How Do External Sector Dynamics Induce Domestic Inflation? An Econometric Analysis for Bangladesh

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Research Article

Abstract

Purpose: *The Bangladeshi economy has recently experienced elevated inflationary pressures, which have significant implications for economic stability and growth. The purpose of this study is to identify the dynamics of the spillover effects of the external sector on domestic inflation in Bangladesh.*

Methods: *The Autoregressive Distributed Lag (ARDL) approach is deployed for the estimation process, utilizing monthly secondary data from January 2015 to October 2024, available from various sources such as the Bangladesh Bureau of Statistics (BBS), Bangladesh Bank (BB), Food and Agriculture Organization (FAO), and the World Bank (WB). In this analysis, the Consumer Price Index (CPI) is treated as the dependent variable. In contrast, the key explanatory variables include* the world oil price, the world food price, exports, imports, and inward remittances. *Additionally, industrial production and broad money (M2) are included as control variables, and 'crisis' as a dummy variable.*

Results: *The empirical findings confirm that external factors, particularly global oil prices, food prices, and trade dynamics, have a significant influence on Bangladesh's inflation. A 1 percent rise in past CPI leads to a 0.7 percent rise in the current CPI, revealing strong inflationary inertia. Additionally, global oil price fluctuations have a statistically significant effect on inflation, while the impact of world food prices is delayed, suggesting a lagged transmission into domestic inflation. Trade variables also play a crucial role—exports contribute to inflationary pressures over time mainly due to inequitable growth, whereas imports exert a deflationary effect by reducing supply-side constraints. Additionally, higher domestic industrial production helps mitigate inflation, supporting the supply-side argument, whereas the broad money supply (M2) influences inflation with a lag, reflecting the delayed transmission of monetary policy. Interestingly, remittances have an insignificant direct effect on CPI, implying that while they boost household purchasing power, their inflationary impact is minimal. Furthermore, economic crises, including the COVID-19 pandemic, do not exert a statistically significant independent effect on inflation, reinforcing the dominance of structural economic conditions over short-term shocks.*

Implications: *Basically, the excessive dynamic forces of inflation need to be discounted to zero (thrust level), considering the static force. According to this empirical analysis, external economic factors have a significant impact on creating inflationary pressures in Bangladesh.*

Originality: *This paper provides a unique investigation into the impact of external sector dynamics, including world oil and food prices, exports, imports, and remittances, on domestic inflation in Bangladesh, utilizing the ARDL approach with monthly data from 2015 to 2024. Unlike prior studies, it incorporates both immediate and lagged effects of external variables and accounts for inflationary inertia in a comprehensive empirical framework.*

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Limitations: *Although the study provides valuable insights into the external drivers of inflation, it is limited by the exclusion of key fiscal variables, such as the fiscal deficit, due to the unavailability of monthly data. Additionally, the model does not account for nonlinear or asymmetric effects, and structural breaks, such as significant policy shifts, are not explicitly considered in the analysis.*

Keywords: **Inflation, ARDL, External Side Dynamics, Trade, Bangladesh**

1. Introduction

Inflation refers to a sustained rise in the general price level of goods and services within an economy, resulting in a higher cost of living (Friedman & Schwartz, 1963). It weakens investor confidence, discourages savings, damages both the public and financial sector balance sheets, and reduces consumer purchasing power (AitHmadouch, 2024). In Bangladesh, inflationary pressures have increased notably in recent years, driven by a combination of domestic and external factors. Domestic factors can be influenced to some degree by a country's policymakers, whereas external factors driving inflation are outside the domestic policymakers' control (Habanabakize & Dickason-Koekemoer, 2024). While domestic factors, such as monetary expansion, fiscal variables, and supply chain disruptions, contribute to price fluctuations, external factors also have a significant impact on the domestic price level, particularly in economies that heavily depend on imports and external trade. As an emerging economy, Bangladesh remains highly vulnerable to external inflationary shocks, mainly due to its dependence on global commodity markets, energy imports, and remittance inflows. According to the IMF, Bangladesh's inflation reached a decade-high of 9.9 percent in August 2023, driven by external shocks and currency depreciation.

As Bangladesh has become increasingly integrated into the global economy through trade, remittances, and capital flows, external shocks can have a significant impact on domestic price levels. The recent global surge in oil and food prices has increased cost-push inflation in Bangladesh, affecting both consumers and businesses. Crude oil prices were significant determinants of inflation, which had an immediate impact on inflation (Mohanty & John, 2015). According to the Bangladesh Bureau of Statistics, in the fiscal year 2022-23, Bangladesh imported 6,867.27 thousand metric tons of petroleum, worth Tk 62,132.61 crore. Of this total expenditure, 17.65 percent was spent on crude oil imports, while 78.74 percent was allocated to importing refined oil. Since Bangladesh imports a substantial portion of its energy and essential commodities, rising global prices directly affect higher domestic inflation, reducing the purchasing power of households and increasing production costs for industries. Similarly, when the local currency depreciates, the cost of imports rises, which can drive inflation higher. Additionally, remittance inflows are a key source of foreign exchange for Bangladesh. Despite global uncertainties and falling foreign exchange reserves, remittances have played a significant role in stabilizing the country's balance of payments. However, remittances can also increase demand-pull inflation by increasing household purchasing power. Roy and Rahman (2014) showed that remittance inflows in Bangladesh contribute to inflationary pressures, particularly affecting food inflation. As global trade and financial markets become more interconnected, external factors have a more significant impact on inflation. However, despite their growing importance, very few studies have deeply analyzed how these factors affect inflation in Bangladesh using econometric methods.

Several studies have investigated the factors driving inflation in Bangladesh, with a focus on the money supply, fiscal policy, and supply-side constraints. However, there is limited research on how external sector dynamics influence inflation. Existing studies suggest that exchange rate fluctuations, global price shocks, and fluctuations in the trade balance can have a significant impact. However, the magnitude and direction of these relationships require further empirical validation in the context of Bangladesh, considering both headwinds and tailwinds related to inflation. The excessive dynamic forces of inflation need to be discounted to zero (thrust level), considering the static force.

Muktadir-Al-Mukit (2018) studied the causative factors of inflation in Bangladesh using various 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

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percent decrease in the inflation rate in the long run. 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 effects of external factors on inflation.

Inflation hinders economic growth by increasing business costs, discouraging savings and investment, and reducing the purchasing power of low- and fixed-income groups (Nisar & Tufail, 2013). Understanding the impact of external factors, such as remittances, exchange rate fluctuations, and global commodity prices, can help businesses, financial institutions, and investors make more informed decisions regarding pricing strategies, cost management, and financial planning. The findings of this study will be beneficial to industries that rely on imports and external financial flows.

According to the IMF, Bangladesh's economy has faced multiple challenges, including disruptions from the COVID-19 recovery and global uncertainties stemming from Russia's war in Ukraine. Rising global commodity prices, supply chain disruptions, and global uncertainties have raised concerns about macroeconomic stability. However, because Bangladesh relies heavily on remittance inflows and imports for essential commodities, policymakers must adopt strategies that mitigate external challenges while maintaining price stability. Achieving a low inflation rate, along with sustainable economic growth, is regarded as one of the primary objectives of macroeconomic policy formulation in developing countries (Asghar et al., 2013). The study can support the formulation of effective monetary, trade, and exchange rate policies, improving inflation forecasting models and contributing to sustainable economic growth and macroeconomic stability.

Considering inflation, the real asset and currency holdings have different impacts. Because a real asset, such as a house, has intrinsic value. On the other hand, generally, currency does not have intrinsic value. However, it has many favorable characteristics. Essentially, as a fiat currency, it is not backed by gold or silver, but rather by a legal guarantee from the government, along with the central bank's prudent management. As a fourth dimension, taking into account like gold substance, currency is influenced by time. Accordingly, it fluctuates due to changes in time. Consequently, only if the substance speed matches the speed of light will there be no change in the time on Earth. However, the power of light is very significant as the universe is created from the explosion of a single dot. Transforming substances into a cold, solid ice form, with specific negative temperatures, makes things invisible, producing unthinkable massive substances as a single dot. Noted that, through fiber optic cable, the electrical signal is converted into light at two-thirds the speed of light for data transmission among the continents. It is also worth noting that the introduction of central bank digital currency (CBDC) may increase cybersecurity threats due to the increased integration of data. Accordingly, the balance between tangible assets and currency is optimum, considering the incidence of fiscal and monetary policy related to inflation in brief.

This study aims to fill that gap by examining how external factors influence inflation and evaluating their relative importance in the country’s inflationary process.

The primary objective is to assess the impact of external sector variables on inflation in Bangladesh. Specifically, it examines how remittances, exchange rates, global oil and food prices, and trade variables such as imports, exports, and the current account balance affect inflationary trends. To account for domestic factors, the study also includes broad money (M2) and industrial production as control variables.

After the introduction, the remaining part of this paper is arranged as follows: Section 2 reviews the existing literature on the relationship between external sector dynamics and inflation. Section 3 outlines the data and econometric methodology used in the study. Section 4 presents empirical results and discussions using the ARDL (Auto-Regressive Distributed Lag) procedure. Finally, Section 5 presents concluding remarks, including policy implications and recommendations for future research.

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2. Literature Review

Although some research has explored how global oil price shocks affect domestic inflation rates, there are very few studies on external sector variables such as global food prices, trade dynamics (exports and imports), and remittances, and their impact on inflation in the context of Bangladesh. Therefore, this study aims to examine these external side variables and their influence on inflation in Bangladesh. The existing literature included in this study helps explain how shocks or increases in domestic and global prices, as well as changes in exports and imports, impact inflation in Bangladesh and other economies.

The paper by Pierce et al. (1974) examines the effects of external inflationary shocks, particularly rising oil prices, on the economy. Using a modified MPS econometric model, the study simulates the impact of these shocks on inflation, real income, and monetary policy. The results show that external price increases lead to inflation, lower real wages, and reduced output. The study finds that accommodating monetary policies can mitigate short-term unemployment but may worsen long-term inflation. The study emphasizes the importance of a balanced policy approach to mitigate the effects of external inflationary disturbances.

Kim& Hammoudeh (2013). used a Structural Vector Autoregression (SVAR) model to examine how global and domestic factors, such as oil prices, exchange rates, and producer/export prices, affect inflation and economic growth in GCC countries and Jordan. The results indicate that oil price fluctuations have a substantial impact on inflation, particularly in Jordan, a country that imports oil. A weaker U.S. dollar raises inflation in both regions, while rising prices in China also contribute to inflation. The study concludes that if the GCC aims only for stabilization, Jordan's inflation trends align with the GCC. However, due to differences in business cycles, integrating Jordan into the GCC would require structural adjustments.

Bindu and Hossain (2022) employed the Vector Error Correction Model (VECM) approach to examine the impact of the recent oil price hike on Bangladesh's inflation rate. They found a significant long-run relationship between domestic oil prices, broad money supply, and inflation in Bangladesh, while global oil prices have no significant impact. In the short term, a rise in oil prices causes inflation to spike, but it gradually stabilizes over time. These findings can support policymakers in managing inflation more effectively.

Habanabakize & Dickason-Koekemoer used quarterly data from 2002 to 2022 to investigate the extrinsic and intrinsic causes of inflation in South Africa. By using econometric methods such as the vector error correction model (VECM), impulse response function (IRF), variance decomposition, and the Johansen cointegration test, , the findings reveal that external factors such as trade openness, exchange rates, and import prices play a more significant role in driving inflation than internal factors like government expenditure and domestic investment.

Nagy and Tengely (2018) examined the impact of external and domestic factors on inflation in Hungary, a highly open economy. By employing statistical approaches like Structural Vector Autoregression (SVAR), Principal Component Analysis (PCA), and an augmented Phillips curve model, they demonstrate that global influences now drive 70–80% of Hungary's inflation variability. At the same time, the domestic economic sector has a diminishing impact.

In understanding the relationship between inflation and inflation expectations, Feldkircher and Siklos (2018) provide valuable insights into how different inflationary pressures shape short-term expectations. Using a global vector autoregressive (GVAR) model with Bayesian techniques, their study examines the impact of domestic demand and supply shocks, as well as global oil price inflation. The study found that domestic demand and supply shocks influence expectations in the short run, but global oil price shocks have a more lasting impact. Živkov et al. (2019) showed that while oil price increases have a relatively small effect on inflation in Central and Eastern European countries, their long-term indirect impact is significant.

Hmadouch (2025) examined the key domestic and external factors driving inflation in oil-importing developing countries. They found that external factors, particularly global oil prices and exchange rates, have a moderate impact on domestic inflation. At the same time, trade openness significantly increases

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inflation, and imports help reduce it. However, global food prices do not significantly affect inflation due to subsidies and price controls. Romer (1993) emphasized that more open economies tend to have lower inflation, based on data from both developed and developing countries. The results indicate that trade openness is associated with higher inflation.

The study by Khalid A. Al-Bassam examined both internal and foreign factors that contributed to Saudi Arabia's inflation from 1970 to 1995. The results showed that both domestic factors, such as money supply growth and real income, and external influences, including exchange rate fluctuations, imported inflation, and U.S. Dollar short-term interest rates, significantly contribute to inflation. The empirical results showed that all explanatory variables, except the U.S. Dollar short-term market interest rate, significantly contribute to inflation.

Adeleye et al. (2019) found that external factors, including exchange rates, imported inflation, and trade openness, have a positive and significant impact on inflation. Internal factors, including government expenditure, net food exports, and lending interest rates, tend to dampen inflation. The study confirmed the structuralist view that the main drivers of inflation in Nigeria are imported inflation, which plays a dominant role in both the short and long run.

Asghar and Asjed (2013) demonstrated that the growth in money supply, lagged inflation, foreign inflation, and the global financial crisis of 2008 have a significant impact on inflation in Pakistan in the long run. The nominal effective exchange rate has a negative impact on inflation, but this effect is statistically insignificant. In the short run, all variables except the money supply influence inflation.

Shokoohi and Saghaian (2022) demonstrated how oil prices affect food nutrition prices in four oil-importing countries (the U.S., Korea, China, and Japan) and four oil-exporting countries (Canada, Saudi Arabia, the UAE, and Iran) from 1974 to 2018. The study finds that in oil-importing countries, food prices first decline before stabilizing, while in oil-exporting countries, they steadily increase.

Bawa et al. (2020) employed a Nonlinear Autoregressive Distributed Lag (NARDL) model to demonstrate how oil price shocks asymmetrically impact Nigerian inflation. The study found that oil price increases lead to higher headline, core, and food inflation. Core inflation is more responsive to oil price shocks than food inflation, likely because many food items are produced domestically. The study recommended focusing on core inflation management during oil price hikes, strengthening foreign exchange reserves, and increasing domestic food production to mitigate inflationary risks.

Ramady (2009) examined the internal and external factors that influence inflation in Saudi Arabia, emphasizing the roles of money supply, interest rates, and exchange rate depreciation. The study found that the fixed exchange rate policy has caused imported inflation, which makes it challenging for decision-makers to manage inflation by employing traditional monetary measures. The analysis also found that Oil prices have no direct influence on inflation, but money supply and interest rates significantly affect inflation. The findings underscore the need for more flexible monetary policies to manage inflation in economies with effective revised exchange rate policies.

Nachega et al. (2024) analyzed the factors influencing inflation in The Gambia from 2014 to 2023, focusing on both domestic and external drivers. It found that inflation is primarily driven by global commodity prices (such as food, oil, and fertilizer), exchange rate depreciation, and the domestic output gap. Using OLS regressions, NARDL models, and local projection methods, the study revealed that while monetary policy can help control inflation, it must be adjusted rapidly and decisively. The research also highlights an asymmetric exchange rate pass-through (ERPT), where currency depreciation significantly raises inflation, but appreciation does not significantly reduce inflation.

Mweni et al. (2016) employed Ordinary Least Squares (OLS) regression to estimate the relationship between external debt and inflation, using data from 1972 to 2012. The study found a significant positive relationship between external debt and inflation, despite the two variables being negatively correlated.

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Additionally, the study suggests that rising inflation leads to higher accumulations of foreign debt. The study concluded that inflation raises borrowing prices and debt levels by weakening monetary stability.

Sharma et al (2019) examined the impact of external and internal factors on inflation in India from 1978 to 2015 using the ARDL model. Their study found that oil prices and employment growth drive inflation in the long run, while deficit financing has a deflationary effect. In the Short run, FDI has a negative and significant effect on inflation, whereas deficit finance creates inflationary pressures. These findings underscore the importance of managing both internal and external shocks to maintain stable inflation.

Using regression analysis with the autoregressive distributed lag (ARDL) technique, Dahiru and Sulong (2017) revealed that exchange rate, broad money supply, and oil prices positively correlated with inflation. Conversely, financial instability, interest rate, GDP, and the nominal effective exchange rate's error correction term demonstrate a negative relationship with inflation. The study suggested that Nigeria should prioritize exchange rate stability and emphasized the need for economic diversification to reduce import dependence and mitigate inflationary pressures.

Using the ARDL model, Khatun and Ahamad (2012) found that prices and the money supply have a positive impact on inflation, though the effect is relatively small. The study recommends controlling petroleum prices and managing the money supply to prevent inflation caused by excessive money in the economy. Taslim M. A. (2014) opined that decreasing oil prices generally contribute to reducing living costs by lowering transportation expenses and inflation.

Ruzima et al. examined the impact of government expenditure, foreign direct investment, population growth, agricultural output, and imports of goods and services on inflation between 1970 and 2013. Using the ordinary least squares (OLS) method, they found that Rwanda's inflation is primarily driven by imports of goods and services, as well as agricultural production.

Galesi and Lombard analyzed how oil and food price shocks impact inflation and the real economy using a GVAR model. Oil price shocks primarily affect developed economies, whereas food prices have a significant impact on emerging markets. The study also found no significant relationship between oil shocks and core inflation for the USA and the EU. Kalim (2015) examined the impact of rising global food prices on inflation in South Asian countries from 1990 to 2011, using panel data analysis. The findings indicate that global food price inflation and oil prices have a significant impact on overall inflation in the region.

Hemmati et al. (2018) examined the impact of external factors on inflation in Iran, specifically focusing on the money supply, exchange rate, import prices, and economic sanctions. Using data from 1999 to 2014 and applying an OLS single-equation model and a vector error correction model (VECM), the study found that external factors play a significant role in the long-run inflation dynamics in Iran, while domestic factors primarily influence short-run inflation.

Danladi (2020) examined how changes in global commodity prices (specifically, between cocoa, oil, and rice prices) affect inflation dynamics in Sierra Leone, using monthly data from 2007 to 2016. The results showed that while rising cocoa prices reduce inflation in the short term, they contribute to long-term inflationary pressures. Additionally, because Sierra Leone is heavily dependent on imports, increases in the price of rice and oil always result in increased consumer prices. The report emphasizes the significance of diversifying energy sources and increasing domestic production of essential goods to reduce inflationary pressures.

Bala and Chin (2018) examined the asymmetric effects of oil price changes on inflation in Algeria, Angola, Libya, and Nigeria using three types of oil price data. The analysis, employing ARDL dynamic panels, revealed that both increases and decreases in oil prices lead to higher inflation, with a more significant impact when oil prices decline. It also found that money supply, exchange rate, and GDP are positively linked to inflation, while food production has a negative relationship with inflation. The study suggested that policymakers should consider the differing effects of oil price changes, employ contractionary monetary policies, and promote domestic food production to manage inflation.

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Ha et al. (2019) examined the impact of global and domestic inflation shocks on core inflation in advanced, emerging, and developing countries from 1970 to 2016. The study found that Global food and energy prices also substantially impact inflation in low-income nations compared to other groups. It also found that weak central bank independence and floating exchange rates make it harder for these countries to stabilize inflation expectations.

3. Data and Methodology

3.1. Data and model specification

This research work is based on secondary data collected from various official sources. However, this study utilized the monthly data of consumer price index, world oil price, world food price, export, import, industrial production index, inward remittance, broad money supply, and crisis (COVID dummy). The data on the consumer price index and industrial production are collected from the Bangladesh Bureau of Statistics (BBS). In contrast, the data on world food prices at the consumer level are sourced from the Food and Agriculture Organization of the United Nations (FAO). The world oil price data is collected from the World Bank, and the data on imports, broad money supply, and inward remittance are collected from the Bangladesh Bank. At last, we also incorporate COVID-19 as a crisis variable. We used monthly data from January 2015 to October 2024 in the estimation process.

3.2. Model of the estimation procedure

In this research, our key variable is the consumer price index, as we aim to investigate how external side variables may impact domestic inflation. We employed the CPI as our dependent variable, and other variables, including the world oil price, world food price, exports, imports, industrial production index, inward remittances, broad money supply, and crisis, were incorporated as explanatory variables.

In the first stage, 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 by 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 mixed orders of integration, such as I(0) and I(1) (Pesaran & Pesaran, 1997). Finally, we examined the presence of any short-run relationships among the variables over time using the error correction model.

However, the variables need to be log-transformed, as in the econometric analysis, and we have used this method appropriately. However, the ARDL approach has been widely utilized in various fields of economic research (Laourari & Abderrahim, 2022). Benabdallah, S. and Oulddali, O. (2024) employed the method to uncover the primary drivers of inflation in Algeria, with a key objective of 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 that the method's effectiveness in capturing both short- and long-run dynamics in inflationary studies.

This study employs a simple ARDL model to examine the long-run effect of inflation, taking into account external side variables. The ARDL equation of this analysis is:

$$\mathbf{logcpi} = f(logcpi_{t-1}, logpoil, logpfood, logexp, logimp, logipi, logrem, logm2, crisis) \ldots\ldots\ldots (1)$$

Where, logcpi = log of consumer price index;
$logcpi_{t-1}$ = lag value of consumer price index;
logpoil = log of world oil price

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logpfood = log of world food price
logexp = log of export
logimp = log of import
logipi= log of Industrial Production;
logrem= log of Inward Remittance;
logm2= log of Broad money supply;
crisis = Covid dummy (2020M03 to 2021M04)

$$logcpi_t = \delta_0 + \sum_{t=1}^{n} \delta_{1i} logcpi_{t-i} + \sum_{t=0}^{n} \delta_{2i} logpoil_{t-i} + \sum_{t=0}^{n} \delta_{3i} logpfood_{t-i} + \sum_{t=0}^{n} \delta_{4i} logexp_{t-i} + \sum_{t=0}^{n} \delta_{5i} logimp_{t-i} + \sum_{t=0}^{n} \delta_{6i} logipi_{t-i} + \sum_{t=0}^{n} \delta_{7i} logrem_{t-i} + \sum_{t=0}^{n} \delta_{8i} logm2_{t-i} + \sum_{t=0}^{n} \delta_{9i} crisis_{t-i} + \alpha_t, \; t = 1,2, \ldots, T \ldots\ldots\ldots\ldots\ldots (2)$$

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 short-run relationship between inflation and its determinants as follows:

$$\Delta logcpi_t = \gamma + \sum_{t=1}^{n} \emptyset_i \, \Delta logcpi_{t-i} + \sum_{t=0}^{n} \beta_i \Delta logpoil_{t-i} + \sum_{t=0}^{n} \rho_i \Delta logpfood_{t-i} + \sum_{t=0}^{n} \gamma_i \Delta logexp_{t-i} + \sum_{t=0}^{n} \alpha_i \Delta logimp_{t-i} + \sum_{t=0}^{n} \mu_i \Delta logipi_{t-i} + \sum_{t=0}^{n} g_i \Delta logrem_{t-i} + \sum_{t=0}^{n} \omega_i \Delta logm2_{t-i} + \sum_{t=0}^{n} \vartheta_i \Delta crisis_{t-i} + \phi ECT_{t-1} + \alpha_t; \; t = 1,2, \ldots, T \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

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 that corresponds to this term, ϕ, represents the speed of adjustment.

4. Results and Discussion

4.1. Correlation matrix

Table 1 shows that the CPI, world oil price, world food price, export, import, industrial production index, inward remittance, broad money supply, and crisis are positively correlated with the inflation rate. According to the correlation between the independent and dependent variables, any change in the independent variables affected the rate of inflation positively. The results correlation matrices are consistent with initial theoretical expectations.

Table 1: Correlation Matrix

	LOGCPI	LOGPOIL	LOGPFOOD	LOGEXP	LOGIMP	LOGIP	LOGREM	LOGM2	CRISIS
Log of CPI	1	0.63	0.77	0.56	0.72	0.94	0.75	0.99	0.12
Log of world oil price	0.63	1	0.78	0.74	0.77	0.70	0.46	0.62	-0.20
Log of world food price	0.77	0.78	1	0.60	0.81	0.78	0.61	0.80	0.11
Log of export	0.56	0.74	0.6	1.00	0.66	0.71	0.50	0.54	-0.28
Log of import	0.72	0.77	0.81	0.66	1.00	0.83	0.60	0.76	0.15
Log of industrial production	0.94	0.7	0.78	0.71	0.83	1.00	0.78	0.96	0.13
log of inward remittance	0.75	0.46	0.61	0.50	0.60	0.78	1.00	0.78	0.24
log m2	0.99	0.62	0.8	0.54	0.76	0.96	0.78	1.00	0.19
CRISIS	0.12	-0.2	0.11	-0.28	0.15	0.13	0.24	0.19	1.00

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4.2. Unit root tests

Since the mean and variance of a random time series are presumed to be time invariant, at first, we examined the stationary test of the variables to start the estimation of the analysis (Gujarati, 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 regardless of the stationarity level of the dataset.

At first, we used the ADF test to determine whether the variables are stationary. ADF is a convenient and straightforward method for determining stationarity. We have also employed the Phillips-Perron (PP) unit root tests (Phillips & Perron, 1988) to examine the stationarity of the variables. The results of the unit root test are presented in Table 2.

Table 2: Unit root test

Variables	ADF-test				PP-test			
	At level, I(0)		At first difference, I(1)		At level, I(0)		At first difference, I(1)	
	t-statistics	p- value	t- statistics	P* - value	Adj.t-statistics	p- value	Adj.t-statistics	P* - value
Log of CPI	2.495	1.000	-14.109	0.000	8.769	1.000	-7.972	0.000
Log of world oil price	-2.005	0.284	-8.429	0.000	-2.112	0.240	-8.099	0.000
Log of world food price	-0.987	0.756	-7.210	0.000	-0.862	0.797	-7.202	0.000
Log of export	-5.003	0.000	----	----	-4.817	0.000	----	----
Log of import	-2.263	0.186	-11.244	0.0000	-2.882	0.051	----	----
Log of industrial production	-1.339	0.609	-9.232	0.000	-1.629	0.465	-28.951	0.000
log of inward remittance	-1.843	0.358	-16.302	0.000	-2.526	0.112	-26.269	0.000
Crisis	-4.142	0.001	-----	-----	-4.296	0.000	-----	-----
log of broad money supply(m2)	-1.327	0.615	-15.626	0.000	-2.463	0.127	-13.425	0.000

Note: The null hypothesis states that there are no unit roots, and * is for statistical significance.

4.3. Lag Selection Criteria

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

4.4. ARDL Bounds Tests

According to the Bounds Test result, the F-statistic value (F = 11.007354) exceeds the upper limits of the critical values at the 10%, 5%, and 1% significance levels, as shown in Table 5. Therefore, we can reject the null hypothesis that there is no long-term relationship, and we can conclude that there is a long-term relationship between the variables in the model. The result indicates that the CPI is cointegrated with world oil price, world food price, export, import, industrial production index, inward remittance, broad money supply, and crisis dummy.

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Table 3: Bound Test

Null hypothesis: No level relationship	
Number of cointegrating variables: 8	
Trend type: Rest. constant (Case 2)	
Sample size: 110	
Test Statistic	**Value**
F-statistic	**11.007354**

Table 4: Bounds test critical Value

	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
Asymptotic	1.850	2.850	2.110	3.150	2.620	3.770

*** Finite sample critical values are valid up to 7 error-correction variables.
Source: Author's calculation.

4.5. Estimation of Long Run Relationship

The confirmation of 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 the table below:

Table 5: Long-run coefficients from the estimated ARDL models

Dependent Variable: LOGCPI				
Automatic-lag linear regressors (3 max. lags): LOGPOIL				
LOGPFOOD_FAO LOGEXP_BOP LOGIMP_BOP LOGIPI				
LOGREM_BOP LOGM2_U CRISIS				
Selected model: ARDL (1,0,3,1,2,0,0,2,0)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
Log of CPI (-1)	0.713258	0.034385	20.74352	0.0000***
Log of world oil price	0.012686	0.004947	2.564423	0.0120***
Log of world food price	-0.049000	0.032054	-1.528660	0.1298
Log of world food price (-1)	0.015618	0.050478	0.309409	0.7577
Log of world food price (-2)	-0.072215	0.050546	-1.428699	0.1565
Log of world food price (-3)	0.095788	0.031499	3.040954	0.0031***
Log of export	0.009371	0.006115	1.532473	0.1288
Log of export (-1)	0.023190	0.004292	5.402842	0.0000***
Log of import	-1.71E-06	0.007773	-0.000221	0.9998
Log of import (-1)	-0.030531	0.006946	-4.395315	0.0000***
Log of import (-2)	-0.011298	0.006043	-1.869617	0.0647**
Log of industrial production	-0.036336	0.018237	-1.992410	0.0493***
log of inward remittance	0.000933	0.005490	0.169936	0.8654
Log of M2	-0.107479	0.097735	-1.099702	0.2743
Log M2(-1)	0.034773	0.108510	0.320460	0.7493
Log of M2(-2)	0.278155	0.089921	3.093340	0.0026***
Crisis	0.002014	0.002906	0.692921	0.4901
C	-1.806197	0.279904	-6.452918	0.0000***
R-squared	**0.998498**	Mean dependent var		4.493755
Adjusted R-squared	**0.998221**	S.D. dependent var		0.163198
S.E. of regression	0.006884	Akaike info criterion		-6.970737
Sum squared resid	0.004359	Schwarz criterion		-6.528841
Log likelihood	401.3906	Hannan-Quinn criter.		-6.791502
F-statistic	3598.392	**Durbin-Watson stat**		**2.234309**
Prob(F-statistic)	0.000000			

*Note: p-values and any subsequent test results do not account for model selection.

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According to the table above, the lag value, or past value, of the CPI rate has a positive and significant impact on current inflation. A 1 percent increase in past CPI leads to a 0.7 percent increase in the current CPI, indicating significant inflationary inertia. Additionally, a 1 percent increase in global oil prices results in a 0.012 percent increase in CPI, indicating that fluctuations in the world oil price have a positive and statistically significant impact on inflation. On the other hand, in the short run, world food price changes do not have an immediate impact on domestic CPI. However, the third lag of world food prices has a positive and significant effect on CPI, suggesting that food price shocks take some time to translate into domestic inflation. Aside from that, while current exports have no immediate impact, past increases in exports lead to higher CPI, possibly due to income effects that increase aggregate demand. A 1 percent increase in domestic exports will increase 0.02 percent of CPI, mainly due to inequitable growth. Additionally, in this estimated model, imports have a negative effect on inflation, suggesting that higher imports may reduce price pressures through increased competition or the availability of cheaper goods. The current value of imports is statistically insignificant. In contrast, the lagged value is statistically significant, exhibiting a negative relationship with CPI, indicating that the impact of imports on CPI becomes more pronounced after a time lag. Additionally, the coefficient of industrial production (IP)indicates that higher IP lowers inflation, likely by increasing supply and reducing cost-push inflation. This also shows a statistically significant result. Alternatively, the impact of remittances, a demand-side variable, on CPI is statistically insignificant, suggesting that the inflow of foreign currency does not directly influence CPI. Another important variable for estimating the inflationary influence is M2. The current period and first lag of the money supply (M2) do not significantly impact the CPI. However, M2 with a two-period lag has a strong positive effect, implying that expansionary monetary policies affect inflation with a delay.

The dummy variable representing economic crises, such as COVID-19, does not have a significant effect on the CPI, suggesting that inflation dynamics are driven more by economic fundamentals than by crisis events.

The negative constant indicates that, controlling for other variables, CPI is expected to be lower in the absence of external shocks. Moreover, the statistical results for R^2 and Adjusted R^2 indicate the model's strong goodness of fit, showing that the independent variables explain around 99 percent of the variation in the dependent variable.

4.6. ARDL Cointegrating Relation

4.6.1. Cointegrating Specification

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

Deterministics: Rest. constant (Case 2)

CE=LOGCPI(-1)-(0.044240*LOGPOIL-0.034205*LOGPFOOD_FAO(-1)+0.113556*LOGEXP_BOP(-1)
0.145883*LOGIMP_BOP(-1)-0.126719*LOGIPI+0.003253*LOGREM_BOP + 0.716494*LOGM2_U(-1) + 0.007023*CRISIS - 6.299032)

4.6.2. Cointegrating Coefficients

The coefficient results indicate that a rise in world oil prices has a statistically significant positive effect on inflation, with a coefficient of 0.0442 and a p-value of 0.0107, highlighting the sensitivity of inflation to global commodity price shocks. Similarly, higher exports contribute positively (0.1136, $p < 0.01$) to inflation, while increased imports exert a deflationary effect (-0.1459, $p < 0.01$). Industrial production is also negatively associated with inflation, implying that increased output helps contain price pressures (-0.1267, $p = 0.0448$).

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Table 6: Cointegrating Coefficients

Variable *	Coefficient	Std. Error	t-Statistic	Prob.
Log of world oil price	0.044240	0.017006	2.601517	0.0107
Log of world food price (-1)	-0.034205	0.040671	-0.841016	0.4023
Log of export (-1)	0.113556	0.024538	4.627741	0.0000
Log of import (-1)	-0.145883	0.034188	-4.267051	0.0000
Log of Industrial Production	-0.126719	0.062354	-2.032251	0.0448
Log of inward remittances	0.003253	0.019148	0.169912	0.8654
Log of m2 (-1)	0.716494	0.049335	14.52299	0.0000
Crisis	0.007023	0.010207	0.688092	0.4930
C	-6.299032	0.664901	-9.473639	0.0000

Note: * Coefficients derived from the CEC regression.

Monetary expansion, captured by broad money (m2), emerges as the most influential factor in driving inflation, with a coefficient of 0.7165 and a highly significant p-value (<0.01). In contrast, remittances (LOGREM_BOP) and the crisis dummy (CRISIS) show insignificant effects, suggesting that their impact on inflation is either weak or transmitted through other economic channels.

Overall, the estimated cointegrating relationship provides strong evidence that monetary expansion, external sector dynamics, and supply-side factors such as oil prices and industrial output primarily influence inflation in the studied economy. The statistically significant negative constant term (-6.2990, $p < 0.01$) suggests that in the long run, inflation stabilizes around a lower level when controlling for these determinants.

4.6.3. Cointegrating Series

From the ARDL cointegrating series, it is likely a representation of the residuals from the estimated cointegrating equation. The large fluctuations or spikes could indicate external shocks, such as financial crises, policy changes, or inflationary pressures from global markets.

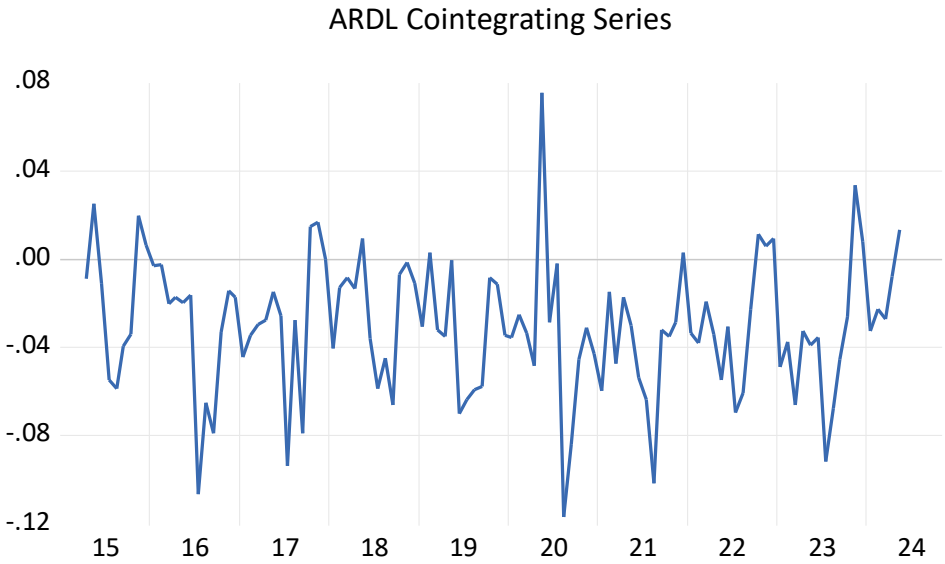

Figure-1

4.7. Error Correction Estimation

The short-run dynamics coefficients from the estimated ARDL model are shown in Table 5, where the lag is selected by Akaike Information Criteria (AIC). The coefficient of the Error Correction Model (ECM) is expected to be negatively significant, and ECM indicates the speed of adjustment to long-run equilibrium after a short-run shock. In other words, it measures the rate of convergence toward equilibrium if there is any short-run disequilibrium. Table 7 indicates that the error correction coefficient, estimated to be -

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0.28which, is statistically significant at the 1 percent level of significance. In order to restore equilibrium, the coefficient suggests that the current period's deviation from the long-run equilibrium level needs to be corrected by 28.70 percent in the subsequent period.

Table 7: Dependent Variable: D(LOGCPI)

Method: ARDL				
Automatic-lag linear regressors (3 max. lags): LOGPOIL				
LOGPFOOD_FAO LOGEXP_BOP LOGIMP_BOP LOGIPI				
LOGREM_BOP LOGM2_U CRISIS				
Deterministics: Restricted constant and no trend (Case 2)				
Model selection method: Akaike info criterion (AIC)				
Selected model: ARDL(1,0,3,1,2,0,0,2,0)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
COINTEQ*	-0.287	0.026	-10.993	0.000
D(log of world food price)	-0.049	0.029	-1.705	0.091
D(log of world food price (-1))	-0.024	0.029	-0.786	0.434
D(log of world food price (-2))	-0.096	0.029	-3.343	0.001
D(log of export)	0.009	0.004	2.568	0.011
D(log of import)	-.0001	0.006	-0.000	0.999
D(log of import(-1))	0.011	0.005	2.249	0.027
D(log of m2)	-0.107	0.062	-1.727	0.087
D(log of m2 (-1))	-0.278	0.076	-3.663	0.000
R-squared	**0.55**	Mean dependent var		0.0052
Adjusted R-squared	**0.52**	S.D. dependent var		0.009
S.E. of regression	0.007	Akaike info criterion		-7.134
Sum squared resid	0.004	Schwarz criterion		-6.913
Log likelihood	401.391	Hannan-Quinn criter.		-7.045
F-statistic	15.487	**Durbin-Watson stat**		**2.234**
Prob(F-statistic) 0.000				

*P-values are incompatible with t-Bounds distribution.

Source: Author's calculation.

5. Diagnostic and Stability Tests of the ARDL Model

5.1. Diagnostic Test

To assess the competencies and robustness of the ARDL model, several diagnostic tests were performed, and the results are presented in Table 8. The most commonly used test to check the presence of serial correlation in the residuals is the LM test, and the p-value for the LM test confirms the absence of serial correlation in the model. The BPG test, which checks heteroscedasticity in residuals, indicates the model is free of heteroscedasticity. Ramsey Reset Test confirms, there is no specification error. Finally, the p-value of the Jarque-Bera test confirms that the residuals are normally distributed.

Table 8: Diagnostic Tests

Diagnostic Test	F-statistics	p-value
Serial Correlation LM test	0.99	0.38
Heteroskedasticity test	0.95	0.52
Jarque Berra Normality Test	2.176461	0.34

Source: Author's calculation

5.2.Stability Test

To ensure the structural stability of the ARDL model established in this study, we checked the cumulative sum (CUSUM) and CUSUM Squares tests suggested by Pesaran and Pesaran (1997). It can be seen that

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parametric constancy and model reliability are achieved when the levels of CUSUM remain within the critical 5 percent range (shown by the red dashed line). The tests are plotted in Figure 2 and show that no roots are lying outside at the 5 percent level of significance. Therefore, our model passes the test of stability.

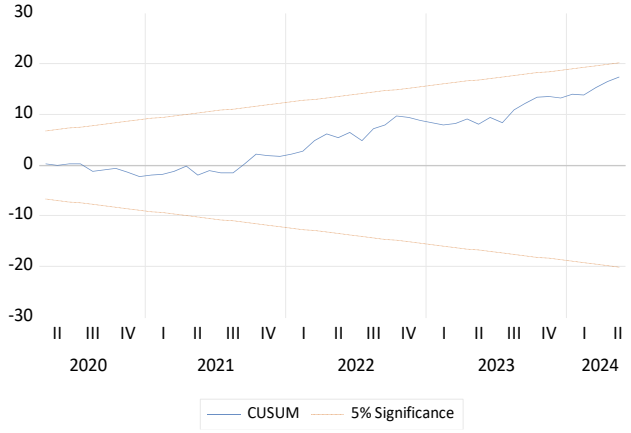

Fig 2: CUSUM Test

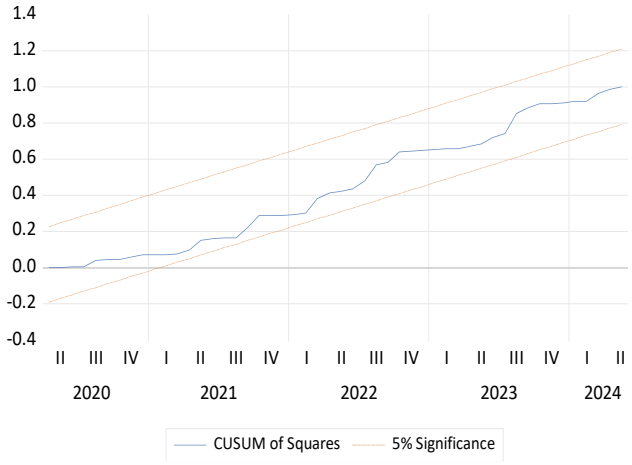

Fig 3: CUSUM Square Test

6. Conclusion and Policy Implications

This research aims to identify the impacts of external sector variables on domestic inflation in Bangladesh using the ARDL approach, based on monthly data from January 2015 to October 2024. The empirical findings confirm that Bangladesh's inflation is significantly influenced by external factors, including world oil prices, food prices, and trade dynamics (both exports and imports). In contrast, domestic economic conditions such as industrial production, broad money supply (M2) also play a key role. The results indicate that past Consumer Price Index (CPI) values strongly influence current CPI, highlighting inflationary inertia in the economy. Among external variables, world oil prices have a direct and statistically significant effect on inflation, reinforcing the vulnerability of Bangladesh's price levels to global energy price fluctuations.

In contrast, the impact of global food prices is delayed, suggesting that food price shocks take time to be reflected in domestic inflation. Export growth has a positive contribution to inflation, particularly in the long run, likely due to increased income and aggregate demand. Conversely, imports exert a deflationary effect, possibly by enhancing market competition and reducing supply-side constraints.

Domestic factors also explain inflationary pressures. Higher industrial production appears to mitigate inflation, aligning with the notion that increased supply can offset cost-push factors. The impact of remittances on inflation is statistically insignificant, indicating that while remittance inflows enhance household purchasing power, their direct influence on CPI remains limited. Moreover, the broad money supply (M2) affects inflation with a lag, suggesting that monetary policy actions take time to be transmitted into price levels. The study also finds that crisis events such as the COVID-19 pandemic do not exert a significant independent effect on inflation, implying that structural economic conditions play a more dominant role.

For instance, based on the empirical analysis, policymakers may consider that oil price management is crucial for inflation control, necessitating hedging strategies that account for calculated risk or subsidies. Monetary policy transmission takes time, so the Bangladesh Bank should anticipate inflationary effects when adjusting policy rates. On the other side, imports help contain inflation, suggesting that trade liberalization can help control price levels. Additionally, production incentives can help curb inflation, underscoring the importance of industrial growth policies.

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Overall, this research underscores the importance of accounting for external shocks in inflation control strategies when formulating policies to maintain macroeconomic stability in Bangladesh.

7. Limitations and Directions for Future Research

Inflation is a multivariate variable, and while fiscal deficit may have a direct influence on inflation, its data is only available on an annual basis. Therefore, we cannot include this variable in our article. Future research can further explore the interaction between external shocks and domestic fiscal and monetary policies to strengthen Bangladesh's macroeconomic stability.

Authors' Contribution: Dr. Imam Abu Sayed provided overall supervision and guidance throughout the research process. Ms. Rifat Ara Bindu was responsible for model estimation and drafting the technical sections of the paper. Ms. Romana Ferdoush contributed in writing the introduction and reviewing the relevant literature.

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Appendix 1

Model selection summary