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Articles

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Message from the Chief Editor

I am delighted that the first volume of the IPF Journal of Economics and Finance is going to be published. This journal is coming out in the backdrop of a growing need for high-quality research that will provide relevant policy guidance needed by the Government in the area of public finance and economics. Its regular publication will create a platform for rigorous analysis, evidence-based policy proposals, and scholarly dialogue that will link academic insights with practical policy choices.

Each of the research articles in this volume includes an abstract to help readers quickly grasp the scope, methodology, and key findings on that article. I hope that the readers will find the articles stimulating but at the same time request all concerned to keep in mind that these are pure academic endeavors of the authors and do not reflect the position of the Government in any way. Views and opinions expressed by the authors will be their own responsibility.

I thank the editors and the Institute of Public Finance Bangladesh (IPF) team for bringing this volume to fruition. This is the first-ever academic journal published by the IPF and I hope that future volumes will come out in regular intervals churning out high-quality research papers. I look forward to the IPF Journal of Economics and Finance becoming a persistent and influential voice that will not only generate fresh ideas but also fill out the research gaps in the fields of economics and finance.

Dr. Md. Khairuzzaman Mozumder
Finance Secretary
&
Chief Editor

Foreword

The Institute of Public Finance Bangladesh (IPF) has been delivering several high-quality training courses to both the public and private sector officials since its inception in 2013. However, there was a persistent gap in conducting research that was originally envisaged as one of the core mandates of this institute. It gives me profound joy that finally that gap has been filled out.

All the articles contained in this first volume of the IPF Journal of Economics and Finance has been written by the officers of the Finance Division and the SPFMS Program. The authors have done a tremendous job producing these articles in a very short period while maintaining high quality of each of the articles which, I am sure, will be appreciated by the scholars.

I sincerely thank the IPF and the Finance Division officials who have worked very hard and closely with the publisher to bring this journal out. I specially thank the Finance Secretary who is also the Chief Editor of this Journal, for being tremendously supportive in this venture. Sincere thanks are also due to everyone who has supplied valuable and constant encouragement that provided much needed boost to complete the task of publishing this journal.

I hope that this volume will induce others to write articles regularly from now on which will be critical to publish this journal in regular intervals.

Dr. Ziaul Abedin
Additional Secretary, Finance Division
& Director General, IPF

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Drivers of Inflation in Bangladesh: Demand-Pull and Cost-Push Perspectives

Md. Rashedur Rahman Sardar[1], Tasnova Rahman[2]

Abstract

This paper investigates the short-run and long-run drivers of inflation in Bangladesh using an ARDL framework. Anchored in both New Keynesian and Fiscal Theory of the Price Level perspectives, the analysis incorporates demand-pull and cost-push variables: aggregate private consumption gap, government consumption expenditure, exchange rate, wage, and real interest rates. Our study finds that the inflation in Bangladesh is highly persistent, and the cost-push factors, particularly captured by exchange rates and wage-sensitive cost index, dominate both short-run and long-run inflation dynamics. Government expenditure also exerts immediate marginal inflationary effects, while the long run effects are significant. The aggregate private consumption gap is somewhat influential, conditional on supply-side disruptions. However, the real interest rate is effective in dampening inflation in the short run, while it may not consistently serve as reliable inflation control mechanism in the long run. Additionally, the inclusion of episodic shock indicators such as flood years and global shock years improves the model fit and highlights the importance of transitory shocks in inflation transmission. Most importantly, the study finds that the cost push factors play a major role in exacerbating the inflationary impacts in Bangladesh. The paper concludes with policy implications aimed at improving macroeconomic stability and inflation control.

Keywords: ARDL Model, Cost push, Demand Pull, Inflation, ECM

JEL Classification Code: C32, E31, E32, O53

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1. Introduction

Inflation dynamics in Bangladesh have long been a subject of macroeconomic inquiry due to its' profound implications for macroeconomic stability, monetary policy, and household welfare in the country. Recent year's data[1] shows that while many countries around the world have been able to reduce the inflationary pressure, Bangladesh is one of the countries which is still fighting with this particular issue. The price pressures in Bangladesh are historically high, and the rising prices have coincided with multiple macroeconomic developments, including global supply chain disruptions, exchange rate depreciation, and rising wage and energy costs. These factors have amplified both demand-pull and cost-push pressures. In these circumstances, govuuernment has adopted stricter monetary and fiscal measures, though inflation shows little sign of expected subsiding with those measures. Recent policy statements of Bangladesh government, including the *National Budget Speech*[2] and *Medium-Term Macroeconomic Policy Statement (MTMPS)*[3] have also highlighted rising inflation as a major concern for the economy.

In the given context, policymakers in Bangladesh have increasingly sought to determine whether inflation is primarily demand-driven, caused by supply-side constraints, or influenced by other structural and macroeconomic factors. Many studies have explained the inflation dynamics of Bangladesh in different aspects and explored the impact of many macroeconomic variables. Along with many other macroeconomic variables, the output gaps, evolving fiscal stances, depreciation of currency, wage pressure, money supply and policy rates play major roles in the development of inflation dynamics. Despite its policy relevance, inflation in Bangladesh remains underexplored in terms of distinguishing the effect of demand-pull and cost-push determinants. Thus, this study

[1] Based on IMF data, while global and regional inflation rates decline- World: 8.6% (2022) to 5.7% (2024), and Emerging and Developing Asia: 3.9% (2022) to 1.96% (2024), Bangladesh's inflation rose from 6.15% to 9.73% in the respective same period.

[2] *National Budget Speech 2025–26*. Government of Bangladesh. Retrieved from https://mof.portal.gov.bd/site/page/d1ca893d-7ab0-4b43-a506-a868545de55e

[3] *Medium-Term Macroeconomic Policy Statement (MTMPS) 2025–26 to 2027-28*. Government of Bangladesh. Retrieved from https://mof.portal.gov.bd/site/page/4bf09755-4723-423f-bcb7-9ddcc631f25d

aims to investigate the relative importance of demand-pull and cost-push factors or any other factors in explaining inflation in Bangladesh, employing an Autoregressive Distributed Lag (ARDL) framework. In particular, it emphasizes the role of the output gap and assesses the contribution of selected macroeconomic variables representing both demand-side and supply-side forces. The analysis covers a sample of 48 annual observations, utilizing key variables such as the real private consumption gap as a proxy of output gap, government expenditure, exchange rate, real interest rate, and wages.

Preliminary estimation using an ARDL framework reveals that inflation in Bangladesh exhibits a robust long-run association with exchange rate- and wage-sensitive cost factors and government expenditure, while demand-side indicators such as the aggregate private consumption gap (from now on- consumption gap) display episodic influence. The cost index, composed of exchange rate and wage, maintains strong and statistically significant coefficients in both short- and long-run specifications, which finds its structural relevance in inflation persistence. The real interest rate is effective in dampening inflation in the short run, while it may not consistently serve as reliable inflation control mechanism in the long run. However, the adjustment term is negative and significant, that confirms convergence toward long-run equilibrium.

The rest of the paper is organized as follows. Section 2 introduces literature review. Section 3 presents our data and preliminary analysis. Section 4 presents the methodology used in the study. Section 5 presents empirical results. Section 6 presents overall discussion of the results and limitations of the study, and Section 7 discusses policy implications and concludes.

2. Literature Review

Inflation theory spans several paradigms, and each offers distinct mechanisms to explain price level behavior. The Quantity Theory of Money (QTM), rooted in classical monetarism, postulates that inflation results from excessive money supply growth relative to output. This phenomenon was famously summarized by Friedman (1968) as "*always*

and everywhere a monetary phenomenon." In contrast, the Fiscal Theory of the Price Level (FTPL) shifts focus from monetary aggregates to fiscal sustainability and argues that prices adjust to equate the real value of government debt with expected future fiscal surpluses (Cochrane, 2023). A third strand, the New Keynesian framework, integrates nominal rigidities and forward-looking expectations, and emphasizes the roles of interest rates, inflation targeting, and output gaps in shaping inflation dynamics (Woodford, 2003). Collectively, these perspectives illuminate both demand-driven and cost-induced inflationary pressures, and inform empirical strategies that account for monetary, fiscal, and structural influences.

A growing body of recent international literature has explored the underlying forces of inflation and often framed the analysis within the demand-supply dichotomy. Lansing (2025) examined U.S. inflation dynamics during the pandemic era and found that demand-side forces became more dominant, and that overshadows supply-side effects. Shapiro (2024) decomposes U.S. Personal Consumption Expenditures (PCE) inflation into supply-driven and demand-driven components, which is intended to help policymakers and researchers understand the relative contributions of supply and demand shocks to inflation in the U.S. economy. It found that monetary tightening significantly reduced demand-driven inflation, while food and energy shocks played a central role on the supply side. Firat and Hao (2023) emphasized that supply-driven inflation is more reactive to oil shocks, while demand-driven inflation responds more to monetary policy changes, implying varying policy effectiveness depending on the dominant inflation source.

A substantial body of empirical literature has also examined the determinants of inflation in Asian economies. These studies have also highlighted the complex interplay between demand-pull and cost-push factors. Salim et al. (2021) used panel data from ten Asian countries and emphasized the significance of money supply and interest rates in shaping inflationary trends, while money supply has emerged as the most influential variable. However, more recent findings by Wulandari and Fuddin (2024) suggest that GDP and loan interest rates play a more prominent role, while the influence of money supply appears limited and unemployment shows no significant impact. Thus, it questions the

traditional Phillips Curve framework in the Asian context. Complementing this, Sajid et al. (2024) documented that both domestic variables (such as money supply and exchange rates) and global shocks (such as oil prices) contribute to inflation in South Asian countries, while interest rates and structural adjustment programs by international financial institutions exert disinflationary effects. Duan et al. (2025) added further explanation by showing that monetary financing through expanded private credit and money supply significantly elevates inflation.

In addition to monetary and structural determinants, several studies have underscored the importance of supply-side and sector-specific factors. Jongwanich et al. (2019) distinguished between the determinants of producer and consumer price inflation, and it noted that external cost-push shocks such as oil and food prices are more relevant for producer prices, while consumer inflation remains largely influenced by domestic demand factors. By applying an open-economy Phillips Curve framework, Dua and Gaur (2010) confirmed the significance of the output gap and international competitiveness in determining inflation across both developed and developing Asian countries, though agriculture-related supply shocks were found much pertinent for the latter. Mishra (2020) contributed to a broader development perspective and showed infrastructure development and financial sector improvements tend to reduce inflation, whereas rising per capita income exerts upward pressure on the general price level. Collectively, these studies underscore that inflation in Asia is shaped by a combination of domestic, external, monetary, and structural variables, while each variable exerts varying degrees of influence across countries and time periods.

Duan et al. (2025) demonstrate that monetary financing is a key driver of inflation across the region, while increased private credit and broad money supply are the major monetary financing tools. Obaid et al. (2020) also confirm that inflation in Bangladesh and its neighbors is predominantly influenced by monetary factors such as money supply, interest rates, and exchange rates, while fiscal indicators like government expenditure and budget deficits show limited explanatory power. Islam (2021) adds that although GDP growth contributes to inflation, broader

measures of socioeconomic development, such as the Human Development Index, have no significant effect. This is important in the context of Bangladesh, where structural development is ongoing, but price-level dynamics may remain more responsive to monetary variables. Moreover, Rizvi and Pathirage (2023) highlight that Bangladesh's monetary and financial interventions during the COVID-19 pandemic were more effective in reducing inflation than fiscal transfers, which reinforces the critical role of central bank policies.

Recent empirical studies have explored the complex interplay of domestic and external factors that shape inflation in Bangladesh. Salma et al. (2025) points to the importance of political stability in lowering inflation. Meanwhile, Basnet et al. (2022) find that remittances, an important income source for Bangladesh, suppress inflation in the short run but contribute to it in the long run. Ahmed (2023) highlights the government's expansionary fiscal stance such as low interest rates, rising fiscal deficits, and increased borrowing from the Bangladesh Bank are critical contributors to prolonged inflation, even after global commodity prices declined. Furthermore, Begum (1991) identified agricultural bottlenecks, wage growth, credit expansion, and import rigidities as key inflation drivers. Similarly, Kreiter and Paul (2010), using a vector autoregression approach, found that prior inflation values and domestic borrowing by the government were key short-term inflation predictors. Collectively, these findings underscore that inflation in Bangladesh is a multifaceted phenomenon, influenced by both demand-pull and cost-push factors, and structural constraints, and these necessitate coordinated approach that spans fiscal discipline, external sector management, monetary regulation, and reforms addressing domestic supply-side inefficiencies.

3. Data and Preliminary Analysis

The analysis employs annual macroeconomic data of Bangladesh spanning from 1976 to 2024, while this data sourced primarily from BBS and Bangladesh Bank. Variables such as the consumption gap, government expenditure, exchange rate, wage rate index, and real interest rates are selected to reflect key demand-pull and cost-push channels, which are consistent with the New Keynesian emphasis on

nominal rigidity and forward-looking expectations and the Fiscal Theory of the Price Level.

Consumer Price Index:

As this study examines the influence of demand-pull and cost-push factors on inflation in Bangladesh, the dependent variable of this study is the Consumer Price Index (CPI). The CPI captures changes in the general price level of a representative basket of goods and services consumed by households, including food, housing, transportation, and utilities. In empirical modeling, the log transformation of CPI helps stabilize variance and facilitates interpretation of percentage changes. Therefore, this study has attempted to model *lcpi* to examine the determinants and propagation mechanisms of inflation in Bangladesh's economy.

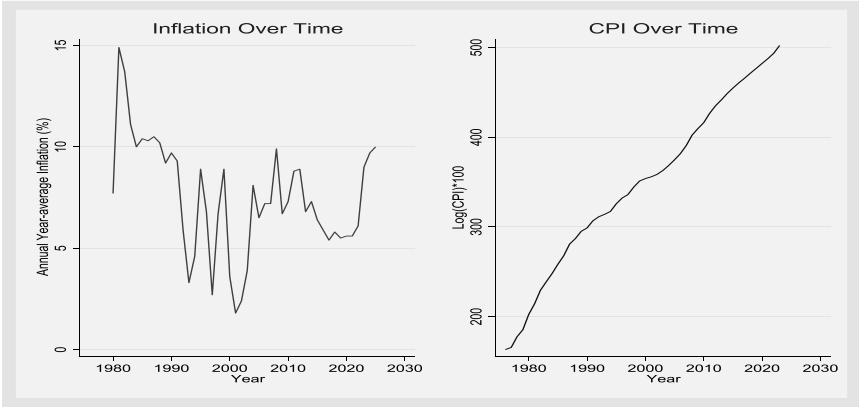

Figure 1: *Inflation and Consumer Price Index (CPI) over the years*

Consumption Gap:

One of the key objectives of this study is to assess the role of demand-pull factors in driving inflation of Bangladesh. Many studies have used the output gap as a demand-pull factor; however, estimating it remains a central challenge in macroeconomic analysis due to its unobservable nature and sensitivity to model assumptions (Orphanides and Norden, 2002; OECD, 2021). Traditional methods of measuring output gap through production function approaches are often subject to end-point bias and frequent revisions, particularly in developing economies with volatile data (Castle, 2003). In light of these limitations, several studies

have explored alternative proxies. For example, Kojima et al. 2005 found the consumption gap peroxide by electricity consumption per unit of capital is a better measure of inflation pressure than the output gap in China. Neiss and Nelson (2001) and Galí and Gertler (1999) suggest that consumption-based indicators, grounded in intertemporal optimization behavior, may better capture cyclical fluctuations than detrended output. Moreover, in consumption-driven economies, deviations in private consumption from its potential path can reflect broader macroeconomic slack.

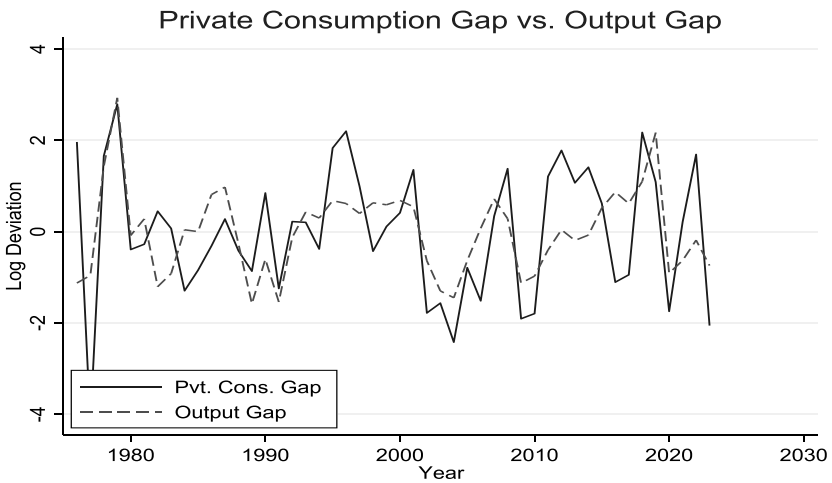

Figure 2: *Aggregate Private Consumption Gap and Output Gap over the Years*

As shown in Figure 2, the consumption gap (solid line) and the output gap (dashed line) are measured by following Hodrick–Prescott (HP) filter method. Though many studies have pointed out different shortcomings and drawbacks of the Hodrick- Prescott filter, the criticisms have not had great effects on its wide use in empirical research (Ahumada and Garegnani, 1999). However, this method is consistent with standard practice in empirical macroeconomics, especially when structural data (like capital stock or labor input) is limited.

The consumption gap shows greater volatility and sharper responsiveness than the output gap, particularly during key macroeconomic episodes such as the early 1980s shocks, the 2008-09 global financial crisis, and the COVID-19 pandemic. This heightened sensitivity suggests that the consumption gap better captures real-time changes in household behavior

and purchasing power which are key drivers of demand-pull inflation. While both gaps exhibit broadly similar cyclical patterns over the sample period, the consumption gap occasionally leads to the output gap. This indicates that changes in consumption behavior show up earlier than the broader shifts in economic activity. This supports the idea that the consumption gap not only reflects current demand conditions but also has predictive power for inflation and output dynamics.

To the best of our knowledge, this study is among the first to empirically examine the impact of the consumption gap on inflation in Bangladesh using an ARDL framework. By doing so, it provides an alternative lens for evaluating inflationary dynamics and contributes to the ongoing debate about appropriate demand-side indicators. Thus, it offers a practical tool for policy analysis in data-constrained settings. The use of the consumption gap in this study is not merely a data workaround, but a theoretically justified and empirically supported innovation. At the same time, consumption gap better aligns with the structural features and measurement challenges of the Bangladeshi economy.

Government Expenditure:

Government expenditure plays a pivotal role in shaping macroeconomic dynamics, particularly in developing economies where fiscal policy often serves as a primary tool for stabilization. In this study, government expenditure, basically the consumption expenditure, is included as an independent variable to capture its potential influence on inflationary pressures and cyclical fluctuations. Though we collected data on public investment, its inclusion was ultimately dropped from the final specification due to weak and counterintuitive empirical relationships. This has been discussed in the Limitations section. This study incorporates both the consumption gap and government expenditure as independent variables to capture the dual channels of aggregate demand that influence inflationary dynamics in Bangladesh. While the consumption gap reflects deviations in private sector demand from its potential path, government's consumption expenditure represents the public sector's contribution to overall demand pressure. Together, they provide a more comprehensive view of the demand-side inflationary forces.

This demand-pull effect is well-documented in both theoretical literature and empirical studies. For instance, Kazi Arif (2012) finds a statistically significant long-run relationship between government expenditure and inflation in Bangladesh, while recent international analyses (MIT Sloan, 2022; Bank of Canada, 2023) also identify fiscal expansion as a key driver of inflationary episodes.

Exchange Rate

The inflationary impact of exchange rate movements depends on the nature of the shock and the structure of the economy. In economies heavily reliant on imports, even modest currency depreciation can significantly raise domestic prices (Stocker and Yilmazkuday, 2020). As a trade deficit country, the exchange rate plays a critical role in shaping domestic inflation in Bangladesh through the mechanism of imported inflation. Aziz (2010) finds that in Bangladesh, exchange rate depreciation has a statistically significant effect on both import prices and consumer price inflation. Additionally, the exchange rate pass-through (ERPT) effect is well-documented in the literature. Ha, Stocker, and Yilmazkuday (2019) show that the ERPT is significantly higher in emerging markets, where monetary policy credibility and inflation expectations are less anchored. Given the openness of Bangladesh's economy and its dependence on imported essentials, incorporating the exchange rate as an independent variable allows the model to capture external cost shocks that directly influence inflation.

Wage Index

Wage dynamics are a fundamental cost-push factor in inflation modeling. Rising wages, particularly when not matched by productivity gains, increase unit labor costs, which firms often pass on to consumers in the form of higher prices. This phenomenon is especially relevant in labor-intensive economies (Suthaharan and Bleakley, 2022). In the context of Bangladesh, where the informal labor market is large and wage adjustments are often politically sensitive, wage increases in key sectors (e.g., garments, construction, agriculture) can have a disproportionate effect on inflation. This study includes the wage index as an independent variable to capture cost-push inflationary pressures arising from labor market dynamics.

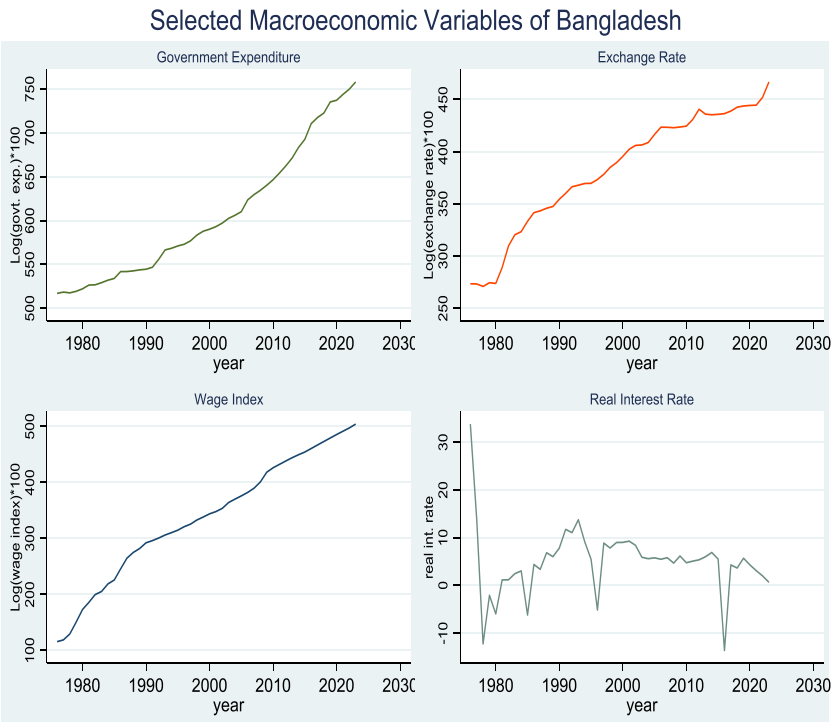

Figure 3: *Selected Macroeconomic Variables of Bangladesh over the Years*

Real Interest Rate

This study includes the real interest rate as an explanatory variable to capture both cost-side and demand-side influences on inflation. The real interest rate is defined as the nominal interest rate adjusted for inflation, and it reflects the true cost of borrowing in the economy. On the cost side, higher real rates raise the cost of capital for firms, which can be passed on to consumers in the form of higher prices. On the demand side, elevated real rates suppress borrowing and consumption, which exerts downward pressure on inflation. This dual-channel transmission mechanism aligns with the framework described by Matheson (2019), which highlights the role of real interest rates in monetary policy and inflation control strategies within both advanced and developing economies. Moreover, Hoffman and Schlagenhauf (1985) find that real interest rates are inversely related to inflation in both developed and developing countries, though the strength of the relationship varies by monetary regime.

Table 1: Definitions of the Variables

Variable	Description	Transformation	Source
cpi	Consumer Price Index with a base year of 2015-16	Converted to log value	Bangladesh Bureau of Statistics (BBS)
routput_gap	Real output gap is measured by HP filter, and that comes from the difference between real output and the potential output with a base year of 2015-16	Converted to log value	
cons_gap	Real consumption gap is also measured by HP filter, and that comes from the difference between real aggregate private consumption and potential aggregate private consumption with a base year of 2015-16	Converted to log value	
govtexp	Central government expenditure which includes the government's consumption expenditure with a base year of 2015-16	Converted to log value	
exrate	Year-average official exchange rate between Bangladeshi currency and US Dollar	Converted to log value	World Development Indicator: https://data.worldbank.org/indicator/PA.NUS.FCRF?locations=BD
wage	Wage Rate Index with the base year of 2015-16	Converted to log value	Bangladesh Bureau of Statistics (BBS)
real_int	Real Interest Rate	Original scale	World Development Indicator: https://data.worldbank.org/indicator/FR.INR.RINR?locations=BD

Summary Statistics:

Table 2 presents the summary statistics for the variables used in the analysis, based on 48 annual observations. The dependent variable, the log-transformed Consumer Price Index (*lcpi*), has a mean value of 347.34 with a standard deviation of 95.97. It ranges from 163.21 to 502.27, which gives an impression of higher variation over the sample period. The log-transformed real output gap (*lroutput_gap*) and the log-transformed consumption gap (*lcons_gap*) are both centered around zero, as expected from HP-filtered cyclical components. However, the consumption gap exhibits greater volatility (standard deviation = 1.86) compared to the output gap (standard deviation = 0.94) which suggests more pronounced fluctuations in aggregate private consumption relative to aggregate output.

Government expenditure (*lgovtexp*), expressed in logarithmic form, has a mean of 606.17 and ranges from 516.93 to 757.96. This range indicates a steady upward trend in public spending over the sample period. The exchange rate (*lexrate*) shows moderate variation with a mean of 381.87 and a standard deviation of 56.61. The lower range of deviation in exchange rates reflects administered currency management system in Bangladesh and gradual depreciation of the domestic currency. The wage index (*lwage*) has a mean of 336.97 and a relatively wide dispersion (standard deviation = 110.08). This wide dispersion is consistent with structural shifts in the labor market. The real interest rate (*real_int*) averages 4.96 percent but exhibits considerable variability (standard deviation = 7.02). It ranges from -13.64 to 33.80 percent, and the higher variability is also visible in Graph 3, which captures both accommodative and contractionary monetary policy episodes.

These statistics highlight the diversity and dynamic behavior of the macroeconomic variables included in the model, providing a robust foundation for analyzing the determinants of inflation in Bangladesh.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Lcpi	48	347.337	95.974	163.207	502.271
lroutput gap	48	0	.941	-1.582	2.928
lcons gap	48	0	1.859	-4.058	3.521
Lgovtexp	48	606.169	74.634	516.931	757.959
Lexrate	48	381.871	56.606	270.912	466.635
Lwage	48	336.973	110.078	115.608	504.072
real int	48	4.963	7.015	-13.642	33.795

To support the selection of explanatory variables in the inflation model, a pairwise correlation analysis was conducted. The results in Table 3 reveal that among the macroeconomic indicators chosen in this study *lgovtexp* ($r = 0.9533$, $p < 0.01$), *lexrate* ($r = 0.9824$, $p < 0.01$), and *lwage* ($r = 0.9984$, $p < 0.01$) are highly and significantly correlated with the consumer price index (*lcpi*), which suggest strong empirical associations with the outcome variable. These findings align with theoretical expectations, where fiscal expansion, currency depreciation, and wage growth are known to exert upward pressure on prices. Although the consumption gap and real interest rate exhibit weak and statistically insignificant correlations with inflation, their inclusion is retained based on theoretical relevance and their potential role in capturing demand-side and monetary policy effects, respectively. Thus, the correlation matrix provides empirical support for the inclusion of both cost-push and demand-side variables in the model.

Table 3: Pairwise Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) lcpi	1.000					
(2) lcons_gap	0.008	1.000				
	(0.956)					
(3) lgovtexp	0.953	0.017	1.000			
	(0.000)	(0.910)				
(4) lexrate	0.982	-0.030	0.897	1.000		
	(0.000)	(0.842)	(0.000)			
(5) lwage	0.998	-0.001	0.939	0.987	1.000	
	(0.000)	(0.995)	(0.000)	(0.000)		
(6) real_int	-0.091	-0.030	-0.131	-0.024	-0.081	1.000
	(0.537)	(0.839)	(0.374)	(0.874)	(0.585)	

P-values are in parentheses

However, a particular concern is the near-perfect linear association between two cost push factor variables. *lexrate* and *lwage* exhibit a correlation of 0.987 ($p < .01$). Such extreme multicollinearity can inflate standard errors, undermine the precision of coefficient estimates, and obscure the distinct effects of each variable (Gujarati & Porter, 2009). To resolve this, we applied principal component analysis (PCA) to *lexrate* and *lwage*, following the approach outlined by Jolliffe (2002). PCA transforms the original, correlated variables into orthogonal principal components, with the first component that captures the maximum shared variance. In our case, the first principal component had an *eigenvalue* well above unity and explained over 95 percent of the combined variance of *lexrate* and *lwage*. We therefore constructed a single composite variable, *cost_index*, equal to this first component's linear combination:

$$cost_index_t = \phi_1 * lexrate_t + \phi_2 * lwage_t$$

where ϕ_1 and ϕ_2 are the normalized PCA loadings. By substituting *cost_index* for the two original series, we preserve the theoretical role of cost-push factors while multicollinearity can be eliminated. Subsequent VIF diagnostics (Table 4) confirm that, although PCA successfully eliminated the extreme collinearity between *lexrate* and *lwage*, some multicollinearity persists between the newly formed *cost_index* and *lgovtexp*. Specifically, *cost_index* and *lgovtexp* exhibit VIFs of 6.83 and 6.93, respectively. Both VIFs exceeds the common threshold of 5, beyond which multicollinearity may distort individual coefficient estimates (Gujarati & Porter, 2009). Nonetheless, Kennedy, 2008 and O'Brien, 2007 suggest a VIF of 10 as the classic cutoff for "serious" multicollinearity. Moreover, *cost_index* remains the most parsimonious proxy for wage- and exchange-rate–driven cost shocks, while *lgovtexp* captures policy-driven fiscal impulses and demand-pull factor. Thus, *cost_index* and *lgovtexp* can be used in this model with a minimum level of multicollinearity.

Table 4: Variance Inflation Factor (VIF) before and after PCA

	Before PCA		After PCA	
Variable	**VIF**	**1/VIF**	**VIF**	**1/VIF**
Lwage	92.83	0.0108	-	-
Lexrate	58.53	0.0171	-	-
Lgovtexp	11.59	0.0863	6.93	0.144
cost_index	-	-	6.83	0.146
real_int	1.14	0.8746	1.05	0.951
lcons_gap	1.04	0.9661	1.01	0.993
Mean VIF	**33.03**		**3.95**	

4. Methodology

The ARDL model is selected as the most theoretically appropriate and empirically robust framework for examining inflation dynamics in Bangladesh. Its ability to simultaneously estimate short-run and long-run effects while addressing the integration challenges provides a reliable basis for identifying the influence of demand-pull and cost-push factors on inflation over time. Moreover, the flexibility inherent in the ARDL approach allows for different lag lengths across the explanatory variables, which is a significant advantage in capturing the varying response speeds typical in macroeconomic phenomena. This feature enables the model to efficiently capture both short-run fluctuations and long-run equilibrium relationships within a single estimation process. The dual capacity of the ARDL methodology to estimate both an error correction term (ECT) for short-run adjustments and the long-run relationship over different time horizons (Pesaran et al., 2001; Narayan, 2005). The general form of the ARDL model used in this study is specified as follows:

$$lcpi_t = \alpha_0 + \sum_{\{i=1\}}^{\{p\}} \alpha_i lcpi_{\{t-i\}} + \sum_{\{j=0\}}^{\{q_1\}} \beta_j lcons_gap_{\{t-j\}} + \sum_{\{j=0\}}^{\{q_2\}} \gamma_j\, lgovtexp_{\{t-j\}} + \sum_{\{j=0\}}^{\{q_3\}} \delta_j\, costindex_{\{t-j\}} + \sum_{\{j=0\}}^{\{q_4\}} \theta_j\, real_int_{\{t-j\}} + \varepsilon_t$$

In this specification, t represents the current time period of observation (e.g., year), while j denotes the lag order applied to each explanatory variable, capturing their delayed effects across time.

4.1 Stationary Test

This study adopts the Auto-Regressive Distributed Lag (ARDL) modeling approach to explore the short-run and long-run effects of various inflation determinants. This framework is widely used to handle mixed-order integration of variables [I(0) and I(1)] determined by the stationarity tests (Pesaran et al., 2001). The Augmented Dickey–Fuller (ADF) unit root tests in Table 5 shows that the key variables in the model exhibit mixed orders of integration. Some of the variables are stationary at level [I(0)] while others require first differencing [I(1)].

Table 5: Augmented Dicky Fuller Unit Root Test

Variable	ADF Statistic (Level)	ADF Statistic (1st Difference)	5% Critical Value	Integration Order
Lcpi	–1.32	–2.29	–2.938	I(1) (weak)
lcons_gap	–2.87	–8.71	–2.938	I(0)
Lgovtexp	3.09	–3.11	–2.938	I(1)
cost_index	-2.84	-3.39	–2.938	I(1)
real_int	–5.31	–8.94	–2.938	I(0)

To ensure the robustness of the stationarity assessment, the Phillips-Perron (PP) test was employed as a complement to the Augmented Dickey–Fuller (ADF) test. While both tests share the same null hypothesis of a unit root, the PP test adjusts for serial correlation and heteroskedasticity in the error terms. The results confirm that the first-differenced series of *lcpi* is stationary, while it was weakly stationary in ADF test. The Phillips-Perron test also confirms that *lcpi* is non-stationary at level but becomes stationary after the first differencing.

Table 6: Phillips–Perron Unit Root Test Results (with Trend)

Variable	PP Statistic (Level)	PP Statistic (1st Difference)	5% Critical Value	Integration Order
Lcpi	–2.23	–5.04	–3.512	I(1)
lcons_gap	–6.56	–11.99	–2.938	I(0)
Lgovtexp	-0.85	-6.09	–2.938	I(1)
cost_index	-1.72	-3.83	-3.512	I(1)
real_int	–6.32	-9.26	-3.512	I(0)

4.2. Lag-Order Selection

As assessing the presence of cointegrating relationships among the I(1) variables is essential before selecting the ARDL model, Johansen's cointegration tests were also employed using both the trace and maximum eigenvalue statistics (Johansen, 1988; Nkoro & Uko, 2016). The test uses one lag and a constant trend specification while the lag is determined based on Akaike and Schwarz information criteria (Table-7).

Table 7: Lag-Order Selection Criteria

Lag	LL	LR	df	p-value	FPE	AIC	HQIC	SBIC
0	–591.957				418761	27.134	27.210	27.337
1	–326.202	531.510	25	0.000	7.4645*	16.191*	16.6421*	17.4075*
2	–305.616	41.171	25	0.022	9.549	16.392	17.219	18.622
3	–289.182	32.868	25	0.134	15.895	16.781	17.984	20.025
4	–267.290	43.785*	25	0.011	23.444	16.922	18.501	21.180

Note: Optimal lag selected by each criterion is marked with an asterisk (*). Endogenous variables: *lcpi, lcons_gap, lgovtexp, cost_index, real_int* Exogenous variable: *Constant term (cons)*

4.3 ARDL Bound Test for Cointegration

To test the existence of a long-run equilibrium relationship among inflation (*lcpi*), demand pull and cost push variables, we employed the ARDL bounds testing approach. Using a parsimonious ARDL (1,0,0,1,0) specification, the null hypothesis of no cointegration is tested against the alternative of a level relationship. We the computed F-statistic was 4.925, which exceeded the upper bound critical values of four regressors (k = 4) at 2.5% level of significance. The critical values of both F and T statistics for different levels of significance in Table 8. Higher F-statistic indicates that the null hypothesis of no cointegration can be rejected. Nonetheless, the T-statistic was -2.186, which lies above the lower bound critical value of -2.57 at the 10% level of significance. This higher T-statistic compared to the lower bound critical value makes the result less conclusive. However, following standard ARDL practice, we rely

primarily on the F-statistics for cointegration inference (Pesaran, Shin, & Smith, 2001), and the ARDL bounds test confirms the existence of a stable long-run relationship among the variables.

Table 8: F-statistics and T-statistics (Case 3) and their Critical Values

Statistics	Magnitude	Significance Level	10%	5%	2.5%	1%
		I(0) Bound	2.45	2.86	3.25	3.74
F-Statistics	4.925	I(1) Bound	3.52	4.01	4.49	5.06
		I(0) Bound	-2.57	-2.86	-3.13	-3.43
T-Statistics	2.186	I(1) Bound	-3.66	-3.99	-4.26	-4.60

4.4 Cointegration Validation and ARDL Specification

As the study has small sample sizes and variables integrated at mixed orders (I(0) and I(1)), it follows the Autoregressive Distributed Lag (ARDL) approach. Moreover, preliminary unit root tests confirmed that none of the series were integrated at order two which satisfies the key precondition for ARDL estimation. Hence, lag selection criteria including AIC, HQIC, and FPE shown in Table 7 supports a parsimonious lag structure with one lag. This does not mean that "all variables must have one lag," but rather that a lag length of one in the system performs best. Within this framework, a bounds test was conducted using a Wald restriction on the lagged level terms. The joint test for all regressors yielded an insignificant F-statistic ($F = 1.37$, $p = 0.2623$), which suggests no cointegration under that specification. However, a focused test on the lagged *cost_index* variable which was constructed via principal component analysis from exchange rate and wage data produces a statistically significant result ($F = 4.22$, $p = 0.0465$). This indicates a meaningful long-run relationship between inflation and this composite cost-push indicator. The findings of different test restrictions are presented in Table 9.

Table 9: ARDL Bounds Test Using Wald Test for Lagged Level Terms

Test Restriction	F-statistic	Degrees of Freedom	p-value
L.lcons_gap = L.lgovtexp = L.cost_index = L.real_int = 0	1.37	(4, 37)	0.2623
L.lcost_index=0	4.22	(1,40)	0.0465

The choice of only lagged *cost_index* variable is also supported by strong economic theory and correlation patterns, which also validates the use of the ARDL framework. The *cost_index* variable captures structural cost pressures consistent with Gordon (1975)'s cost-push inflation theory and reinforces its inclusion in the model. The ARDL model is therefore adopted to estimate both the short-run dynamics and long-run elasticity of inflation with respect to both demand-pull and cost-push macroeconomic drivers.

4.5 Why the ARDL framework is appropriate for the study

Conventional multivariate cointegration techniques, such as the Vector Error Correction Model (VECM), require that all variables be integrated of order one [I(1)] and exhibit at least one cointegrating relationship. These prerequisites are not satisfied in the present study, as the explanatory variables include a mixture of I(0) and I(1) series, and all I(1) variables do not display confirmed cointegration. Likewise, a standard unrestricted Vector Autoregression (VAR) model is unsuitable, as it assumes stationarity and cannot capture long-run equilibrium dynamics through an error correction term (ECT). Although VECM accommodates ECT structures, its requirement of uniform integration order and cointegration limits applicability to this dataset. In contrast, the Autoregressive Distributed Lag (ARDL) approach, as formulated by Pesaran and Shin (1999), is flexible to mixed orders of integration (excluding I(2)) and does not necessitate pre-established cointegrating relationships. This makes ARDL particularly appropriate for the current empirical context. This also ensures robust and unbiased parameter estimation while it can mitigate the risks of spurious regressions associated with level-based non-stationary series.

4.6 Model Equation

In its unrestricted form, our ARDL model captures dynamic interactions among variables without distinguishing between long-run equilibrium relationships and short-run adjustments. The model has the following form:

$$lcpi_t = \alpha_0 + \alpha_1\, lcpi_{t-1} + \beta_0\, lcons_gap_t + \gamma_0\, lgovtexp_t + \delta_0\, cost_index_t + \delta_1\, cost_index_{\{t-1\}} + \theta_0\, real_int_t + \varepsilon_t$$

To overcome this limitation and enhance interpretability, the model is re-specified using the ec1 option in Stata, which reformulates the ARDL framework into its Error Correction representation. This enriched version decomposes the estimated relationships into three analytically distinct components: the adjustment coefficient, indicating the rate at which inflation reverts to its long-run trajectory following a deviation; the long-run multipliers, reflecting the sustained influence of explanatory variables; and the short-run effects, which account for immediate, transitory impacts. Such disaggregation strengthens both the econometric robustness and the policy relevance of the findings by separating equilibrium dynamics from short-term fluctuations.

The short run form:

$$\Delta\, lcpi_t = \phi\{EC\}_{\{t-1\}} + \sum_{\{j=0\}}^{\{q_1\}} \beta_j\, \Delta\, lcons_gap_{\{t-j\}} + \sum_{\{j=0\}}^{\{q_2\}} \gamma_j\, \Delta lgovtexp_{\{t-j\}} + \sum_{\{j=0\}}^{\{q_3\}} \delta_j \Delta cost_index_{\{t-j\}} + \sum_{\{j=0\}}^{\{q_4\}} \theta_j \Delta realint_{\{t-j\}} + \varepsilon_t$$

The long run form:

$$lcpi_t = \alpha_0 + \beta_1 lconsgap_t + \gamma_1\, lgovtexp_t + \delta_0\, costindex_t + \delta_1 costindex_{\{t-1\}} + \theta_0 realint_t + \varepsilon_t$$

4.7. Adoption of Structural Shock Markers

A growing body of research shows that natural disasters, particularly floods, can cause severe supply-side disruptions and acute food-price spikes in developing economies (Loayza et al., 2012). Though it is always evident that flood causes price hike due to supply chain disruptions, especially for food items, there is limited or no empirical studies on the effect of flood on Bangladesh's inflation. Likewise, global commodity-price shocks and financial-market turmoil transmit rapidly to domestic price levels via import costs and exchange-rate pass-through (Rogoff, 2007). Omitting these episodic, high-magnitude disturbances risks misattributing transitory inflationary spikes to underlying macroeconomic drivers. To isolate persistent demand- and cost-push effects, we therefore introduce two binary indicators: *flood_year* (1 if the

year faced major flooding) and *global_shock_year* (1 if Bangladesh economy faced a significant global-market shock in that year). Figure 4 shows inflation over the years with structural shock markers such as floods and global shock. To differentiate the effect of structural shock markers, the first empirical Model does not include the structural shock markers while second empirical model incorporates both.

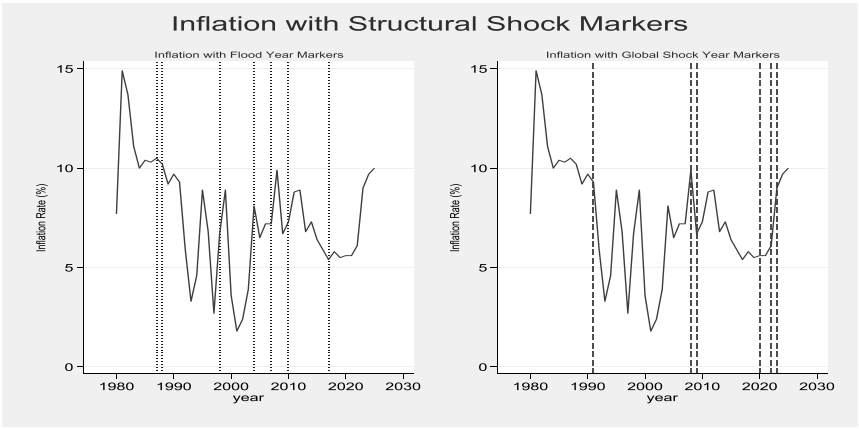

Figure 4: *Inflation with Structural Shock Markers: Flood and Global Shock*

5.0 Empirical Result

5.1 General ARDL Model Result:

Table 10 presents the results of the general ARDL model. The estimated ARDL(1,0,0,1,0) model reveals a statistically robust and well-fitted specification of inflation dynamics in Bangladesh. The lagged dependent variable, *L.lcpi*, exhibits a strong and highly significant positive coefficient across both models (0.833** and 0.843***). It indicates considerable inertia in the inflation process. Though consumption gap (*lcons_gap*), becomes significant in Model 1 (0.339, p>0.10), it becomes marginally significant in Model 2 (0.526*, p < .10) which also suggests that demand-side pressures are more salient once flood and global-shock indicators are introduced. Fiscal influence captured by government expenditure (*Lgovtexp*) remains positive and statistically stable across both models (≈0.05*) which supports the view that expansionary fiscal activity contributes to inflation. The composite index for exchange rate and wage (*cost_index)* displays a strikingly large and significant coefficient in both specifications (20.26*** and 18.21***). This reflects

the effects of cost-push factors, primarily wage growth and exchange rate depreciation, on inflation. Its lagged component (*L.cost_index*) enters with a negative sign which seems counter intuitive; however, *cost_index* is a composite index of log transformed exchange rate and wage index. Thus, the negative sign doesn't mean a real negative association between *lcpi* and *cost_index*. Real interest rates (*real_int*) exhibit a consistently negative and significant coefficient (≈ – 0.23***) which also confirms immediate dampening effect on inflation through contractionary monetary channels. The inclusion of *flood_year* and *global_shock_year* in Model 2 yields marginally significant positive coefficients (1.85* and 2.25*), which suggests that transitory supply-side shocks exert upward pressure on inflation. The constant term is both large and significant (≈30–32) and implies persistent baseline inflation even after accounting for structural and cyclical influences. Overall, the results point to a layered inflationary structure driven by entrenched cost-push dynamics, moderated demand-side impulses, and episodic exogenous shocks.

Table 10: ARDL(1,0,0,1,0) Regression

Variable	Model 1	Model 2
L.lcpi	0.833** (0.076) [0.679, 0.987]	0.843*** (0.073) [0.695, 0.991]
lcons_gap	0.339 (0.266) [-0.198 – 0.876]	0.526* (0.265) [-0.010, – 1.063]
Lgovtexp	0.053* (0.029) [-0.006, 0.111]	0.049* (0.028) [-0.007, 0.105]
cost_index	20.258*** (5.966) [8.199, 32.316]	18.209*** (5.795) [6.477, 29.941]
L.cost_index	-12.006** (5.844) [-23.818, -0.195]	-10.673* (5.698) [-22.208, 0.862]
real_int	-0.225*** (0.076) [-0.377, -0.072]	-0.226*** (0.072) [-0.373, -0.080]
flood_year		1.851*

		(1.009) [-0.191, 3.893]
global_shock_year		2.253* (1.147) [-0.068, 4.574]
_cons	31.809** (13.926) [3.663, 59.954]	30.468** (13.584) [2.969, 57.966]
R^2	0.9993	0.9994

Standard errors are in parentheses, Lower bound and Upper Bound of Confidence Interval in [ ]

*** p<.01, ** p<.05, * p<.1*

5.2 Error Correction ARDL Model Result:

Table 11 presents error-correction adjustment, short-run and long-run results. The ARDL error correction model yields a statistically significant adjustment term, and the estimated short-run and long-run coefficients also provide nuanced insights into both transitory shocks and persistent structural drivers of inflation in Bangladesh's economy.

5.2.1 Adjustment Terms:

The negative and statistically significant adjustment term confirms the presence of a long-run relationship among the variables. The error correction term *(L.lcpi*) is negative and statistically significant in both Model (1) and Model (2) (–0.167 and –0.157, respectively) which confirms a stable long-run relationship and indicates that approximately 16–17% of deviation from the long-run equilibrium is corrected each year. This finding validates the use of the ARDL error correction model and confirms that inflation responds to disequilibrium shocks in a stable and predictable manner over time.

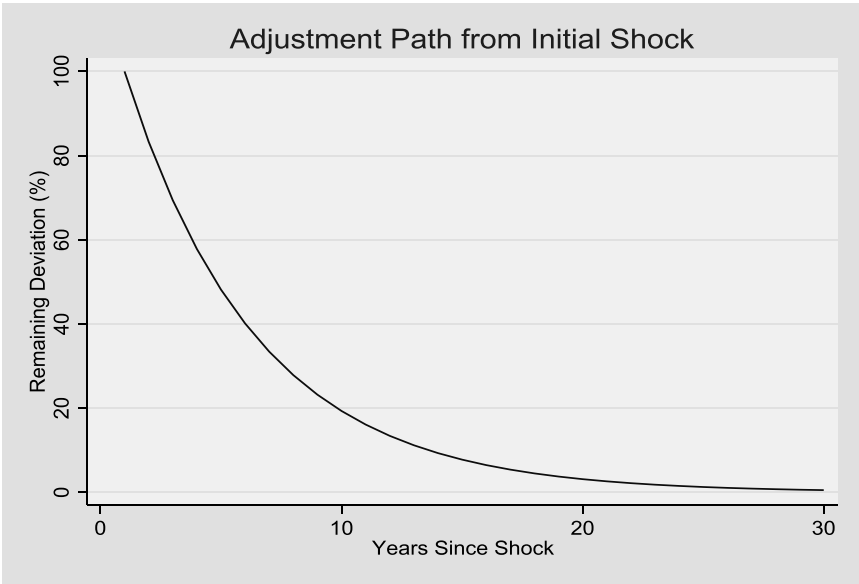

Figure 5: *Shock Absorption Dynamics in Bangladesh: A 30-Year Projection*

5.3 Long-Run Coefficients

In the long-run component, the lagged consumption gap (*L.lcons_gap*) exhibits a positive relationship with inflation. The relationship becomes stronger and statistically significant at the 10% level in Model (2) (coefficient: 3.348; $p < 0.1$), which highlights the role of demand-side pressures. This finding suggests, once the economy adjusts, a 1% increase in the consumption gap is associated with a 3.35% increase in CPI (inflation), assuming all other variables are held constant. Government expenditure (*lgovtexp*) remains consistently significant ($p < 0.01$) across both models with a coefficient of approximately 0.31, and that also implies a 1% increase in government expenditure is associated with a 0.31% increase in inflation, holding other factors constant. So, the impact of *lgovtexp* is positive and inelastic which also indicates a mild but persistent effect of government expenditure in inflation.

The *cost_index*, comprises of wage and exchange rate components, displays a remarkably large and highly significant coefficient (approximately 48-50) and underscores the magnitude of cost-push effects on the inflation trajectory. The exceptionally large coefficient associated with the composite *cost_index* (≈48–50) reflects the

compounded inflationary pressure exerted by its underlying components-exchange rate depreciation and wage growth. This magnitude appears odd relative to other regressors, but it is methodologically consistent with the use of Principal Component Analysis (PCA). Since PCA standardizes and orthogonally rotates the original variables, the resulting index captures the maximum shared variance but loses its original economic scale. Thus, a one-unit change in *cost_index* represents a significant joint structural shift in both wage and exchange rate levels, not a marginal percentage movement. Interpreting the coefficient through the lens of cost-push inflation theory (Gordon, 1985), the finding aligns with established evidence that structural supply-side pressures, including rising input costs and currency depreciation are potent inflation drivers, especially in developing economies with import dependencies and wage-price rigidities. The statistical robustness and consistency of the *cost_index* across model specifications affirm its explanatory relevance. Rather than distorting the model, its strength highlights the importance of capturing compound cost-push mechanisms through dimensional reduction techniques like PCA when there are issues of multicollinearity.

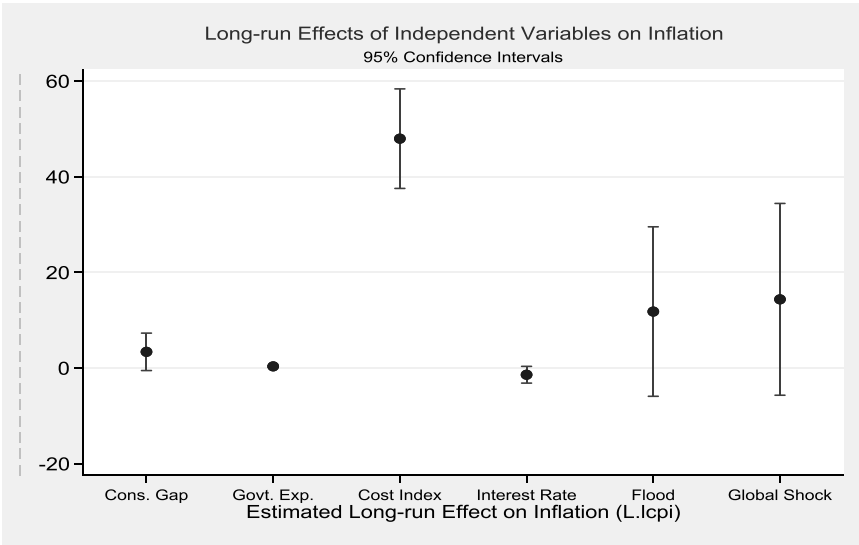

Figure 6: *Long-run Effects of Independent Variables on Inflation*

Real interest rate (*real_int*) is negatively associated with inflation in the long run, although the relationship is not statistically significant at the conventional 10% threshold level (p=0.108). This suggests that tighter

monetary conditions may not consistently translate effectively into inflation control in the long run. The two exogenous dummy variables—*flood_year* and *global_shock_year*—though positive, do not exert statistically significant effects in the long run, and this situation indicates that such shocks have more transient effects.

Table 11: ARDL (1, 0, 0, 1, 0) Regression[4]

Outcome Variable: *lcpi* (log value of Consumers Price Index)			
Variables		(1)	(2)
Adjustment Terms	*L.lcpi*	−0.167*	−0.157*
		(0.076)	(0.073)
		[−0.321, −0.013]	[−0.305, −0.009]
Log Run Coefficient	*lcons_gap(L1.)*	2.032	3.348*
		(1.566)	(1.933)
		[−1.132, 5.197]	[−0.565, 1.063]
	lgovtexp(L1.)	.316***	.311***
		(.085)	(.089)
		[0.144,0.488]	[0.131,0.491]
	cost_index(L1.)	49.477***	47.924***
		(4.786)	(5.139)
		[39.804,59.150]	[37.520, 58.329]
	real_int(L1.)	-1.346	-1.44
		(.819)	(.866)
		[-3.002,0.309]	[-3.193,0.313]
	flood_year(L1.)		11.771
			(8.753)
			[-5.949, 29.491]

[4] Stata has been used to produce the estimates, and it's ec1 option directly transforms the ARDL into ECM and reports long-run coefficients. However, estimates of this study were cross validated using both Stata and EViews.

	lobal_shock_year(L1.)		14.326
			(9.905)
			[-5.724, 34.377]
Short Run Coefficient	*D.lcons_gap*	.339	.526*
		(.266)	(.265)
		[−0.198, 0.876]	[−0.010, 1.063]
	D.lgovtexp	.053*	.049*
		(.029)	(.028)
		[−0.006, 0.111]	[−0.007, 0.105]
	D.cost_index	20.258***	18.209***
		(5.966)	(5.795)
		[8.199, 32.316]	[6.477, 29.941]
	D.real_int	-.225***	-.226***
		(.076)	(.072)
		[−0.378, −0.072]	[−0.373, −0.080]
	D.flood_year		1.851*
			(1.009)
			[−0.191, 3.893]
	D.global_shock_year		2.253*
			(1.147)
			[−0.068, 4.574]
	Consant	31.809**	30.468**
		(13.926)	(13.584)
		[3.663, 59.954]	[2.969, 57.966]
	Observations	47	47
	R-squared	.531	.595

Standard errors are in parentheses, Lower bound and Upper Bound of Confidence Interval in []

*** p<.01, ** p<.05, * p<.1

5.4 Short-run Coefficients :

The short-run dynamics reveal additional important patterns of inflation in Bangladesh. Most notably, the cost-push component (*cost_index*) exerts a strong and immediate effect, with a coefficient of approximately 18–20 and high significance levels ($p < 0.01$–0.003 across both specifications). This underscores the volatility of input costs particularly due to wage adjustments and exchange rate fluctuations as a primary short-term inflationary driver. Additionally, the real interest rate (*real_int*) consistently shows a negative and statistically robust coefficient ($\approx$ -0.22, $p < 0.01$). It implies that 1% increase in real interest rate is associated with 0.22% decrease in inflation immediately, keeping everything else constant. This suggests monetary tightening exerts a meaningful and immediate dampening effect on inflation in the short run. Government expenditure (*lgovtexp*) also plays a role, with marginal significance ($\sim$0.05, $p \approx 0.07$–0.08). A 1% increase in government expenditure is associated with 0.05% increase of inflation, indicates that fiscal injections may contribute to inflationary pressures during policy shifts or expenditure surges, though the impact is more modest compared to other shocks.

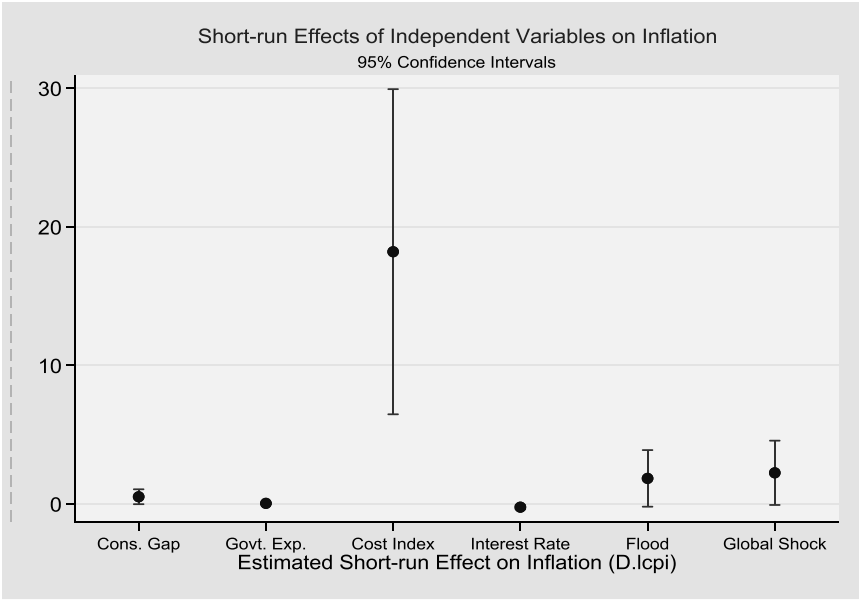

Figure 7: *Short-run Effects of Independent Variables on Inflation*

When accounting for episodic exogenous shocks, the extended ARDL model incorporating *flood_year* and *global_shock_year* captures notable transient effects. Both indicators exhibit positive coefficients (1.85 and 2.25 respectively) and hover near the conventional threshold for significance ($p \approx 0.074$ and 0.057). This implies that supply-side disruptions, whether climate-induced or externally driven, can amplify inflation in the short term. The consumption gap (*lcons_gap*), considered as a key demand-side determinant, shows inconsistent short-run significance. As the consumption gap becomes borderline significant ($p \approx 0.054$) only when exogenous shocks are included, which suggests its short-run effect may be conditional or secondary. Overall, these results point to a layered short-run inflation structure where cost shocks dominate, policy instruments exert measurable influence, and unforeseen supply-side disruptions seek much attention in the context of forecasting and policy response frameworks.

However, the constant terms in both models are also positive and statistically significant. This may indicate the presence of persistent inflationary forces not directly explained by the macroeconomic variables included. This residual pressure may also reflect structural inefficiencies such as extortion, governance shortcomings, monopolistic pricing behavior, or market rigidities within essential sectors.

5.5 Robustness and Stability Diagnostics

To ensure the reliability of the estimated ARDL model, we conducted a series of specification, stability, and variance diagnostics. First, the Ramsey RESET test was applied to detect potential functional form misspecification. The F-statistic (0.00046) and associated p-value (0.983) of the test indicate no evidence of omitted nonlinearities and confirm the adequacy of the model specification. Structural stability was further assessed using the CUSUM and CUSUM of Squares tests based on recursive residuals. In both cases, the test statistics remained within the 5% significance bounds throughout the sample period, which suggests no structural breaks or parameter instability. To test for heteroskedasticity, we also employed the Breusch-Pagan-Godfrey test. The test yielded a p-value of 0.3785, which indicates that the null hypothesis of homoskedasticity could not be rejected. The Breusch-Godfrey LM tests

for serial correlation at both one and two lags[5] were also employed and those confirm the absence of autocorrelation in the residuals These suggest that the residuals exhibit constant variance. Collectively, these diagnostic results confirm the robustness of the model and validate its use for inference.

6. Discussions and Limitations

6.1 Discussions

Our analysis reveals that Bangladesh exhibits very high inflation persistence, which is reflected by the estimated error correction term (ECT) of approximately -0.16. This coefficient implies that only about 16% of the deviation from the long-run equilibrium is corrected each year in the absence of further disturbances. This slow convergence suggests a sluggish adjustment process and underlying deep-rooted structural rigidities within the Bangladesh economy. In contrast, Rasul & Tarique (2018) report an ECT of -0.65 for India using annual data, while Chakrabarty & Varma (2015) finds the estimated ECT of -0.66 for the Wholesale Price Index (WPI). These indicate a far faster speed of adjustment toward long-run equilibrium and inflation dynamics responds more promptly to disequilibrium shocks in India compared to Bangladesh.

Results of this study also confirm that both demand-pull and cost-push factors play significant roles in driving inflation in Bangladesh. The significance of the consumption gap and government expenditure supports the relevance of domestic demand conditions and aligns with Lansing (2025) and Shapiro (2024). Meanwhile, the strong role of wages, exchange rate, and interest rate points toward cost-push mechanisms, in line with Ahmad et al. (2024), Mahmud and Mondal (2024), and international findings (e.g., Ascari et al., 2024).

The aggregate private consumption gap appears to influence inflation intermittently. The magnitude is higher in the long-run and lower in the short-run while the statistical significance is relatively better in the short-

[5] P-values of Breusch-Godfrey LM tests for serial correlation are 0.717 for one lag and 0.511 for two lags.

run specification but weaker in long-run robustness. This suggests the private consumption gap contributes more reliably to short-term inflation fluctuations than to sustained long-run momentum. The episodic nature of influence indicates that domestic consumption shocks are not a structural driver of inflation in Bangladesh. Government expenditure exhibits consistently significant long-run and marginal short-run effects on CPI with a reliable statistical significance. Thus, it has a sustained role in inflation dynamics and validates fiscal stance as a central demand-pull contributor. Increased public consumption spending potentially amplifies aggregate demand pressures, with lagged effects that persist beyond current budget cycles.

The statistical strength of cost index both in short- and long-run horizons reinforces the interpretation that inflation in Bangladesh is substantially cost-push in nature and rooted in structural wage-price mechanisms and currency-linked input shocks. This finding is consistent with Bangladesh Bank (2025), which identifies wage growth in agriculture, industry, and services as a key cost push driver of inflation. When wages rise without a commensurate increase in productivity, firms often pass on the higher labor costs to consumers through price increases, which eventually fuels inflation (Begum, 1991). This dynamic is further compounded by institutional wage-setting mechanisms in Bangladesh, where public sector pay scale revisions and statutory minimum wage hikes in key industries are implemented periodically based on political and social considerations rather than market efficiency. Moreover, Bangladesh's dependence on external commodities and supply chains, the depreciation of exchange rate intensifies local production costs and amplify the pass-through to consumer prices. Moreover, exogenous shocks such as floods and global shock show a notable increase of inflation in the short run, though the long run impact was not visible in the study.

Our study finds the real interest rate is significant in the short run, which suggests that monetary tightening can temporarily suppress inflation. However, the long-run specification indicates that interest rate policy alone may be insufficient to structurally anchor inflation. This finding emphasizes the need for coordinated macroeconomic responses that would combine monetary policy steps with supply-side interventions.

Furthermore, the statistically significant constant term in the ARDL model points to persistent inflationary forces not directly explained by the included macroeconomic variables. These residual pressures may reflect deeper institutional challenges, which include limited market transparency, price distortions, and governance-related inefficiencies. These issues were broadly acknowledged in Bangladesh's macroeconomic assessments (IMF, 2023). The Centre for Policy Dialogue (CPD) has also highlighted domestic price anomalies, cartel behavior, and weak enforcement of competition laws as contributors to inflation persistence, particularly in essential sectors like food and energy (CPD, 2024).

Additionally, market concentration in essential sectors fosters monopolistic or oligopolistic price-setting behavior, which dampens responsiveness to macroeconomic shocks and contributes to inflation persistence. Empirical studies based on developed countries have shown that concentrated industries exhibit heightened price rigidity and reduced transmission of policy effects (Wang & Werning, 2022; Philippon, 2019; Boston Fed, 2022). On the other hand, there is no strong evidence in the research literature that market concentration is a primary cause of inflation in Bangladesh, perhaps due to data constraints. In Bangladesh, industries such as poultry, edible oil are dominated by only a handful of large firms that exercise significant market power. These monopolistic or oligopolistic structures maintain elevated markups and display little incentive to adjust prices swiftly when input costs change.

6.2 Limitations

While this study provides robust insights into the long run and short run dynamics of inflation using ARDL framework, it does not incorporate all the possible drivers of inflation. Potentially influential factors such as energy price, credit growth and inflation expectations were not included due to data constraints and model parsimony considerations. For example: this study does not incorporate a global energy price index in the empirical model, despite evidence in the literature suggests that a positive relationship remains between international energy prices and domestic inflation. Inclusion of such an index was empirically unsustainable within the model and Bangladesh context. Energy prices in

Bangladesh are largely determined by administrative decisions and political considerations. There are regular practices of providing subsidies and imposing price controls rather than market mechanisms. Consequently, domestic prices for electricity, gas, diesel, and fertilizer often diverge from global energy price trends and do not respond predictably to international supply-demand shifts. The inflationary impact of these disconnects manifests indirectly through increased public expenditure, as the state absorbs fiscal pressure to maintain regulated prices. Therefore, in this model, cost-push inflation arising from energy subsidies is proxied through the government expenditure variable, rather than modeled as a separate price channel.

Similarly, this study excludes log-transformed public investment from the final specification. Though public investment is theoretically relevant variable, its coefficients across multiple specifications were statistically insignificant and exhibited counterintuitive signs. The decision of dropping this variable can avoid empirical instability; however, the modeling focus on recurrent expenditure can capture more accurately in both short-term and long-term inflation pressures in the Bangladesh context.

7. Conclusion and Policy Implications

This study offers robust empirical evidence that inflation in Bangladesh is highly persistent and primarily driven by cost-push factors, notably wage-sensitive input costs and exchange rate pressures. These cost-push factors dominate both short-run and long-run dynamics. Government expenditure also contributes to immediate inflationary spikes, while its persistent impact appears marginal. Demand-side indicators like the consumption gap exert modest influence, particularly when interacting with supply-side shocks. Importantly, episodic disruptions such as floods and global shocks amplify inflation pressures and improve model fit. This underscores the significance of transitory events in the inflationary process.

From a policy standpoint, the findings highlight the need for a multi-pronged inflation management strategy. Authorities should focus on mitigating cost-side volatility, including wage rigidities and imported inflation from exchange rate depreciation. Strengthening targeted

subsidies, improving wage-productivity alignment, and enhancing agricultural resilience may curb supply-side inflation. Additionally, short-run monetary tightening via interest rates shows effectiveness which suggests that coordination with fiscal policy is essential. Incorporating structural shock monitoring into macro-fiscal surveillance can help formulate more responsive and adaptive inflation control frameworks.

Persistent inflationary pressures in Bangladesh may be partially rooted in opaque market practices, including cartel behavior, price manipulation by syndicates, and weak regulatory oversight. Tackling these institutional distortions requires robust competition policy, transparent enforcement mechanisms, and greater accountability in market surveillance. Strengthening governance and dismantling informal pricing networks will be critical in complementing macroeconomic strategies aimed at inflation control.

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An Empirical Analysis of the Sensitivity of Bangladesh's Inflation and Output Gap to Taylor Rule Parameters

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Abstract

The analysis explores the bidirectional influence between monetary policy shifts in Bangladesh and fluctuations in output and prices. Specifically, the study attempts to identify the impact of the Taylor Rule parameters on inflation and output gap. Estimated by standard production function (Cobb-Douglas) and Hodrick–Prescott (HP) filter, output gap accounting is conducted from yearly data of 1990 to 2024. The monetary policy reactions were identified by estimating a Structural Vector Autoregression (SVAR) model consisting of output gap, inflation and real policy rates. Analysis of the structural shocks to the equations indicates that the aggregate demand shocks are smoothly absorbed by the economy within the medium term. Secondly, the aggregated supply shocks impact sluggishly on the price levels, indicating significant price rigidity in the Philips Curve. Thirdly, the monetary policy sensitivity towards the output gap and inflation are not found to be counter-cyclical, rather the reaction seems to be slow and pro-cyclic, especially against inflation. The recent high inflationary persistence of Bangladesh provides an impetus for undertaking a rule based countercyclical monetary policy adoption.

Keywords: Inflation, Output gap, Taylor rule, Philips curve, Monetary policy.

JEL Classification: E52, E58, E31, E32, C32

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1. Introduction

Economic growth and price stability are the two major policy objectives that the monetary policy of Bangladesh tries to achieve. It is customary that the macroeconomic policy undertaking along with fiscal policy stances of the Government are coordinated for informed decision making. However, as economies are becoming more complex due to various financial innovations and diversities, the debate of taking rule based monetary policy decisions has become prominent (Mishkin, 2018; Taylor, 2011). Like Bangladesh, many countries target monetary expansion as the main policy variables, which may lack transparency accountability and equity for the economic agents (Friedman, 1976). The argument, however, against rule-based monetary policy undertaking is that it is very stringent and does not provide enough flexibility, especially during uncertainty in the real economy. Mishkin (2018) states that rigid policy stance eventually bars policymakers from taking discretionary actions for unforeseen events. In this backdrop, the primary objective of the study here is how the monetary policy decisions have been aligned with the overall macroeconomic goals of the country. In doing so, the study addresses two specific questions: i) Could it had been an efficient trade-off between inflation and growth if Taylor Rule were used? ii) Is it possible to improve the policy reaction of the central bank by following Taylor principles for policy undertaking?

Analyzing some of the past studies and Monetary Policy Statements (MPS), it is found that in most instances monetary policy in Bangladesh is undertaken by a combination of monetary targeting with prudential guidelines aimed at limiting the extend of credits expansion for the Banks and Non-Bank Financial Institutions (Alam, 2015). Although there is an implicit target for inflation in the policy undertaking, the policy instruments in most of the cases turn out to be targeting broad money (M2) instead. In recent years, however, Bangladesh Bank has started making an explicit announcement on inflation targeting in the policy statements. The underlying assumption here is that the policy signals from the money market transmit to and from the goods market with reasonable ease. Although, Alam (2015) has showed in an analysis that monetary policy of Bangladesh is not efficient in impacting the short run economic fluctuations. This study, however, undertakes that analysis

with recent data stretching up to 35 years. Based on the relationships among inflation, Gross Domestic Products (GDP) and monetary policy the study tries to find if there is any definite pattern in the monetary policy undertaking. Specifically, the analysis tries to disentangle the response of monetary policy due to change in price levels and output gap of Bangladesh.

While this study tries to identify the policy reactions of the Central Bank due to wider macroeconomic changes, it is also imperative to understand how economic growth and inflation interact among themselves in different phases of economic expansion and contraction. To do that a description of the Philips Curve is given in the context of Bangladesh. The analysis delves into the nature of inflation by evaluating the linear relationship between output gap and inflation over the 35-year period. As this analysis requires output gap data, this study undertakes the task of computing that by widely used Cobb-Douglas production function and filtering approaches.

The study is conducted by a New Keynesian Model for Bangladesh consisting of a simple univariate demand function, an aggregate supply equation and the Taylor Rule interest principle for monetary policy. As the variables of these three equations are endogenous in the economy, they are combined into a Structural Vector Autoregression (SVAR) modeling with appropriate identification restrictions. The impulse response functions, variance decomposition and estimation of the model are discussed to understand how monetary policy is undertaken and what are the consequences of such policies.

After starting with the introductory section, the paper provides an analysis of the monetary policy adoption by the Central Bank of Bangladesh. Subsequently, an account of inflation and output gap is discussed to understand how Bangladesh economy has evolved over supply and demand shocks. The following section provides with a SVAR modeling of Bangladesh economy where output gap, inflation and real policy rates are taken as the key variables. The modeling consists of three main equations namely, output equation, a Philips Curve relationship and Taylor principle for real policy rates. The paper concludes with results, discussion and policy implication for Bangladesh economy.

2. Macroeconomic trends and monetary policy in Bangladesh

Bangladesh Bank, immediately after establishment in 1972 adopted a highly interventionist monetary policy to address post-independence reconstruction (Ahmed, 2007). The government nationalized all banks on March, 1972 under the Bangladesh Banks (Nationalisation) Order, 1972, which enabled the state with direct control over the financial sector to channel resources into rebuilding the war-torn economy. This is done by imposing interest rate controls, selective credit allocation, and administrative directives, all under the explicit direction from the Government (Afrin, 2017; Barkawi & Monnin, 2015).

State-led development priorities during this period focused on rehabilitating key industries, particularly jute and textiles, and expanding agricultural production. These objectives were outlined in the First Five Year Plan, launched in July 1973, which targeted an annual GDP growth rate of 5 percent (Alam, 2016). To realize these goals, directed lending through nationalized commercial banks was implemented, with 75 percent of total advances in the 1970s allocated to the public sector and trade (Mollik & Bepari, 2009). Bangladesh Bank's intervention was further supported by concessional foreign aid and credits, such as the first IDA loan of 50 million US Dollars from the World Bank in November 1972, aimed at reconstructing vital sectors including agriculture, industry, transport, and telecommunications (IDA, 1972).

In 1980-1990, the government of Bangladesh took the first initiative to liberalize monetary policy by appointing the National Commission on Money, Banking and Credit in July 1984 and crucially, issuing Bangladesh Bank's interest-rate deregulation circular on November 1989 that replaced fixed rates with floor-and-ceiling bands and began phasing out directed credit ceilings (Choudhury & Raihan, 2000). In that regime a wave of private financial institutions was established and proliferated rapidly (Jahan & Muhiuddin, 2020; Watanagase, 1990). The non-bank segment also expanded for longer term investment (Ahmed & Chowdhury, 2007). During this period policy directives used to communicated solely through internal circulars to banks, with no formal Monetary Policy Statements or systematic disclosure of objectives, targets or data (Nawaz & Chowdhury, 2014). Throughout this period, there was an explicit strategic emphasis on expanding the banking sector

through the rapid expansion of new private and non-bank financial institutions, without focusing on macroeconomic stabilization or developmental targets (World Bank, 1990).

Bangladesh Bank's prolonged reliance on administered instruments—credit ceilings, interest-rate caps and selective lending has encountered increasing challenges in containing inflation and stabilizing exchange rate, as underscored by the IMF and World Bank (Canton, 2021; Maimbo & Henriquez Gallegos, 2014). In response, the Financial Sector Reform Program (FSRP) was launched in June 1990 under IDA's Financial Sector Adjustment Credit, marking a gradual shift toward market-based monetary management. This reform process included the liberalization of interest rates in April 1992, the adoption of indirect monetary tools such as periodic adjustments to the Cash Reserve Ratio (CRR) and Statutory Liquidity Ratio (SLR) to manage liquidity and the implementation of Open Market Operations (OMS). Additionally, the policy framework shifted focus toward targeting monetary aggregates, specifically broad money (M2), with annual growth ceilings set at 14 percent for 1991–1995. As a result, the average annual growth rate of broad money moderated to 12.9 percent during the 1990s, accompanied by a decline in inflation to 5.7 percent (Islam, 2008; Mujeri & Younus, 2009). To further align monetary policy with market signals, Bangladesh adopted a floating exchange rate regime on May 2003, primarily to enhance export competitiveness and better absorb external shocks. This move was part of broader efforts to liberalize trade and allow the domestic currency to adjust freely against foreign currencies (Dalton, 2007). Finally, the introduction of biannual Monetary Policy Statements (MPS) in January 2006 institutionalized transparency and predictability in the Central Bank operations (Bhattacharya & Khan, 2009).

Despite limited exposure to international financial markets, the economy of Bangladesh faced challenges from global financial crisis of 2007-2008 through reduced export demand, declining remittances and global commodity prices volatility. Bangladesh Bank responded that by reducing the repo rate from 6.0 percent to 4.75 percent and cut the CRR from 5.5 percent to 4.0 percent in March–April 2009. Despite the introduction of the 13 percent lending rate cap in FY2008-09, Bangladesh achieved approximately 6.0 percent GDP growth while

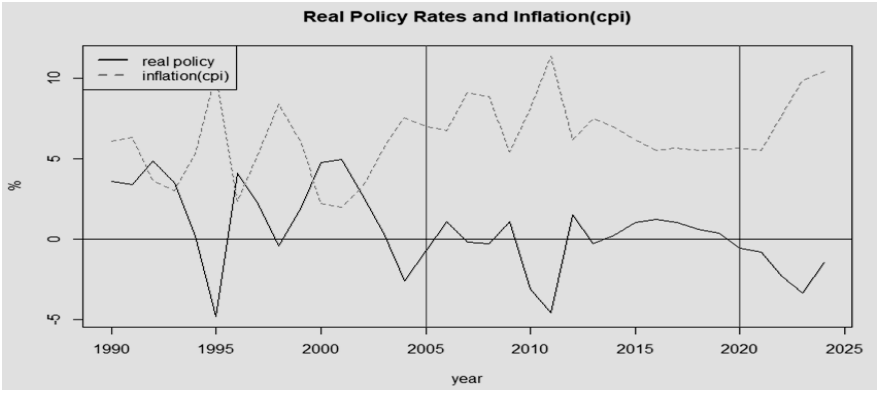
maintaining manageable inflation (ADB, 2009; Bhattacharya & Khan, 2009). Research conducted by Bangladesh Bank in 2012 suggesting that a threshold inflation level of 7-8 percent was optimal for Bangladesh's economic growth. The findings provided empirical support for the government's inflation target of 7.5 percent set in the FY2012-13 (Younus, 2015). Simultaneously, institutional development and wider financial inclusion, including the launch of the Bangladesh Automated Clearing House (BACH) in 2010 and the Bangladesh Electronic Funds Transfer Network (BEFTN) in 2011, paved the way for further digital transformation in the financial sector (BangladeshBank, 2013).

From 2016 to 2021, Bangladesh Bank continued an accommodative stance with policy rates around 6.0–6.75 percent and inflation targets of 5.5–5.7 percent. The most consequential development was the implementation of interest rate caps in April 2020, introducing a 9 percent lending rate ceiling that remained in effect until May 2024, significantly undermining monetary policy effectiveness (Bangladesh Bank, 2022). The period from 2022 onwards marked a fundamental transformation as persistent inflation emerged as the primary challenge, with point-to-point inflation surging from 6.15 percent in FY22 to 10.49 percent in August 2024. This has prompted the most aggressive monetary tightening cycle in Bangladesh history by increasing the repo rate from 5.0 percent to 10.0 percent through 11 successive increments. The transition to interest rate-based monetary policy was formalized in July 2023 with the introduction of the Interest Rate Corridor (IRC) system, marking a significant departure from monetary aggregate targeting to inflation targeting (Asia & Pacific Dept, 2024; BangladeshBank, 2024).

An examination of the key financial indicators over time illustrates the implications of different monetary policy regimes to the real economy. Figure 1 below shows the relationship between real policy rates and consumer price index (CPI) during 1990 to 2024. In early 1990s, the central bank managed to keep real rates slightly positive as inflation fluctuated around 5 percent, demonstrating some counter-inflationary resolve. However, by the mid-1990s, real policy rates declined to around (-) 5 percent when inflation spiked above 10 percent, reflecting policy accommodation that contributed to price pressures. From year 2000 to

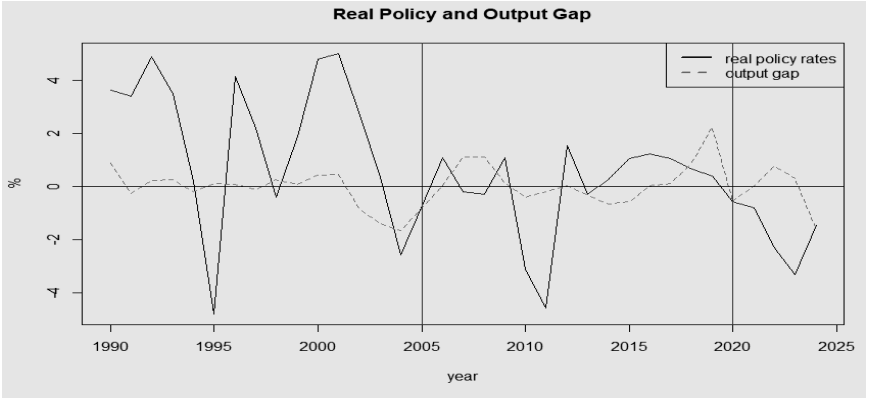
2005, the real policy rate and inflation briefly converged as the policy rate rises marginally above inflation, but after 2005 the real policy rate remained persistently negative or near zero while inflation stayed elevated above 5 percent, even breaching 10 percent again in the 2010s and early 2025.

Figure 1: Real policy rate and Inflation (1990-2024)



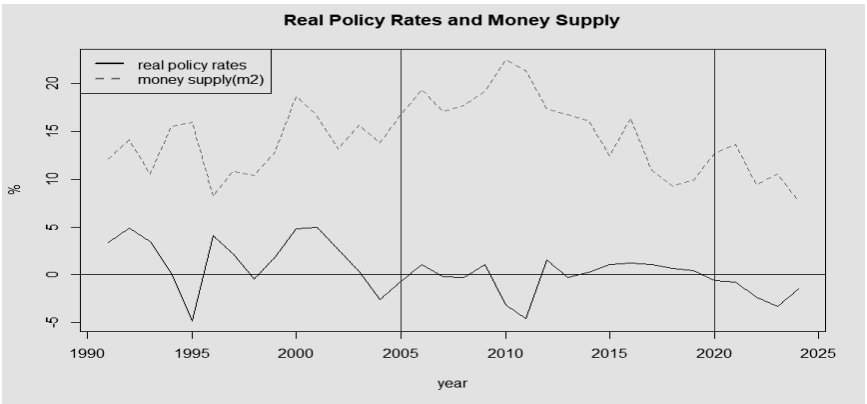
The prolonged period of near-zero or negative real interest rates despite high inflation indicates that Bangladesh Bank has not systematically adjusted the nominal policy rate in response to deviations of inflation from target, as prescribed by Taylor's rule. This is consistent with empirical evidence showing that Bangladesh Bank's monetary policy during 1972-2016 responded pro-cyclically to output rather than counter cyclically to inflation, producing a pro-inflationary bias (Zayed, 2018).

Figure 2: Real policy rate and Output Gap (1990-2024)



Illustrated in Figure 2, the positive real policy rates in early 1990s coincided with modestly positive output gaps, suggesting limited monetary tightening in response to output surge. By the mid-1990s, real rates fell sharply to around (–)5 percent during negative output gaps, reflecting a countercyclical easing intended to support the economy in downturns. From year 2000 to 2005, real policy rates rose significantly, reaching the highest level, while output gaps were slightly positive or near potential, indicating that tighter policy coincided with a strengthening economy. After 2005, real policy rates stayed near zero regardless of output fluctuations, signaling a neutral stance that did not respond actively to either overheating or slack. During the 2007-08 crisis, the Central Bank continued cutting real policy rates even as output gaps closed, showing a clear bias toward supporting growth and maintaining liquidity.

Figure 3: Real policy rate and Money Supply (M2) (1990-2024)



Now to understand the evolution of money circulation in the economy, it is seen that in early 1990s, real policy rates remained slightly positive while broad money (M2) growth moderated around 12 to 15 percent, indicating some restraint on money creation (Figure 3). However, by the mid-1990s, large negative real policy rates coincided with surging M2 growth above 15 percent, reflecting a very relaxed monetary policy stance that fueled high liquidity with upward price pressures. Growth of money supply has reached the highest level after 2010 owing to one of the lowest real policy rates stances of the Central Bank in that period. After that until the year 2020 the real policy rates remain positive in most of the time which helps control the upward spiral of money growth in the

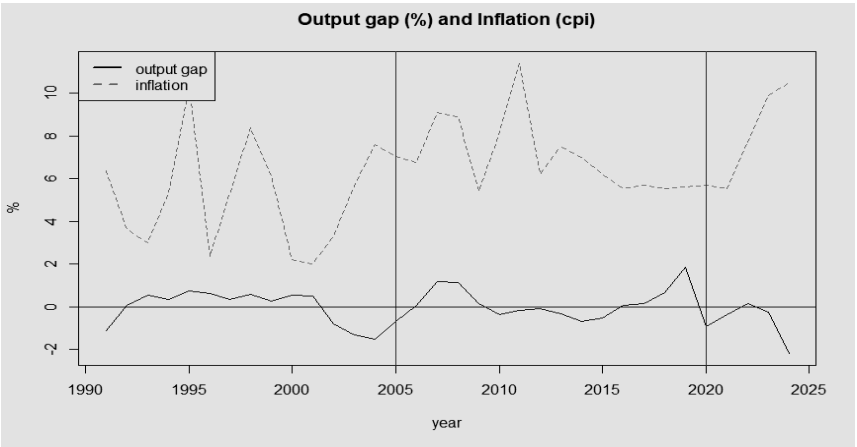
economy. The post COVID monetary growth shows somewhat counter intuitive trend as both real policy rates and money growth are subsiding simultaneously. This is an indication that the sensitivity of the interest rates signals to the money growth are now somewhat reduced to some degrees at the latter part of the study period.

In general, it is seen that there are some divergences among monetary policy, output gap and inflation in Bangladesh. These variations may arise when the policy instruments are mostly focused towards short-term liquidity management alone.

3. Inflation and output gap dynamics in Bangladesh

Like any small and open economy, inflation in Bangladesh is not only a monetary phenomenon rather the supply side of the economy has a significant impact on the general price level. To conduct this analysis output gap and inflation are taken for discussion. From 1990 to 2024 the relationship between the two variables reveals a negative correlation of (–) 0.18, indicating that inflation tends to rise when the output gap is negative. This finding is somewhat counterintuitive, as conventional macroeconomic theory often suggests that higher economic growth (a positive output gap) is associated with increased inflationary pressure. For comparison, a recent study on South Africa finds a positive relationship between GDP growth and inflation, although the inflationary impact of growth shocks diminishes when inflation is already low (Ndou & Gumata, 2024). The Figure 4 below illustrates this inverse relationship between inflation and the output gap in Bangladesh.

Figure 4: Output Gap and Inflation (1990-2024)



As shown, inflation in Bangladesh tends to decline when output exceeds its potential and rises when output falls below the natural level. This pattern is especially evident in 2024, when inflation surged during a period of negative output gap. Similarly, the Phillips Curve relationship between inflation and unemployment appears weak in the context of Bangladesh. While A. W. Phillips (1958) first demonstrated an inverse relationship between inflation and unemployment in the UK, later studies in the U.S. by Samuelson and Solow supported the same finding. However, Friedman and Phelps in the late 1960s argued that the trade-off between inflation and unemployment would eventually disappear as expectations adjust. Recent empirical research in Bangladesh also challenges the Phillips Curve hypothesis. Ruhia et al. (2024), using data from 1991 to 2022, find no significant relationship between inflation and unemployment. Instead, they report a strong positive correlation between money supply growth and inflation.

The concept of the non-accelerating inflation rate of unemployment (NAIRU) is critical to this discussion. Blanchard (2021) explains that when unemployment falls below NAIRU, inflation rises, and vice versa. Gondal et al. (2014), in a panel data analysis of five SAARC countries covering the period 1971 to 2012, estimate Bangladesh's NAIRU to be 7.85 percent. They argue that if unemployment remains below this threshold, wage pressures intensify, contributing to inflation. Conversely, if unemployment exceeds the NAIRU despite positive output, slack in the labor market results in subdued inflation. These findings suggest that labor market conditions significantly influence inflationary dynamics and highlight the importance of job-creating policies to maintain supply-side stability.

Persistent supply-side disruptions are widely recognized as a key driver of recent inflation in Bangladesh. The Monetary Policy Statement 2025 identifies prolonged disruptions and market inefficiencies as critical contributors to inflation (MTMPS, 2025). Events such as the COVID-19 pandemic, the Russia–Ukraine war, and global food price volatility have amplified these challenges. However, inflation began to moderate in late 2024 due to a tighter monetary stance, stabilization efforts, and improvements in supply chain operations.

Hossain et al. (2025), using monthly data from 2018 to 2024, find that both short- and long-term inflation in Bangladesh are influenced by exchange rates, import volumes, global food prices, and consumer expectations—consistent with demand-pull and cost-push inflation theories. Given the country's dependency on food imports, inflation is especially sensitive to exchange rate volatility and food availability perceptions. Alam (2015) used a structural vector autoregression (SVAR) model to illustrate that monetary policy tools in Bangladesh—such as repo, reverse repo, CRR, SLR, and the call money rate—have limited effectiveness in curbing inflation due to structural inefficiencies. These include underdeveloped financial markets, high government borrowing, and reliance on microcredit. Moreover, the CPI inflation index may be distorted due to its heavier weighting on rural consumption and food items, particularly rice, as noted by Rahman et al. (2009).

Roy et al. (2023) report that policy interest rates have limited transmission effects on large-scale industries and small enterprises. Large firms are more responsive to exchange rate dynamics, while smaller businesses are less reliant on formal bank credit. These findings reinforce the idea that supply-side shocks have a more dominant influence on inflation in Bangladesh than interest rate policies. In early 2025, the government introduced tariff cuts and import facilitation measures during Ramadan to ease inflationary pressure—demonstrating that supply-side policies can have an immediate disinflationary effect. Some economists argue that monetary policy alone is insufficient to contain inflation in Bangladesh. While high policy rates may temporarily suppress demand, long-term inflation control requires structural reforms to improve supply chain efficiency and reduce market distortions (Khatun, 2024). Experts emphasize on addressing market syndication, improving value chains, and enforcing regulatory measures are crucial (BonikBarta, 2025).

4. Modeling

Based on the discussion above, this section provides a generic modeling framework where the interactions of the variables can be analyzed in the specific context of Bangladesh economy. To accomplish that a brief theoretical discussion is given, and after that the model specification is

provided. Then the identification strategy is presented followed by an elaboration on data and descriptive statistics.

4.1 Theoretical construction

In shaping the policy framework for economic stability and growth, the interaction between key macroeconomic variables such as output gap, inflation, and real interest rates are significant. Output gap signifies the extent of over or underperformance of the economy. While inflation in the economy shows price stability which may stem either from output shocks or monetary shocks in the economy. The real interest rates, on the other hand, are the reaction functions of the central bank to keep the economy aligned with the policy priorities. The interactions of these variables are important for achieving long-term growth and stability, which eventually are the principal objectives of any monetary policy undertaking. To explore the dynamic relationships between output gap, inflation and real interest rates, this study uses a Structural Vector Autoregression (SVAR) model. SVAR has a large empirical literature where understanding the effectiveness of monetary policy shocks is discussed at lengths (Bernanke & Mihov, 1998; Gerlach & Smets, 1995; Sims, 1992). To leverage from this econometric process, this study combines these endogenous variables to identify how they interact in a dynamic environment. As the combination of a typical economic relationship in a dynamic simultaneous equation model becomes difficult for identification, the class of SVAR modeling helps avoid those problems by imposing certain identifying restrictions with appropriate theoretical supports (Sims, 1980). This modeling allows to study both contemporaneous and lagged relationships among variables. By imposing restrictions on the contemporaneous structure, one can identify shocks and trace their effects over time through the lag dynamics of the system.

4.2 Model specification

In this exercise a New Keynesian approach of macroeconomic modeling is constructed, where a set of three equations consisting of an aggregate demand curve (AD), an aggregate supply curve (AS) and a Monetary Policy (MP) rule are brought together to construct the macroeconomic

foundation for Bangladesh economy. The underlying assumption in sequencing the variables in the data vector $[x_t]$ shows that output gap $[y_t]$ is not contemporaneously affected by real interest rates $[r_t]$; and inflation $[p_t]$ can react to output gap, but not to the real interest rate shocks instantly. Finally, real interest rates respond immediately to both the output gap and inflation.

The data series is in the following 3×1 vector:

$$x_t = [y_t \quad p_t \quad r_t]'$$

In equation (1), A is a 3×3 matrix of contemporaneous impact coefficients with one along the diagonal, μ is a 3×1 vector of intercepts, $B_j,\ j = 1,2,3 \ldots q,$ is a 3×3 is a matrix of autoregressive coefficients, and ε_t is a 3×1 vector of serially and mutually uncorrelated structural noises. This structural specification implies that the impact of an exogenous shock can be identified by the shocks to the vector ε_t.

$$Ax_t = \mu + \sum_{j=1}^{q} B_j\, x_{t-j} + \varepsilon_t \quad \text{---------- (1)}$$

The equation (2) is a demand equation where output gap is shown as a recursive process where only the lag variables of the $[x_t]$ vector determine the current output gap $[y_t]$ in the system.

$$y_t = \mu^{(1)} + \sum_{j=1}^{q} B_j^{(1)}\, x_{t-j} + \varepsilon_t{}^{ad} \quad \text{---------- (2)}$$

The equation (3) is a Philips Curve for supply side economy where inflation is determined by output gap and past lag values of the endogenous variables $[x_t]$ in the system.

$$p_t = \mu^{(2)} + \alpha_{py} y_t + \sum_{j=1}^{q} B_j^{(2)}\, x_{t-j} + \varepsilon_t{}^{as} \quad \text{---------- (3)}$$

Equation (4) is a modified Taylor Rule, generally used by the Central Banks to set policy rates in response to the changes in inflation and output gap.

$$r_t = \mu^{(3)} + \alpha_{ry} y_t + \alpha_{rp}\, p_t + \sum_{j=1}^{q} B_j^{(3)}\, x_{t-j} + \varepsilon_t{}^{tr} \quad \text{----- (4)}$$

This rule was first introduced by economist John B. Taylor in 1993. The idea here is that when inflation rises above target and output gap is positive the Central Bank should lower interest rates and vice versa. This rule-based system is systematic and transparent which allows both price stability and economic growth at the same time. The specification

indicates here that the current real interest rates are determined by output gap, inflations and other lag endogenous variables of the system.

4.3 Model Identification

To identify the structural model, cross-equation restrictions are imposed in the upper triangle of A matrix of the equation (1). Based on the economic reality, it can be assumed that price levels do not impact the supply of output in the same year, which implies that price signals transmit to the goods markets with lag effects. For similar reasoning the interest rates signal of the Central Bank is assumed to be impacted with only lags as well. The underlying assumption here is that current demand can be impacted by previous level of income. Because of these restrictions, inflation and real interest rates will not be able to impact output gap contemporaneously. Similarly, real policy rates will not be able to impact inflation in the same year. Based on these assumptions, the model identification by imposing restriction can be summarized as follows:

a) $\alpha_{12} = 0$, Inflation cannot impact output gap contemporaneously;

b) $\alpha_{13} = 0$, Real interest rates cannot impact on output gap contemporaneously;

c) $\alpha_{23} = 0$, Real interest rates cannot impact inflation contemporaneously;

d) $\alpha_{21} = \alpha_{py}$, Output gap can impact inflation contemporaneously;

e) $\alpha_{31} = \alpha_{ry}$, *Output gap can impact real interest rates contemporan*eously;

f) $\alpha_{32} = \alpha_{rp}$, Inflation can impact real interest rates contemporaneously;

After imposing the above restrictions and specifications, the A matrix is transformed as below:

$$A = \begin{bmatrix} 1 & 0 & 0 \\ \alpha_{py} & 1 & 0 \\ \alpha_{ry} & \alpha_{rp} & 1 \end{bmatrix}$$

The contemporaneous coefficient α_{py} indicates the impact of output gap on inflation on the economy in the same year. According to Philps Curve

a positive output gap brings about higher inflations in the economy and a negative one induces lower inflation, which indicates the sign of the coefficient is expected to be a positive one. Similarly, the contemporaneous coefficients α_{ry} and α_{rp} are for impact of output gap and inflation on real interest rates respectively. If the response of monetary policy is contractionary to a positive output gap, then the sign of α_{ry} will be positive or vice versa. In this case the policy signal from the real economy may come from the targeted output growth in the economy along with other determining factors. In the same note, if the reaction of monetary policy to higher inflation is elevated interest rates, then the sign of α_{rp} will be positive. In this case inflation targeting of that economy will determine the nature of the coefficient.

The structural shock of the equation (1), ε_t is a 3×1 vector where individual shock for each equation can be identified separately.

$$\varepsilon_t = [{\varepsilon_t}^{ad} \quad {\varepsilon_t}^{as} \quad {\varepsilon_t}^{tr}]'$$

Even after imposing restrictions on the structural equation (1), the identification is not possible until the equation is converted back to reduced form. The equation (5) is a representation of reduced form, where the inverse of the *A* matrix of equation (1) is factored into all the components of the right-hand side of the equation.

$$x_t = A^{-1}\mu + \sum_{j=1}^{q} A^{-1}B_j\, x_{t-j} + A^{-1}\varepsilon_t \text{ ---------- } (5)$$

Now the equation (5) can be re-written as reduced form as equation (6), which can be estimated easily.

$$x_t = v + \sum_{j=1}^{q} \varphi_t\, x_{t-j} + \delta_t \text{ ---------- } (6)$$

$$\text{Here, } v = A^{-1}\mu, \varphi_t = A^{-1}B_j, \delta_t = A^{-1}\varepsilon_t$$

In such specification, the impact of any structural shock coming from outside the system through the ε_t vector can be isolated by estimating the reduced form of equation (6). To accomplish that Impulse Response Functions (IRFs) are generally used for dynamic evaluation of the shock's propagation in response to impulse of the other variables in the system. Specification testing with model stability and variance decomposition are shown in the Appendix.

4.4 Data

This study uses a set of macroeconomic data from 1990 to 2024 from multiple sources, including the Bangladesh Bureau of Statistics (BBS), Bangladesh Bank and the World Bank's World Development Indicators (WDI). The inflation data are taken from the point-to-point Consumer Price Index (CPI), computed monthly by the BBS, which is converted to a 12-month average to represent yearly CPI movement. BBS recently introduced a new base year: 2021–22 = 100, replacing the previous base of 2015–16. This update was made for a better assessment of current consumption patterns, rural-urban shifts, the composition of economic growth, and changes in household expenditure behavior. During the study period, the average inflation rate was 6.37 with standard deviation of 2.29.

In addition to inflation, data on real output and capital formation are also taken from the National Income Accounts of the BBS to compute the output gap for this study. Since the base years were changed on three times during the study period, the data have been re-based using the most recent base year of 2015–16. This harmonization facilitates accurate calculation of potential output and output gap estimates utilizing the Cobb–Douglas production function and Hodrick–Prescott (HP) filter. Throughout the study period, a steady growth of both real GDP and investment was observed. As the BBS does not produce yearly labor data, these data are taken from the World Bank's World Development Indicators (WDI) database for this study. The trend in labor force participation in Bangladesh is seen to be increasing during this period.

The interest rates are sourced from the policy rates of Bangladesh Bank (including bank rates, repo rates, etc.). During the study period, the policy rates remained relatively stable, with a slight increase following the COVID-19 pandemic. The policy rates generally ranged from 6 percent to 7 percent with 1.31 standard deviation. Real interest rates are computed by adjusting the Central Bank's policy rates with corresponding CPI inflation rates. This study also uses the growth of broad money (M2) in the economy, which is taken from Bangladesh Bank. The output gap is calculated by the authors using relevant variables from Table 1.

Table 1: Descriptive statistics

Variables (from 1990 to 2024)	Mean	ST. DV
Real output (million BDT)[a]	14,683,738	8,356,332
Capital formation (million BDT)[a]	4091799.73	3076725.59
Labor (million)[b]	54.92	11.90
Output gap (%)[d]	-0.003	0.78
Inflation (CPI) (12-month average)[a]	6.37	2.29
Policy rates (%)[c]	6.93	1.31
Broad money growth (M2) (%)[c]	14.33	3.70
Real policy rates (%)[d]	0.56	2.51

Sources: *a: Bangladesh Bureau of Statistics, b: World Development Indicators (WDI), c: Bangladesh Bank, d: Authors' calculation*

5. Estimations and results

Based on the theoretical construction, model specification, identification strategy and data, the following sections provide empirical estimation of the Structural Vector Autoregression (SVAR) system with model fitting for Bangladesh economy. Along with other macro variables, this study incorporates output gap data in the SVAR estimation. As this data is not available in the public domain, this study estimates output gap for Bangladesh economy.

5.1 Output gap estimation

This study estimates output gap for Bangladesh where different factors of production are brought together to compute the economic output. Three types of production factors are considered, namely, physical capital, human labor and human capital. Physical capital includes buildings, machinery and equipment, usable natural resources; employment includes labor force and labor force participation rate; and human capital includes knowledge and skills of the labor force widely known as Total Factor Productivity (TFP). TFP is the amount of technical "know-how" available, and the economic structure determine how efficiently capital and labor are used to produce goods and services. Potential output

growth depends on the long-term developments of the factors of production.

In this study, output gap for Bangladesh is estimated by Cobb-Douglas production function approach as follows:

$Y_t = A_t \cdot K_t^{\alpha} \cdot L_t^{1-\alpha}$ ---------- (7)

After log transformation:

$ln\, Y_t = ln\, A_t + \alpha\, ln\, K_t + (1-\alpha)\, ln\, L_t$ ---------- *(8)*

Here,

- $0 < \alpha < 1$ is output elasticity of capital or capital share of the income;
- Similarly, $(1-\alpha)$ is the output elasticity of labor or labor share of the income;

The assumption here is that since capital and labor share of income is unity $[\alpha + (1-\alpha) = 1]$, the economy has constant returns to scale meaning doubling capital and labor doubles the output. With perfect competition, the share of national income that accrues to capital should equal α and the share for labor should equal $(1-\alpha)$. The estimation of capital stock in the economy is done by perpetual inventory method where an estimate of the capital stock (K) in a given initial year assumed, and subsequently the capital stock series builds up from that date with additional investment each year as shown below:

$$K_t = (1-\delta)K_{t-1} + I_t \text{ ---------- } (9)$$

Here:

I_t, is investment in year t

δ, is a depreciation rate in the economy

For estimating labor inputs in the production function, an approximation of actual and active labor force is essential. There are three possible ways to do that which may be estimated from the working age population or from the labor force participation rates or total work hours by the working age population. In this study the first approach is adopted where the working age population is estimated to be from 14 to 60 years from the World Development Indicators (WDI).

The third factor of the production function is TFP, also known as Solow residual, calculated from equation (7) as follow:

$$A_t = \left[\frac{Y_t}{L_t^{1-\alpha}.K_t^{\alpha}}\right] \text{---------- (10)}$$

After identifying the constituent elements of the production function, the individual ingredients are then transformed into log function and pass them through under HP-Filter to separate the trend and stochastic components of each variable. Then the de-trend variables are transformed back to level from log, which eventually become potential variables of the corresponding ones. Subsequently, with the potential elements of the production function potential output is computed from the following equation:

$$Y_t^* = A_t^*.K_t^{*\alpha}.L_t^{*(1-\alpha)} \text{---------- (11)}$$

Where, Y_t^* is potential output, A_t^* is potential TFP, K_t^* is potential capita and L_t^* is potential labor. The indices α and $(1-\alpha)$ are potential capital and labor share of the output respectively.

Finally, the output gap is calculated as:

$$Y_t^{OG} = \left[\frac{Y_t}{Y_t^*} - 1\right] \times 100\ \% \text{---------- (12)}$$

For computing output gap for Bangladesh as above, the following assumptions are taken:

i) In 1991 Capital-Output (K/Y) ratio was 2.06;

ii) Capital depreciation per year is, $\delta = 5\%$*;*

iii) In computing the Total Factor Productivity (TFP) by Cobb-Douglas equation capital share of output is, $\alpha = 0.5$ and labor share of output is, $(1-\alpha) = 0.5$ *;*

5.2 Model estimation

Estimation of A-matrix

The SVAR specification assumed that the output gap is the most exogenous in the short run, meaning it is not contemporaneously affected by inflation or interest rate shocks (at least within the same period).

Inflation is partly endogenous as it can contemporaneously respond to shocks in output gap, but not yet to interest rate within the same period. The interest rate is the most endogenous because it can contemporaneously react to both output gap and inflation shocks. The variables are tested with Augmented Dickey Fuller (ADF) and Phillips–Perron (PP) tests and found them to be stationary in level. The VAR stability is also tested and found that all the roots are less than one indicating a stable system. The estimates of the SVAR as specified above are as follows:

$$A = \begin{bmatrix} 1 & 0 & 0 \\ \alpha_{py} & 1 & 0 \\ \alpha_{ry} & \alpha_{rp} & 1 \end{bmatrix} \sim \begin{bmatrix} 1 & 0 & 0 \\ .24(.17) & 1 & 0 \\ -.03(.18) & 1.1(.17) & 1 \end{bmatrix}$$

Note: Standard Errors are in parenthesis ($p < .001$***, $p < .05$**, $p < .1$*)

The estimation of the supply side of the economy shows that a positive shock in the output gap on average will in turn increase inflation contemporaneously. This indicates that economic growth also comes up with inflationary pressure in the economy which supports the classical Philips Curve relationship. Although looking at the linear progression of the two variables in Figure 4 of section 3 does not provide enough evidence in favor to this obvious relationship, the estimation of the structural equations decuples the influences of other variables on inflation in this analysis. Regarding the statistical significance level (0.17) of the estimates, the fact may need to be considered that the sample size of the data is only 35 years' observation.

The estimation of the monetary policy equation (Taylor Rule) shows the probable relationship between real interest rates and inflation on average. According to the estimation, a positive shock to inflation leads to a positive reaction on average from monetary authority. This is to notice that the average positive reaction does not indicate how quickly the reaction is taken along the period. The reaction time of such an action can be traced by the impulse response functions (IRFs) discussed afterwards. The second structural parameter of the Taylor Rule is the monetary reaction of the central bank to the output gap in Bangladesh. Like the relationship of these two variables shown in Figure 2 in section 2, there is little relationship revealed during their co-movement which is

supported by a very small coefficient size (-.03). The negative sign here indicates a positive output shock leads to decrease in real policy rates indicating a procyclical nature of policy undertaking.

IRFs of contemporaneous coefficients

The major shortcomings of analyzing the elements of the contemporaneous coefficient matrix (A-matrix) are that they provide an average impact of the variables under consideration but hide the true nature of the relationship and how they behave in the medium to long term. Therefore, it is crucial to discuss the impulse response functions (IRFs) which can answer these questions in an instructive way. The relationship between the output gap and inflation as shows in Figure 5(D) indicates that the impulse of output shock in Bangladesh produces a very minor reaction to inflation along the medium-term. Although the initial reaction started with a reduction in inflation, it ends up being positive after around two years' time. This gives an indication that the inflations in Bangladesh in general is not a supply side issue so long as the volume of supply is concerned. Although it is possible that the distribution in the supply side may cause variation in inflation, the scope of the study will not allow to analyze that claim.

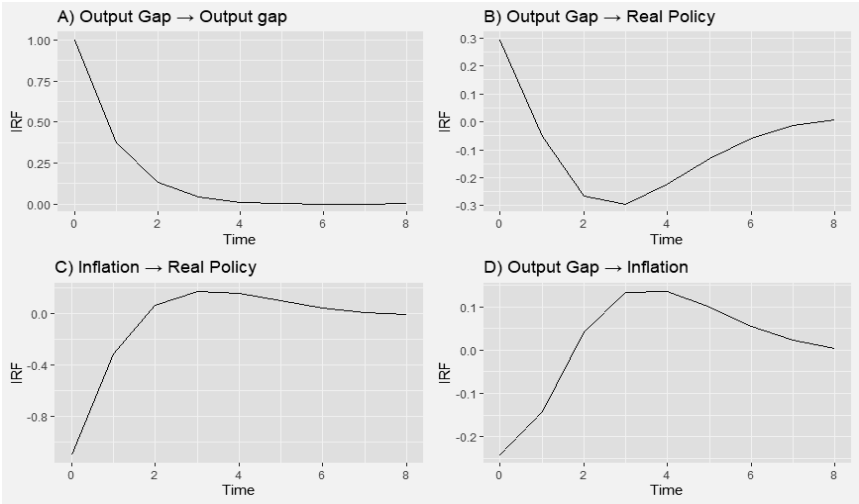
Turning to the demand side of the model, it is seen that identification restrictions are imposed on the aggregate demand (AD) equation in such a way that both inflation and real policy rates cannot impact the output gap contemporaneously. Therefore, the AD equation becomes an autoregressive (AR) process where its own lags impact recursively. The impulse response for a positive AD shock shows a self-reinforcing dynamic loop, which stays elevated for medium to long term (Figure 5A). This persistence suggests that the initial stimulation in demand is not just a sudden effect to the economy rather the feedback loops create this lasting impact in the economy. These shocks may arise from unexpected fiscal stimulus, increase in consumer confidence, or windfall endowments of natural resources. The smooth propagation of the of the demand shock for Bangladesh also implies a resilient economy with a sustained increase in growth.

From the discussion of supply and demand sides of Bangladesh economy from above, it is evident that the demand side is more sensitive towards

outside shocks compared to supply side. This may be because output gap has very little influence over inflation in Bangladesh economy. In this situation the inflationary events in Bangladesh are needed to be explained mostly by monetary policy of the central bank. As such, the Taylor principle becomes relevant in explaining the influence of economic growth and domestic price level movements on the policy undertaking by the Central Bank. As discussed in section 2, the transmission of monetary policy through money supply (M2) to the economy requires some time which eventually may impede the policy objectives. In such cases, a very quick or preferably preemptive monetary policy reaction is important. To achieve that a counter cyclical monetary policy may make sure that the economy falls back on to the medium-to- long-term potential output trajectory by minimizing any positive or negative output gaps. The policy reaction of the central bank of Bangladesh due to an inflation shock can be observed from Figure 5C, which displays that a positive inflation shock eventually leads to an expansionary monetary policy stance for around there years before reaching into a positive real policy rates territory. One of the explanations for the counterintuitive monetary policy undertaking during such cases is that due to inflation adjustment, the real policy rates become negative when the economy faces high inflation. Another explanation maybe that the Central Bank is not very aggressive in response to inflation due to other economic reasons.

The policy reaction of the central bank to a positive output shock is another important area of discussion for Taylor principle of monetary policy. The impulse response function here shows that with a positive output shock; the central bank temporarily reacts with slight positive policy rates before falling back to the negative real policy rates territory for medium-to-long term (Figure-5B). In this case, the policy stance for a positive output shock allows the economy to run above potential instead of bringing it back to potential output trends. The adverse consequence of such a stance is that large credit accumulation, wasteful investment proposition and inefficient usage of resources.

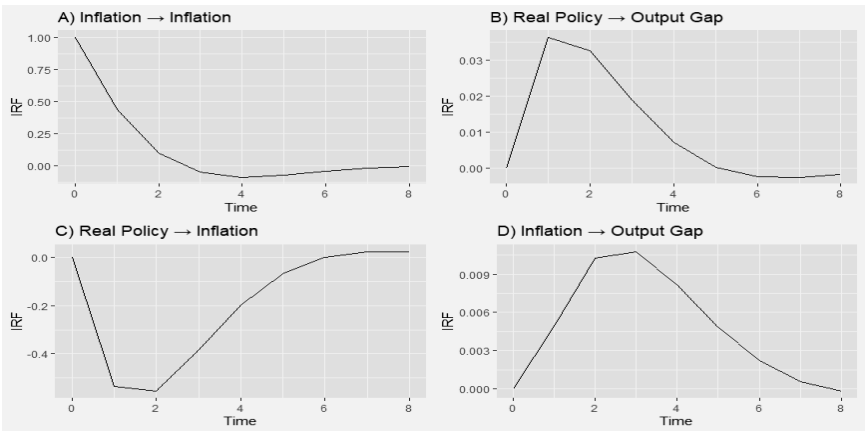
Figure 5: SVAR Impulse Response (Contemporaneous)



IRFs of lag coefficients

Due to identification restrictions, the contemporaneous impulse response from inflation and policy rates to output gap could not be assessed. However, the impulse response of the lags of these variables can be evaluated. It is seen from Figure 6D that like the contemporaneous impact of output gap on inflation, a positive shock to the lags of inflation has little or no impact on the output gap. This again implies that inflation in Bangladesh is not a supply side phenomenon or at least not related to the volume of production in the economy.

Figure 6: SVAR Impulse Response (Lag dynamics)



Now to see how the past policy action impacts the real economy, it is observed that positive policy shocks do not subdue output rather than the impulse response shows a slight increment in the output which remains in the positive territory in the periods ahead (Figure 6B). This remind the possibility that the vast portion of the GDP is not directly connection to the formal financial system of Bangladesh demanding greater role of financial inclusion. One of the most important findings, however, from the impulse of the past real policy rates is that higher policy rates lead to decrease inflation substantially in the medium term (Figure 6C). This is also an indication that the transmission of monetary policy may take some time before actual results are produced.

6. Discussion and policy

Monetary policy in Bangladesh operates through a comprehensive framework combining policy rates with regulatory and prudential guidelines, including reserve requirements, liquidity facilities, targeted credit programs, refinancing schemes, and open market operations. The analysis reveals that policy rate responses by the central bank, based on prevailing consumer price levels, exhibit significant transmission lags in the real economy. This finding aligns with empirical evidence showing that aggregate supply shocks impact price levels sluggishly, indicating substantial price rigidity in the Phillips Curve relationship. The delayed adjustment mechanism suggests that preemptive monetary policy actions can effectively reduce inflationary pressures over the medium term, as demonstrated by the impulse response functions in the structural model. It is seen, anecdotally, that the high inflationary pressure started after COVID pandemic in Bangladesh has been slowed down in early part of the year 2025 by a decision taken for an increment of policy rates back in 2024.

Another significant insight from the study is the weak responsiveness of prices to fluctuations in real output, which appears to challenge the efficient market hypothesis. The analysis indicates that variations in output volume do not produce predictable inflationary trends. Moreover, inflation shocks do not significantly affect production in subsequent periods. These findings suggest a structural market segmentation between the supply and demand sides of the economy. Producers may face price discrimination or encounter market access challenges in the

absence of supportive input pricing mechanisms. To address these issues, government interventions have included enhancing storage infrastructure, expanding food subsidy programs, and ensuring minimum support prices for agricultural producers (FPMU, 2021). Additionally, measures such as subsidized fertilizer distribution aim to reduce input costs and ease supply-side constraints. Infrastructure development is supported by expedited fertilizer import subsidies, where the government absorbs a significant portion of the subsidy cost on urea imports, ensuring that farmer prices remain affordable despite rising import costs. This integrated policy framework represents approximately 1.43 percent of GDP in FY2025-26 (MOF, 2025).

While monetary policy, particularly real policy rates adjustment, plays a role in inflation management, it must be complemented by strategies that foster employment generation. Elevated interest rates may deter private investment, leading to adverse effects on economic growth. Therefore, policy initiatives that incentivize investment i.e., income tax relief, duty-free importation of capital machinery, improved port logistics, and streamlined public service delivery for businesses, need to be prioritized. Recent reforms, such as the adoption of a floating exchange rate in April 2025, have so far stabilized foreign exchange markets and enhanced investor confidence. To further encourage foreign direct investment, policies ensuring profit repatriation and regulatory predictability are necessary. Given Bangladesh's large working-age population, job creation remains an essential pillar for building economic resilience and inclusive growth which eventually will bring the price levels to a sustainable zone.

However, the analysis reveals significant disconnects in monetary transmission mechanism of Bangladesh, which explain the persistent expansion of the M2 money supply without corresponding output gains. Over the period from 1990 to 2024, M2 growth averaged 14 percentage points annually, while the output gap remained virtually unchanged at (-)0.06 percentage point. This indicates an inefficacy in the traditional money-output relationship. Contributing factors include sluggish aggregate supply shock impacts on price levels, reflecting substantial price rigidity within the Phillips Curve, which limits the economy's responsiveness to monetary policy. Additionally, banking sector inefficiencies, with non-performing loans accounting for around 38

percentage points of total financial assets, create liquidity traps where increased money supply fails to flow into productive lending. Furthermore, the implementation of interest rate caps from April 2020 to May 2024 undermined the transmission mechanisms, fostering artificial credit expansion without productive investment. The reliance on discretionary liquidity management rather than systematic interest rate policies has highlighted the need for comprehensive structural reforms to restore effective transmission channels and ensure that monetary policy can drive sustainable economic growth.

Overall, the findings of this study underscore the potential benefits of incorporating inflation and output gap targeting into the monetary policy framework. The observed procyclicality of policy responses may stem from institutional lags or delayed decision-making. Incorporating rule-based frameworks—such as Taylor's Rule—could enhance the responsiveness and consistency of monetary policy. Aligning policy instruments with inflation trends and output dynamics may yield more effective outcomes. However, the efficacy of such policies hinges on deeper financial inclusion, accurate GDP measurement, and a conducive business environment. Moreover, policy formulation must adopt a dual focus on both aggregate supply and demand dynamics to ensure macroeconomic stability and sustained growth.

7. Conclusion

The paper started with an analysis of the Central Bank's monetary policy undertaking to assess whether it follows Taylor principle or any other rules while setting policy rates. To understand the supply side of the economy, a historical evaluation of inflation and output gap is conducted to see the pattern in the data ranging from 1990 to 2024. For this analysis, the computation of output gap was conducted by classical production function and HP filtering method. With the help of a New Keynesian approach consisting of output gap, inflation and real policy rates, SVAR modeling was conducted to find the dynamic nature of the relationships among the variables. The estimates along with the impulse response functions (IRFs) provide evidences that positive demand shocks reinforce a feedback loop in the economy making smooth absorption of the shocks over the medium-term. The supply side, however, shows sufficient price rigidity indicating that inflation in Bangladesh is not

primarily caused by production volume but instead by shortcomings in the functioning of efficient market mechanisms. Regarding the monetary policy reaction of the Central Bank, the analysis shows that during high inflation, the real policy rates were very lenient and slow in responding. To validate the effectiveness of the stringent policy stance during high inflation, the past positive shocks from real policy rates adoption show an improvement in inflation for the medium-term. The analysis may help adopting the Central Bank of Bangladesh a rule based monetary policy.

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Appendix

1. Stationarity of the variables:

Phillips-Perron Unit Root Test

Variables	Z-statistics(P-value)	Stationarity
Real Policy Rates	-22.14(0.02)	I(0)
Output Gap	-19.77(0.04)	I(0)
Consumer Prices Index (CPI)	-22.86(0.01)	I(0)

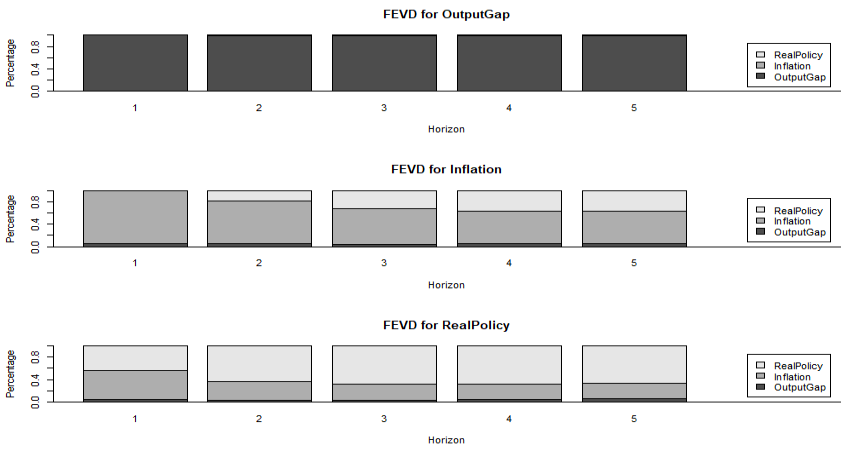
Augmented Dickey-Fuller Test

Variables	Z-statistics(P-value)	Stationarity (k=1)
Real Policy Rates	-4.26(0.01)	I(0)
Output Gap	-3.52(0.06)	I(0)
Consumer Prices Index (CPI)	-3.88(0.03)	I(0)

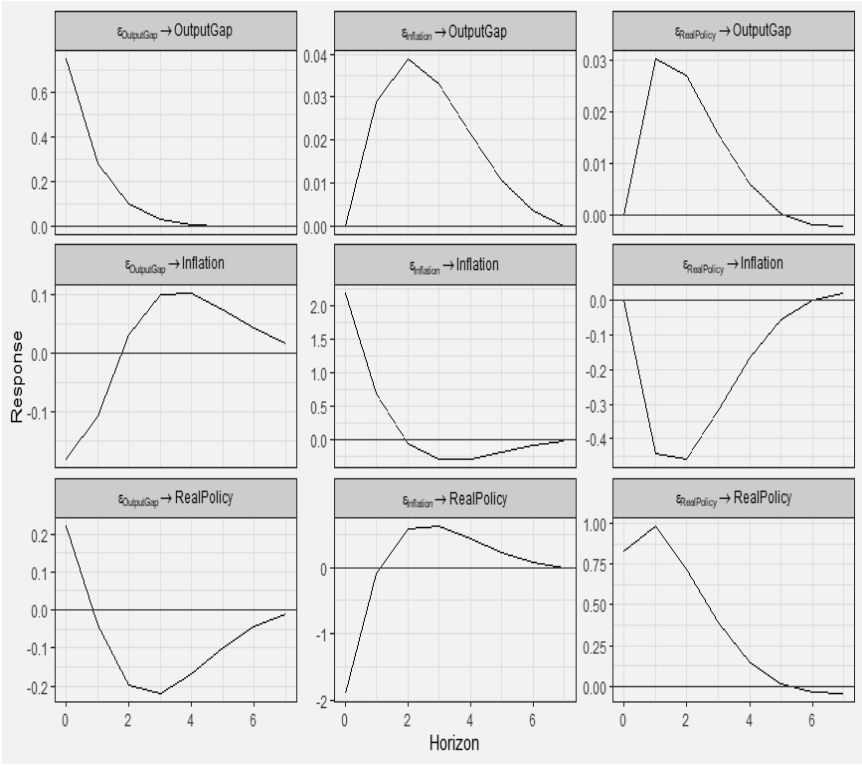
2. VAR Model stability:

Roots of the VAR system	Values	Stability
Root 1	0.5968147	Stable
Root 2	0.5968147	Stable
Root 3	0.3827380	Stable

3. Variance Decompositions



4. IRF of Cholesky decomposition



Bangladesh's Remittance Trends: Unpacking the Macroeconomic Influences

Suhana Islam[1], Ashraful Alam[2]

Abstract

This study endeavors to reveal the macroeconomic determinants influencing remittance inflows to Bangladesh, a country heavily dependent on the remittance income for macroeconomic stability and development. Based on the annual data ranging from 1980-2023, the paper employs Autoregressive Distributed Lag (ARDL) model for cointegration to determine both short-run and long-run associations between remittance growth and major macroeconomic variables including GDP growth, inflation, interest rate differentials, exchange rate fluctuations, unemployment in host countries and global oil prices. The study reveals that remittance growth is counter-cyclical to the GDP growth of Bangladesh and pro-cyclical with respect to the economic conditions of host countries while inflation and unemployment in host economies demonstrate strong positive impacts. These patterns of behavior suggest altruistic motives dominate remittance behavior particularly in economic distress in home country and inflationary pressure abroad. This paper confirms the existence of long-run cointegration among the variables and highlights the rapid short-run responsiveness of remittance growth due to host-country labor market shocks. The diagnostic tests validate the model's robustness, normality and stability. The negative sign of error correction term (ECT) suggests adjustment of the variables toward long-run equilibrium but value more than 1 indicates a problem which may have arisen from using less frequency time series data. Future research should explore the association of remittance inflows with macroeconomic determinants using high frequency data and incorporating non-linearities in the model.

Keywords: Remittances, ARDL, macroeconomic determinants, Co-integration, ECT.

JEL Classification: F24, F22, E60, O11, O15, C32

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1.0 Introduction

Shewly Islam, resident of a small village of Bangladesh, used funds sent by her husband working in Italy not merely for daily needs but to launch small-scale enterprises—establishing cattle farms, poultry, and a fishery. She proudly shares "After my husband returns home, just to make sure that he is not unemployed, I have built these farms ourselves. From these farms I acquire up to 15 lakh (1.5 million) takas annually. Moreover, I have employed 10 workers in my farms. I have seen from my surrounding people that using remittance, they have started some sort of small self-employment for them." (Mostafiz, 2023). Like the example of Shewly, remittances have emerged as a pivotal driver of economic development and financial stability across numerous developing economies, particularly those characterized by substantial labor-exporting nations. The financial transfers made by migrant workers to their families in their countries of origin constitute a critical source of foreign exchange and play a significant role in alleviating poverty, elevating household living standards, and improving broader macroeconomic indicators. Bangladesh is no exception which saw an average annual flow of USD 19.90 billion in the past 10 years making remittances as one of the key drivers of the economy (Bangladesh Bank). Here, remittance inflows account for a considerable share of gross national income and have been instrumental in sustaining balance of payments equilibrium, bolstering the domestic currency, and stimulating economic growth through heightened consumption expenditures. Over the past several decades, the persistent influx of remittances has profoundly influenced Bangladesh's macroeconomic landscape. As one of the world's foremost remittance-receiving countries, Bangladesh exhibits substantial reliance on these external financial inflows to maintain economic resilience amid both domestic and global uncertainties. Remittances from Bangladeshi migrants have steadily increased, especially during the period examined in this study. This development offered a measure of relief in mitigating the persistent current account deficit. This rise in remittances is largely credited to various government measures designed to promote the use of formal remittance channels. Key actions included provision of cash incentives for remittances, simplifying regulatory processes, and introducing official recognition programs for remitters. However, the magnitude and effects of remittance flows are contingent upon many other diverse

arrays of micro and macroeconomic variables in both source and recipient countries. Prominent among these determinants are total number of migrants, the economic conditions in both the origin and the destination countries, exchange rate fluctuations, interest rate differentials, inflationary dynamics, GDP growth trajectories, labor market conditions, investment opportunities and institutional factors such as the efficiency of the financial system and the robustness of regulatory frameworks.

A rigorous examination of the micro and macroeconomic determinants influencing remittance flows is essential for informing policy measures that optimize their developmental impact. Within the Bangladeshi context, empirical analysis of these factors yields valuable insights into the structural patterns governing remittance behavior and informs the design of strategies aimed at promoting financial inclusion, augmenting foreign exchange reserves, and supporting long-term economic sustainability. Accordingly, this study focuses on investigating the key macroeconomic variables that shape the volume and stability of remittance flow. In this regard the study tries to find out whether there is a long run relationship between macroeconomic variables (such as real gross domestic product, interest rate, inflation rate, exchange rate) and size of remittances inflow in Bangladesh. In addition, the study examines the short run long run impacts of the identified macroeconomic variables on migrants' remittances inflow in Bangladesh. Furthermore, an attempt has been made to find out how do migrants' remittance inflows respond to macroeconomic shocks caused by these variables in Bangladesh. We begin by outlining the theoretical framework surrounding the determinants of remittances, followed by a detailed review of the literature at the macroeconomic level. And finally, through comprehensive analysis, with the help of sophisticated econometric techniques.

2.0 Literature Review

According to (IMF, 2010) "Remittances represent household income from foreign economies arising mainly from the temporary or permanent movement of people to those economies. Remittances include cash and noncash items that flow through formal channels, such as via electronic wire, or through informal channels, such as money or goods carried

across borders. They largely consist of funds and noncash items sent or given by individuals who have migrated to a new economy and become residents here, and the net compensation of border, seasonal, or other short-term workers who are employed in an economy in which they are not resident." A wide range of studies have explored the determinants of remittances from both microeconomic (Cox & Stark, n.d.; Funkhouser, 1995; Gilal & Hong, 2024) and macroeconomic (Banerji & Chandrawanshi, 2021; Jijin et al., 2022) perspectives, utilizing various methodologies across different countries and regions, often yielding diverse findings. While global literature provides robust frameworks for understanding remittance dynamics, studies specific to Bangladesh are relatively sparse and often limited in scope, time frame, or econometric rigor. This lack of understanding makes it difficult for policymakers to design effective strategies to encourage the use of formal remittance channels, improve access to financial services, and reduce the use of informal systems like hundi. This study aims to fill the exiting gap with the help of existing literature and using updated data from 1980 to 2020 which is relatively large sample comparing the previous studies and using robust panel techniques to isolate the macroeconomic drivers of remittance inflows to Bangladesh.

The motivations for remittance flows are typically framed under two paradigms: altruistic motives and self-interest motives. (Lucas & Stark, 1985) introduced influential ideas that fundamentally shaped the understanding of migration and remittance patterns. They identified altruistic motives and self-interest motives (including "enlightened self-interest" or "tempered altruism") as key drivers of migrant behavior. In this context, altruism implies that migrants gain satisfaction from improving the welfare of their families back home, whereas self-interest indicates that remittances are motivated by the expectation of future returns by investing in home country assets. These motivations underpin decisions to remit, influenced by, implicit family contract, specifically in the forms of loan repayment (Djajić, 1986; Durand et al., 1996; Russell, 1986; Solimano, 2004; Stark, 1991) and co-insurance (Solimano, 2004). The loan repayment model posits that an implicit agreement exists between the migrant and their family, whereby the family invests in the individual's education and often covers the costs associated with migration—such as travel expenses and initial subsistence in the

destination country. This investment is later repaid by the migrants once they have become financially established abroad (Brown, 1997; Poirine, 1997).

A related but distinct framework is the co-insurance model of the implicit family contract, which emphasizes risk-sharing within the household. According to this theory, families send members—typically those with higher education levels—abroad as a strategy to mitigate economic uncertainty. This approach assumes that economic conditions in the origin and host countries are not perfectly correlated, allowing the family to diversify risk (Solimano, 2004).

At the micro-analytical level, the focus is typically on individuals' motivations for sending remittances. A range of micro-level factors—such as the socio-demographic characteristics of migrants and their families which encompass factors such as the migrant's age, gender, level of education, marital status, duration of stay, migration costs, exposure to risk, household income, wealth, size of the household of the remitter, household needs, specific family characteristics, experiences of shocks and dependency ratio- also play a significant role in influencing remittance behavior (Agarwal & Horowitz, 2002; Gilal & Hong, 2024; Holst & Schrooten, 2006; Islam & Nasrin, 2015; Nabi, 2012). Macroeconomic factors influencing remittance flows include the number of migrants, economic conditions in both host and home countries, differences in interest rates, unemployment differentials between the host and home nations, wage, income, exchange rate fluctuations, inflation levels, the state of financial development, and available investment opportunities (Gilal & Hong, 2024).

While considering the macro-economic variables that influence remittances flow elaborately, a stream of literature suggests that remittances increase during periods of economic growth in the recipient (home) country. This pro-cyclical behavior reflects self-interest motivations, where migrants view remittances as investments or responses to improved economic opportunities. Empirical evidence supporting this view comes from El-Sakka & Mcnabb (1999), Giuliano & Ruiz-Arranz (2009), Vargas-Silva & Huang (2006) all of whom find that higher GDP per capita in-home countries correlate with increased remittances. Contrarily, remittances are often described as counter-

cyclical, rising during economic downturns in the recipient country. This behavior reflects altruistic motives, whereby migrants remit funds to support family welfare during hardship. Evidence for this comes from studies such as(Amuedo-Dorantes & Pozo, 2006; Bettin & Zazzaro, 2012; Yang, 2008). These studies consistently report a negative relationship between GDP per capita and remittances. Studies such as (Swamy (1981) and (Elbadawi & Rocha, 1992) consistently find that stronger economic activity in host countries correlates with increased remittances. Conversely, unfavorable conditions in the home country (e.g., inflation, unemployment) often lead to increased remittances under altruistic motives (Bouhga-Hagbe, 2006; Vargas-Silva & Huang, 2006). The link between domestic inflation and remittance flows is unclear. High inflation may indicate weak economic policy, discouraging investment-driven remittances, while altruistic remitters may send more to support household welfare (Ali, 2012). Exchange rate fluctuation is cited as another critical determinant of remittances in many publications. Currency depreciation in the home country can increase the local purchasing power of remittances, encouraging migrants to send more funds. Studies by Bouhga-Hagbe (2006), and (Yang, 2008) confirm this relationship. These findings typically align with altruistic remittance behavior, especially under inflationary conditions. However, some panel data studies (Lueth & Ruiz-Arranz, 2008) found mixed or even negative effects of depreciation on remittance flows. An IMF study (Chami et al., 2005) using panel data from 87 countries (1980–2003) found that eliminating exchange rate distortions raised remittances by 1–2% of GDP, highlighting the significant impact of policies and regulations on remittance inflows. The role of interest rate differentials remains debated. Some studies (Azizi, 2017; Giuliano & Ruiz-Arranz, 2009; Quinn, 2005) find that higher interest rates in the home country attract remittances, consistent with investment motivations. El-Sakka and McNabb (1999) argue that interest rate differentials may deter remittances if migrants perceive higher returns abroad. (Hassan & Holmes, 2019) further distinguish between short-run and long-run effects, noting a positive short-term but negative long-term relationship. (Glytsos, 1997) in his study differentiates between remittances from temporary and permanent migrants, finding that temporary migrants remit mainly for investment and future consumption, while permanent migrants remit out of altruism. The unemployment rate in the host

countries influences the remittance growth in home country. This can be caused through liquidating the assets in the host countries by the migrants and bringing savings in home country due to uncertainty (Dustmann & Weiss, 2007) and remitting more money by working more hours to achieve the target faster (Yang & Choi, 2007). Moreover, the global oil prices can impact the remittance flows from host countries to home countries. Several studies found strong association between global oil price shock and remittance inflows (Das, 2020; Muhammad et al., 2022; Zahran, 2023).

Specific studies on Bangladesh remain limited. However, those available, including Barua et al., (2007), Datta & Sarkar (2014), Hasan (2008) and Rahman & Wadud (2014) emphasize the significance of GDP differentials, inflation, interest rates, and exchange rates. These variables have mixed influences depending on whether remittances are viewed through altruistic or investment lenses. Datta & Sarkar (2014), Nabi (2012), and Barua et al. (2007) found strong and consistent evidence that economic conditions in host countries significantly affect remittance flows. Specifically, host country GDP was found to have a positive and statistically significant impact on remittances in both Nabi's and Barua et al.'s studies, suggesting that improved economic performance in labor-receiving countries enhances migrants' capacity to remit. This aligns with findings from global literature (e.g. Elbadawi & Rocha, 1992 and Swamy, 1981) reinforcing the idea that remittance behavior is pro-cyclical with respect to host country income. In contrast, the economic condition of the home country, proxied by domestic GDP, exhibits a negative relationship with remittance inflows in the studies by Nabi (2012). This suggests a counter-cyclical pattern—migrants increase remittances in response to economic downturns at home, often to support consumption smoothing among recipient households. Such behavior is indicative of altruistic motivations, where remittances act as informal insurance during times of domestic economic stress. This altruism is further supported by Barua et al. (2007), who show that income differentials between host and home countries—measured by per capita GDP at purchasing power parity—positively correlate with remittance flows. The role of the exchange rate is also uniformly significant in the aforementioned three studies. A depreciation of the Bangladeshi Taka against foreign currencies leads to increased remittances, as evidenced in

Datta & Sarkar (2014), Nabi (2012), and Barua et al. (2007). This can be attributed to both wealth effects and improved purchasing power in the home country, which incentivize migrants to remit more funds, particularly through formal channels. Moreover, the appreciation of the host country currency increases the relative value of remitted amounts in domestic terms, thus encouraging further transfers. The impact of inflation presents a more nuanced picture. While Nabi (2012) finds no significant effect of inflation on remittances, Barua et al. (2007) detect a negative and weakly significant relationship, particularly when the differential between home and host countries is high. This suggests that inflation-induced macroeconomic uncertainty in Bangladesh may deter remittance flows, especially those motivated by investment or savings purposes.

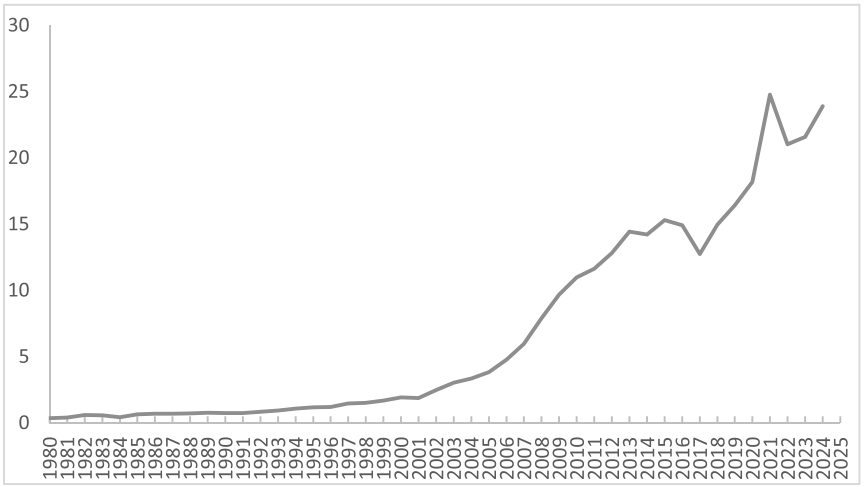
Finally, evidence of investment motives for remitting is mixed. While Datta & Sarkar (2014) acknowledge the theoretical relevance of portfolio motives, they do not explicitly test them. Barua et al. (2007), however, provide limited empirical support for investment motives, finding some significance for real interest rate differentials in alternative regression models using data from six major host countries. This indicates that remittance flows may, under certain conditions, respond to relative returns on financial assets, though altruism remains the dominant behavioral driver in the Bangladeshi context. In sum, the findings from these studies converge on several robust determinants of remittance inflows to Bangladesh: host country income, domestic economic hardship, exchange rate movements, interest rate and inflation. Altruistic motivations consistently underpin remittance behavior, while investment considerations play a more marginal and context-dependent role. Policymakers seeking to sustain and enhance remittance inflows must therefore focus on macroeconomic stability, exchange rate competitiveness, and the development of efficient, low-cost financial infrastructures to attract remittances through formal channels.

3.0 Remittances of Bangladesh: Some Stylized Facts

Remittances have become a cornerstone of Bangladesh's economic framework, playing a crucial role in sustaining national income, bolstering foreign exchange reserves, and improving the standard of living for millions of households. As one of the leading remittance-

receiving countries in the world, Bangladesh has continually reaped the benefits of financial inflows from its extensive diaspora. These earnings, primarily generated by migrant workers employed across a range of sectors overseas, have not only supported individual families but also provided critical macroeconomic stability by supplementing the country's fiscal and external accounts.

Figure 1: Trend of remittance flow (in billion USD)

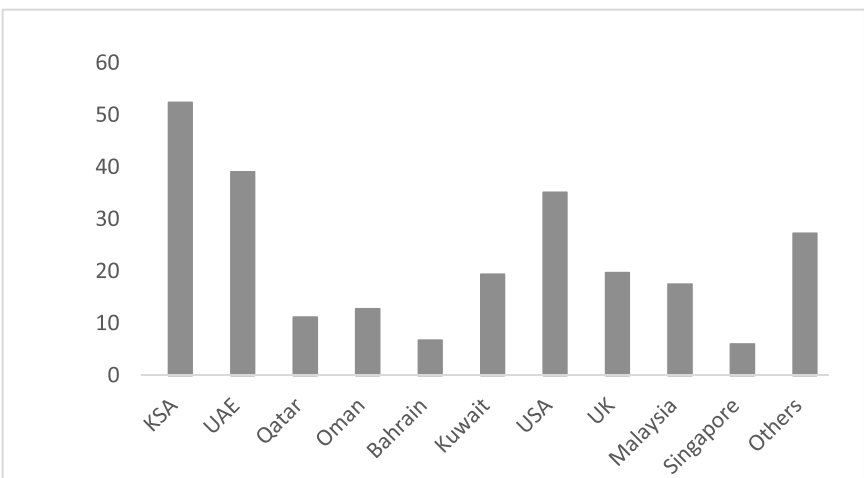


Source: *Bangladesh Bank*

Over the past few decades, the volume of remittance inflows into Bangladesh has shown a steady upward trend, with notable resilience even during global economic downturns. There were two times when the remittance inflows declined sharply. From FY2015 to FY2017, the remittance reduced for several reasons like- the decrease of oil revenue in Gulf countries which in turn reduced the migrants' income, fiscal tightening of GCC countries and increase of the expansion of hundi (curb market) (Bangladesh Bank, 2017). In the second phase of remittance down-turn is during the COVID shock (FY2021 to FY2023) worldwide. According to the *World Migration Report 2024*, Bangladesh ranked as the 8th largest recipient of international remittances in 2022, alongside countries like India, Mexico, China, and the Philippines. Bangladesh continuously ranks among the top ten remittance receiving countries of the world. This placement underscores the critical role that remittances play in the Bangladeshi economy and reflects the country's strong and

sustained reliance on its migrant workforce abroad. According to Bangladesh Bank data, remittances accounted for an average of 6.4% of the country's GDP over the past decade, positioning them as the second-largest source of foreign exchange earnings after ready-made garment (RMG) exports. In times of global stress, remittances have proven to be a reliable buffer. During the COVID-19 pandemic, when trade and RMG exports declined sharply, remittance inflows surged to a record high of USD 24.8 billion in FY2020–21. Historically Bangladesh faces deficit in trade account. According to data from the Bangladesh Bank, the country's current account deficit stood at USD 6.5 billion in FY2023–24, down from USD 18.6 billion in FY2021–22. Amid global inflationary pressures and dollar shortages in FY2022–23, remittances helped finance 60–65% of the country's merchandise trade deficit with a flow of 21.6 billion. In FY2023–24, remittance inflows reached approximately USD 23.9 billion, equivalent to 10.65% of GDP that year, reinforcing Bangladesh's status as one of the most remittance-dependent economies in South Asia.

Figure 2: Flow of remittance from source countries in last 15 years (in billion USD)



Source: *Bangladesh Bank*

The bar chart presents a longitudinal snapshot of remittance inflows to Bangladesh, categorized by source countries over a 15-year span. The data reveal a clear geographical concentration of remittance sources, with

predominant reliance on Middle Eastern countries—particularly the Gulf Cooperation Council (GCC) states such as Saudi Arabia (KSA) and the United Arab Emirates (UAE). Over this period, Saudi Arabia has been the largest single source of remittances, followed by the UAE. The United States ranks third and is the highest contributor among non-Middle Eastern countries. Mid-level contributions come from Kuwait and the United Kingdom, while from the Asian region Malaysia also plays notable role. This distribution reflects both traditional labor migration corridors and the gradual diversification of destination countries for Bangladeshi migrants. Hence, this study uses these findings while examining the macroeconomic determinants of remittance in Bangladesh.

4.0 Data and Methodology

4.1 Data

This study utilizes annual time-series data spanning the period from 1980 to 2023. As illustrated in Figure 2 (Section 3), the empirical evidence indicates that Saudi Arabia, the United Arab Emirates (UAE), the United States of America (USA), the United Kingdom (UK), and Malaysia have consistently ranked as the top five source countries for remittance inflows to Bangladesh over the past 14 years (2010–2023).

Given the structural and economic similarities between Saudi Arabia and the UAE—both being major Gulf Cooperation Council (GCC) economies with significant Bangladeshi migrant labor populations—this study selects Saudi Arabia as the representative case for the Middle Eastern region. Additionally, among the developed economies in this group, the United States has been prioritized due to its substantial and stable remittance contributions. Furthermore, Malaysia is included as a key remittance-sending country, reflecting its importance as a major destination for Bangladeshi migrant workers in Southeast Asia.

This study further enriches the empirical analysis by incorporating key macroeconomic determinants of remittance flows, including inflation rates, interest rates, exchange rates, and GDP growth for both Bangladesh and the major remittance-sending countries. By integrating these domestic and host-country economic indicators into our model

specification, we account for the dual influence of source- and recipient-economy conditions on remittance behavior, thereby enabling a more robust examination of the underlying transmission mechanisms. The description of the variables is given in Table 1.

Table 1: Data Description

Variables	In EViews	Unit	Description	Data Source
Remittances	rem3_gr	Percent	Yearly remittance growth to Bangladesh	BB
Oversees Employment	empl_gr	Percent	Year on year growth rate of remitters sending abroad	BB
Exchange Rate	exr_ch	Percent Change	Yearly percentage change in the nominal exchange rate of BDT/USD	BB
GDP Growth (Home)	gdpgr_bd	Percent	Yearly GDP growth rate of Bangladesh	WDI
GDP Growth (Host)	gdpgr_wa	Percent	Weighted Average GDP growth of host countries (KSA, USA, Malaysia)	WDI
Inflation	inf_wa	Percent	Annual average inflation rate	Malaysia, USA: WDI KSA: Macrotrends
Interest Rate Differential	intr_dif	Percent	Difference between Bangladesh interest rate and average interest rate of USA and malaysia USA: Annual 3 months T-bill rate Bangladesh: Annual Deposit Rate Malaysia: Annual Deposit Rate	USA: FRED Bangladesh & Malaysia: WDI
Unemployment Rate	unemp	Percent	Average Unemployment rate of host countries (USA and Malaysia only. Saudi Arabia dropped due to data limitation).	WDI
Oil Price	oil	Number	USD per barrel of Crude oil, Brent	World Bank Commodity Price

BB = Bangladesh Bank, WDI = World Development Indicators, FRED = Federal Reserve Bank of St. Louis

4.2 Methodology

This study attempts to determine the short-run and long-run macroeconomic determinants of remittance growth in Bangladesh. To do so, we employ the Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran et al. (2001). The ARDL model allows for testing the presence of cointegration in the presence of I(0) and I(1) variables, while traditional method requires variables to be I(1). Moreover, the ARDL approach is free from the issue of endogeneity arising from the use of lags of the dependent variables in the model.

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i \Delta Y_{t-1} + \sum_{j=1}^{n} \gamma_j \Delta X_{1t-j} + \cdots + \sum_{k=1}^{n} \delta_k \Delta X_{nt-k} + \theta_0 Y_{t-1} + \theta_1 X_{1t-1} + \cdots + \theta_n X_{nt-1} + \varepsilon_t \text{ ----(1)}$$

Here, Y_t denotes the dependent variable which is remittance inflow to Bangladesh. X_t represents a list of independent variables which are overseas employment of Bangladeshi labour (empl), change in nominal exchange rate of BDT per USD (exr_ch), GDP growth rate home (gdpgr_bd), GDP growth rate host countries (gdpgr_wa), interest rate differential between home and host countries (intr_dif), Inflation in host countries (inf_wa), unemployment rate in host countries (unemp_a), oil price in global market (oil). These variables have been taken after extensive review of literature.

To determine the existence of long run relationships, we need to perform cointegration test. In this case, the null hypothesis will be $\theta_0 = \gamma_j = 0$ and the alternative hypothesis will be $\theta_0 \neq \gamma_j \neq 0$. Once cointegration among the variables is established, the error correction estimation is performed based on the equation (2).

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i \Delta Y_{t-1} + \sum_{j=1}^{n} \gamma_j \Delta X_{1t-j} + \cdots + \sum_{k=1}^{n} \delta_k \Delta X_{nt-k} + \theta Z_{t-1} + \varepsilon_t \text{--- (2)}$$

Where, $Z_{t-1} = (Y_{t-1} - \alpha_0 - \alpha_1 X_{1t-1} \ldots - \alpha_n X_{nt-1})$

This equation is then used to determine the long-run relationships between dependent and independent variables.

5.0 Results and Discussion

5.1 Data Validation and Model Specification

5.1.1 Stationarity Test

Before starting the estimation, the data needs to be stationary to perform OLS. The detailed unit root test results have been shown in Appendix A. Based on the unit root test results and graphs the following inferences have been drawn (Table 2).

Table 2: Data Stationarity Test Summary (Authors' Calculation)

Variables	At Level			First Difference		
	C	C & T	without C & T	C	C & T	without C & T
rem3_gr	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary
empl_gr	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary
exr_ch	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary
gdpgr_bd	Stationary	Stationary	Non-Stationary	Stationary	Stationary	Stationary
gdpgr_wa	Stationary	Stationary	Non-Stationary	Stationary	Stationary	Stationary
inf_wa	Stationary	Stationary	Stationary	Stationary	Stationary	Stationary
intr_dif	Stationary	Non-Stationary	Non-Stationary	Stationary	Stationary	Stationary
unemp_a	Non-Stationary	Non-Stationary	Non-Stationary	Stationary	Stationary	Stationary
oil	Non-Stationary	Non-Stationary	Non-Stationary	Stationary	Stationary	Stationary

Note: *Here, C refers to Constant, T refers to Trend*

Source: *Authors' Calculation in EViews 14*

From the above table, the variables rem3_gr, empl_gr, exr_ch, gdpgr_bd, gdpgr_wa, inf_wa are stationary at level and can be used as it is in the model. On the other hand, intr_dif, unemp_a and oil are non-stationary at level and are stationary at first differences. That's why the first differences of unemp_a and oil have been taken for analysis in the following parts. As the data are mixture of I(0) and I(1), the ARDL approach seems suitable (Pesaran et al., 2001).

5.1.2 Variable Description and Summary Statistics

An overview of the summary statistics of different variables are shown in Table 2. Overseas employment growth shows highest variability with right-skewed distribution. Contrary to this, home country GDP growth (gdpgr_bd) exhibits a more symmetric distribution and less volatility. Change in nominal exchange rate (exr_ch) and host countres' inflation (inf_wa) are examples of variables that exhibit positive skewness, but host countries GDP (gdpgr_wa) is left-skewed (-1.33). Overseas employee growth (empl_gr) contains high tails (13.44) indicating possibility of outliers in the data.

Table 3: Summary Statistics (Author's Calculation)

Variable	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
rem3_gr	11.65	10.76	56.60	-26.12	16.33	0.18	4.05
empl_gr	16.47	10.36	256.46	-45.58	50.05	2.72	13.44
exr_ch	4.71	3.73	22.97	-4.59	5.23	1.34	5.31
gdpgr_bd	5.27	5.24	7.88	2.13	1.43	-0.25	2.28
gdpgr_wa	2.74	3.14	7.08	-8.27	3.09	-1.33	5.45
inf_wa	2.20	2.07	7.26	-0.97	1.67	0.79	4.02
intr_dif	5.19	5.07	10.79	0.88	2.28	0.26	2.55
d_unemp	-0.01	-0.22	2.84	-1.41	0.85	1.44	5.55
d_oil	1.04	-0.76	31.30	-46.57	14.94	-0.59	4.89

Source: *Authors' Calculation in EViews 14*

Table 3 exhibits the results of the correlation matrix of different variables. Remittance growth (rem3_gr) is positively correlated with overseas employment growth (empl_gr), nominal exchange rate change (exr_ch), and host countries' inflation (inf_wa), but negatively correlated with host countries' GDP growth (gdpgr_wa). Strong negative correlations are found between host countries unemployment (d_unemp) and host countries' GDP growth (gdpgr_wa) and oil price (d_oil), while oil price (d_oil) is positively linked to host countries GDP growth (gdpgr_wa) (0.38) and host countries' inflation (inf_wa) (0.33). These results indicate possible interdependencies among macroeconomic variables and require further analysis to be performed.

Table 4: Correlation Matrix (Authors' Calculation)

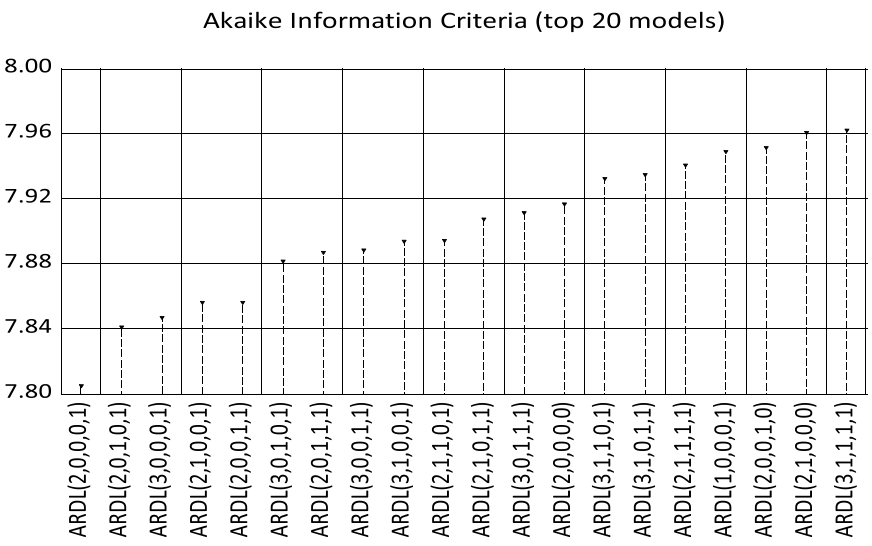
	rem3_gr	empl_gr	exr_ch	gdpgr_bd	gdpgr_wa	inf_wa	intr_dif	d_unemp	d_oil
rem3_gr	1.00								
empl_gr	0.24	1.00							
exr_ch	0.34**	0.34**	1.00						
gdpgr_bd	-0.26	0.10	-0.21	1.00					
gdpgr_wa	-0.30*	0.02	-0.37**	0.40***	1.00				
inf_wa	0.35**	0.27*	0.07	0.17	0.20	1.00			
intr_dif	-0.20	-0.15	-0.28*	-0.14	0.11	-0.09	1.00		
d_unemp	0.47***	0.18	0.24	-0.20	-0.58***	-0.04	-0.06	1.00	
d_oil	-0.01	0.18	0.09	0.18	0.38**	0.33**	-0.20	-0.33**	1.00

Source: *Authors' Calculation in EViews 14*

5.1.3 Model Selection and Specification

Based on the data diagnosis, the ARDL model is going to be used to estimate the mode. To determine the optimal lag structure, the Akaike Information Criterion (AIC) has been used. Based on the evaluated results of 20 different models, the best fitting model for this estimation is ARDL (2,0,0,0,1) (Figure 3).

Figure 3: The Akaike Information Criterion (AIC) for 20 Models



Source: *Authors' Calculation in EViews 14*

5.1.4 Cointegration *Test*

Considering the outcomes of the unit root tests, we need to identify whether there is any existence of long-run relationship among the variables. To do so, ARDL bounds test has been performed to determine any cointegration among the variables. The summary results have been presented in Table 5.

Table 5: ARDL Bound Test Results

Null hypothesis		No levels relationship	
Number of dynamic cointegrating variables		4	
Deterministics		Rest. constant (Case 2)	
Sample size		38	
F-statistics		**10.565**	
	Critical Values at 10%	*Critical Values at 5%*	*Critical Values at 1%*
I(0)	2.46	2.947	4.093
I(1)	3.46	4.088	5.532

Source: *Authors' Calculation in EViews 14*

Here, the F-stat of 10.565 exceeds the thresholds of all critical values which suggest rejecting the null hypothesis of no level relationships. Therefore, it is evident that there is strong cointegration at all levels.

5.1.5 Stability of the Model

Having conducting unit root tests and cointegration tests, a stability test has been conducted to determine the stability of the model. Firstly, Ramsey RESET test has been performed to determine whether the model is correctly specified.

Table 6 Ramsey RESET Test Summary Table

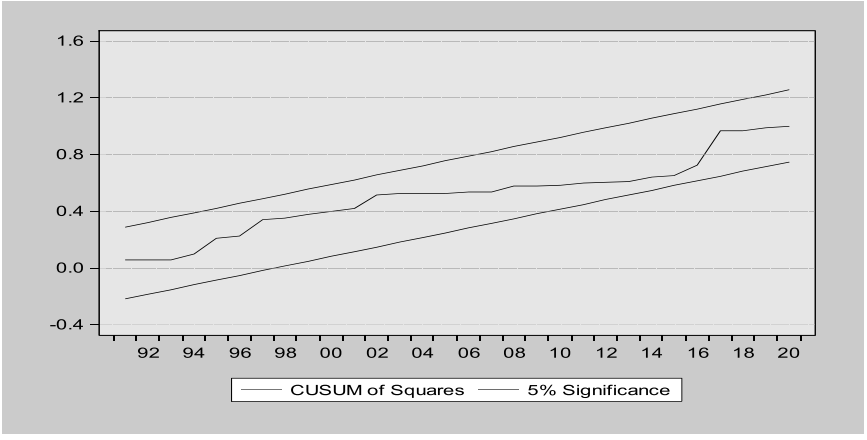
Test Component	Value	Probability	Interpretation
Null Hypothesis	No misspecification (correct functional form)	-	-
F-statistic	0.488	0.4902	>0.05→Fail to reject null
t-statistic	0.699	0.4902	>0.05 → Fail to reject null
Likelihood Ratio	0.635	0.4257	>0.05→Fail to reject null
Fitted² Coefficient	-0.0168	0.4902	Insignificant (p>0.05)

Source: *Authors' Calculation in EViews 14*

The F-statistics, t-statistics and Likelihood Ratio are greater than the critical value (0.05) which indicate rejecting the null hypothesis of misspecification. Moreover, the squared fitted term is statistically insignificant which confirms the functional form of the model is adequate.

Having confirmed the correct specification and functional form of the model, the CUSUM of squares test has been conducted to assess the stability of regression coefficients over time through examining for structural breaks in the time series model.

Figure 4: CUSUM of Squares (CUSUMQ) Test Plot



Source: *Authors' Calculation in EViews 14*

From the above graph, it is evident that there is no structural breaks or parameter inconsistency of the model. The error variance is stable over time. As a result, the ARDL relationship remains stable over time.

5.1.6 Normality Test

Based on the summary of the normality test results (Table 7), it can be concluded that the model follows a multivariate normal distribution (Joint JB p-value = 0.774).

Table 7: Normality Test Summary

Statistic	Value	Benchmark	Interpretation
Mean	$-2.08 \times 10^{-15} \approx 0$	0	Residuals are centered at zero.
Median	-0.225	-	Slightly negative median.
Std. Deviation	9.661	-	Moderate spread around the mean.
Skewness	-0.424	0	Mild left skew (longer left tail).
Kurtosis	3.497	3	Slightly heavy tails (leptokurtic).
JB p-value	0.465	> 0.05	Fail to reject normality (residuals are normal).

Source: *Authors' Calculation in EViews 14*

From the Jarque-Berra test, the p-value of 0.465 is greater than the critical value confirming the normal distribution of residuals.

5.1.7 Test for serial correlation

To identify serial correlation, the Breusch-Godfrey LM test for serial correlation has been performed. From the Table 8, the both F-statistic of 1.311 (p = 0.286) and an Obs*R^2 statistic of 3.253 (p = 0.197) fail to reject the null hypothesis of no serial correlation at two lags. This is further supported by the Durbin-Watson statistics of 2.024 (≈2) for uncorrelated residuals. The p-value of lagged residuals (RESID(-1) of 0.495, RESID(-2) of 0.249) of this test equation ar statistically

insignificant which confirm the absence of autocorrelation (Detailed result in Appendix C). These results jointly validate the model's error-term independence assumption.

Table 8: Breusch-Godfrey Serial Correlation LM Test

Test Statistic	Value	p-value	Remarks
F-statistic	1.3108	0.2856	Fail to reject null ($p > 0.05$)
Obs*R-squared	3.2532	0.1966	Fail to reject null ($p > 0.05$)
Durbin-Watson Stat	2.023840	≈2	No autocorrelation detected

Source: *Authors' Calculation in EViews 14*

5.1.8 Test for heteroscedasticity

The Breusch-Pagan-Godfrey test yields an F-statistic of 1.002 ($p = 0.450$) and an Obs*R^2 statistic of 7.198 ($p = 0.409$), failing to reject the null hypothesis of homoskedasticity. Moreover, the Scaled explained SS also conforms with F-statistics of homoskedasticity. These results indicate that the error variance is constant, confirming the standard error estimates of the ARDL model.

Table 9: The Breusch-Pagan-Godfrey test

Test Statistic	Value	p-value	Null Hypothesis (H_0)	Remarks
F-statistic	1.002	0.450	Homoskedasticity	Fails to reject H_0
Obs*R-squared	7.198	0.409	Homoskedasticity	Fails to reject H_0
Scaled explained SS	5.601	0.587	Homoskedasticity	Fails to reject H_0

Source: *Authors' Calculation in EViews 14*

From the different data diagnostics, we can conclude that the data are normally distributed, not serially correlated and homoscedastic in nature.

Moreover, the variables are cointegrated and there is a long-term relationship. Based on the model stability result, we found that the model is correctly specified and no omitted variable bias. Therefore, we can estimate the relationship using ARDL model for this study.

5.2 Results

After establishing the cointegration between variables, we estimate the Equation (2) to determine the short run and long-run coefficients of the model. After validating and checking the reliability of the model, the short-run and long-run relationships between remittance and the macroeconomic variables are discussed. Primarily, the model is estimated considering the rem3_gr as regressed variable and empl_gr exr_ch gdpgr_bd gdpgr_wa inf_wa d_intr_dif d_unemp d_oil as regressors. The time series of the data has been taken from 1980 to 2020 to avoid the COVID shock impact from the model. Based on the findings from the ARDL model (Appendix F), it is found that empl_gr (p-value= 0.9825), exr_ch (p-value = 0.7105), d_intr_dif (p-value= 0.8375), d_oil (p-value= 0.8973) are not statistically significant at all. Therefore, these variables have been dropped from the model and estimated the results. Based on these new estimates, long-run and short-run dynamics of the model have been discussed.

5.2.1 Long Run Relationships

The ARDL model reveals the significant long-run relationship between remittance growth in Bangladesh with major macroeconomic variables. Domestic GDP growth (GDP growth of Bangladesh) has a significant negative relationship with remittance growth which supports the counter-cyclical nature of remittances. The reason behind this nature is that when the growth of home country decreases, the income of the family decreases and the remitters try to provide more remittances to family to support them in distress. This finding is supported by the empirical results of Amuedo-Dorantes & Pozo (2006); Bettin & Zazzaro (2012) Yang (2008). The inflation in host countries has a significant positive impact on remittance growth. This relationship arises from rational behavioral responses by migrants: as inflation erodes the real value of savings in host-country currencies, remitters strategically reallocate resources toward cross-border transfers to preserve the purchasing power

of household incomes in their origin countries. Empirical evidence like (Adams & Page, 2005; Bettin & Zazzaro, 2018; Gupta et al., 2009; Yang, 2008) consistently support this result. This compensatory mechanism aligns with the 'target income hypothesis,' wherein migrants prioritize maintaining fixed consumption thresholds for dependents despite macroeconomic shocks (Gupta et al., 2009). The unemployment rate in the host countries leads to the most significant change in remittance growth in home country. A one percent increase in the unemployment rate causes 14.67 percent increase in remittance growth in home country. This can be caused through several channels- (i) returning migrants liquidate host-country assets, bringing savings home during economic downturns (Dustmann & Weiss, 2007); (ii) migrants remits more by working more hours to achieve the target faster (Yang & Choi, 2007). The GDP growth rate of host countries (gdpgr_wa), although statistically insignificant (coefficient 1.15, p-value 0.21), suggests a positive relationship with remittance growth, in line with the theory. This positive relationship suggests that productivity increases in the host countries increases the income of migrants and their capacity to remit in the home country.

Table 10: Long-Run Dynamics of the ARDL Model

Variable	Coefficient	p-value
GDPGR_BD	-2.935**	0.048
GDPGR_WA	1.148	0.208
INF_WA	3.616***	0.009
D_UNEMP(-1)	14.673***	0.002
Constant (C)	21.365***	0.011

Source: *Authors' Calculation in EViews 14*

5.2.2 Short-Run Dynamics

The estimated error correction term (ECT) is negative and highly significant. Although the sign of this adjustment is aligned with the theory, the coefficient of ECT is -1.5 which exceeds the expected

theoretical range between 0 and -1. This anomaly may be due to the limitations of using less frequency data (here, annual data). As in this case, the model suggests 150 percent of annual adjustment to equilibrium meaning that remittance is normally adjusted in every 8 months. Future studies may consider using high frequency data to address this issue.

The short-run dynamics are smaller in magnitude but very highly significant. The first difference of unemployment differential d(d_unemp) dominates the short-run dynamics suggesting migrants react quickly to labor market shocks. While a 1 percent increase in the first difference in the unemployment differential causes 7.54 percent increase in the remittance growth rate. On the other hand, the first difference of the lagged dependent variable d(rem3_gr(-1)) is positive and statistically significant (coefficient = 0.341, p = 0.000) which indicates that past growth in remittance flows influences current growth.

Table 11: Short-Run Dynamics of the ARDL Model

Variable	Coefficient	p-value
REM3_GR(-1) (ECT)	-1.507***	0.000
D(REM3_GR(-1))	0.341**	0.014
D(D_UNEMP)	7.536***	0.007

Source: Authors' Calculation in EViews 14

5.2.2 Diagnostic Test Results

The diagnostic test results of the ARDL (2,0,0,0,1) model advocates that the estimated model is well-specified and statistically robust. The R-squared value (0.7516) and adjusted R-squared value (0.7374) assure the goodness of fit of the model and 75 percent variation in the dependent variable remittance growth (rem3_gr) can be explained by the variation in the selected independent variables. The F-statistics of 52.96 suggests that the overall regression model is highly significant. There is no autocorrelation in the residuals, as indicated by the Durbin-Watson test score of 1.72, which is quite near 2. Both the Schwarz Criterion (SC) and the Akaike Information Criterion (AIC) have values that are within a reasonable range. Moreover, from the previous data analysis in data and

model specification part of this section, the ARDL bounds testing result confirm the existence of cointegration. Overall, the diagnostics tests results validate the reliability of the estimated ARDL (2,0,0,0,1) model for both short-run and long-run interpretation.

Table 12 : Diagnostic Tests Summary

Test	Statistics / Value	Interpretation
R-squared	0.7516	The model explains about 75.16% of the variation
Adjusted R-squared	0.7374	After adjusting for DF, the explanatory power remains high.
F-statistic	52.96 (p = 0.0000)	The overall model is highly significant
Durbin-Watson statistic	1.7177	Indicates no severe autocorrelation in residuals
Akaike Info Criterion	7.5053	A lower value suggests better model fit with parsimony
Schwarz Criterion (SC)	7.6346	Helps confirm model selection; slightly higher than AIC

Source: *Authors' Calculation in EViews 14*

6.0 Conclusion and Policy Recommendation

The macroeconomic determinants of the remittance inflow in country-specific and cross-country aspects have been covered broadly in the current literature and several studies found in case of Bangladesh as well. However, the less studies have been found which have covered long data range and taken into consideration of several host countries' macroeconomic determinants. This paper tries to bridge this literature gap by taking data range from 1980 to 2023, later dropped data of 2021 to 2023 to avoid the structural problems from Covid shocks, and taking the variables of three countries as host countries by applying the ARDL bounds testing approach. The empirical results confirm the presence of long-run cointegration relationship between remittance growth and

different macroeconomic variables. Remittance growth is found to be counter-cyclical with respect to home country's economic conditions whereas, pro-cyclical to the economic conditions of the host countries. Inflation in host countries exerts a positive long-run effect on remittances which implies that remitters find it less attractive to save in host countries than to remit more in the home country. Moreover, unemployment shocks in host countries positively impact on the remittance inflow as the remitters try to make extra earnings before returning and remit all their previous and current earnings.

In short run, remittance behavior is responsive to the change in the unemployment differential indicating the quick adjustment of remittance growth from host countries labor market situations. In addition, the past growth in remittance flows influences current growth of the remittances. The diagnostic tests of the model validate the robustness of the model-residuals are normally distributed, no serial correlation and homoscedastic. The error correction term (ECT) is negative and statistically significant, suggesting adjustment of the variables toward long-run equilibrium. However, the negative ECT value of more than 1 indicates the problem arising from using data with less frequency.

Despite the positive relationship between remittance growth and unemployment in host countries, there is possibility of future remittance loss due to the unemployment in the host economies. To reduce this risk, the government of Bangladesh can diversify the migrant's destination and provide insurance supports of the remitters if migrants return to home country due to unemployment hike in host countries. The exchange rate should be market based as this will shift the remittance sending from informal channel to formal channel. One of the objectives of this study is to contextualize the behavioral equations used in the projection tools developed by World Bank and IMF in the medium-term macroeconomic framework used by the Finance Division. These macroeconomic determinants with these coefficients can be incorporated into the model to make the projection more accurate. Last but not the least, as this study has used annual data and faced a possible problem from aggregation, future research should explore the association of remittance inflows with macroeconomic determinants using high frequency data and incorporating non-linearities in the model.

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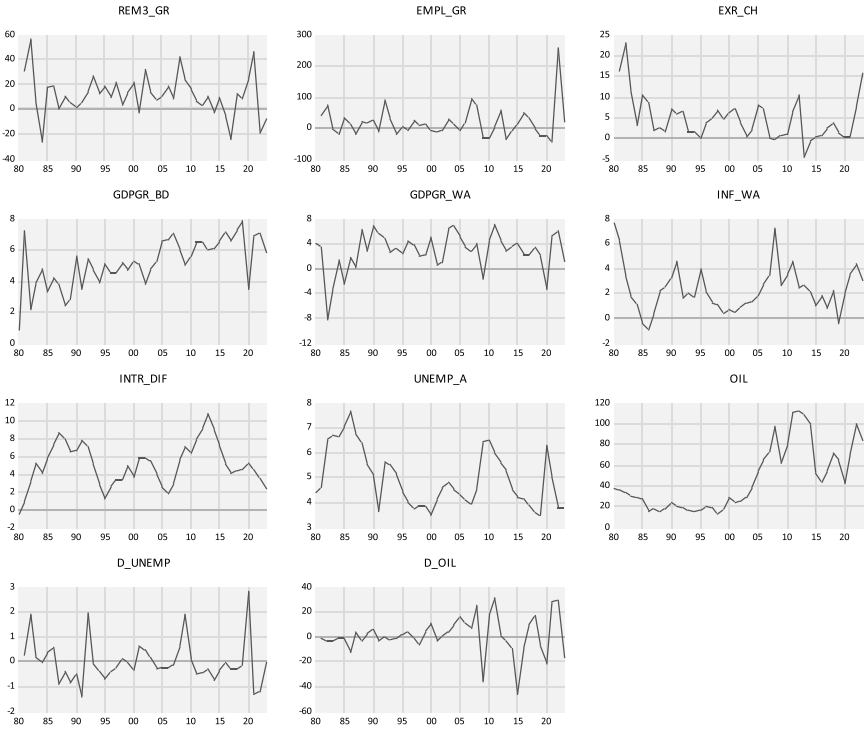
Appendix

Appendix A

1. Unit Root Results

At Level										
		rem3_gr	**empl_gr**	**exr_ch**	**gdpgr_bd**	**gdpgr_wa**	**inf_wa**	**intr_dif**	**unemp_a**	**oil**
With Constant	t-Statistic	-5.74	-5.79	-5.49	-5.55	-4.90	-4.18	-3.30	-2.45	-1.38
	Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.13	0.58
		***	***	***	***	***	***	**	n0	n0
With Constant & Trend	t-Statistic	-5.75	-5.61	-5.01	-9.25	-4.19	-4.14	-3.15	-3.00	-2.52
	Prob.	0.00	0.00	0.00	0.00	0.01	0.01	0.11	0.14	0.32
		***	***	***	***	**	**	n0	n0	n0
Without Constant & Trend	t-Statistic	-4.34	-6.18	-2.54	0.55	-1.28	-2.36	-1.19	-0.62	-0.38
	Prob.	0.00	0.00	0.01	0.83	0.18	0.02	0.21	0.44	0.54
		***	***	**	n0	n0	**	n0	n0	n0
At First Difference										
		d(rem3_gr)	d(empl_gr)	d(exr_ch)	d(gdpgr_bd)	d(gdpgr_wa)	d(inf_wa)	d(intr_dif)	d(unemp_a)	d(oil)
With Constant	t-Statistic	-4.35	-6.74	-6.77	-9.30	-9.16	-7.87	-4.30	-6.37	-5.89
	Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		***	***	***	***	***	***	***	***	***
With Constant & Trend	t-Statistic	-4.24	-6.73	-7.18	-9.15	-9.05	-7.96	-4.40	-6.33	-5.85
	Prob.	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
		***	***	***	***	***	***	***	***	***
Without Constant & Trend	t-Statistic	-4.43	-6.83	-6.85	-9.28	-9.23	-7.95	-4.36	-6.45	-5.91
	Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		***	***	***	***	***	***	***	***	***

2. Graphs of variables



Appendix B

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
REM3_GR	-7.150123	0.0065	-47.36508	0.0044
EMPL_GR	-6.429119	0.0284	-118.4599	0.0000
EXR_CH	-4.616346	0.4172	-29.50793	0.3709
GDPGR_BD	-2.321498	0.9960	-11.34639	0.9943
GDPGR_WA	-5.569704	0.1219	-35.92785	0.1222
INF_WA	-4.536611	0.4512	-27.35320	0.4844
D_INTR_DIF	-5.171717	0.2169	-34.13705	0.1750
D_UNEMP	-7.666059	0.0021	-49.48117	0.0019
D_OIL	-5.800253	0.0843	-37.57708	0.0847

*MacKinnon (1996) p-values.

Intermediate Results:

	REM3_GR	EMPL_GR	EXR_CH	GDPGR...	GDPGR...	INF_WA	D_INTR...	D_UNEMP	D_OIL
Rho - 1	-1.127740	-1.564510	-0.702570	-0.355151	-0.855425	-0.651267	-0.812787	-1.178123	-0.894692
Rho S.E.	0.157723	0.243347	0.152192	0.152983	0.153585	0.143558	0.157160	0.153680	0.154251
Residual variance	170.7817	1563.336	15.93034	1.063872	4.225254	1.534760	1.444632	0.362829	133.7743
Long-run residual variance	170.7817	5331.761	15.93034	0.645968	4.225254	1.534760	1.444632	0.362829	133.7743
Number of lags	0	1	0	1	0	0	0	0	0
Number of observations	42	41	42	41	42	42	42	42	42
Number of stochastic trends**	9	9	9	9	9	9	9	9	9

**Number of stochastic trends in asymptotic distribution

Appendix C: LM Test for Serial Autocorrelation

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	23.59493	36	0.9445	0.522145	(36, 24.7)	0.9631
2	32.77274	36	0.6229	0.819587	(36, 24.7)	0.7122
3	37.21104	36	0.4131	0.988664	(36, 24.7)	0.5214
4	52.08472	36	0.0404	1.706295	(36, 24.7)	0.0837

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	23.59493	36	0.9445	0.522145	(36, 24.7)	0.9631
2	NA	72	NA	NA	(72, NA)	NA
3	NA	108	NA	NA	(108, NA)	NA
4	NA	144	NA	NA	(144, NA)	NA

*Edgeworth expansion corrected likelihood ratio statistic.

Appendix D: Normality Test

Component	Skewness	Chi-sq	df	Prob.*
1	0.089516	0.048079	1	0.8264
2	-0.146118	0.128104	1	0.7204
3	-0.659276	2.607869	1	0.1063
4	0.404723	0.982806	1	0.3215
5	-0.470017	1.325494	1	0.2496
6	0.221502	0.294379	1	0.5874
Joint		5.386731	6	0.4953

Component	Kurtosis	Chi-sq	df	Prob.
1	2.334876	0.663584	1	0.4153
2	3.484242	0.351735	1	0.5531
3	3.295092	0.130619	1	0.7178
4	2.809419	0.054482	1	0.8154
5	3.755239	0.855580	1	0.3550
6	2.320083	0.693431	1	0.4050
Joint		2.749431	6	0.8396

Component	Jarque-Bera	df	Prob.
1	0.711663	2	0.7006
2	0.479838	2	0.7867
3	2.738488	2	0.2543
4	1.037288	2	0.5953
5	2.181073	2	0.3360
6	0.987811	2	0.6102
Joint	8.136161	12	0.7744

*Approximate p-values do not account for coefficient estimation

Appendix E: Ramsey Reset Test

	Value	df	Probability
t-statistic	0.698866	29	0.4902
F-statistic	0.488414	(1, 29)	0.4902
Likelihood ratio	0.634661	1	0.4257

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	57.19963	1	57.19963
Restricted SSR	3453.477	30	115.1159
Unrestricted SSR	3396.278	29	117.1130

LR test summary:

	Value
Restricted LogL	-139.6011
Unrestricted LogL	-139.2838

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REM3_GR(-1)	-0.246021	0.179395	-1.371396	0.1808
REM3_GR(-2)	-0.456005	0.211265	-2.158451	0.0393
GDPGR_BD	-4.030899	2.127715	-1.894474	0.0682
GDPGR_WA	1.520251	1.045738	1.453759	0.1568
INF_WA	5.257625	2.688492	1.955604	0.0602
D_UNEMP	11.32102	6.015902	1.881850	0.0699
D_UNEMP(-1)	10.20710	5.385121	1.895427	0.0680
C	28.18219	12.60506	2.235785	0.0332
FITTED^2	-0.016782	0.024014	-0.698866	0.4902

R-squared	0.456914	Mean dependent var	10.35130
Adjusted R-squared	0.307097	S.D. dependent var	13.00069
S.E. of regression	10.82188	Akaike info criterion	7.804410
Sum squared resid	3396.278	Schwarz criterion	8.192260
Log likelihood	-139.2838	Hannan-Quinn criter.	7.942404
F-statistic	3.049815	Durbin-Watson stat	1.656786
Prob(F-statistic)	0.012884		

Appendix F: ARDL Results

ARDL Model Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Distributed-lag Regressors				
Dependent				
REM3_GR(-1)	-0.201774	0.153366	-1.315641	0.2002
REM3_GR(-2)	-0.308406	0.145013	-2.126740	0.0435
Independent				
EMPL_GR	0.001529	0.068863	0.022199	0.9825
EXR_CH	-0.245312	0.653486	-0.375389	0.7105
GDPGR_BD	-3.109834	1.567101	-1.984451	0.0583
GDPGR_WA	1.286748	1.096585	1.173413	0.2517
INF_WA	3.155692	1.639440	1.924860	0.0657
D_INTR_DIF	0.351023	1.693573	0.207268	0.8375
D_UNEMP	7.378673	2.854062	2.585323	0.0159
D_UNEMP(-1)	8.283096	3.620465	2.287854	0.0309
D_OIL	-0.024025	0.184337	-0.130333	0.8973
D_OIL(-1)	0.197500	0.167061	1.182205	0.2482
Deterministic Regressors				
C	23.54403	10.15254	2.319029	0.0289
R-squared	0.485838	Mean dependent var		10.35130
Adjusted R-squared	0.239041	S.D. dependent var		13.00069
S.E. of regression	11.34089	Akaike info criterion		7.960206
Sum squared resid	3215.393	Schwarz criterion		8.520433
Log likelihood	-138.2439	Hannan-Quinn criter.		8.159531
F-statistic	1.968570	Durbin-Watson stat		1.881611
Prob(F-statistic)	0.074153			

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

ARDL Revised Model with dropped insignificant variables-

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Distributed-lag Regressors				
Dependent				
REM3_GR(-1)	-0.201774	0.153366	-1.315641	0.2002
REM3_GR(-2)	-0.308406	0.145013	-2.126740	0.0435
Independent				
EMPL_GR	0.001529	0.068863	0.022199	0.9825
EXR_CH	-0.245312	0.653486	-0.375389	0.7105
GDPGR_BD	-3.109834	1.567101	-1.984451	0.0583
GDPGR_WA	1.286748	1.096585	1.173413	0.2517
INF_WA	3.155692	1.639440	1.924860	0.0657
D_INTR_DIF	0.351023	1.693573	0.207268	0.8375
D_UNEMP	7.378673	2.854062	2.585323	0.0159
D_UNEMP(-1)	8.283096	3.620465	2.287854	0.0309
D_OIL	-0.024025	0.184337	-0.130333	0.8973
D_OIL(-1)	0.197500	0.167061	1.182205	0.2482
Deterministic Regressors				
C	23.54403	10.15254	2.319029	0.0289

R-squared	0.485838	Mean dependent var	10.35130
Adjusted R-squared	0.239041	S.D. dependent var	13.00069
S.E. of regression	11.34089	Akaike info criterion	7.960206
Sum squared resid	3215.393	Schwarz criterion	8.520433
Log likelihood	-138.2439	Hannan-Quinn criter.	8.159531
F-statistic	1.968570	Durbin-Watson stat	1.881611
Prob(F-statistic)	0.074153		

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

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
		Long-run Regressors		
Linear: Dependent				
REM3_GR(-1)	-1.507193	0.192165	-7.843207	0.0000
Linear: Independent				
GDPGR_BD	-2.934954	1.425738	-2.058551	0.0483
GDPGR_WA	1.148200	0.892380	1.286672	0.2080
INF_WA	3.615928	1.296388	2.789232	0.0091
D_UNEMP(-1)	14.67258	4.352106	3.371375	0.0021
Deterministic				
C	21.36490	7.914850	2.699344	0.0113
		Short-run Regressors		
Linear: Dependent				
D(REM3_GR(-1))	0.340858	0.131104	2.599913	0.0143
Linear: Independent				
D(D_UNEMP)	7.536257	2.597216	2.901668	0.0069
R-squared	0.751626	Mean dependent var		-0.848184
Adjusted R-squared	0.693672	S.D. dependent var		19.38537
S.E. of regression	10.72921	Akaike info criterion		7.768480
Sum squared resid	3453.477	Schwarz criterion		8.113235
Log likelihood	-139.6011	Hannan-Quinn criter.		7.891142
F-statistic	12.96934	Durbin-Watson stat		1.717692
Prob(F-statistic)	0.000000			

Empirical and Theoretical Insights into Bangladesh's Import Demand: A Policy Perspective

Asif Iqbal[1], Syed Mahmud Hasan[2], Abdul Mannan[3]

Abstract

This paper investigates the determinants of Bangladesh's import demand by integrating a forward looking Dynamic Stochastic General Equilibrium (DSGE) model with empirical estimation via the Autoregressive Distributed Lag (ARDL) approach. A utility-maximizing framework is developed to derive the optimal import demand function, incorporating the roles of real income, relative prices, and external shocks such as oil price fluctuations. Using annual data from 1993 to 2022, the ARDL bounds testing methodology is applied to estimate long-run and short-run elasticities, accounting for the mixed order of integration among variables. The results show that income elasticity exceeds unity, the real effective exchange rate (REER) has a strong and statistically significant positive effect, and oil prices exert a moderate influence on import, consistent with partial cost pass-through and the composition of Bangladesh's import basket. To complement the ARDL findings, a DSGE model calibrated in Mathematica simulates the impact of persistent oil price shocks, revealing a short-run nominal increase in import value (19.0%–15.5%) due to oil cost inflation and forward-looking behavior, followed by a gradual convergence to baseline as oil prices recede. The simulation highlights the importance of expectations, anticipatory adjustment, and intertemporal smoothing in shaping trade outcomes. Together, the empirical and theoretical insights underscore the need for coordinated exchange rate management, reserve adequacy frameworks, and fiscal stabilization tools to enhance Bangladesh's external sector resilience against global shocks. This paper is the first to integrate ARDL estimation with DSGE-based forward-looking simulation for Bangladesh's import demand, offering a novel framework that bridges empirical evidence with dynamic policy modeling.

Keywords: Import demand, DSGE model, ARDL, Exchange rate.

JEL Classification: F14, C32, O53, E32

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1. Introduction

International trade remains a central pillar of Bangladesh's economic development, underpinning its industrial expansion, infrastructure modernization, and energy security. Among the drivers of this trajectory, the dynamics of import demand play a uniquely strategic role—shaping the country's ability to absorb external shocks, sustain growth, and respond to evolving global pressures. For an emerging economy with persistent external deficits and critical dependencies on energy, capital goods, and industrial intermediates, understanding the determinants of import demand is essential for effective macroeconomic management and forward-looking policy design.

Over the past few decades, Bangladesh's import structure has undergone a notable transformation. What began as reliance on food grains and basic capital inputs has evolved into a diversified trade profile, fueled by the global integration of the ready-made garments (RMG) sector and growing demand for textiles, machinery, and petrochemical products (Ahmed, 2023). Energy imports—particularly oil and natural gas—have become increasingly pivotal amid repeated global commodity price spikes and rising supply vulnerabilities (Hasan, Rahman, & Alam, 2019). Simultaneously, food and essential input imports remain sensitive to global price fluctuations, as starkly illustrated during the 2008 financial crisis and the recent disruptions following Russia's invasion of Ukraine.

Empirical literature on developing countries highlights that import demand is largely governed by real domestic income, relative prices—often measured by the real effective exchange rate (REER)—and global shocks such as oil price volatility (Narayan & Narayan, 2005). Bangladesh mirrors this pattern: elasticity estimates frequently reveal strong responsiveness to income, but more muted or delayed price effects, reflecting the predominance of essential and production-linked imports (Sarker, Rahman, & Islam, 2022). These dynamics are further shaped by the structure of the import basket and constraints in trade financing and policy flexibility.

In this context, empirical investigation into Bangladesh's import demand is not merely academic—it is crucial for shaping trade, exchange rate,

and reserve policies. The disruptions of 2022–2024, marked by oil price shocks, exchange rate depreciation, and nominal import surges in BDT, forced urgent policy responses, including LC rationing and fuel subsidy revisions. Yet the long-term sustainability and effectiveness of these interventions remain under debate, given the structural rigidity of import demand and the increasing importance of expectations and forward-looking behavior in determining trade flows.

This study advances the literature by employing a hybrid macroeconomic approach. It integrates a micro-founded, utility-maximizing DSGE model with an ARDL (Autoregressive Distributed Lag) framework using annual data from 1993 to 2022. This combination enables robust estimation and simulation of both short- and long-run elasticities, while explicitly incorporating persistent global shocks and enhancing policy relevance in the context of Bangladesh's evolving external sector (Rahman, Choudhury, & Hasan, 2022). By combining empirical results with dynamic simulation of import responses to oil shocks, the study offers a richer understanding of how cost inflation and forward-looking behavior jointly shape observed trade outcomes. In particular, it demonstrates—through DSGE simulation—that nominal import values may rise sharply (by up to 19%) in response to oil price increases even when real import volumes stagnate or fall—highlighting the critical need to distinguish between price-level effects and real demand elasticity. By embedding real-world context and recent data, this paper seeks to inform ongoing debates on resilience-building, exchange rate management, and reserve policy design for a small open economy facing growing exposure to global volatility.

2. Literature Review

A substantial body of research investigates the determinants of import demand, particularly in developing and emerging economies where trade openness exposes domestic markets to both opportunity and vulnerability. The classic framework, as established by (Khan & Ross, 1977) and re-examined by (Goldstein & Khan, 1985), identifies real domestic income and relative prices as the primary factors shaping import demand, while allowing for the influence of tariff policy, exchange rates, and exogenous commodity price shocks. More recent studies have added sophistication to this paradigm, incorporating

cointegration and error correction techniques to address the non-stationarity of macroeconomic time series (Tang & Nair, 2002).

For developing countries, including Bangladesh, the ARDL (Autoregressive Distributed Lag) bounds testing approach has become especially popular due to its flexibility in handling I(0) and I(1) variables and relatively small sample requirements (Pesaran, Shin, & Smith, 2001). Applications of this methodology across South and Southeast Asia consistently report that income elasticity of import demand tends to exceed unity, while price elasticity remains statistically significant but smaller in magnitude (Baek, Koo, & Villano, 2009). Such findings reflect the essential nature of many imports—particularly intermediates and fuel—where substitution possibilities are limited in the short run (Geda & Seid, 2005).

The literature focusing specifically on Bangladesh, though once limited, has grown considerably in the past decade. (Sarker, Rahman, & Islam, 2022) document the prominent role of real GDP and global oil prices in determining import flows, employing ARDL and cointegration diagnostic tools to uncover both short- and long-term elasticities. (Hossain & Hossain, 2020) further elaborate that while exchange rate changes modestly affect import demand in the long term, short-run pass-through is hampered by contractual rigidities and import composition, a view echoed by (Islam & Sultana, 2021) in their work on exchange rate pass-through. The critical dependence on energy imports, especially in light of global price shocks, is a recurring finding; (Hasan, Rahman, & Alam, 2019) show that persistent oil price increases have delayed but powerful impacts on Bangladesh's trade balance and reserve adequacy, a point reinforced by more recent trade analyses in the World Bank (2024) and Bangladesh Bank (2024) policy reports.

Significant recent shocks, notably the 2022 global commodity price surge following the Russia–Ukraine war, have revived discussion on the vulnerability of Bangladesh's external sector (Ministry of Finance, 2024). Emerging empirical work, for instance, by (Choudhury & Rahman, 2023), suggests that incorporating expectation-driven adjustment (as in DSGE-type models) alongside ARDL estimates can improve the forecasting of import dynamics under persistent terms-of-trade shocks—a key methodological motivation for this paper.

International comparative analyses underscore that Bangladesh's import demand behaves in line with lower-middle-income economies, where rising domestic income and a structural reliance on capital and intermediate goods dominate over any substitution effect related to import prices ((Furlanetto, Ravazzolo, & Sarferaz, 2017); (Constant & Yue, 2010)). However, cross-country work also reveals that policy responses—such as foreign reserve accumulation, hedging, and managed floating exchange rates—can help mitigate vulnerabilities and reinforce macroeconomic stability, lessons that are directly relevant for current policy debates in Bangladesh (Ahmed, 2023).

Despite this progress, research gaps persist. There is still limited empirical work integrating forward-looking expectations and simulation methods (such as DSGE) with traditional ARDL-based estimation for Bangladesh. Many earlier studies omit the role of episodic external shocks or fail to account for sector-specific import dependencies, such as those found in the ready-made garments sector or energy infrastructure. Accordingly, this paper fills an important gap by being the first to explicitly integrate forward-looking DSGE simulations with ARDL-based estimation for Bangladesh, ensuring that structural elasticities and expectation-driven dynamics are examined together within a single framework. By combining an empirically estimated ARDL model with a calibrated DSGE framework, this study introduces a forward-looking simulation in the context of Bangladesh, where earlier work has largely relied on static regression methods.

3. Theoretical Framework: DSGE-Based Derivation of Import Demand

This section presents the theoretical structure that underpins our empirical estimation. We derive an import demand function from a micro-founded Dynamic Stochastic General Equilibrium (DSGE) framework relevant for a small open economy like Bangladesh. The model captures the optimizing behavior of a representative household facing intertemporal decisions under income constraints and external price shocks, particularly from oil.

We consider a representative household that derives utility from consumption C_t and seeks to maximize lifetime utility subject to

intertemporal budget constraints. The household allocates income between imported goods and domestic consumption, but for simplicity, we focus on the imported composite.

The lifetime utility function is:

$$U = \sum_{t=0}^{\infty} \beta^t . \frac{C_t^{1-\theta}}{1-\theta}$$

- β is the subjective discount factor $(0 < \beta < 1)$,
- θ is the coefficient of relative risk aversion

At each period, the representative household earns income Y_t, which can be spent on an imported consumption composite $C_{m,t}$ at price $P_{m,t}$. For tractability, we assume only imported goods are consumed (extensions with a CES composite are possible but omitted here).

$$P_{m,t} \cdot C_{m,t} = Y_t$$

We define the imported consumption good as a Cobb-Douglas function of two essential imported commodities:

$$C_{m,t} = (REER_t \cdot P_{oil,t}^{\phi_1} \cdot P_{food,t}^{\phi_2})^{-1} \cdot Y_t$$

Here, $P_{oil,t}$ is the oil price in foreign currency; $P_{food,t}$ is the food commodity price; $REER_t$ is the real effective exchange rate; $\phi_1, \phi_2 > 0$ are the commodity-specific elasticities and $P_{m,t} = REER_t \cdot P_{oil,t}^{\phi_1} \cdot P_{food,t}^{\phi_2}$

Substituting into the budget constraint:

$$(REER_t \cdot P_{oil,t}^{\phi_1} \cdot P_{food,t}^{\phi_2}) C_{m,t} = Y_t \Rightarrow C_{m,t} = \frac{Y_t}{P_{oil,t}^{\phi_1} \cdot P_{food,t}^{\phi_2} \cdot REER_t}$$

This gives us the static import demand function:

$$M_t = C_{m,t} = \frac{Y_t}{P_{oil,t}^{\phi_1} \cdot P_{food,t}^{\phi_2} \cdot REER_t}$$

Taking natural logs:

$$\log M_t = \log Y_t - \log REER_t - \phi_1 \log P_{oil,t} - \phi_2 \log P_{food,t}$$

This functional form motivates the empirical regression specification in log-log format. If ϕ_2 is very small, the food price index can be omitted

as an identifying restriction, especially when the oil price is the more volatile shock.

While the main estimation uses static formulation, a dynamic version can be derived by incorporating expectations:

$$\log M_t = \mathbb{E}_t \left[\sum_{j=0}^{\infty} \beta^j \left(\log Y_{t+j} - \log P_{m,t+j} \right) \right]$$

This highlights that current import behavior depends on expected future income and relative prices, making it suitable for simulation with calibrated parameters under oil price shocks.

4. Empirical Model and Estimation Strategy

This section develops the empirical strategy used to estimate Bangladesh's import demand function. We use a log-linear ARDL model derived directly from the DSGE-based static import demand equation. The ARDL model accommodates short-run dynamics and long-run relationships among non-stationary macroeconomic variables, making it well-suited to real-world time-series data from Bangladesh (Pesaran, Shin, & Smith, 2001).

4.1 Model Specification

Building on the theoretical derivation in Section 3, we posit the following log-linear import demand model:

$$\log M_t = \alpha_0 + \alpha_1 \log Y_t + \alpha_2 \log REER_t + \alpha_3 \log P_{oil,t} + \varepsilon_t$$

Where:

- M_t: Total imports (in BDT)
- Y_t: Real GDP (in BDT, constant prices),
- $REER_t$: Real effective exchange rate index (higher implies appreciation),
- $P_{oil,t}$: Crude oil price (USD/barrel),
- ε_t: Error term.

This forms the long-run equation, which we estimate using the ARDL bounds testing approach as proposed by (Pesaran, Shin, & Smith, 2001).

To capture short-run fluctuations, we specify the ARDL model as follows:

$$\Delta \log M_t = \gamma_0 + \sum_{i=1}^{p} \gamma_1^i \Delta \log M_{t-i} + \sum_{j=0}^{q} \gamma_2^j \Delta \log Y_{t-j} + \sum_{k=0}^{r} \gamma_3^k \Delta \log REER_{t-k} + \sum_{l=0}^{s} \gamma_4^l \Delta \log P_{oil,t-l} + \lambda ECT_{t-1} + \varepsilon_t$$

Where:

- Δ: First difference operator,
- ECT_{t-1}: Error correction term from the long-run equation (Engle and Granger 1987),,
- Coefficients γ represent short-run elasticities
- λ is the speed of adjustment toward long-run equilibrium
- Lags p,q,r,s: Chosen based on Schwarz Bayesian Criterion (SBC).

The Autoregressive Distributed Lag (ARDL) approach offers several distinct advantages over the traditional Ordinary Least Squares (OLS) method, particularly in the context of macroeconomic analysis for developing economies like Bangladesh. While OLS assumes that all variables must be either stationary at level or cointegrated in the same order, this condition often proves restrictive when dealing with real-world economic data, which frequently exhibit mixed orders of integration. In contrast, the ARDL model accommodates both I(0) and I(1) variables within a single estimation framework, eliminating the need for pre-testing all variables for a common integration order. Furthermore, ARDL models are well-suited for small sample sizes, a common limitation in macroeconomic studies involving annual or quarterly data (Bannerjee et al. 1993). The approach also facilitates the optimal selection of lag structures, ensuring that dynamic relationships among variables are properly captured. Most importantly, the ARDL methodology distinctly identifies both short-run dynamics and long-run equilibrium relationships, providing richer insights into the temporal behavior of economic variables. These features make ARDL a particularly appropriate and flexible choice for modeling import demand

and other macroeconomic relationships in the Bangladeshi context (Senhadji, 1998).

4.2 Data Description

We use annual data from 1993 to 2022. Variables have been log-transformed to interpret coefficients as elasticities (Gujarati & Porter, 2009). The sources include Bangladesh Bank (annual economic reviews), World Bank WDI, IMF IFS- 2024, and BIS(BIS 2024).

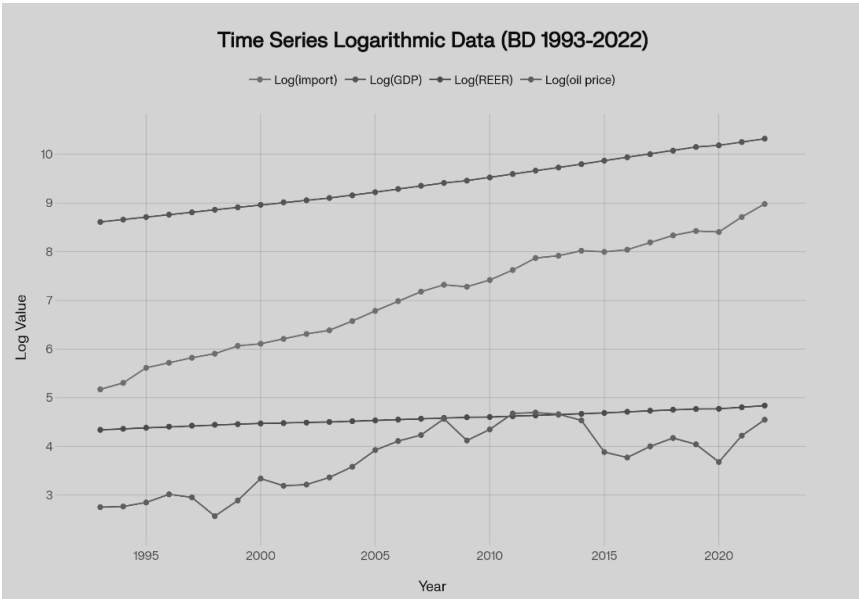

Figure 1: *Time Series Plot of Variables*

Table 1: Data Description

Variable	Symbol	Description	Transformation
Imports	$\log M_t$	Total imports	Log
Real GDP	$\log Y_t$	Constant price GDP (BDT)	Log
REER	$\log REER_t$	Real Effective Exchange Rate index	Log
Oil Price	$\log P_{oil,t}$	Crude oil price (USD/barrel)	Log

5. Estimation and Results

This section presents the results of the empirical estimation of Bangladesh's import demand function using the ARDL model based on annual data from 1993–2022. It includes stationarity tests, lag selection, long-run elasticity estimates, short-run dynamics, and diagnostic evaluations.

5.1 Unit Root Test: Stationarity Check

We first conduct Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to check whether variables are stationary. The results indicate:

Table 2: Augmented Dickey-Fuller Test for Stationarity

Variable	Level	First Difference	Order of Integration
$\log(M)$	Non-stationary	Stationary	$I(1)$
$\log(Y)$	Non-stationary	Stationary	$I(1)$
$\log(REER)$	Non-stationary	Stationary	$I(1)$
$\log(P_{oil})$	Non-stationary	Stationary	$I(1)$

This confirms that ARDL is appropriate, as all variables are I(1) but none are I(2).

5.2 Lag Selection:

Using the Schwarz Bayesian Criterion (SBC), the optimal lag structure is selected as:

ARDL(1,0,1,0): 1 lag for imports, 0 lag for GDP, 1 lag for REER, and 0 lags for oil price.

5.3 Long-run Coefficients

With the SBC-selected ARDL(1,0,1,0), the long-run form of import demand equation will be:

$$\log M_t = \alpha_0 + \alpha_1 \log Y_t + \alpha_2 \log REER_t + \alpha_3 \log P_{oil,t} + \varepsilon_t$$

The long-run import demand equation is estimated as:

$$\log M_t = -16.105 + 1.02 \log Y_t + 2.70 \log REER_t + 0.32 \log P_{oil,t} + \varepsilon_t$$

Table 3: Long-run Results from the ARDL

Regressor	Coefficient	t-Statistic	Significance
Log Real GDP	1.021	2.19	** (5%)
Log REER	2.703	~0.90*	Jointly significant
Log Oil Price	0.318	6.98	*** (1%)
Constant	–16.105	–	–

Note: REER effect combines REER and REER(-1). Reported t-statistics are approximate.

The estimated long-run elasticities from the ARDL model provide meaningful insights into the determinants of Bangladesh's import demand. The income elasticity of imports is found to be 1.02, suggesting that a 1% increase in real GDP leads to a 1.02% rise in real imports. This slightly elastic response indicates that economic growth in Bangladesh is closely associated with an expansion in import demand, reflecting the country's reliance on imported inputs, capital goods, and consumption items to sustain growth. The elasticity with respect to the Real Effective Exchange Rate (REER) is estimated at 2.70, implying that a 1% appreciation in the REER leads to a 2.70% increase in imports. This substantial sensitivity highlights the importance of exchange rate dynamics, as a stronger taka reduces the domestic price of foreign goods, thereby significantly boosting import volumes. Finally, the oil price elasticity of 0.32 indicates that a 1% rise in global oil prices increases import demand by 0.32% in the long run. The oil price elasticity is also consistent with findings in energy-importing countries (Narayan & Narayan, 2005). This positive and moderately inelastic relationship likely reflects the essential role of petroleum products in Bangladesh's energy, transport, and industrial sectors, where alternatives are limited in the short to medium term. These results echo studies such as (Bahmani-Oskooee & Niroomand, 1998) and (Senhadji, 1998). Collectively, these

findings underscore the pivotal roles of income growth, exchange rate policy, and commodity price fluctuations in shaping Bangladesh's long-run import behavior.

5.4 Short-run Dynamics and Error Correction

The short-run error correction model is:

$$\Delta \log M_t = -0.6629 \cdot ECT_{t-1} + 5.0330 \cdot \Delta \log REER_t + 0.2109 \cdot \Delta \log P_{oil,t} + \varepsilon_t$$

Table 4: Short-run Results from the ARDL

Component	Coefficient	t-statistic	Significance
ECT(−1)	−0.6629	−3.33	*** (1%)
Δlog(REER$_t$)	5.0330	2.88	** (5%)
$\Delta \log P_{oil,t}$	0.2109	6.98	*** (1%)

The short-run dynamics derived from the ARDL error correction model offer valuable insights into the immediate responsiveness of Bangladesh's import demand to key macroeconomic shocks. The speed of adjustment coefficient is estimated at –0.66, indicating that approximately 66% of any short-term disequilibrium from the long-run relationship is corrected within a single year. This robust and rapid adjustment mechanism not only confirms the existence of a strong cointegrating relationship (Engle and Granger 1987) but also suggests that the underlying economic forces driving imports are tightly aligned in the long run. In the short run, the elasticity of imports with respect to the real effective exchange rate (REER) is exceptionally high at 5.03. This implies that a 1% appreciation in the REER leads to a 5.03% increase in import demand, underscoring the high sensitivity of imports to currency movements. Such a pronounced response likely reflects the prevalence of price-inelastic capital and intermediate goods in Bangladesh's import basket, where even modest currency shifts can have amplified effects. Large short-run REER effects and energy price pass-through are common in open economies dependent on imported capital and

intermediate goods (Bahmani-Oskooee and Niroomand 1998). Additionally, the short-run oil price elasticity is estimated at 0.21, suggesting that a 1% increase in global oil prices results in a 0.21% rise in import value. This immediate effect may stem from pre-existing contractual obligations or an inability to reduce consumption in sectors heavily reliant on petroleum. In contrast to earlier specifications, no statistically significant lagged oil price terms were detected in the current model, indicating that the short-run adjustment is largely contemporaneous. These short-run results emphasize the responsiveness of Bangladesh's import demand to external price signals and the economy's ongoing dependence on energy and exchange rate conditions.

To ensure the robustness of the ARDL error correction specification, several diagnostic and stability tests were conducted. The Durbin–Watson statistic and Breusch–Godfrey LM test assess potential serial correlation in the residuals. The Jarque–Bera test examines residual normality, while the Ramsey RESET test checks for functional form misspecification. Finally, the CUSUM and CUSUMSQ statistics evaluate parameter stability over time. The results of these diagnostic checks are reported in Table 5.

Table 5: Diagnostics

Test	Result
	2.37 — Close to 2, suggesting no first-order autocorrelation.
Breusch-Godfrey LM Test	$p > 0.10$ — Fails to reject null, no higher-order serial correlation.
Jarque-Bera Normality Test	$p > 0.10$ — Residuals are normally distributed.
Ramsey RESET Test	$p > 0.10$ — No evidence of functional form misspecification.
CUSUM & CUSUMSQ Stability Tests	Both statistics remained within 95% confidence bounds — model is stable over time.

These results confirm that the estimated model is statistically robust, structurally stable, and suitable for policy analysis, consistent with standards in applied macro-econometric modeling for open developing economies (Harris & Sollis, 2003).

6. Calibration and Simulation of the DSGE Model

To enrich our understanding of import dynamics and macroeconomic transmission, we construct a small-scale Dynamic Stochastic General Equilibrium (DSGE) model. This allows us to simulate how an exogenous oil price shock impacts import demand, capturing inter temporal decision-making and expectation channels that go beyond regression (Backus, Kehoe, & Kydland, 1992).

6.1 Model Structure: Static Import Optimization

We begin by considering a representative household or firm that maximizes utility or output, where imported goods are necessary inputs for production or consumption. This follows classic trade and open economy modeling (Corsetti, Dedola, & Leduc, 2008). Let total real income Y_t be spent on domestic and imported goods, subject to a static budget constraint:

$$P_{d,t} \cdot C_{d,t} + P_{m,t} \cdot C_{m,t} = Y_t$$

We define an import demand function derived from CES (constant elasticity of substitution) preferences or cost minimization:

$$M_t = (1 - \alpha) \cdot \frac{Y_t}{P_{m,t}}$$

The static budget constraint and CES preferences or cost minimization set-up are standard in international macroeconomics (Feenstra 2015). Here, the optimal import demand function is influenced by import prices and income, consistent with micro-foundation-based import models (Obstfeld & Rogoff, 1996). Import prices are influenced by:

$$P_{m,t} = REER_t \cdot P_{oil,t}^{\phi_1} \cdot P_{food,t}^{\phi_2}$$

Substituting, the optimal import demand becomes:

$$M_t = (1 - \alpha) \cdot \frac{Y_t}{REER_t \cdot P_{oil,t}^{\phi_1} \cdot P_{food,t}^{\phi_2}}$$

Taking logs:

$$\log M_t = \log(1 - \alpha) + \log Y_t - \log REER_t - \phi_1 \log P_{oil,t} - \phi_2 \log P_{food,t}$$

In this paper, we simplify by excluding food price shocks and calibrate using only oil price influence, as supported by our ARDL results.

6.2 Calibration: Key Parameters

We calibrate parameters for both the static and dynamic formulations of the import demand model, where Parameter values are chosen based on best practices in DSGE calibration (Canova, 2007) and the empirical ARDL results.

Table 6: Parameters for Static Model

Parameter	Symbol	Value	Source/Justification
Oil price elasticity	ϕ_1	0.32	Long-run estimate from ARDL model
Share of imports in income	1-α	0.2	Assumed based on Bangladesh import ratios

Oil price elasticity is 0.32 (from estimated long-run ARDL coefficient – (Narayan & Narayan, 2005); Section 5.3 above). Share of imports in income (1-α) is 0.2 (based on Bangladesh's historical import-to-GDP ratios). Parameters for Dynamic Forward-Looking Model:

Table 7: Parameters for Dynamic Model

Parameter	Symbol	Value	Source/Justification
Discount factor	β	0.95	Standard macroeconomic value, see (Gali, 2008)
Import price elasticity	η	-0.32 ARDL)	From section 5.3
Oil shock persistence	ρ	0.7	Estimated from oil price AR(1) process see (Hamilton, 2009)
Simulation horizon	T	20 years	typical for examining long-run macro response; (Schmitt-Grohé & Uribe, 2012)

6.3 Dynamic Oil Price Shock Simulation

We simulate a 20% sudden increase in oil prices and track the dynamic adjustment of Bangladesh's import demand over a 20-year horizon. The oil price follows a persistent process:

$$\log P_{oil,t} = \rho \cdot \log P_{oil,t-1} + \varepsilon_t$$

with persistence parameter ρ =0.7, representing a typical case where prices decline slowly following a shock. Import behavior is modeled through a forward-looking dynamic import demand function:

$$\log M_t = \beta \cdot \log M_{t+1} - \eta \cdot \log P_{oil,t}$$

This system is solved recursively using backward induction (Schmitt-Grohé & Uribe, 2012). This setup captures the intertemporal optimization behavior of importers who respond not only to current oil prices but also to their expected path.

We consider two key calibrations. Calibration A applies the short-run oil price elasticity η =−0.32 as estimated from our ARDL regression, paired with a high discount factor β =0.95, representing forward-looking agents. Calibration B retains the same elasticity but assumes a lower β =0.85, introducing myopia and greater weight on current conditions.

Table 8: Impulse Response from Oil Shocks: Dynamic Model

Year	% Change in Imports (ARDL-based) (η= -0.32, β= 0.95)	% Change in Imports (ARDL-based Myopic) (η= -0.32, β= 0.85)
1	+19.02%	+15.49%
5	+4.26%	+3.52%
10	+0.69%	+0.58%
20	≈ 0.00%	≈ 0.00%

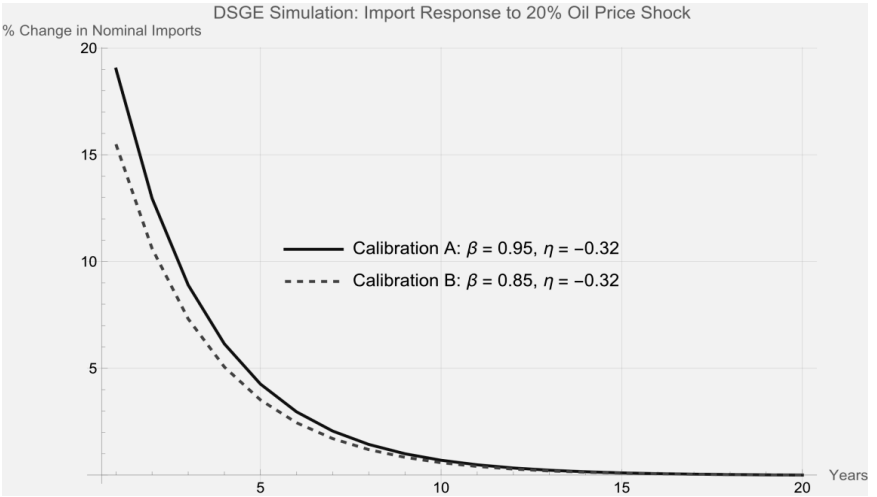

Figure 2: *Impulse response function to Oil price shock*

The dynamic DSGE simulation shows an initially positive response of nominal imports to the oil price shock. Under Calibration A, nominal imports increase by 19.02% in Year 1, while the myopic scenario (Calibration B) generates a smaller 15.49% rise. This counterintuitive result—an increase in import value in response to a cost-push shock—is well grounded in economic logic. Since oil is itself a significant component of Bangladesh's import basket, a surge in oil prices directly inflates the nominal value of total imports, even if real import volumes decline or remain flat. Additionally, forward-looking agents anticipate that the oil price will gradually revert, prompting them to front-load import purchases when price volatility is high. The result is a short-run nominal spike, followed by gradual adjustment.

Over time, as the oil price recedes (due to $\rho = 0.7$), nominal import values also trend downward. By Year 5, imports remain about +4.26% (Calibration A) and +3.52% (Calibration B) above baseline, with the deviation narrowing to +0.69% and +0.58%, respectively, by Year 10. By Year 20, imports have virtually returned to pre-shock levels, confirming the transitory nature of the nominal surge. The myopic scenario ($\beta = 0.85$) exhibits a smaller initial spike but faster convergence, reflecting the dominance of present over future considerations in that calibration.

Economic Interpretation:

These results reaffirm the importance of expectations, persistence, and the price structure of imports in shaping Bangladesh's response to oil shocks. Unlike real volume measures, nominal import values respond not only to quantities but also to price-level changes, which means that a rise in the cost of a key input like oil automatically raises the total import bill. This is especially relevant for Bangladesh, where energy products constitute a non-negligible share of total imports, and importers may accelerate purchases during volatile periods.

The IRFs in both calibrations display a hump-shaped trajectory—an immediate nominal spike followed by smooth, asymptotic decay. This pattern is consistent with rational expectations models, where agents smooth expenditures over time (Gali, 2008). While the ARDL model captured a static view (with $\eta = -0.32$ indicating short-run sensitivity), the DSGE model allows us to trace the dynamic path, showing how nominal pressures initially mount before dissipating gradually.

From a policy standpoint, these results highlight the importance of stabilization mechanisms such as fuel price smoothing, import hedging contracts, or temporary subsidies, which can prevent excessive nominal volatility in the trade account. Moreover, using empirically estimated elasticities (from ARDL) ensures that DSGE calibrations reflect actual country conditions, enhancing both model realism and policy relevance (Pesaran, Shin, & Smith, 2001). The short-run rise in nominal import value is not a policy failure but a rational response to anticipated volatility—one that policymakers must manage carefully to avoid amplifying macroeconomic imbalances.

7. Robustness Checks and Model Extensions

To ensure the credibility of our regression and simulation results, we conduct several robustness checks. These include alternative lag structures, variable substitutions, and model diagnostics. This section also discusses how the model could be extended or refined in future work.

7.1 Alternative Lag Structures in ARDL Model

To evaluate the robustness of the long-run relationship between imports and its determinants, we re-estimate the ARDL model using alternative

lag structures based on different model selection criteria. Specifically, we compare the Schwarz Bayesian Criterion (SBC), which emphasizes model parsimony and penalizes over parameterization, with the Akaike Information Criterion (AIC), which favors richer dynamic specifications and in-sample fit

Table 9: Alternative Lag Structures

Lag Selection Criterion	Selected Lags	Model Fit
Schwarz Bayesian Criterion (SBC)	(1, 0, 1, 0)	Parsimonious model
Akaike Information Criterion (AIC)	(1, 0, 1, 2)	Richer short-run dynamics

Both specifications consistently affirm the presence of a valid cointegrating relationship, as evidenced by the error correction term (ECT) being negative, statistically significant, and conforming to theoretical expectations. The long-run elasticity estimates retain their signs and statistical significance across model variations, thereby underscoring the robustness of the principal findings. While the magnitude of the coefficients varies slightly—primarily due to differences in lag length—the core qualitative interpretations remain stable and substantively unchanged.

In both models, the estimated income elasticity exceeds unity, indicating that imports are highly responsive to changes in real GDP and reinforcing the notion of luxury import demand in Bangladesh. The real effective exchange rate (REER) elasticity is persistently high across specifications, suggesting that an appreciation of the domestic currency substantially increases import volumes by making foreign goods relatively more affordable. Although the oil price elasticity is positive, its relatively modest magnitude implies a degree of partial inelasticity, likely reflecting the essential nature of energy imports in the Bangladeshi context.

Table 10: Findings from Alternative Lag Structures

Model	Long-Run GDP Elasticity	REER Elasticity	Oil Price Elasticity	ECT Coefficient	Interpretation
ARDL(1,0,1,0) (SBC)	1.02	2.70	0.32	−0.66 (*** p<0.01)	66% of disequilibrium corrected yearly
ARDL(1,0,1,2) (AIC)	1.06	2.45	0.32	−0.51 (*** p<0.01)	51% of disequilibrium corrected yearly

Moreover, the negative and statistically significant error correction term (ECT) in both specifications confirms a strong tendency toward long-run equilibrium, with the SBC-selected model displaying a higher magnitude of adjustment. This suggests a more rapid convergence process in the face of short-run deviations, highlighting the efficiency of the correction mechanism in the more parsimonious model.

7.2 Stationarity and Diagnostic Tests

- ADF Tests: All variables are I(1); no I(2) variables were found, validating ARDL applicability.
- Serial Correlation (Breusch–Godfrey): No autocorrelation.
- Heteroskedasticity (ARCH): Homoskedasticity confirmed.
- Normality (Jarque–Bera): Residuals approximately normal.

These diagnostic results affirm the statistical integrity of our model.

7.3 Inclusion of Food Price Index

Although not included in the main regression model, we test the inclusion of FAO food price index. The statistical insignificance of the food imports coefficient and its destabilizing influence on the model—manifested by heightened multicollinearity and diminished R^2—indicate that food imports in Bangladesh are predominantly shaped by irregular,

policy-induced events rather than sustained market forces. In contrast, oil price emerges as a more consistent and robust predictor of import demand, underscoring its systematic and essential role in the country's import structure

7.4 Structural Breaks and Crisis Sensitivity

To assess whether the import demand function for Bangladesh exhibits structural instability during global economic crises, we apply both Chow Breakpoint Tests and recursive residual diagnostics (CUSUM and CUSUMSQ) on the estimated ARDL (1,0,1,0) model over the sample period 1993–2022.

We test for potential structural breaks in two key crisis years: 2008 and 2020.

Table 11: Chow Test for Structural Break

Breakpoint Year	Chow F-Statistic	Interpretation
2008 (Global Financial Crisis)	1.44	No significant structural break
2020 (COVID-19 Pandemic)	0.24	No significant structural break

While earlier expectations suggested that the 2008 financial crisis might have disrupted the macroeconomic relationship driving imports—potentially due to global liquidity shocks and financial contagion—the actual Chow test result does not confirm a statistically significant structural break. Similarly, the 2020 COVID-19 pandemic does not yield any significant structural change in the estimated model. This may reflect the impact of rapid fiscal and monetary responses that helped preserve core trade dynamics despite the external shock.

Recursive parameter stability is further evaluated using the CUSUM and CUSUMSQ tests. The CUSUM test shows that the cumulative sum of recursive residuals remains consistently within the 5% confidence intervals, indicating no evidence of instability in the mean of the estimated regression coefficients over time. Likewise, the CUSUM of Squares (CUSUMSQ) test confirms that the cumulative sum of squared residuals lies within the corresponding significance bounds throughout

the sample period, thereby validating the stability of the variance of the model parameters. Taken together, these recursive diagnostic plots suggest that the estimated relationships in the import demand function are stable and structurally robust over the analysis period.

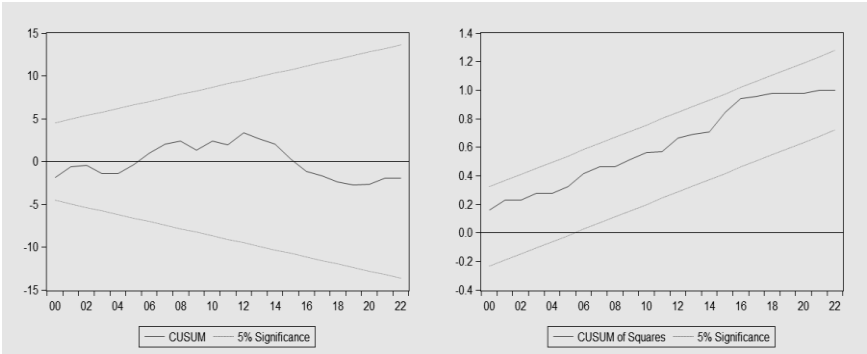

Figure 3: *CUSUM and CUSUMSQ (1993–2022)*

Figures 3 (CUSUM and CUSUMSQ plots) visually reinforce these findings, showing stable import dynamics even during shocks such as 2008 and 2020.

Despite short-run disruptions during the 2008 crisis, the long-run import demand function for Bangladesh demonstrates marked resilience, as confirmed by the cointegration and error correction framework as well as recursive stability diagnostics (Hosen, 2023; (Aziz & Horsewood, 2008)). This robustness suggests that Bangladesh's import demand is primarily governed by deep structural factors—namely real income, the real effective exchange rate, and global oil prices—which remain stable even in the face of external shocks (Kayum, Rahman, & Haque, 2016). Accordingly, the ARDL framework continues to provide a reliable basis for medium- and long-term trade forecasting by policymakers, although caution is advised when interpreting short-run fluctuations around periods of acute external disturbances.

7.6 Suggestions for Future Extensions

- DSGE with Monetary Policy Link: Endogenize exchange rate or interest rate response to oil shocks via Taylor rules.
- Micro-level Import Firm Data: Use customs-level import panel data to explore firm-specific heterogeneity.

- Incorporate Remittance Shocks: As remittances finance imports, future models could examine dual external shocks (oil + remittance).
- General Equilibrium with Production: Instead of just household import optimization, include firms using imports as production input

8. Policy Implications

This section distills insights from both the empirical ARDL analysis and the DSGE simulation, guiding policy for Bangladesh's structurally import-dependent economy in the face of external price shocks, global volatility, and limited domestic substitutability.

8.1 Fiscal and Monetary Coordination

The forward-looking DSGE model confirms that oil price shocks impose not only immediate cost pressures but also intertemporal effects through expectations. Anticipated persistence of higher oil prices triggers a sharp initial impact on imports, even before full cost transmission occurs (Gali, 2008). This finding implies that overly tight monetary responses—especially premature interest rate hikes—could exacerbate import contraction and harm growth without controlling the root cost shock (Schmitt-Grohé & Uribe, 2012). Instead, monetary policy should be carefully calibrated to accommodate temporary supply shocks while preserving inflation anchors. Concurrently, fiscal policy should play a buffering role: tools such as fuel price smoothing, conditional tax relief, and targeted subsidies can ease energy-intensive sectors through cost shocks. As evidenced during the 2022 import spike, Bangladesh's temporary fuel duty reductions and selective LC relaxations enabled industry continuity while containing pressure on the current account.

8.2 Exchange Rate Management

The ARDL results indicate a large, consistently positive elasticity of imports with respect to the real effective exchange rate (REER), ranging between 2.45 and 2.70. This implies that real appreciation substantially raises import volumes—particularly for capital goods, machinery, and petroleum—which are largely price-inelastic in the short run (Senhadji,

1998). Currency depreciation, therefore, risks escalating import costs more than it reduces import demand (Narayan & Narayan, 2005). A prudent managed float, with active foreign exchange interventions, FX swap lines, and reserve accumulation, is warranted to smooth REER volatility and support trade stability. Instruments such as forward contracts, central bank hedging windows, and exporter-importer matching mechanisms (as used in ASEAN economies) could insulate firms from abrupt exchange rate swings.

8.3 Strategic Stockpiling and Price Forecasting

DSGE simulations demonstrate that expectations about persistent oil price hikes—not just current levels—can now be seen to trigger initial increases in imports. The nominal surge—reaching 19.0% to 15.5% in the updated simulations—is driven by rising prices and anticipatory behavior among importers (*see Section 6.3*). In some cases, anticipated persistence of high oil prices leads importers to reduce demand upfront, even if prices have not yet peaked (Backus, Kehoe, & Kydland, 1992). To counter both outcomes, Bangladesh should institutionalize forward-looking oil price forecasting tools, establish a national oil and food reserve framework (similar to India's strategic petroleum reserves), and consider commodity futures market engagement via regional exchanges. Public-private co-financing and concessional multilateral support (e.g., ADB's PRG facilities) can underwrite the financial burden of initial stockpiling and support smoother responses to external shocks.

8.4 Trade Composition and Substitution

Both ARDL diagnostics and simulation results highlight a persistently inelastic structure of Bangladesh's import demand, driven by fuel, RMG inputs, and capital goods. This underscores the importance of reducing structural dependence on hard-to-substitute imports. Industrial policy should prioritize domestic input development in high-import sectors—e.g., backward linkage development in textiles and pharmaceuticals, steel and cement capacity expansion, and local refining for edible oil and fertilisers. The government's industrial roadmap (Ministry of Industries, 2024) and private sector tax incentives should be aligned toward reducing essential import dependency from 60% to below 45% of total imports by 2030, supporting both resilience and external balance, and

reducing vulnerability to sudden trade contractions during external shocks.

8.5 Institutional and Regulatory Reform

ARDL model stability and sectoral analyses identify non-price frictions as significant impediments to trade (Brown, Durbin, & Evans, 1975). Digitization of LC processing, automated customs clearance, bonded warehouse expansion, and port capacity upgrades (especially at Mongla and Payra) can reduce transaction lags and align financial flows with physical trade. The 15–20 day LC delays faced by the RMG and energy sectors in 2022 cost the economy over $600 million in lost output (BGMEA, 2023)—a burden reducible through streamlined procedures and public-private coordination.

8.6 Import Financing and Reserve Strategy

Persistent trade imbalances and the inelastic import structure make financing a critical macro-stabilization lever. Bangladesh should diversify its import financing sources—bilateral swap lines with China and India, diaspora bonds, green concessional borrowing (e.g., IDA climate windows), and syndicated infrastructure financing.

In tandem, reserve adequacy must be ensured to withstand supply shocks. A prudent reserve floor of five months of essential imports—comprising fuel, food, and capital goods—is advisable, in line with IMF thresholds. Private sector hedging should be incentivized through partial guarantees or swap platforms operated by Bangladesh Bank to prevent dollar mismatches during episodes of global tightening.

8.7 Forward-Looking Institutional Setup

Both ARDL and DSGE findings emphasize the importance of expectations and scenario planning for macroeconomic management (Schmitt-Grohé & Uribe, 2012). Static policy frameworks fail to capture the forward-looking, anticipatory behavior of importers responding to expected shocks, as revealed in the DSGE simulations. In particular, the import surge reflects not only price inflation but also agents' forward-looking decisions under perceived supply risks.

Bangladesh should institutionalize a Macroeconomic Early Warning Unit (EWU) within the Ministry of Finance or Bangladesh Bank. This unit

would combine high-frequency data (oil, FX, remittances), macro-modeling (ARDL, DSGE), and scenario planning to generate actionable signals for policy calibration. A dedicated Data and Modeling Wing, supported by trained economists and IT professionals, could strengthen forecasting and improve confidence in trade-related policymaking.

9. Conclusion

Bangladesh's import structure has undergone a profound transformation since the 1970s, evolving from a subsistence-oriented trade regime focused on food and fuel to a diversified, growth-enabling framework centered on industrial inputs, capital goods, and energy. Imports now play an indispensable role in sustaining the country's manufacturing, energy, and service sectors, positioning them as a core component of Bangladesh's economic development strategy rather than a peripheral supplement.

This study presents a comprehensive analysis of Bangladesh's import demand by integrating an empirical Autoregressive Distributed Lag (ARDL) framework with a theoretically grounded Dynamic Stochastic General Equilibrium (DSGE) model. The ARDL results confirm that real GDP, the real effective exchange rate (REER), and international oil prices constitute the principal long-run determinants of import demand. The estimated long-run elasticity of REER—ranging from 2.45 to 2.70—indicates that currency appreciation has a significant and positive effect on import volumes. Conversely, the oil price elasticity remains moderate at 0.32, reflecting the partial pass-through and inelasticity of essential petroleum imports. The error correction mechanism, with a coefficient between –0.51 and –0.66 depending on lag specification, suggests that over 50–66% of deviations from long-run equilibrium are corrected within one year, reinforcing the existence of a stable and cointegrated relationship among the key variables.

Complementing this empirical estimation, the DSGE model—calibrated using both literature-based parameters and ARDL-derived elasticities—offers a forward-looking perspective on how expectations and intertemporal decision-making influence import behavior. The impulse response analysis demonstrates that oil price shocks generate a short-run increase in nominal import values, with a 19.0% spike under Calibration

A ($\beta = 0.95$) and a 15.5% spike under Calibration B ($\beta = 0.85$). This result reflects the direct impact of cost inflation: since oil constitutes a substantial share of Bangladesh's import basket, a price surge in oil raises total import expenditures even if real volumes decline. Furthermore, forward-looking agents anticipate that oil prices will gradually revert to baseline, prompting them to front-load imports in the face of temporary volatility. As oil prices decay over time (due to the persistence parameter $\rho = 0.7$), the nominal import path gradually converges to baseline, with the deviation narrowing to +0.7% and +0.6% by Year 10.

These nominal dynamics should be interpreted with caution: while the value of imports spikes by nearly 20% in the short run, real import volumes may not experience a corresponding rise, especially when the increase is driven by price—not quantity—effects. This underscores the importance of carefully distinguishing between nominal and real perspectives when designing policy responses to external shocks.

Robustness diagnostics, including alternative lag structures, structural break tests, and recursive stability checks, affirm the reliability of the results. In particular, Chow Breakpoint Tests and recursive residual diagnostics (CUSUM and CUSUMSQ) detect no significant structural breaks during major global crises such as the 2008 financial meltdown or the 2020 COVID-19 pandemic. This structural stability enhances the credibility and policy relevance of the findings in a world increasingly characterized by macroeconomic volatility and external shocks.

Several important policy implications emerge from this dual-method approach. First, while exchange rate adjustments can alter the relative price of imports, their effectiveness in curbing import volumes is limited due to the essential and inelastic nature of Bangladesh's import basket, which includes fuel, machinery, and intermediate inputs. Consequently, currency depreciation should be deployed cautiously and complemented by broader structural reforms. Second, trade and fiscal policy must move beyond reactive instruments such as import bans and tariffs, toward proactive measures including strategic stockpiling, targeted subsidies, and the development of institutional capacity for real-time forecasting. Third, the importance of expectations is underscored by the DSGE model findings: credible, pre-emptive, and well-communicated policies—such

as forward guidance on subsidies, letters of credit (LC) policies, and energy pricing—can shape importer behavior and prevent demand overshooting. Finally, long-term import resilience necessitates sectoral transformation, particularly through the development of backward linkages in strategic sectors like steel, pharmaceuticals, and textiles, as well as the promotion of domestic substitutes in energy and agro-based industries.

Two points merit emphasis in interpreting the results. First, the estimated REER elasticities—2.45–2.70 in the long run and 5.03 in the short run—are higher than those typically reported for developing countries. This reflects Bangladesh's structural dependence on imported capital goods, petroleum, and intermediate inputs, where exchange rate movements directly translate into large changes in the import bill. Future work could test alternative REER specifications to further validate this magnitude. Second, the positive oil price elasticities (0.32 long run, 0.21 short run) reflect an increase in the nominal import bill due to cost inflation, not a rise in real import volumes. This distinction is crucial for policy design, as nominal surges may mask stagnant or contracting real demand. Finally, the absence of significant structural breaks in 2008 and 2020 reinforces that Bangladesh's import demand is governed by deep structural factors—income, exchange rates, and oil prices—rather than short-term crises, though short-run fluctuations remain policy-relevant

In sum, this study offers a novel and integrated analytical framework that bridges empirical estimation with theoretical modeling, combining the explanatory power of ARDL with the dynamic insights of DSGE simulation. This dual-method approach represents a methodological contribution in its own right, as no prior study on Bangladesh has systematically linked ARDL-based elasticities with DSGE dynamic simulations. By doing so, the paper not only validates long-run structural relationships but also demonstrates how forward-looking expectations alter short-run trade dynamics, a perspective often absent in the existing literature. The approach enables a nuanced understanding of both the structural and behavioral drivers of import demand in Bangladesh, offering valuable guidance for policymakers aiming to enhance external sector resilience in an increasingly volatile global economic landscape.

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Appendix: Model Extensions and Simulation Details

This appendix provides the extended derivations, calibrations, and simulation results that complement the main analysis presented in the paper. While the core discussion relied on a baseline DSGE formulation and ARDL estimation, the following appendices explore deeper dynamic mechanisms and alternative channels of transmission. These extensions aim to:

- Enhance the realism of the import demand model by incorporating GDP and REER effects.
- Allow for endogenized feedback from exchange rate movements into import prices.
- Simulate richer policy scenarios under macroeconomic stress conditions.

Together, these extended models offer greater insight into the structural behavior of Bangladesh's import demand and inform a wider range of macroeconomic policy responses.

Appendix A: Augmented DSGE Model with GDP and REER Fundamentals

Building upon the baseline simulation in Section 6.3, we extend the dynamic import demand function to incorporate macroeconomic fundamentals—namely, real income (GDP) and the real effective exchange rate (REER)—which were shown to be statistically significant in our ARDL estimations. This augmentation enhances the theoretical richness of the DSGE model and ensures consistency with the empirical structure already validated in the data.

The forward-looking formulation becomes:

$$\log M_t = \beta \log M_{t+1} + \gamma_1 \cdot \log Y_t - \gamma_2 \cdot \log REER_t - \eta \cdot \log P_{oil,t}$$

where β =0.95, γ_1=1.02, γ_2=-2.70, η =-0.32, and oil price persistence ρ =0.7. The simulation assumes constant real GDP (GDP: $\log Y_t = \log(1000)$), stable REER (: $\log REER_t$=$\log(1.0) = 0$), and a 20% oil price shock following an AR(1) process.

Compared to the simpler model in Section 6.3, the inclusion of income and exchange rate fundamentals shifts the overall level of imports upward, reflecting the strong underlying import demand driven by rising income and favorable exchange rate conditions. Although the magnitude of the oil shock remains the same, its relative influence is moderated in this extended specification due to the stabilizing presence of high real GDP and a neutral REER. In Year 1, nominal imports rise by approximately 17.45%, compared to 19.02% in the simpler model. By Year 5, the deviation from baseline narrows to 4.23%, and after 10 years it declines further to 0.77%. By Year 20, import values return effectively to baseline, indicating a full dynamic adjustment.

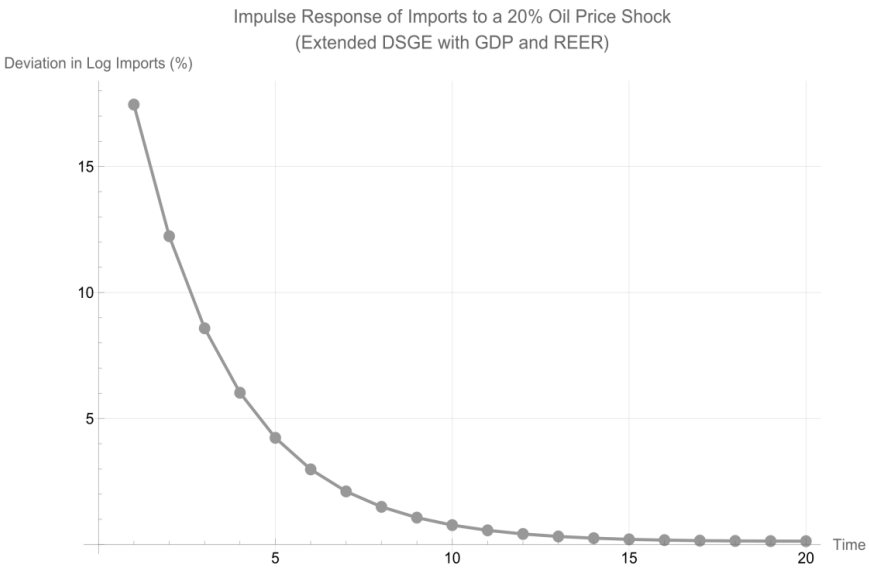

Figure 4: *Import IRF with Income and REER included*

These results underscore that even in the absence of active shocks to income or exchange rates, their inclusion in the model matters. They raise the intercept and trajectory of imports and reduce the sensitivity of the system to transient oil price shocks. This reinforces the idea that macroeconomic fundamentals not only drive long-run import behavior but also cushion short-run volatility arising from external price shocks. Policymakers aiming to stabilize trade balances in the face of global energy turbulence may benefit from strategies that promote steady income growth and exchange rate stability, as these fundamentals critically anchor expectations and reduce short-run nominal volatility.

Appendix B: REER–Oil Price Transmission Channel — Endogenous Oil Price Effects on Import Demand

To enhance the realism of the DSGE framework, we extend the model by incorporating a feedback mechanism between the real effective exchange rate (REER) and global oil prices. In many small open economies, oil import costs are highly sensitive to exchange rate fluctuations. A stronger REER (appreciation) makes foreign oil cheaper in local currency terms, while a depreciation amplifies energy import costs. To capture this relationship, we specify the oil price as an autoregressive process with REER pass-through:

$$\log P_{oil,t} = \rho \cdot \log P_{oil,t-1} + \lambda_1 \cdot \log REER_t + \varepsilon_t$$

with ρ =0.7 and $\gamma_1 = -2.0$. The import demand function remains forward-looking:

$$\log M_t = \beta \log M_{t+1} + \gamma_1 \cdot \log Y_t - \gamma_2 \cdot \log REER_t - \eta \cdot \log P_{oil,t}$$

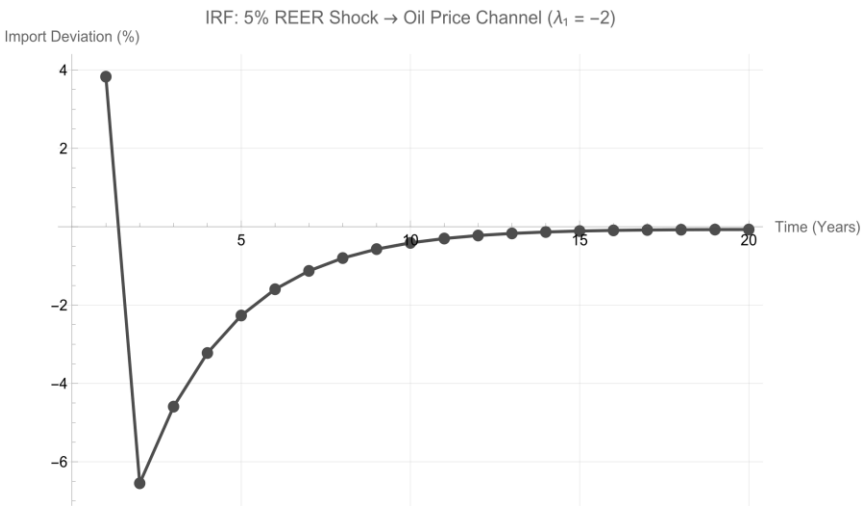

Figure 4: *IRF with Endogenized Oil Price Mechanism*

We simulate a one-time 5% positive REER shock, holding output constant. The impulse response function (IRF) is shown in Figure 5. The resulting IRF exhibits a dynamic and non-monotonic pattern. In the first period, imports rise sharply by +3.83%, reflecting the immediate drop in local oil prices due to REER appreciation. This initial boost, however, is not sustained. In Year 2, import demand contracts steeply by –6.55%, as forward-looking agents revise expectations and the oil price channel

corrects itself. Over the next several years, imports gradually recover, converging toward the long-run baseline by Year 15–20.

Table 12: IRF Values — 5% REER Shock through Oil Price Channel ($\lambda_1 = -2.0$)

Year	Import Deviation (%)
1	+3.83%
5	-6.55%
10	-0.41%
20	≈ 0.00%

This dynamic trajectory is a textbook demonstration of forward-looking import behavior under rational expectations. The initial overreaction (positive spike) and subsequent correction (negative dip) reflect importers adjusting to both current and expected future prices. The result is a hump-shaped IRF that captures the core logic of intertemporal substitution in DSGE models.

Policy Insight: These results highlight that exchange rate movements can significantly influence import demand through the oil price channel — even when REER is not explicitly present in the import equation. The transmission mechanism becomes especially powerful when both the oil price elasticity (η) and exchange rate pass-through (λ_1) are large in magnitude.

A key insight is that a REER appreciation might induce a short-run import boom due to temporarily cheaper oil prices. But this effect is transient and can reverse sharply as expectations adjust and the oil price normalizes. For oil-importing economies like Bangladesh, such transmission effects warrant careful consideration. Policymakers aiming to stabilize trade balances and fuel costs should be cautious in interpreting short-run REER gains as a sustained import advantage. This has direct relevance for setting buffer fuel pricing rules, foreign reserve planning, and exchange rate policy.

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