0}^{n} \delta_{8i}\, Limp\_u_{t-i} + \sum_{t=0}^{n} \delta_{9i}\, Lm2_{t-i} + \alpha_t,\ t = 1,2, \dots, T \quad \text{.....(2)}$$

Where δ_0 is the constant, α is the error term, and $\delta 1$, $\delta 2$, $\delta 3$, $\delta 4$, $\delta 5$ are the long-term coefficients. The ARDL technique estimates the short-run relationship between inflation and its determinants as follows:

$$\Delta Inf_t = \gamma + \sum_{t=1}^{n} \emptyset_i\, \Delta Inf_{t-i} + \sum_{t=0}^{n} \beta_i\, \Delta Lipi_{t-i} + \sum_{t=0}^{n} \rho_i\, \Delta cm\_u_{t-i} + \sum_{t=0}^{n} \gamma_i\, \Delta repo\_u_{t-i} + \sum_{t=0}^{n} \alpha_i\, \Delta rrepo\_u_{t-i} + \sum_{t=0}^{n} \mu_i \Delta Lremii\_u_{t-i} + \sum_{t=0}^{n} g_i \Delta Limp\_u_{t-i} + \sum_{t=0}^{n} \omega_i \Delta Exch_{t-i} + \sum_{t=0}^{n} \vartheta_i \Delta Lm2_{t-i} + \phi ECT_{t-1} + \alpha_t;\ t = 1,2, \dots, T \quad \text{.....(3)}$$

When the model has reached equilibrium, the short-term dynamic coefficients are represented by the terms $\emptyset, \beta, \rho, \gamma, \alpha, g, \mu, \omega$ and ϑ. The error (or equilibrium) correction term, ECT_{t-1}, is derived from the long-run equilibrium relation. The coefficient corresponding to this term, ϕ, represents the speed of adjustment.

5. Results and Discussion

5.1.Correlation matrix

Table 1 shows that Industrial Production, Repo, Reverse Repo, Call money rate, Import, Exchange Rate, Inward Remittance, and M2 positively correlate with the inflation rate. According to the correlation between the independent and dependent variables, any change in independent variables positively affects the inflation rate. The results of the correlation matrixes are consistent with initial theoretical expectations.

Table 1: Correlation matrix

	INF	LNIPI	REPO	RREPO	CM	EXCH	LNIMP	LNM2	LNREMII
Rate of inflation	1	0.62	0.44	0.45	0.77	0.93	0.35	0.68	0.52
log of Industrial Production	0.62	1	-0.23	-0.03	0.22	0.77	0.82	0.96	0.79
Repo Rate	0.44	-0.23	1	0.90	0.72	0.35	-0.38	-0.20	-0.20
Reverse Repo Rate	0.45	-0.03	0.90	1	0.73	0.48	-0.22	0.03	0.07
Call Money	0.77	0.22	0.72	0.73	1	0.68	-0.06	0.28	0.26
Exchange Rate	0.93	0.77	0.35	0.48	0.68	1	0.47	0.83	0.65
log of import	0.35	0.82	-0.38	-0.22	-0.06	0.47	1	0.75	0.60
log of Broad money supply	0.68	0.96	-0.20	0.03	0.28	0.83	0.75	1	0.80
log of Inward Remittance	0.52	0.80	-0.20	0.07	0.26	0.65	0.60	0.80	1

Source: Author's own calculation

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Since the mean and variance of a random time series are presumed to be time-invariant, we first examined the stationary test of the variables to start the estimation of the analysis (Gujarti, 1995). According to Pesaran and Pesaran (1997), ARDL can be applied if the underlying variables are I(0), I(1), or a combination of both. This means that it can be used irrespective of the order of the stationarity level of the data set.

At first, we used the ADF test to determine whether the variables were stationary. ADF is a simple and convenient approach to determining stationarity. We have also been used to test for stationarity among the variables using the Philips-Perrron (PP) unit root tests (Philips-Perrron, 1988). The results of the unit root test are presented in Table 2.

Table 2: Unit root test

Variables	ADF-test				PP-test			
	At level		At first difference		At level		At first difference	
	t-statistics	p-value	t- statistics	P* - value	Adj.t-statistics	p-value	Adj.t-statistics	P* - value
Rate of inflation	0.18	0.97	-14.11	0.00	-0.18	0.94	-14.18	0.00
log of Industrial Production	-1.33	0.62	-9.19	0.00	-1.61	0.48	-29.08	0.00
Repo Rate	0.30	0.98	-3.15	0.03	0.41	0.98	-9.02	0.00
Reverse Repo Rate	3.06	1.00	-2.97	0.04	1.68	1.00	-9.11	0.00
Call Money	-1.21	0.67	-10.77	0.00				
log of import	-2.29	0.17	-11.26	0.00	-2.93	0.05*	--	--
log of Inward Remittance	-1.98	0.30	-15.53	0.00	-2.54	0.11	-3.08	0.00
Exchange Rate	3.80	1.00	-8.42	0.00	3.59	1.00	-8.63	0.00
log of Broad money supply	-1.36	0.60	-15.63	0.00	-2.38	0.15	-13.46	0.00

The null hypothesis states that there are no unit roots, and * is for statistical significance.
Source: Author's own calculation.

5.2. Lag Selection Criteria

For the lag selection criterion, we selected the automatic selection criterion and used the Akaike Information Criterion (AIC) to choose the length with a maximum lag of 3. According to the Akaike Information Criterion (AIC), the optimal combination is ARDL (2,1,2,2,1,0,3,0,3). The model selection according to the AIC is shown in Appendix 1.

5.2.1. **ARDL Bounds Tests**

According to the Bounds Test result, the F-statistic value (F = 4.52) exceeds the upper limits of the critical values at the 10%, 5%, and 1% significance levels, as shown in Table 5. Therefore, we reject the null hypothesis of no long-term relationship and conclude that a long-term relationship exists among the variables in the model during the pre-COVID period.

For the post-COVID period, the Bounds Test result shows that the F-statistic (F = 4.52) is significantly higher than the critical upper bound values at the 10%, 5%, and 1% significance levels. This indicates a strong cointegrating relationship among the variables, showing that long-term interactions with its key determinants influence inflation trends in the post-COVID era.

Then, over the Period, the Fisher test value (F = 5.89) exceeds the upper limits of the critical values, which are presented in Table 3 below. Therefore, we can reject the null hypothesis that there is no long-term relationship and conclude that there is a long-term relationship between the variables in the model.

Table 3: Bounds Test					
Pre-covid		**Post covid**		**Over the Period**	
Null hypothesis: No levels relationship		Null hypothesis: No levels relationship		Null hypothesis: No levels relationship	
Number of cointegrating variables: 8		Number of cointegrating variables: 8		Number of cointegrating variables: 8	
Trend type: Rest. constant (Case 2)		Trend type: Rest. constant (Case 2)		Trend type: Rest. constant (Case 2)	
Sample size: 59		Sample size: 43		Sample size: 114	
Test Statistic	Value	Test Statistic	Value	Test Statistic	Value
F-statistic	4.52	F-statistic	7.31	F-statistic	5.89

	Bound Critical Value					
Pre-COVID		10%		5%		1%	
	Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	Asymptotic	1.85	2.85	2.11	3.15	2.62	3.77
	*** Critical values for finite samples are valid up to 7 error-correction variables.						

	Bound Critical Value					
Post COVID		10%		5%		1%	
	Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	Asymptotic	1.85	2.85	2.11	3.15	2.62	3.77
	*** Critical values for finite samples are valid up to 7 error-correction variables.						

	Bound Critical Value					
Over the Period		10%		5%		1%	
	Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	Asymptotic	1.85	2.85	2.11	3.15	2.62	3.77
	*** Critical values for finite samples are valid up to 7 error-correction variables.						

5.2.2. Estimation of Long-Run Relationship

Confirming the existence of the long-run relationship in the model allows us to estimate the long-run form of the equation. Using the ARDL approach, the estimated long-run relationship is described in Table 4. From Table 4 in Model-1, the inflation rate's lag value or past value positively and significantly impacts the current inflation. On the other hand, industrial production has a negative and statistically significant impact on the rate of inflation; i.e., if industrial production increases by 1 percent, then the rate of inflation will decrease by 2.07 percent in the long run while its lag value indicates the statistically significant result with a positive relationship. The most noticeable aspect of this estimation process is that the central bank policy rates, or monetary policy, do not show statistically significant results; however, the sign of the coefficient aligns with theoretical expectations. Besides, the coefficients of import and broad money supply (m2) positively impact inflation. From this estimation, it is clear that any change in the exchange rate previously may influence the current inflation rate in the long run, while the past values of exchange rates showed statistically significant results. Furthermore, the coefficient of inward remittances also positively impacts inflation, though these variables showed statistically insignificant results. Moreover, the statistical results for R2 and Adjusted R2 show that the model has a high goodness of fit, indicating that almost 98% of the variation in the dependent variable can be explained by the independent variables.

On the other hand, in model 2, the long-run estimation results highlight several key drivers of inflation in the pre-COVID period. Lagged inflation (-1)) exhibits a significant positive coefficient of 0.40 ($p = 0.00$), indicating inflation persistence over time. Industrial production (LNIPI) exerts a significant negative influence (-1.087, $p = 0.01$), suggesting that increased production reduces inflationary pressures. The repo rate (REPO) has a significant positive impact (0.49, $p = 0.00$), implying that higher policy rates may be

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associated with inflation in the long run. Similarly, the lagged reverse repo rate (RREPO(-1)) positively influences inflation (0.77, p = 0.02). Other variables, such as remittances (LNREMII), also show a significant positive effect (0.76, p = 0.00). At the same time, the exchange rate (EXCH) has a marginally significant positive coefficient (0.06, p = 0.09), indicating that the exchange rate depreciation contributed to inflation by increasing the cost of imports. Overall, the results emphasize the interplay of demand-side and supply-side factors in influencing inflation. While inflation persistence, remittance inflows, and exchange rate depreciation drive demand-side inflationary pressures, higher industrial production is a mitigating supply-side factor.

Table 4: Long-run coefficients from the estimated ARDL models

Variables	Model-1 (Over the period)		Model-2 (Pre-COVID)		Model-3 (Post-COVID)	
	Long-run coefficients from the estimated ARDL model		Long-run coefficients from the estimated ARDL model		Long-run coefficients from the estimated ARDL model	
	Selected model: ARDL(2,1,2,2,1,0,3,0,3)		Selected model: ARDL(2,1,2,2,1,0,3,0,3)		Selected model: ARDL(2,1,2,2,1,0,3,0,3)	
	Coefficient	Prob.*	Coefficient	Prob.*	Coefficient	Prob.*
Rate of inflation(-1)	0.39	4.70 (0.00)	0.40	0.40 (0.00)	0.10	0.10 (0.45)
Rate of inflation(-2)	0.21	2.66 (0.01)	--	--	0.19	0.19 (0.23)
log of Industrial Production	-2.072	-4.16 (0.00)	-1.08	-1.09 (0.01)	-3.39	-3.39 (0.02)
log of Industrial Production(-1)	0.79	2.12 (0.04)	--	--	-2.62	-2.62 (0.07)
Call Money	-0.02	-0.32 (0.75)	-0.01	-0.01 (0.78)	0.20	0.20 (0.23)
Call Money(-1)	0.12	1.68 (0.10)	--	--	0.51	0.51 (0.00)
Call Money (-2)	0.09	1.53 (0.13)	--	--	--	--
Repo Rate	-0.09	-0.38 (0.71)	0.49	0.49 (0.00)	-3.47	-3.47 (0.00)
Repo Rate(-1)	0.71	2.39 (0.02)	--	--	1.84	1.84 (0.03)
Repo Rate (-2)	-0.26	-1.40 (0.16)	--	--	--	--
Reverse Repo Rate	0.02	0.06 (0.95)	-0.49	-0.49 (0.12)	1.36	1.36 (0.09)
Reverse Repo Rate (-1)	-0.57	-2.00 (0.05)	0.77	0.77 (0.02)	-1.31	-1.31 (0.04)
log of Inward Remittance	0.00	0.93 (0.35)	0.76	0.76 (0.00)	1.24	1.24 (0.07)
Exchange Rate	0.05	1.57 (0.12)	0.056	0.06 (0.09)	0.10	0.10 (0.08)
Exchange Rate (-1)	-0.10	-2.18 (0.03)	--	--	0.10	0.10 (0.13)
Exchange Rate (-2)	0.32	6.87 (0.00)	--	--	--	--
Exchange Rate (-3)	-0.25	-7.21 (0.00)	--	--	--	--
log of import	1.02	3.85 (0.00)	0.05	0.05 (0.79)	1.18	1.18 (0.11)
log of import (-1)	--	--	--	--	1.27	1.27 (0.07)
log of Broad money supply	9.70	2.88 (0.00)	0.93	0.93 (0.10)	-31.41	-31.41 (0.00)
log of Broad money supply(-1)	-7.72	-1.96	--	--	29.72	29.72

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		(0.05)				(0.00)
log of Broad money supply (-2)	4.84	1.36 (0.18)	--	--	--	--
log of Broad money supply (-3)	-5.53	-1.94 (0.05)	--	--	--	--
C	-23.06	-2.38 (0.02)	-21.38	-21.38 (0.01)	21.72	21.72 (0.78)
	R-squared	0.98	R-squared	0.86	R-squared	0.98
	Adjusted R-squared	0.98	Adjusted R-squared	0.84	Adjusted R-squared	0.97
	*Note: P-values and any subsequent test results do not account for model selection.		*Note: P-values and any subsequent test results do not account for model selection.		*Note: P-values and any subsequent test results do not account for model selection.	
Source: Author's own calculation						

The R-squared value of 0.86 indicates that the model explains approximately 86.43% of the variation in inflation during this period.

In Model-3, the long-run estimation results for the post-COVID period reveal different inflationary dynamics compared to the pre-COVID era. Industrial production (LNIPI) shows a significant negative impact both contemporaneously (-3.39, p = 0.02) and with a lag (-2.62, p = 0.07), indicating its stabilizing effect on inflation by improving the supply of goods. However, lagged commodity prices CM (-1)) have a significant positive relationship with inflation (0.51, p = 0.00). On the demand side, monetary policy effects are mixed: the repo rate (REPO) reduces inflation in the current period (-3.47, p = 0.00) but increases it with a lag (1.84, p = 0.03). The reverse repo rate (RREPO) has contrasting effects, with a positive coefficient for the current period (1.36, p = 0.09) and a significant negative lagged effect (-1.31, p = 0.04). Additionally, money supply (LNM2) significantly reduces inflation in the current period (-31.41, p = 0.00) but increases it with a lag (29.72, p = 0.00). The exchange rate (EXCH) has a marginally significant positive influence (0.10, p = 0.08). The adjusted R-squared value of 0.97 demonstrates a high level of explanatory power, with the model accounting for 96.89% of the variability in inflation during the post-COVID period.

5.3.Cointegrating Specification

The estimation process involves a cointegrating specification with a restricted constant (Case 2) to explore the long-term relationship between the inflation rate (INF) and its determinants. The estimated cointegrating equation is given as:

Table 5: Cointegrating Specification
Deterministic: Rest. constant (Case 2)
CE = INF(-1) - (-3.24*LNIPI(-1) + 0.90*REPO(-1) - 1.36
*RREPO(-1) + 0.46*CM(-1) + 0.04*EXCH(-1) + 2.50
*LNIMP + 3.32*LNM2(-1) + 0.51*LNREMII - 61.88)

Table 6: Cointegrating Specification

Variable *	Coefficient	Std. Error	t-Statistic	Prob.
log of Industrial Production(-1)	-3.24	1.10	-2.93	0.00
Repo Rate(-1)	0.90	0.35	2.54	0.01
Reverse Repo Rate(-1)	-1.36	0.28	-4.91	0.00
Call Money(-1)	0.48	0.09	5.04	0.00
Exchange Rate(-1)	0.04	0.05	0.88	0.38
log of import	2.50	0.70	3.59	0.00
log of Broad money supply(-1)	3.32	1.82	1.82	0.07
log of Inward Remittance	0.51	0.57	0.91	0.37
C	-61.88	26.09	-2.37	0.02
Note: * Coefficients derived from the CEC regression.				

The coefficients largely align with theoretical expectations, indicating that the model captures meaningful relationships between inflation and its determinants. Policy variables (REPO, RREPO) have the expected

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signs but vary in statistical significance, pointing to the mixed effectiveness of monetary tools in controlling inflation. Supply-side variables like industrial production and imports significantly influence inflation, highlighting the importance of addressing structural factors.

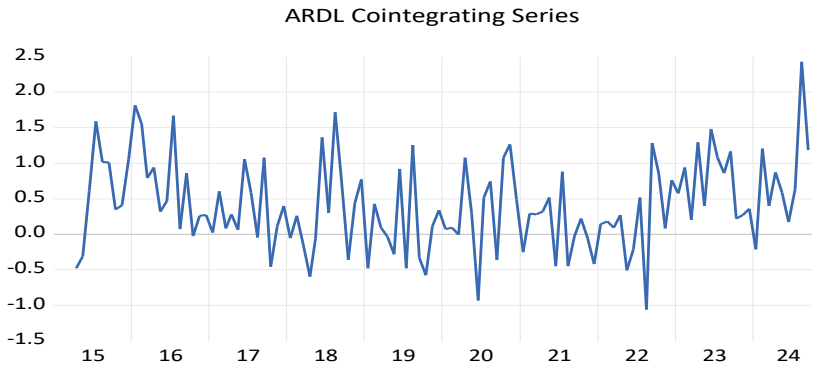

Fig. 3: ARDL Cointegrating Series

5.4. Error Correction Estimation

The short-run dynamics coefficients from the estimated ARDL model are shown in Table 7, where the lag is selected by Akaike Information Criteria (AIC). The Error Correction Model (ECM) coefficient is expected to be negatively significant, and ECM indicates the speed of adjustment to long-run equilibrium after a short-run shock.

Table 7: ECM Regression: Selected Model
ARDL (2,1,2,1,2,3,0,3,0)
Deterministic: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ*	-0.40	0.05	-8.04	0.00
D(INF(-1))	-0.21	0.07	-3.15	0.00
D(LNIPI)	-2.09	0.34	-6.12	0.00
D(REPO)	-0.09	0.22	-0.41	0.68
D(REPO(-1))	0.26	0.16	1.61	0.11
D(RREPO)	0.01	0.23	0.03	0.98
D(CM)	-0.02	0.05	-0.38	0.70
D(CM(-1))	-0.09	0.05	-1.74	0.09
D(EXCH)	0.05	0.03	1.82	0.07
D(EXCH(-1))	-0.06	0.03	-2.22	0.03
D(EXCH(-2))	0.25	0.03	9.39	0.00
D(LNM2)	9.62	2.58	3.72	0.00
D(LNM2(-1))	0.70	2.24	0.31	0.75
D(LNM2(-2))	5.49	2.27	2.42	0.02
R-squared	0.66	Mean dependent var		0.03
Adjusted R-squared	0.62	S.D. dependent var		0.39
S.E. of regression	0.24	Akaike info criterion		0.14
Sum squared resid	5.98	Schwarz criterion		0.47
Log-likelihood	6.29	Hannan-Quinn criteria.		0.27
F-statistic	14.96	Durbin-Watson stat		1.91
Prob(F-statistic)	0.00			

* p-values are incompatible with the t-bounds distribution.

In other words, it measures the convergence rate toward equilibrium if there is any short-run disequilibrium. Table 7 indicates that the error correction coefficient is estimated to be -0.40, which is statistically

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significant at the 1% significance level. To restore equilibrium, the coefficient suggests that the current period's deviation from the long-run equilibrium level needs to be corrected by 40.00 percent in the subsequent period.

5.5. Stability Test

The cumulative sum (CUSUM) was suggested by Pesaran and Pesaran (1997) to ensure the stability of the ARDL model developed in this study. The CUSUM is updated recursively and plotted against the breakpoints in Figure (4). When the levels of CUSUM stay within the key 5% range, parametric consistency and model dependability are attained (shown by the red dashed line). The plot of the tests shows that there is no root lying outside at the 5 % level of significance. Therefore, our model passes the stability test.

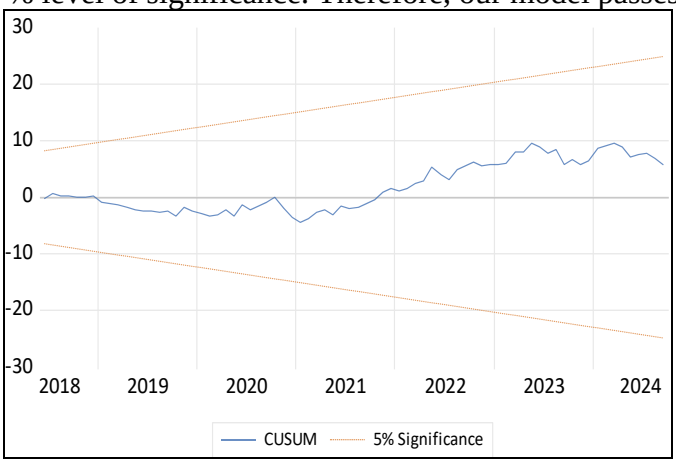

Fig. 4: CUSUM Test

6. Conclusion and Policy Implications

This study analyzed the post-COVID-19 inflation dynamics in Bangladesh using an Autoregressive Distributed Lag (ARDL) model, considering three distinct scenarios: pre-COVID, post-COVID, and the overall period. Our findings reveal that inflationary pressures have evolved significantly post-pandemic, influenced by key macroeconomic variables such as exchange rate fluctuations, broad money supply, inward remittances, and industrial production. The results indicate that inflation is driven by both supply-side factors, such as import costs and production constraints, and demand-side factors, such as monetary expansion and remittance-induced consumption. Using the ARDL approach for three models, we examined the long-run relationship between inflation and several factors highlighted in the literature. After controlling for relevant variables, we found empirical evidence of a co-integration relationship, emphasizing the impact of industrial production, imports, the exchange rate, and money supply on inflation. Muktadir-Al-Mukit (2018) studied the causative factors of inflation in Bangladesh using different econometric methods to examine both the long-term and short-term relationships between variables. However, one of our key findings is that a 1 percent increase in industrial production leads to a 2.07 percent decrease in the inflation rate in the long run.

While inflation remains a critical concern for the country's overall macroeconomic stability, targeted interventions by BB and the government have attempted to alleviate the situation. Firstly, a depreciation of BDT passes through to inflation by increased import payments, which can be referred to as imported inflation. Thus, maintaining a more stable exchange rate is crucial. This may involve targeted interventions in the foreign exchange market and promoting export growth to mitigate import-related inflation. According to the study of Ulke and Ergün (2011), there is a long-term and short-term co-integration relationship between inflation and import volume in Turkey, with a one-way Granger causality from import to inflation. Secondly, policies should be designed to channel inward remittances into productive investment sectors rather than consumption-driven inflationary pressure. This is because, before and after the Covid period,

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remittances created upward risks for inflation, raising the demand for the recipient household. The relationship between remittance inflows and inflation is significant in the long run, but no relationship is found between them in the short run. (Khan & Islam, 2013). Finally, implementing a formal inflation-targeting framework could strengthen the credibility of monetary policy and improve the central bank's capacity to effectively manage inflation expectations, balancing classical, neoclassical, and Keynesian approaches. A balanced approach to monetary tightening is necessary if monetary policy is loose to control inflation without stifling economic recovery. Adjustments to the repo and reverse repo rates should be made in response to changing inflationary pressures.

Bangladesh has been facing inflationary pressures, primarily driven by both supply-side and demand-side factors. However, our key findings show that inflation in our model is mainly driven by supply-side factors, such as industrial production and imported goods, which lead to cost-push inflation and impact the supply side.

7. Limitations and Direction for Future Research

In this analysis, we did not include fiscal variables such as the fiscal deficit, government borrowing, or public expenditures because these variables are only available in Bangladesh's annual data, and no monthly data is available. Future research can explore the role of fiscal policy in shaping inflation dynamics by incorporating variables such as fiscal deficit, government borrowing, and public expenditure using high-frequency proxies or alternative modeling approaches.

Author Contributions: Dr. Imam Abu Sayed and Dr. Ripon Roy developed the idea and planned for the analysis. Dr. Ripon Roy supervised the methodology and estimation results. Rifat Ara Bindu wrote the methodology and policy recommendation, reviewed the literature, conducted the regression analysis, and contributed to interpreting the results. She also helped compile the references. Ms. Romana Ferdoush reviewed the literature, planned the format of the paper, and penned the overview section of the paper. She also proofread the entire document. Each author's critical input shaped the final version of the paper. Dr. Imam Abu Sayed led the whole team.

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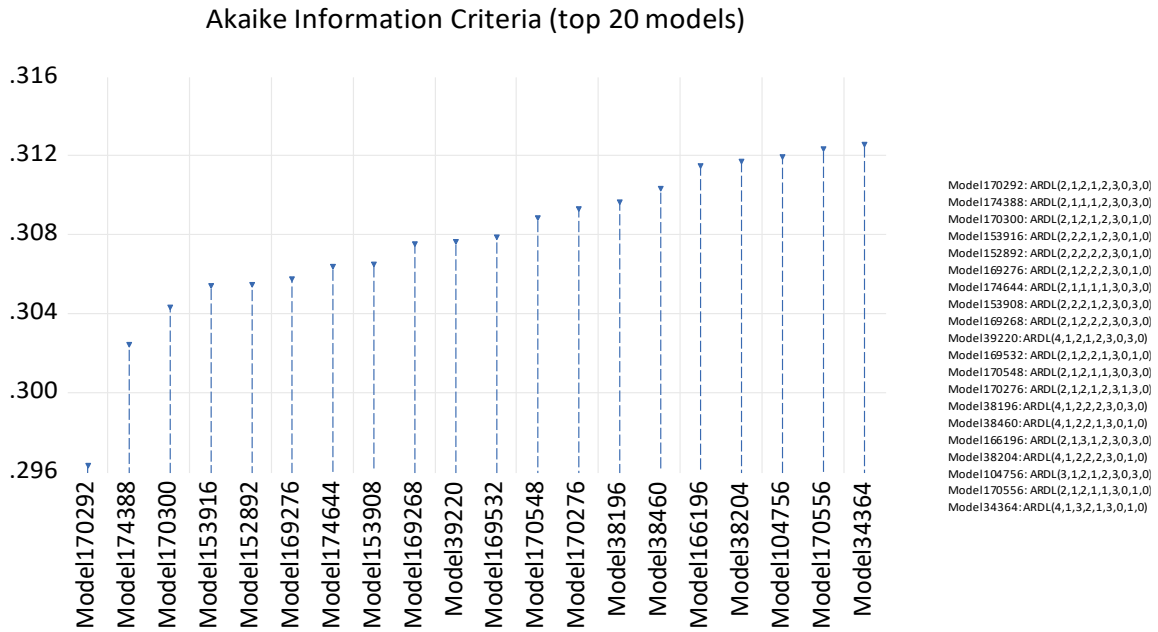
Appendix-1

Model Selection Summary



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