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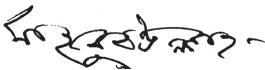
Editor's Note

The *Bangladesh Journal of Political Economy (BJPE)* has long served as a vital forum where rigorous economic inquiry meets the lived realities of our people. Volume 39, Number 1 (June 2023) arrives at a defining juncture. Though grounded in the empirical landscape of 2023, these contributions carry remarkable foresight, anticipating the monetary tightening, reserve constraints, and climate vulnerabilities that now define our present trajectory.

True progress can not be reduced to cold aggregates or market indices; it must be measured in the dignity and resilience of our most vulnerable citizens. This issue places human development at the heart of economic analysis. From the intricate interlocking of agricultural labour in Dinajpur and the fragile livelihoods of Tanguar Haor, to the social costs of parental migration on child schooling and the emerging burden of adolescent health, our contributors illuminate the human face of structural change. Alongside these grassroots examinations, the volume offers precise macroeconomic assessments: commercial bank capital adequacy, exchange rate dynamics, equity market volatilities, and the delicate trade-offs between industrial expansion, defence expenditure, and ecological sustainability.

As Bangladesh navigates LDC graduation, our policy architecture must evolve. We must transcend mere growth metrics and cultivate institutions that deliver equitable opportunity, transparent governance, and environmental stewardship—a vision deeply aligned with the pursuit of a ‘Enlightened Society’. Economic stability, after all, is meaningless unless it translates into lasting human welfare.

I extend my profound gratitude to our reviewers, the Editorial Board, and the dedicated researchers—both experienced scholars and emerging voices—whose careful work gives this volume its substance. In my many decades of teaching and public engagement, I have remained convinced that the surest compass for our future is a clear-eyed, compassionate reading of our present. May these pages inspire thoughtful dialogue and courageous, people-centred strategies for a resilient Bangladesh.



Professor Mahbub Ullah, Ph.D

Editor, Bangladesh Journal of Political Economy

Convener, Interim Committee, Bangladesh Economic Association

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Volume 39, Number 1, June 2023

Contents

1. Agricultural Labor Market Dynamics and Interlocking Arrangements: Evidence from Rural Dinajpur, Bangladesh <i>A. T. M Rezaul Hoque, A N H Angona, Md. Fahim Al Fahad & Md. Shams Ebrahim</i>	1
2. Adolescent Overweight and Obesity in Bangladesh: A Scoping Review <i>Nigar Sultana & Rina Akter</i>	17
3. Factors Influencing the Capital Adequacy Ratio of Commercial Banks of Bangladesh: A Panel Data Analysis <i>Khan A. Matin, PhD</i>	37
4. Employment Pattern of People Living in Tanguar Haor <i>Md. Khairul Alam & Faisal Ahmmed</i>	53
5. Impact of Parental Migration on School Attendance and Child Labor in Bangladesh <i>Bidhan C. Shaha & Sharif M. Hossain</i>	71
6. Does Military Spending Impede Economic Growth? ARDL and Causality Analysis for Bangladesh <i>Ashiqur Rahman, Nourush Jahan & Mohammad Sadiqunnabi Choudhury</i>	91
7. The Effects of Industrialization, Energy Consumption, and Economic Growth On Carbon Emissions in Bangladesh <i>Md. Omor Faruq</i>	111
8. Exchange Rate Depreciation and Its Connection to Falling Reserves in Bangladesh: Evaluating the Domino Effect <i>Md. Aynul Islam & Md. Saddam Hossain</i>	131
9. An Inquiry into the Influence of Key Macroeconomic Variables on the Dhaka Stock Exchange Equity Prices <i>Mallik Rawshan Alam & Aoulad Hosen, PhD</i>	149

Agricultural Labor Market Dynamics and Interlocking Arrangements: Evidence from Rural Dinajpur, Bangladesh

A. T. M Rezaul Hoque *

A N H Angona **

Md. Fahim Al Fahad ***

Md. Shams Ebrahim ****

Abstract

The present study aims to examine the performance of the agricultural labor market in Birampur Upazila, Dinajpur district. A cluster of three villages (Katla, Shibpur, and Catra) in Birampur Upazila, Dinajpur district, was randomly selected for the study. Thirty respondents from each village were randomly selected from the cluster of villages. The pre-tested schedules were used to collect primary data from the selected agricultural labor households during 2022-23. The collected data were processed and analyzed by using various statistical and mathematical tools. The frequency of labor-credit interlocking was much higher than that of labor-land interlocking. More than half of the laborers had borrowed money from their employers. There was no definite rate of interest on the money loaned by the employers. However, the employers recovered a very high implicit rate of interest through a large number of small jobs. The labor-land interlocking, however, was yet another form of wage labor, since all the inputs were provided by the landowners. It ranged from 13 to 17 percent. However, the average wage/day earned in this system was slightly higher (TK. 480-500) than the average wage rate in the casual labor system. Family size, family income, family socioeconomic status, and age significantly affected the probability that an agricultural labor household entered into interlocked arrangements.

Keywords: *agricultural labor market · labor credit interlocking · labor-land interlocking · casual labor system*

1. Introduction

Labor is the most important input in increasing production in traditional agriculture. In the early stages of development, when land was plentiful, an

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increase in the labor supply led to the clearing of more land for cultivation. The labor market in Bangladesh consists of three types: formal, rural informal, and urban informal. A small portion of the total labor force, however, works under the formal labor market framework.

Close to 50 percent of Bangladesh's population is employed in agriculture, and more than 70 percent of its land is dedicated to crop production (BBS 2019). The rural labor market in Bangladesh, as in many developing countries, is usually characterized by peculiarities that make a straightforward application of the conventional definitions of the labor force, unemployment, etc., rather unsatisfactory. These 'peculiarities' of the rural labor market significantly affect labor availability and efficiency. Therefore, it is important to understand some of the peculiarities in order to put the subsequent discussion on a proper footing.

First, the seasonal nature of agricultural production in these economies causes labor demand to vary considerably over time, resulting in labor shortages at certain times of year and significant unemployment at others. Second, primarily due to seasonality and its implications for fluctuations in earnings and poverty levels over time, the size of the rural labor force varies considerably, with frequent entries and exits. A person who, at certain periods of the year, is neither employed nor actively looking for work (because of the non-availability of jobs, personalized nature of rural labor markets, etc.) may seek and get employed at peak periods of demand. Third, the rural labor market is characterized by considerable variability in work hours, both over time and over activities. In peak periods, a day's work may extend to 12 hours of intensive fieldwork, whereas in slack periods it may fall to about 6 hours a day, with reduced work intensity. Fourth, rural workers (both self-employed and wage laborers) often engage in multiple economic activities each day. As a result, accounting for time spent on different economic activities is difficult unless one can closely observe switches between activities and use a time unit for work much smaller than the conventional accounting unit of a labor day.

The above-mentioned 'peculiarities' of the rural labor market significantly affect labor availability. Consequently, the concept of interlocked transactions is rising as a significant issue in this sector. The unequal distribution of land holdings is one of the distinguishing factors in a poor socio-economic culture in agriculture. This disproportionate distribution of land holdings encourages leasing land to optimize land use. Therefore, those who have spare land either lease it or hire labor to make the most of their land resources. Correspondingly, those who do not have sufficient land either lease-in land or hire out labor services to earn a livelihood. This circumstance promotes labor markets in agriculture; thus, the two labor markets may be complementary, functioning independently and

simultaneously.

Therefore, the concept of interlocked transactions is rising as a significant issue in this sector. Consequently, the need for a comprehensive, strategic framework to consolidate the rural labor market has emerged as an important issue within the wider policy community. To address this need, schoolwork could help guide policymakers in developing effective policies to advance Bangladesh sustainably and financially. With that in view, this study was conducted to present a detailed examination of the extent of interlinkage in the labor-land and labor-credit markets, the explicit and implicit costs of these contracts, and the factors affecting the interlocking of factor markets.

In this investigation, Birampur Upazilla of Dinajpur district has been purposively selected, as it is an area of promising development. Then, three villages have been randomly selected for the detailed study. The pre-tested schedules were used for face-to-face interviews with agricultural laborers to collect primary data over two consecutive seasons of the 2022-23 agricultural year. The collected data was processed and analyzed using various statistical and mathematical tools in Microsoft Excel to achieve objective-oriented results.

2. Problem Statement

An agricultural laborer can be defined as the involvement of any person in connection with cultivating the soil, or in connection with raising or harvesting any agricultural or horticultural commodity, management of livestock, bees, poultry, etc. Agricultural laborers face unemployment and underemployment. For a substantial part of the year, they have to remain unemployed because there is no work on the farms and no other sources of employment exist.

In Bangladesh, the agricultural and rural labor markets are the same, depending on how they function. Although there is no conventional definition that provides an exact description of the term, the rural dimension is usually defined by comparison with its opposite, the urban dimension. The latter is usually characterized by superior access to financial, physical, human, and social capital, which implies lower rates of labor productivity in the rural sector. As Wiggins and Proctor (2001) point out, the term ‘rural’ refers to things of the countryside: “rural areas constitute the space where human settlement and infrastructure occupy only small patches of the landscape, most of which is dominated by fields and pastures, woods and forests, water, mountains, and desert”. A few formalized facts are commonly acknowledged in describing rural areas:

- (i) relative abundance of land and other natural resources, which are immobile; hence, rural areas are usually the location for farming;

- (ii) distance between rural settlements and cities, which implies high costs of movement;
- (iii) relative poverty of many of the inhabitants, as average incomes are lower in rural areas than in towns and cities, with the exception of some rural areas in Bangladesh.

In this situation, the linked transaction is preferred because such interlinking of markets reduces the stronger party's control, as partial operations in any one market may occur due to tradition, custom, or fiscal factors. Again, the interpenetration of markets allows them to submit applications across diverse markets and phase out operations over time. Interlocked transactions are used, among other things, to enforce contracts, reduce transaction costs in labor recruitment, and form labor unions. The incidence of interlocking between the labor-credit and labor-land markets is not only low but also less exploitative, given the explicit and implicit interest and wage rates. Factors such as land ownership, family size, dependency ratio, non-farm sources of income, farm assets (including livestock), age, literacy, etc., affect the probability that an agricultural labor household enters into interlocked arrangements.

3. Rationale of the Study

Labor is one of the most important inputs in agricultural production. How it is measured and valued is critical to establishing the cost of producing agricultural commodities and accurately portraying labor's relative share of total production costs. The problems of agricultural labor in Bangladesh are as follows:

- Marginalization of agricultural workers
- Wages and income issues
- Employment and working conditions
- Indebtedness and
- Low wages for women in agricultural labor. Female agricultural workers are generally forced to work harder and paid less than their male counterparts.

Many economies are characterized by imperfect rural labor markets, due to transaction costs and structural impediments, which result in a sub-optimal allocation of labor, lower worker incomes, and thus constrained rural development. To the extent that rural development is the key objective for improving people's living conditions and their income, well-functioning rural labor markets are an essential prerequisite for rural agricultural economies. Therefore, it is crucial

to gain insights into the functioning of rural labor markets by examining the interlinkages between the labor-land and labor-credit markets, the explicit and implicit costs of these contracts, and the factors that affect the interlocking of factor markets.

To understand and describe the functioning of the labor market in rural areas, it is crucial to define the nature of interlinkages in the labor-land and labor-credit markets, the explicit and implicit costs of these contracts, the factors affecting the interlocking of factor markets, and thus recognize the main variables of interest.

The results will provide insights into the functioning of the agricultural labor market and the policy environment. This information will be useful for subsequent labor development strategies and will provide valuable insights for policies aimed at improving structural and financial development in the agricultural/rural labor sector.

Since the goal of this study is a comprehensive assessment of the rural labor market, a number of methodological challenges had to be met simultaneously. Knowing the details of this aspect would facilitate the planning and implementation of effective rural labor policy in the future.

4. Objectives of the Study

To study the extent of incidence of inter-linkage in the labor-land and labor-credit markets, explicit and implicit costs of these contracts and the factors affecting interlocking of factor markets is necessary to know. The aim of the present research work was to study of micro-evidences for agricultural labor market functioning in agriculturally developed Birampur upazilla of Dinajpur district.

The objectives which have been placed within the horizon of this study are as follows:

- i. To identify the incidence of interlocking among casual agricultural labor households
- ii. To identify and quantify the cost of labor-credit interlocking in the study area
- iii. To measure the cost of labor-land interlocking in the study area

Therefore, for a wide-ranging and strategic framework for consolidating the rural labor market, it is necessary to pay policy attention in this regard. To discuss such a requirement, the exercise might help facilitate the managerial principle to policy-makers so that they may initiate effective policies for the sustainable, commercially feasible advancement of Bangladesh.

5. A Brief Review of the Literature

A literature review is a piece of academic writing demonstrating knowledge and understanding of the academic literature on a specific topic placed in context. A literature review also includes a critical evaluation of the material; hence, it is called a literature review rather than a literature report.

This section reviews the literature related to the study. Khan *et. al.* (1981) found that the labor days expended in non-farm activities were about 1.5 times higher than those in farm activities. Even though non-activities usually subsume non-agricultural activities, the shares of non-agricultural activities in the two study villages are likely to be higher than those of agricultural activities. Khuda (1982) found that seasonal variation in productive employment is less pronounced for females than for males. It is hard to see why the females should have more stable employment than males unless he has picked up in his sample only the regularly employed females, many of whom are primarily engaged as domestic help. Bhaduri (1984) on rural labor markets dealt with the issues of interlocked factor markets and captive labor, focusing on the personalized nature of the labor market as well as bonds, sanctions, and the interlocked nature of different markets, which can, and often do, create captive labor. Though labor is primarily unskilled and less differentiated than in urban areas, education and skill barriers, and the lumpy character of certain jobs create differentiation and allow only restricted labor mobility. Muqtada and Alam (1983) found that workers from small farm households were more likely to be employed than those from other household groups in both low- and rapid-growth agricultural areas. Only in the industrial center area do landless workers have higher employment than other workers. Large farmers are generally found to have lower employment. The BIDS study (1985), on the other hand, found the highest employment among landless and near-landless workers. The large farmers were found to have more employment than other households, a phenomenon explained by the greater availability of non-farm activities among larger farmers.

Rahman & Islam (1986) noted that women workers spend a substantial part of their time on other agricultural activities, such as livestock rearing and vegetable gardening. Second, a large share of women's labor time is devoted to post-harvest activities. In fact, post-harvest activities and other agricultural operations account for more than four-fifths of the total labor time female workers devote to agriculture. Third, junior workers spend more time than female workers in field activities, but like the females, they also concentrate more on post-harvest and other agricultural activities, mostly in animal rearing. The analysis by Rahman & Islam (1986) shows that land ownership, on the whole, has a rather negative impact on labor use, particularly after income reaches a certain level. Education is also found to have a negative impact on agricultural labor use but a positive

impact on non-agricultural labor use. Productive labor use by female workers is negatively affected by both the proportion of children in the family and the total land area. Both kitchen gardening and the number of livestock per household are found to positively affect female labor use. The impact of education on female labor is found to be rather indeterminate.

Fiendeis et al. (1991) argued that the institutionalized perspective provides the rationale for minimum wage policies to counter exploitation by ensuring all workers receive a fair wage and, more generally, as an anti-poverty policy. This view sees minimum wages both in a rights-based framework and as a social policy. While distortionists argue that, if set above the competitive equilibrium wage, a minimum wage can price low-productivity workers out of the (formal) labor market, hurting exactly those people the policy was meant to benefit. Moreover, it questions minimum wages as an effective anti-poverty tool, arguing that they are poorly targeted to poor households, which may be unlikely to have covered workers. Brown (1999), in a frequently cited review, concludes that the minimum wage effect is small (and zero is often hard to reject). In its reexamination of the Job Strategy, the OECD (2006) reached a similar conclusion, basing its policy advice on the considerable body of studies that have found the adverse impact of minimum wages on employment to be modest or non-existent.

The above review leads us to conclude that the literature on the rural labor market in many developing countries, particularly Bangladesh, has raised and sustained interesting debates on various aspects of the market.

6. Approaches or Methodologies of the Study

A. Proposed Area and Sample Selection

In this investigation, Birampur Upazilla of Dinajpur district was purposively selected, as it is an area of promising development. Then, three villages, namely Katla, Shibpur, and Catra, were randomly selected for the detailed study. A cluster of three villages was randomly selected. Using probability-proportional-to-size sampling, 30 respondents from each village were randomly selected, and primary data were collected from the selected agricultural labor households.

B. Data Collection Methods

The pre-tested schedules were used for face-to-face interviews with agricultural laborers to collect primary data over two consecutive seasons of the 2022-23 agricultural year. The collected data were processed and analyzed using various statistical and mathematical tools in Microsoft Excel to achieve objective-oriented results.

C. Targeting Methodology

Explicit cost = wage of hired labor, value of seed, manure, fertilizer, irrigation

charges, etc.

Implicit cost = interest on loan.

The cost (both explicit and implicit) of interlinkages of labor-credit and labor-land markets was worked out by following the procedure given below:

Explicit interest = the amount of interest paid on the loans

Implicit interest = $L (Mw - Aw) + (N \times Mw)$

Where

L = is the total number of days worked for the landlord creditor on a wage less than the prevailing market wage

Mw = the market wage rate

Aw = the actual wage received

N = the number of days worked without wages for the landlord creditor.

The total interest = explicit interest + implicit interest

The rate of interest = $(i/p) \times 100$

Where

I = the explicit + implicit interest and

P = the total amount borrowed

Likewise, the cost of labor-land inter-linkages will be computed

The explicit rent = the amount of rent paid

The implicit rent = $L (Mw - Aw) + (N + Mw)$

Total rent = explicit rent + implicit rent

Where

L = the number of days worked for the landlord on wages less than the market wage

Mw = the market wage rate

Aw = the actual wage that he gets and

N = number of days worked for the landlord without wages.

7. Results and Discussion

7.1 Incidence of Interlocking among Casual Agricultural Labor Households

Some of the relevant indications establish the empirical importance of interlinking. Generally, a discussion of the reasons for interlinking and the principal-agent and bargaining theoretical approaches is presented, compared, and contrasted in the context of resource allocation, innovation, and welfare. The discussion refers to rural life and its principal actors: farmers, laborers, landlords, tenants, moneylenders, and traders.

The percent of households involved in labor-credit and labor-land interlocking was very high in all selected villages (Table 1). The table shows that more than 82% of the selected households were observed to be either borrowing or leasing land from their employers in the study area. Additionally, labor-credit interlocking was reported to be more prominent than labor-land interlocking.

Table 1: Incidence of Interlocking Among Casual Agricultural Labor Households

Sl. No.	Particulars	Villages			All
		Katla	Shibpur	Catra	
1.	Land – credit	72	67	62	67.0
2.	Labor-land	13.9	15.8	16.7	15.47
3.	Labor-credit and labor land	13.9	15.8	16.7	15.47
4.	Sample households in interlocking	87.7	83.9	82.01	84.54
5.	Sample households	30	28	29	87

Source: Field Survey, 2022-23

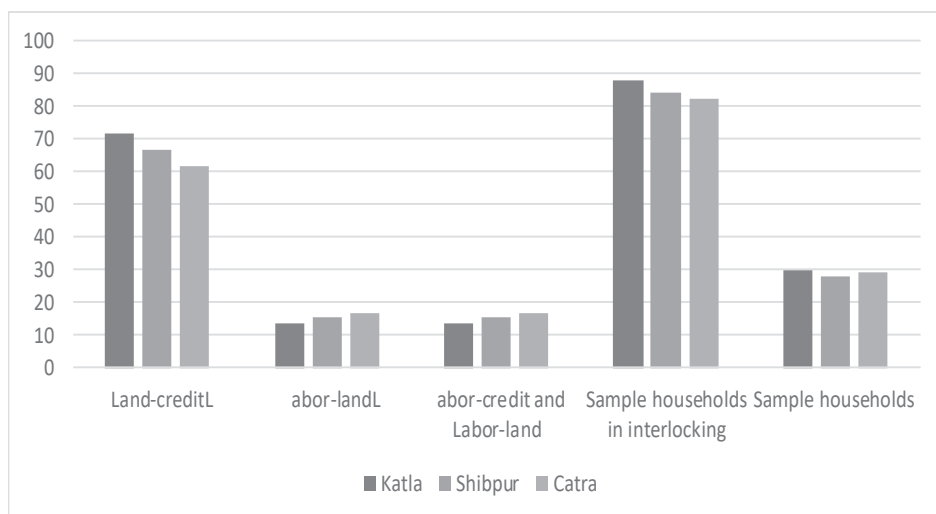


Figure 1. Incidence of Interlocking Among Casual Agricultural Labor Households

7. 2 Causes of Interlocking of Agricultural Markets

Interlocking often acts as a security against risk. The reason is that one can recover their loan from the tenants' share of the crop. Thus, the risk of default is reduced through the interlocking of the land (lease) and the credit market. Similarly, if there is crop failure due to adverse weather or a natural calamity, the landowner can recover his rent by compelling the tenant to provide his labor services free of charge in the next agricultural season. This is possible because the land (lease) market and the labor market are interlinked. About 79.67 percent replied regarding this issue.

Another reason for such interlocking is to derive some economies or advantages. During peak season, wages rise due to high labor demand. But due to inter-market contractual relations (in this case, between the credit and labor markets), the landowner can obtain labor services from tied laborers at lower wage rates. In this way, the wage cost of the landowner becomes much less than it would be in the absence of interrelation between these two markets. On average, 33.01 percent responded to this issue.

Finally, the interlocking of different markets serves as a substitute for money. In some parts of the area, the exchange system still exists. Commodities are directly exchanged for commodities. But the success of this system requires double coincidence of wants, which is created through the interlocking of different markets in agriculture. On average, 15.47 percent answered relating to this issue.

Table 2. Causes of Interlocking of Agricultural Markets

Sl. No.	Particulars	Villages			All
		Katla	Shibpur	Catra	
1.	Risk reduction	81	79	79	79.67
2.	Economic security	31	34	32	33.01
3.	Money substitute	13	15	16	15.47

Source: Field Survey, 2022-23

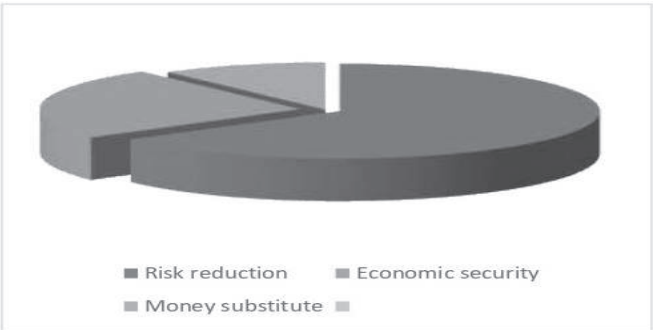


Figure 2. Causes of Interlocking of Agricultural Markets

7.3 Cost of Labor-Credit Interlocking

Two factors were identified that significantly influence the analysis. First, in terms of information, there is the distinction between not knowing what sort of being one is dealing with, which may lead to adverse selection. Second, the problems of contractual enforcement and determination, or avoidance by borrowers, are given a prominent place. Again, a third theme arises from these exits from the framework of complete and competitive markets—namely, how the scope for strategic behavior is balanced.

The amount borrowed in the interlocked transactions varied from Tk. 2690 in Katla to Tk. Tk. 2410 in Catra (Table 2). The frequency of borrowing ranged from 2.00 in Katla to 3.00 in Shibpur. No sample household reported paying the interest rate on the amount borrowed from their employers. The employers, however, charge an implicit rate of interest by requiring extra work without payment and by paying lower wages to those who had borrowed money from them. The data at our disposal showed that the number of days worked on poorer pay per annum varied from 79 (Catra) to 62 (Katla). This covered additional hours of work on routine working days and the performance of many small works like leaving the message or other things to the relatives of the employers, help in irrigating the field, bringing inputs from the market, delivering some small goods etc. without getting any extra wage taking into account the number of hours put

for performing those unusual jobs and the extra hours without wage, the average difference in the wage, which they ought to have received and what they actually received varied between Tk. 6.50 to Tk. 11.00 in the sample villages.

Considering the number of days worked for lower pay and the difference between the wage rate and the average amount borrowed, the interest rate ranged from 35 to 23 percent. Traditional debt was observed in only one village in Tk. 11,900 in Catra. It is, however, important to note that, since both employers and laborers belonged to the same nearby villages and knew one another, the degree of market imperfections arising from asymmetrical information, moral hazard, and adverse selection was very low.

Table 3. Cost of Labor-credit Interlocking

Sl. No.	Particulars	Villages			All
		Katla	Shibpur	Catra	
1.	Amount borrowed (Tk/ annum)	2690	2530	2410	2543.33
2.	Frequency of borrowing (Number per annum)	2.0	3.0	2.50	2.52
3.	Explicit rate of interest	-	-	-	-
4.	Days worked on lower wage Number per annum)	62	73	79	71.33
5.	Difference in the wage rate (Tk.)	8	11	6.5	8.5
6.	Total implicit interest paid(Tk.)	642	698	581	640.33
7.	Implicit rate of interest (Percent per annum)	23	31	35	29.67
8.	Hereditary debt				
8 (i).	Household (Percent)	-	-	7.0	2.38
8 (ii).	Amount (Tk.)	-	-	11,900	4110.01

Source: Field Survey, 2022-23

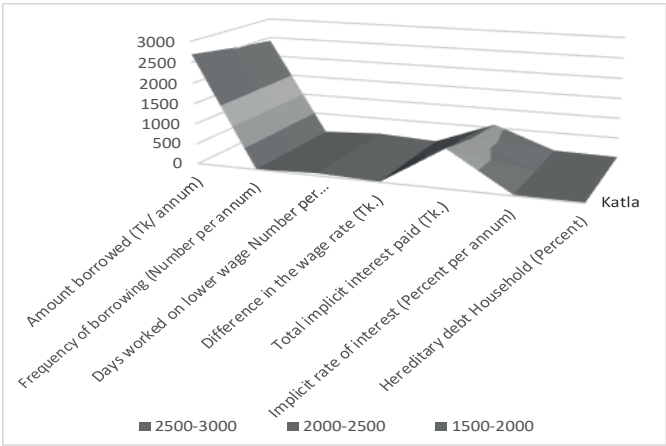


Figure 3. Cost of Labor-credit Interlocking

7. 4 Cost of Labor-Land Interlocking

An interlinked transaction is one in which the parties trade in at least two markets on the condition that the terms of all trade between them are jointly determined. According to their definition, two or more parties and more than one market are involved in the interlocked factor market. Interlocking of the agricultural factor market is possible due to the interlocking of the land (lease) market and the labor market. This interlocking of different agricultural markets reduces risk.

The low frequency of labor-land interlocking ranged from 13 to 17 percent of sample households involved in such interlocking (Table 3). The low frequency of labor-land interlocking was primarily because most agricultural labor households lacked the supporting inputs required for farming. They also lacked farming skills. In the villages of the study areas, land was leased for both Kharif and Rabi seasons to grow wheat and maize. The average amount of land leased per household was 3-6 hectares. Since the employer-landlords provided all inputs except labor, three-fourths of total production was paid to the landlords as rent for leased-in land. The remaining one-fourth of the total production was given as the reward for the labor.

The system was thus yet another form of wage labor. The average daily wage rate in this system varied from as high as Tk. 500 in Shibpur to Tk. 480 in Catra, which was higher than the average wage under the casual labor system. As mentioned above, agricultural labor households are thankful to borrow from their landlord-employers for purposes such as illness, social ceremonies, and buying food grains. Similarly, in a recent investigation, the low incidence of labor-land interlocking was primarily due to the fact that most agricultural labor households lacked the supporting inputs, such as bullocks and other farm implements, which are essentially required for farming.

Table 4. Cost of Labor-land Interlocking

Sl. No.	Particulars	Villages			All
		Katla	Shibpur	Catra	
1.	Labor land interlocking (percent household)	13	15	17	15.01
2.	Land leased in (ha)	4	6	3	4.35
3.	Total output of (q/ha)				
	(i) Wheat	42	44	43	43.10
	(ii) Maize	24	25	24.5	
4.	Rent (q/ha)	14	12	11	12.31
5.	Tenant's share (q/ha)	4.00	3.50	5.00	4.18
6.	Number of days worked	27	28	26	27.01
7.	Total value of tenant's share (Tk.)	9600	8400	10200	9400.02
8.	Wage rate (Tk./day)	481	500	480	487.12

Source: Field Survey, 2022-23

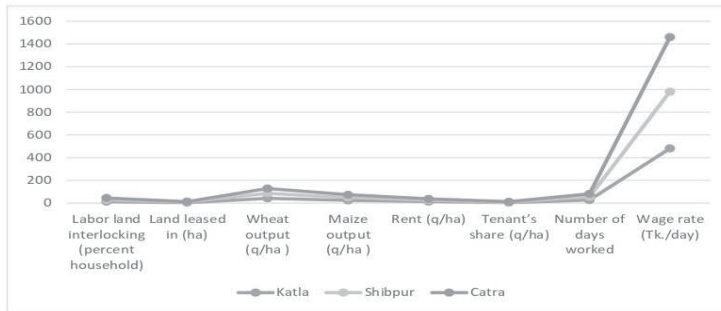


Figure 4. Cost of Labor-land Interlocking

8. Conclusion

The study reveals that, in most cases, the frequency of labor credit interlocking was higher than that of labor-land interlocking; more than half of the laborers had borrowed money from their employers. There was no explicit interest rate on the funds borrowed from the employers. On the other hand, the employers recovered a very high intrinsic rate of interest in terms of the number of small jobs owed. The labor-land interlocking, however, was yet another form of wage labor, since all the inputs were provided by the landlords. However, the average wage/day earned in this system was higher than the average wage rate in the casual labor system. Family size, family income, family socio-economic status, and age had a significant effect on the probability that an agricultural labor household entered into interlocked arrangements.

In order to strengthen rural labor markets, a few policy preparations have been encouraged in different literatures, such as creating jobs in rural areas, especially those complementary with agricultural activities in terms of skill requirements and seasonal labor demand, and supporting education through extensive programs to address low levels of human capital in rural areas. Therefore, investments in education and human capital would improve the quality of the labor-credit and labor-land interlocking system and would increase its flexibility, reducing labor-credit and labor-land interlocking mismatch and facilitating the move towards a more efficient labor adjustment. At the same time, it is fundamental to support rural infrastructure to encourage rural businesses, increase the user-friendliness of jobs for rural residents, and provide job-specific training programs for rural inhabitants.

References

- BBS 2019. Bangladesh Bureau of Statistics. Statistical Pocketbook of Bangladesh. 2018-19, Dhaka.
- Bardhan, P. 1980. *Interlocking factor markets and agrarian development*. A review of issues. Oxford Economic Papers. 32(1-2): 82- 97.
- Bhadhuri, 1984. *An Economic structure of backward agriculture*. Macmillan Indian Ltd. New Delhi.
- Corsi, A. and Findeis, J. 2000. “*True State Dependence and Heterogeneity in Off-Farm Labor Participation*”. European Review of Agricultural Economics. Vol. 27, No. 2, pp. 127-151.
- De Silva, S., Evenson, R.E. and Kimhi, A. 2006. “*Labor Supervision and Institutional Conditions: Evidence from Bicol Rice Farms*”, American Journal of Agricultural Economics. Vol. 88, No. 4, pp. 851-865
- Findeis, J. L., Lass, D.A. and Hallberg, M.C. 1991, “*Effects of Location on Off-Farm Employment Decisions in Multiple Job-Holding Among Farm Families*.” Iowa State University Press. Ames.
- Inter-Locking of Indian Agricultural Market: Causes and Effects*. 2008. Article shared by Sanket Suman
- Khan, A. R. 1981. *Employment, Income and Mobilization of Local Resources*. A Study of Two Bangladesh Villages. Asian Employment Program. ARTEP/ILO Bangkok.

- Barkat-e-Khuda. 1982. *The Use of Time and Under- Employment in Rural Bangladesh*. University of Dhaka. Dhaka.
- Muqtad and Alam. 1983. *Hired labor and Rural labor Market in Bangladesh*. Asian Employment Program. Working Paper. ARTEP/ILO. Bangkok.
- Rahman and Islam. Atiq Rahman and R. Islam. 1986. *Patterns and Determinants of Labor Use in Rural Bangladesh*. ILO-ARTEP Working Paper. New Delhi.
- Asiwal, R.C., Sharma, R.C and Sharma, B. K. 2017. *The incidence of labor-land and labor-credit interlocking in agriculturally developed region of Rajasthan*. Agric. Update. 12(2): 281-287. DOI. 10.15740/HAS/ AU/12.2/281-287.

Adolescent Overweight and Obesity in Bangladesh: A Scoping Review

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Abstract

The rising prevalence of overweight and obesity among adolescents is a growing public health concern worldwide, including in Bangladesh. This study conducted a scoping review to examine the prevalence and key risk factors associated with adolescent overweight and obesity in Bangladesh. The review followed the Arksey and O'Malley framework for scoping reviews and adhered to PRISMA guidelines for study identification and selection. Relevant literature published between January 2011 and December 2021 was identified through electronic databases, including PubMed and Google Scholar. Based on predefined inclusion criteria, seven studies were included in the final analysis. The findings indicate that several behavioral and lifestyle factors are associated with adolescent overweight and obesity in Bangladesh. Two studies reported a positive association between frequent fast-food consumption and overweight/obesity, while another study found that higher meal frequency increased the risk. Regular consumption of junk food and frequent restaurant dining were also linked to a higher prevalence of overweight and obesity. In contrast, one study reported that adolescents with higher fruit and vegetable intake had a lower prevalence of overweight and obesity. Sedentary behavior and limited physical activity were also identified as contributing factors. However, the available evidence remains limited, and few studies have explored effective intervention strategies. Further research is needed to better understand the determinants of adolescent overweight and obesity and to develop evidence-based interventions that promote healthier dietary practices and active lifestyles among adolescents in Bangladesh.

Keywords: *Adolescents · Overweight · Obesity · Dietary habits · Physical activity · Bangladesh · Non-communicable diseases*

Introduction

Overweight and obesity have emerged as major global public health challenges in recent decades. While undernutrition remains a persistent concern in many low- and middle-income countries, the prevalence of overweight and obesity is rapidly increasing, creating a dual burden of malnutrition. This growing trend is particularly concerning among adolescents, as excessive weight gain during

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adolescence can lead to serious health consequences later in life.

Obesity and overweight, ironically, when undernutrition still remains a big nutritional issue in many, including low-developing countries, have spread like a pandemic and by 2022 are predicted to outweigh undernutrition in terms of prevalence rate. Overweight and obesity generally result from an imbalance between energy intake and energy expenditure. Unhealthy dietary habits, increased consumption of energy-dense foods, and reduced physical activity are widely recognized as key contributors to this imbalance. These conditions significantly increase the risk of developing non-communicable diseases (NCDs), including cardiovascular diseases, type 2 diabetes, and certain cancers.

According to the World Health Organization (WHO), approximately 1.9 billion adults aged 18 years and older were overweight in 2016, and more than 650 million of them were classified as obese. Alarmingly, the prevalence of overweight and obesity among children and adolescents has also increased dramatically over the past few decades. Globally, the number of overweight or obese children and adolescents aged 5–19 years rose from 11 million in 1975 to over 340 million in 2016.

Childhood overweight and obesity have emerged as major public health problems in both developing and developed countries, as their prevalence has increased significantly over the past two decades (Jahnavi et al., 2011). In Bangladesh, rapid urbanization, changing dietary patterns, and increasingly sedentary lifestyles are contributing to a growing prevalence of overweight and obesity, particularly among adolescents. Increased consumption of fast food, sugar-sweetened beverages, and highly processed foods, combined with reduced physical activity and increased screen time, are emerging as key behavioral risk factors. Changes in dietary and physical activity patterns are often the result of environmental and societal changes, as well as the lack of supportive policies in sectors such as health, agriculture, transport, urban planning, environment, food processing, distribution, marketing, and education.

In Bangladesh, the latest Multi Cluster Indicator Survey (MICS) 2019 found the overweight rate among children aged 5 and under to be 8.4 percent and the obesity rate to be 0.8 percent. While these figures may seem low, in 2012–13, when the earlier MICS was carried out, the overweight proportion was 1.6 percent. Thus, over a span of 6/7 years, the proportion has risen by 50% or so. The present report is a scoping review related to adolescent O-O in Bangladesh.

Below, we first provide in Section II a situational review of the general obesity problem in Bangladesh, which serves as the background to the specific obesity among adolescents.

Section III provides the objective, followed by definitional issues and methods of the study in Section IV

Section V continues by analyzing adolescent obesity nationwide and identifying knowledge gaps. Lastly, in Section VI, suggestions and recommendations for future actions are provided.

Despite this growing concern, research focusing specifically on adolescent overweight and obesity in Bangladesh remains limited. Existing studies are scattered across different disciplines and vary in terms of study design, population groups, and reported outcomes. As a result, there is a need to systematically map the available evidence to better understand the prevalence and determinants of overweight and obesity among adolescents in Bangladesh.

A scoping review provides an appropriate approach for synthesizing existing literature, identifying research gaps, and providing an overview of the current evidence base. Therefore, this study aims to review and synthesize the available research on the prevalence and risk factors of overweight and obesity among adolescents in Bangladesh.

Findings from the Bangladesh Literature Review

There is now a burgeoning literature on overweight, obesity, and associated factors. In Bangladesh, obesity and overweight among children, adolescents, women, and, less frequently, males have been investigated to understand their patterns and associated factors, including food habits, lifestyle, rural-urban differences, and intra-urban residential differences.

The relevant literature shows that socioeconomic status, occupation, education, and regional and urban-rural context have an association with overweight or obesity among children and women. Studies indicate that the prevalence of obesity was higher among children from high socioeconomic classes, whereas the prevalence of underweight children was higher in lower socioeconomic classes. The association between socio-economic status (SES) and overweight and obesity is reported as significant and positive. One study reported that children and adolescents with higher SES and urban residence were 18 times more likely to become overweight or obese compared to those with low SES and rural residence. (8, 9, 10, 13, 15)

Furthermore, it has been observed that income and assets play a key role in the odds of rich people being obese compared to poor people. The probability of being overweight and obese was higher among the richest women relative to the poorest women (2, 11, 15, 17, 23), however, the middle, richer, and richest rural women had higher odds of being overweight compared with women in the

lowest wealth index group (6, 11, 14, 16, 18, 19, 20, 21, 22).

One study showed that parents' occupation has a significant influence on the level of obesity among children. But this was true more for fathers' occupation, which was significant, not for that of the mother, which was insignificant. A higher rate of overweight and obesity was noted among those adults (businessmen, servicepersons, and housewives) who had less scope to be involved in physical activities. They were 38 percent more likely to be overweight and obese compared to another group of adults who had more physical activities. Another study showed that working urban women had a 21% and 46% lower probability, respectively, of being overweight or obese compared to those who do not work outside the home (2, 4, 13, 15, 17, and 24). Residence does matter. It has been observed that the prevalence of overweight/obesity among urban residents is higher than that among rural residents (1, 3, 6, 8, 10, 11, 15, 16, 17, 18, 19, 20, 21, 22, and 25). Moreover, studies revealed that overweight /obesity has a significant prevalence among those who eat junk food and restaurant food, don't follow a balanced diet, and sleep at noon on a regular basis. In the case of female students, skipping breakfast highly affects the outcome of being overweight or obese. Consumption of carbohydrates, protein, and fat was significantly associated with general obesity and central obesity (2, 4, 5, 7, 9, 12, 13, and 23).

Previous research indicates that people from Asia, especially women in Bangladesh, hold specific cultural beliefs and attitudes towards exercise. One study found that home-based activities, such as regular exercise for 30 minutes/day, are a protective factor against overweight/obesity. The same study also noted a positive association between engaging in sedentary activities for more than 4 hours/day and being overweight/obese. Additionally, among adults who did not perform any physical work, the prevalence of overweight and obesity was 50% (1, 4, 5, 7, 8, 9, 10, 12, 14, 20, and 23).

Major Factors Leading to O-O

Several factors that may lead to overweight and obesity include unhealthy eating or dietary practices, lack of physical activity, genetic factors, and certain medical conditions. Among these, the first two are the major ones. Unhealthy dietary or eating habits include

- frequent eating of large amounts of processed or fast food
- eating much more than is necessary or comfort eating
- frequent eating out of the home, which usually has much more fat
- drinking too many sugary drinks or alcoholic beverages

In each case, too much of calorie is consumed than is necessary for a healthy body.

When physical inactivity, either due to the sedentary nature of work or for other reasons, is added to the above kind of eating habits, the calorie so consumed is not expended and, if continued for a long time, may result in excess energy being stored by the body as fat. When such accumulated fat exceeds a certain threshold, as measured by BMI, people become overweight or obese.

The issue of genetic factors behind O-O It is not entirely clear, but eating habits, including unhealthy ones as discussed above, often run in families. Similarly, there are certain rare medical conditions, such as underactive thyroid glands and Cushing syndrome, which may result in O-O. On the other hand, certain medications such as corticosteroids, epilepsy and diabetes medicines, certain depressants, and medicines for schizophrenia may also lead to O-O.

While the immediate factors are dietary practice, lifestyle, and other factors as discussed above, these themselves are also influenced by various social, economic, and other issues. The above brief literature review on Bangladesh's general overweight and obesity reflects all of these in one form or another.

Overall observation: This scoping review examined the available literature on overweight and obesity among adolescents in Bangladesh and identified key behavioral and lifestyle factors associated with this emerging public health concern. The findings suggest that although the number of available studies is limited, there is growing evidence that adolescent overweight and obesity are increasing in Bangladesh, particularly in urban settings. The initial picture we get is that the studies have generally focused on situational analysis and on identifying correlating factors, but not so much on what may have been done to arrest the trend. The studies underscore the urgent need to promote healthy lifestyles with a view to effectively addressing the increasing problem among adolescents of overweight and obesity. Given the already large volume of literature, an immediate issue is to conduct a scoping review to identify policy perspectives rather than undertake any fresh analysis. This may be examined in the context of Bangladesh. Similarly, the perceptions of primary caregivers, such as mothers' perceptions, also matter, as shown by one study that even when adolescents are obese, parents may not think so. This means one needs to understand why such perceptions exist or whether they will persist.

The reviewed studies indicate that dietary behaviors and physical activity patterns are among the most frequently reported determinants of adolescent overweight and obesity. Several studies identified frequent consumption of fast food, junk food, and sugar-sweetened beverages as potential contributors to increased body weight among adolescents. These findings are consistent with global research, which has shown that increased consumption of energy-dense and highly

processed foods plays a major role in the rising prevalence of overweight and obesity among young populations.

Sedentary behavior and limited physical activity were also identified as important factors associated with overweight and obesity. Activities such as prolonged television viewing, increased screen time, and reduced participation in outdoor games may contribute to lower energy expenditure among adolescents. Similar trends have been reported in many low- and middle-income countries undergoing rapid urbanization and lifestyle transitions. The findings related to gender differences in overweight and obesity were inconsistent across the reviewed studies. While some studies reported higher prevalence among girls, others found higher rates among boys. These inconsistencies may reflect differences in study design, geographic location, and sample characteristics. Cultural norms, gender roles, and differences in physical activity opportunities may also influence these patterns and require further investigation.

A situation analysis of trends and ways forward by the World Bank 2019 reported that adolescent overweight and obesity increased from 13 to 23 percent between 2012 and 2014 and findings from the study showed that the Dhaka division has comparatively high rates of overweight and obesity. Another important observation from this review is the concentration of studies in urban settings. Urban adolescents may be more exposed to unhealthy dietary environments, including greater availability of fast food outlets, increased consumption of processed foods, and more sedentary lifestyles. As urbanization continues to expand in Bangladesh, these factors may further contribute to the rising prevalence of overweight and obesity among adolescents.

Despite these insights, the review also highlights significant gaps in the current evidence base. Most studies focused on identifying risk factors rather than evaluating interventions to prevent or control adolescent overweight and obesity. Furthermore, limited research has explored the role of school environments, family influences, and community-level interventions in shaping adolescent dietary behaviors and physical activity patterns.

Addressing adolescent overweight and obesity requires a multi-sectoral approach involving the health, education, and policy sectors. Schools can play a particularly important role in promoting healthy behaviors by integrating nutrition education, encouraging regular physical activity, and providing supportive environments for active lifestyles. In addition, public health policies aimed at reducing the consumption of unhealthy foods and promoting healthier dietary choices may improve adolescent health outcomes.

Overall, the findings of this review underscore the need for more comprehensive

research and targeted interventions to address the growing burden of overweight and obesity among adolescents in Bangladesh.

Objective

Given that adolescent O-O Ultimately, leading to the adult population O-O, there is an imperative to understand it better. The present study has been undertaken to understand the association between measured overweight and obesity and food habits and physical activities among adolescents, and to explore background factors associated with these immediate factors.

This information is expected to provide guidance for future policy-making and/or implementation to improve physical activity and dietary habits among the targeted adolescent group in Bangladesh, as well as nutritional outcomes.

Methods

The methods section is divided into two sub-sections: definitional issues and, secondly, literature review methods. First, the definitional issues.

Concept of O-O and Measurement

Obesity and overweight indicate that a person has accumulated excess body fat. A simple measure of O-O is body mass index (BMI). BMI is measured as:

A person's weight in kilograms is divided by the square of the person's height in meters (kg/m^2).

According to the WHO

An adult with a BMI of 25 or higher is overweight. If the BMI is 30 or more, then the person is obese.

For children, the measure is different. For children under 5 years of age:

- *Overweight is weight-for-height greater than 2 standard deviations above the WHO Child Growth Standards median; and*
- *Obesity is weight-for-height greater than 3 standard deviations above the WHO Child Growth Standards median.*

Thus, for children, overweight and obesity are the opposite of wasting.

For children between 5 and 19 years, the measures are again somewhat different.

- *for overweight, BMI-for-age greater than 1 standard deviation above the WHO Growth Reference median; and*
- *For obesity, BMI is greater than 2 standard deviations above the WHO*

Growth Reference median.

- *At the age of 19 years, the first one translates to a BMI equal to 25, and for the second one, it is 30.*

There are, however, debates regarding the WHO threshold points for BMI indicating overweight or obesity. Particularly for different groups of people by age and sex, as well as by where they are originally from (i.e., geographic region), the threshold should differ. Some have called BMI-based estimates rather conservative. In this study, we attempted to review those articles analyzing adolescent nutritional outcomes that used O-O definitions according to the following criteria:

WHO definition for overweight and obesity, with a cutoff value of body mass index of 25 and 30, respectively, for both sexes, which has been widely used for overweight ($> 1SD$) and obese ($> +2SD$) growth reference median.

CDC: overweight (85th–95th percentile), obese (>95 th percentile) of the distribution of BMI.

IOTF: overweight (23.0–25.0 kg/m²), obese (>25.0 kg/m²)

Methods for Literature Review

We conducted the scoping review using the following steps, as suggested by Arksey and O' Malley from the University of York. We have followed this framework for this review.

Stage 1: Identifying the research question

Stage 2: Identifying the relevant studies

Stage 3: Study selection

Stage 4: Charting the data

Stage 5: Collating, summarizing, and reporting the results

Stage 1: Identifying the Research Question

Since the third policy cycle, NIPN has identified policy topics related to overweight/obesity. To identify the research question, we have reviewed literature, reports, etc., to understand why obesity is a problem, and provided an overview of the obesity trend in the country. This has been reported earlier briefly. The available literature seems to bear out that obesity is basically a function of two factors: eating far more than is needed and not burning the energy. Medical and genetic factors are rare. The policy question then is: Why/how are food habits and physical activities risk factors for being overweight/obese for adolescents, and what are the background factors associated with these immediate factors that lead to adolescents being overweight or obese?

Stage 2: Identifying the Relevant Studies

The second step was to identify research papers in the broad area of interest by searching peer-reviewed published literature on PubMed and Google Scholar. The well-known PRISMA (Papers Reporting Items for Systematic Reviews and Meta-Analyses) Flow chart for literature search strategy has been used to identify relevant literature (Figure 1). Available titles were gathered using key terms and selected using the said inclusion and exclusion criteria. The literature was searched for the following specific keywords/ terms: obesity, overweight, physical activities, food habits, adolescents, and Bangladesh. Search terms were combined in PubMed using Boolean operators (AND, OR, NOT) to narrow the results.

Stage 3: Selection of Literature

The inclusion criteria for selecting articles for review were original journal articles with an abstract, full text in the main body, clear exposition of the introduction to the researchable problem, methods of investigation, results obtained, and the discussion based on them, and a conclusion. Because of the large volume of literature, the authors limited themselves to papers published more than a decade ago, from January 2011 to December 2021. The other requirement was that the papers be in English because the researchers had limited knowledge of or proficiency in other international languages. Duplicates, titles, and abstracts that were not related to adolescent obesity (see later) were excluded. Also, the papers have to address a Bangladesh-specific relevant nutrition problem or issue.

Inclusion Criteria

Publications were included if these described the prevalence, determinates of obesity and/or overweight as its primary or secondary outcome and its associated risk factors are physical activities and or food habits; The term physical activities included if related issues such as physical activities, attitudes, practice, sedentary activities, time-wasting, exercise, physical activeness, watching TV, having played outdoor and indoor games, walking or cycling and physical education. Subsequently, the terms we included related to food habits, such as dietary patterns, frequency of food consumption, restaurant foods, junk foods, meal frequency, soft drinks, etc.

Study respondents were Bangladeshi adolescents aged 10-19 years; we selected only studies specific to Bangladesh. In this review, adolescents are defined as individuals aged 10–19 years, according to the World Health Organization.

Some studies with broader age ranges were included when adolescents constituted a substantial portion of the study population or when adolescent data were reported separately.

Written in English, and the publication year was between 2011 and 2021

Exclusion Criteria

- Excluded the publication if the sample cases of the studies were fewer than 10 and older than 19 years of age
- Excluded if participants were disabled, had some health problems, were pregnant, had mental disorders, or had any diseases
- Countries other than Bangladesh, LMIS, South Asia, or Global.
- Studies were excluded due to duplication or overlapping

After completing all these steps, the selected titles were searched, and the full research articles of the screened abstracts were downloaded and checked for selection against the inclusion and exclusion criteria. The full texts of the literature were studied, and relevant articles were included. Articles that were not fully accessible or not relevant to the target indicators were excluded. After access to the full articles, further inclusion was based on the key priority areas related to Adolescent Obesity, as well as those analyzing Bangladesh issues. Using a standardized protocol, two reviewers extracted the following information from each study: study design, duplication, and defining indicators. Disagreements were resolved by consensus. A total of 511 titles were identified, and abstracts were retrieved in the first step; 7 full research articles were finally selected for analysis (Fig 1 - PRISMA flow chart). The abstract and results section of each selected article was carefully read to generate the results.

PRISMA Flow Chart

The initial search of electronic databases identified 511 records. After screening titles and abstracts, 164 articles were excluded as not relevant to the topic. The remaining 347 articles were further assessed for eligibility. Among these, 13 duplicate or overlapping records were removed. Additional exclusions were made for studies conducted outside Bangladesh (n=100), studies published outside the specified time period (n=15), studies involving participants with disabilities or specific diseases (n=16), articles not written in English (n=15), and studies that did not include adolescents within the defined age range (n=97).

After applying these criteria, the remaining articles were reviewed in greater detail. Fifty-nine studies were excluded because their objectives were not directly related to adolescent overweight or obesity, and 25 articles were excluded due to a lack of full-text access. Finally, seven studies met all inclusion criteria and were included in the scoping review.

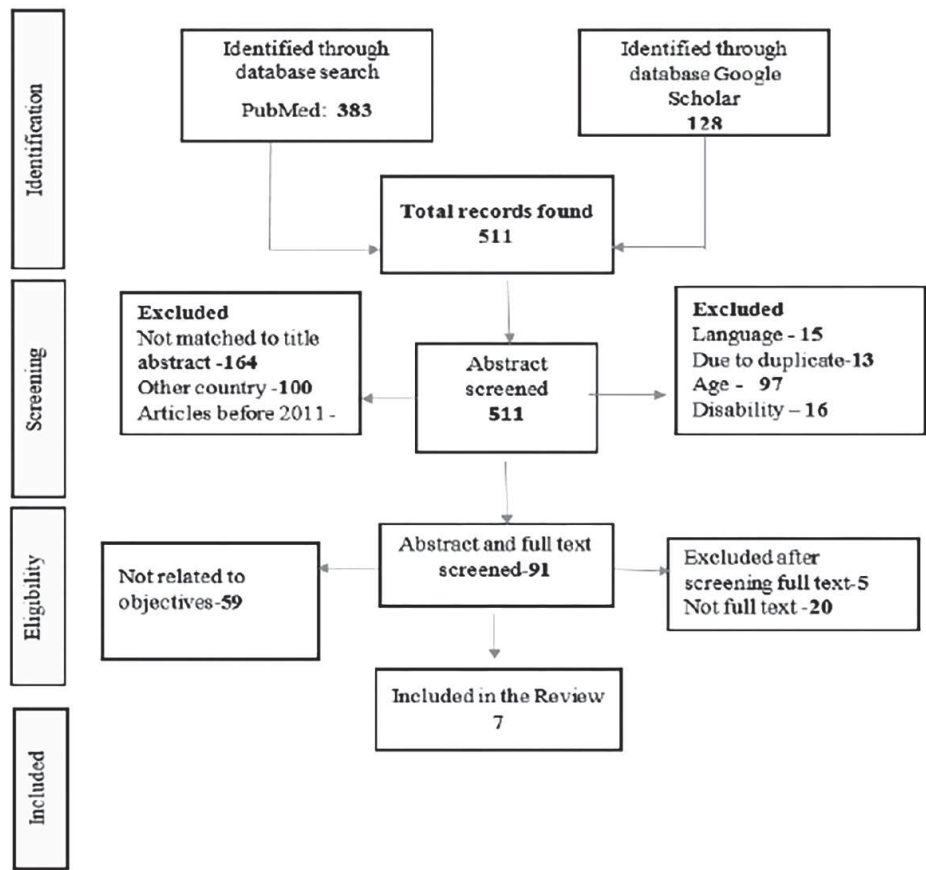


Figure 1. PRISMA Flow Chart

Stage 4: Charting the Data

Data were charted using Excel. The data extraction file is attached in the annex, though a summary table has been inserted here as Table 1. Summary of the Studies. We inserted the informations related to the study population, methodology, risk factors, and outcome measures, which are as follows:

- Study Name, Author, Year of Publication,
- Study Population, Number of Participants, Study Site
- Sampling Technique
- Risk Factors
- Outcome measurements and
- Results

Table 1. Summary of the Studies

Outcomes	•Overweight	•Obesity	•Overweight	•Obesity	•Overweight	•Obesity	•Overweight	•Obesity	•Overweight	•Obesity
Location	Country wide	Urban	Urban	Urban	Urban	Urban	Urban	Urban	Country wide	
Sample Size (N)	20 studies	N = 112 (Boys=67, Girls=45)	N = 198 (99 cases and 99 controls)	N = 426	N = 898	N = 1768 (980 boys; 788 girls)	N = 2989			
Sampling Technique	N/A	Not found	purposeful sampling technique	systematic random sampling	Not found	purposive sampling	Clustered sampling technique and a standardized scientific sample selection process.			
Sex	M & F	M & F	M & F	M & F	M & F	M & F	M & F			
Age group /Mean age	0 - 19 years	7 - 14 years	10-15 years corresponding to class 5 to class 10 mean age = 13.1 years	18 - 24 years	13 - 16 years	6-12 years	aged= 11-17 years mean age = 14.2			
Study Population	Children and adolescents	School Children	School children and adolescents	University students	School children in Dhaka	School children	Adolescents			
Study Design	Systematic review	Cross sectional study	a case-control study	A cross-sectional study	Cross-sectional study	cross-sectional study	cross-sectional study			
Year of the Data Collection	Studies published between 1998 and 2015	Not found	Seven schools located in Dharmadi, Mohammadpur and Siddeswar area in Dhaka, Bangladesh during October through November 2007	Study was carried out from March to April, 2014	November 2012 - January 2013	Study was conducted from June 2012 to May 2013 in different areas of Dhaka city	2014			
Date of Pub	2017	2014	2013	2014	2020	2018	2019			
Author Name	a) T. Biswas et al.	b)M. N. Rahman et al.	c)Meghah Uddin Bhuiyan et al.	d)Shatabdi Goon et al.	e)A. Khan et al.	f)N. Sultana et al	g) Md. Mostawared Ali Khan et al.			

Results

Seven studies met the inclusion criteria for this scoping review. Among these, one study was a systematic review, one used a case–control design, and the remaining five were cross-sectional studies. Most studies were conducted in urban settings, while only two included both urban and rural populations. Overall, the available studies indicate that the prevalence of adolescent overweight and obesity in Bangladesh has increased over time, although estimates vary across studies due to differences in study populations and methodologies.

The findings related to gender differences in overweight and obesity were inconsistent. Some studies reported higher prevalence among girls, while others found higher prevalence among boys. These variations may reflect differences in sample characteristics, geographic locations, and measurement approaches used in the individual studies. Therefore, conclusions regarding gender differences should be interpreted cautiously.

Prevalence

Biswas *et al.* (2017) in their systematic review showed that the prevalence of overweight/obesity is increasing over time.

Additionally, the study indicates that sedentary activities, or the absence of exercise at home, and having at least one overweight parent were the risk factors for being overweight/ obese in adolescent children. Rahman *et al.* (2014) revealed in a cross-sectional study that the prevalence of overweight among girls is higher than in boys, but the prevalence of obesity among boys is higher than in girls. Another study by Sultana *et al.* (2018) in a cross-sectional study painted just the opposite picture, i.e., the prevalence of overweight among boys is higher than in girls, and obesity among girls is higher than in boys. Khan *et al.* (2019) in another cross-sectional study found males to have a higher prevalence than girls for both obesity and overweight.

Risk Factors

Most of the studies identified that physical activity-related issues and dietary habits are risk factors for overweight and obesity in adolescents. Moreover, with these two associated factors, 2 studies (a,f) showed that having at least one overweight parent and a family history of obesity is positively associated with overweight and obesity.

Food Habit

Dietary behaviors were frequently identified as potential risk factors for adolescent overweight and obesity. Two studies reported a positive association between frequent consumption of fast food and overweight or obesity among adolescents. One study also found that higher meal frequency may be associated

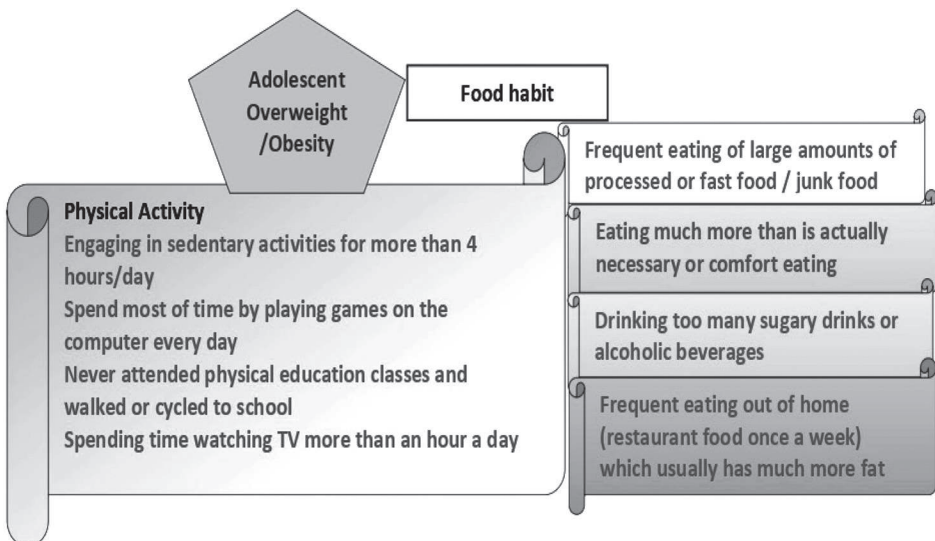
with a greater likelihood of being overweight. In addition, regular consumption of junk food and eating in restaurants were reported among adolescents with higher body weight in one study. Another study found that adolescents who reported higher consumption of fruits and vegetables had a lower prevalence of overweight and obesity. However, given the limited number of studies examining these factors, these associations should be interpreted cautiously.

Physical Activity and Sedentary Behavior

Several studies identified physical inactivity and sedentary behaviors as important factors associated with overweight and obesity among adolescents. Activities such as prolonged screen time, watching television, and spending long hours on computers were linked to a higher prevalence of overweight or obesity in some studies. In contrast, adolescents who engaged in regular physical exercise, outdoor games, or active commuting, such as walking or cycling to school, were less likely to be overweight or obese. These findings suggest that physical activity may play a protective role, although further research is needed to confirm these associations.

Salient Points from the Scoping Review

The scoping review on overweight/obesity among Bangladeshi adolescents revealed that the prevalence of overweight/ obesity is increasing over time. While the number of studies under review was not large, there is a commonality in the findings: most studies identified that physical activity-related issues and food/dietary habits are risk factors for overweight and obesity in adolescents. Diagram 1 below shows the two most important types of background factors that influence the prevalence of obesity/overweight.



What are the Gaps in Knowledge and Understanding

Based on the short review, if the selected studies represent a fair sample of adolescent overweight and obesity in the country, and given the results of the general situation review, this is likely to be a fair sample, food habits and physical activities are major determinants of O-O. Higher levels of wealth, income, and having O-O Urban parents are at risk. However, overall, including the general review, there appear to be certain gaps in understanding, particularly regarding interventions to curb the rising trend towards O-O. These may be listed as follows:

- Limited information or analysis exists on any appropriate design and implementation plan and interventions aimed at promoting healthy lifestyles and behaviors among adolescents
- There is little discussion or analysis of cost-effective intervention measures for early detection and control of risk factors associated with overweight and obesity among adolescents
- No research on educational curriculum activity in schools for a healthy lifestyle and food habits.
- Parents/teachers' awareness related to physical activities and food habits of adolescents to reduce obesity has not been identified clearly or emphasized
- Did not find any research on the impact of obesity of Adolescent club/ adolescent groups/ peer counselors
- While junk food habits have been analyzed as to their effects on O-O, specific food ingredients, such as high use of salt/ sugar in such food and their effect on obesity, do not seem to have been focused on.

Policy Implications

The findings from this review highlight the potential importance of dietary habits and physical activity patterns in shaping adolescent overweight and obesity in Bangladesh. Several studies identified frequent consumption of fast food, junk food, and sugary drinks as possible contributors to increased body weight among adolescents. At the same time, sedentary behaviors such as prolonged screen time and limited physical activity were also reported as associated factors.

Given that adolescents spend considerable time in schools, school-based interventions may play an important role in promoting healthier behaviors. These may include strengthening physical education programs, encouraging participation in sports and outdoor activities, and integrating nutrition education into school curricula. In addition, public health awareness campaigns targeting parents, teachers, and adolescents could help promote healthier dietary habits and more active lifestyles.

Policy initiatives may also consider regulating the availability and marketing of unhealthy food and beverages, particularly those high in sugar and salt, while promoting access to healthier food options. However, further research is needed to identify effective and context-specific interventions to address adolescent overweight and obesity in Bangladesh.

Limitations

This review has several limitations. First, only 7 studies met the inclusion criteria, limiting the strength and generalizability of the conclusions. Second, most of the included studies were conducted in urban areas, which may not fully reflect conditions in rural populations. Third, variations in study design, sampling methods, and measurement criteria across studies may affect the comparability of results. Finally, some studies included broader age ranges, and adolescent-specific findings were sometimes limited. Future research with larger and more representative samples is needed to better understand the determinants of adolescent overweight and obesity in Bangladesh.

Conclusion

This scoping review examined the available evidence on overweight and obesity among adolescents in Bangladesh and identified several behavioral and lifestyle factors associated with this growing public health issue. The findings suggest that unhealthy dietary habits, frequent consumption of fast food and sugary beverages, and sedentary lifestyles may contribute to the increasing prevalence of overweight and obesity among adolescents.

However, the number of available studies remains limited, and most existing research focuses primarily on identifying risk factors rather than evaluating intervention strategies. Future research should therefore focus on generating more comprehensive evidence on the determinants of adolescent overweight and obesity, including the influence of family environments, school settings, and community factors.

Policy makers and public health practitioners should consider developing integrated strategies that promote healthier dietary behaviors and increased physical activity among adolescents. School-based interventions, public awareness campaigns, and supportive policy measures to improve food environments may play an important role in addressing this emerging health challenge in Bangladesh.

References

- Biswas, T., et al. (2017). *Overweight and obesity among children and adolescents in Bangladesh: A systematic review and meta-analysis*. Public Health.
- Bhuyan, K. C., et al. (2019). Discriminating Bangladeshi Children and Adolescents of Affluent Families by Level of Obesity, *American Journal of Biomedical Science and Research*, 4 (4).
- Bulbul, T., & Hoque, M. (2014). Prevalence of childhood obesity and overweight in Bangladesh: Findings from a countrywide epidemiological study. *BMC Pediatrics*, 14, 86. <https://doi.org/10.1186/1471-2431-14-86>.
- Rahman, M. N., et al. (2014). *Prevalence of overweight and obesity among school children in Bangladesh*. Journal of Public Health.
- Karmakar, P et al, (2016), Food Habits, Obesity and Nutritional Knowledge among the University Students in Noakhali Region of Bangladesh: A Cross Sectional Study, *Journal of Food and Nutritional Disorders*, 5:4.
- Islam, M. Z. (2018). Generalized traditional risk factors of being overweight and obesity among ever married non-pregnant women in Bangladesh: An application of decision tree analysis. *ABC Research Alert*, 6(2), 1–10.
- BK-Rauniyar et al, (2019) Lifestyle has Significant Influence over Obesity among School Children in Bangladesh, *Current Research in Diabetes and Obesity Journal*, 10(1).
- Chandra, B. K., & Jannatul, F. (2019). Level of obesity and socioeconomic factors of a group of adult people of Bangladesh: A factor analysis approach. *American Journal of Data Mining and Knowledge Discovery*, 4(1), 8–14.
- Siddiquee, T., et al. (2015). Prevalence of obesity in a rural Asian Indian (Bangladeshi) population and its determinants. *BMC Public Health*, 15, 860.
- Islam, F., et al. (2020). Prevalence and associated risk factors of general and abdominal obesity in rural and urban women in Bangladesh. *PLOS ONE*, 15(5).
- Chowdhury, M. A. B., Adnan, M. M., & Hassan, M. Z. (2018). Trends, prevalence and risk factors of overweight and obesity among women of reproductive age in Bangladesh: A pooled analysis of five national cross-sectional surveys. *BMJ Open*, 8(7).

- Burton, N. W., Kadir, M. A., & Khan, A. (2020). Physical activity attitudes among adolescents in Bangladesh. *Public Health*, 179, 59–65.
- Mistry, S. K., & Puthussery, S. (2015). Risk factors of overweight and obesity in childhood and adolescence in South Asian countries: A systematic review of the evidence. *Public Health*, 129(3), 200–209.
- Hossain, M. T., & Luies, S. K. (2017). Prevalence of overweight and obesity among the public and private primary school children (9–14 years) in Dhaka City in relation to their dietary habits and physical activities. *Journal of Community Medicine and Health Education*, 7(1).
- Ferdaush, J. (2019). *Socioeconomic inequalities affecting adult obesity in rural Bangladesh: Evidence from the Bangladesh Integrated Household Survey* (M.Sc. thesis). BRAC University.
- Tanwi, T. S., et al. (2019). Socioeconomic correlates of overweight and obesity among ever-married urban women in Bangladesh. *BMC Public Health*, 19, 842.
- Bhuyan, K. C., & Ahmmmed, M. M. (2020). Socioeconomic factors associated with overweight and obesity: A case study among adult people of Bangladesh. *AIUB Journal of Science and Engineering (AJSE)*, 16(2).
- Uddin, M. S. G., & Alam, M. A. (n.d.). Trends and determinants of obesity among women of reproductive age in Bangladesh 2004–2014: A multivariate decomposition analysis.
- Biswas, T., et al. (2017). The prevalence of underweight, overweight and obesity in Bangladeshi adults: Data from a national survey. *PLoS ONE*, 12(5).
- Ali, N. B., et al. (2020). Overweight and obesity among urban women with iron deficiency anaemia in Bangladesh. *Maternal and Child Nutrition*, 16 (e12934).
- Bishwajit, G. (2017). Household wealth status and overweight and obesity among adult women in Bangladesh and Nepal. *Obesity Science & Practice*, 3(3), 278–286.
- Hashan, M. R., et al. (2020). Differences in prevalence and associated factors of underweight and overweight/obesity according to rural–urban residence strata among women of reproductive age in Bangladesh: Evidence from a cross-sectional national survey. *BMJ Open*, 10.

Hossain, M. S. (2019). Is childhood overweight/obesity perceived as a health problem by mothers of preschool-aged children in Bangladesh? A community level cross-sectional study. *International Journal of Environmental Research and Public Health*, 16, 1–15.

De Onis, M., Blössner, M., & Borghi, E. (n.d.). Global prevalence and trends of overweight and obesity among preschool children.

Shawon, M. S. R., et al. (2019). Trends in the prevalence of overweight among Bangladeshi children aged 24–59 months (2004–2014) by sex and socioeconomic status. *International Journal of Obesity*.

Factors Influencing the Capital Adequacy Ratio of Commercial Banks of Bangladesh: A Panel Data Analysis

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Abstract

This paper examines the explanatory factors influencing the capital adequacy ratio (CAR) of commercial banks in Bangladesh. The study covers all commercial banks during the period 2010-2020. There were 47 banks in 2010, which increased to 60 by 2020. Thus, the panel was unbalanced. We examined the relationship between CAR, the dependent variable, and the following independent variables: earnings-to-assets ratio, profitability, liquidity, net interest margin, growth, size, loans-to-assets ratio, and deposits-to-assets ratio. We have used Ordinary Least Squares, GLS-random effect, and GLS-fixed effect models using STATA-14 to estimate the parameters in multiple regression analysis. The results show that bank size, equity-to-asset ratio, and earnings on assets had a significant positive effect on the capital adequacy ratio, whereas nonperforming loans, interest rate spread, credit growth, net interest margin, and inflation rate had negative and statistically significant effects.

Keywords: Capital Adequacy Ratio (CAR) · Commercial Banks · Bangladesh

JEL Classification: C4 · F15 · G21 · G28 · L19

1. Introduction

The capital adequacy ratio ensures that banks have the capacity to meet their liabilities and other risks, such as credit, market, and operational risks. Capital adequacy focuses on a bank's overall capital position and on protecting depositors and other creditors from potential losses the bank might incur. It helps banks absorb potential losses from credit, market, and operational risks they may be exposed to in the normal course of business. Under Basel-III, banks in Bangladesh are required to maintain the minimum capital requirement (MCR) at 10.0 percent of risk-weighted assets (RWA) or BDT 5.0 billion in capital, whichever is higher. The aggregate regulatory capital of the banking sector was

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BDT 1571.8 billion as on 31 December 2022, rising to BDT 1578.1 billion at the end of June 2023. The CRAR of the banking industry as a whole was 11.2 percent at the end of June 2023 (BB Annual Report 2022-23).

The average Capital to Risk-Weighted Asset Ratio (CRAR) across our panel of banks was 11.64% during 2010-2020. Capital adequacy ratios are a measure of a bank's capital expressed as a percentage of its risk-weighted credit exposures. According to international standards, banks must maintain a minimum capital adequacy ratio to absorb a reasonable level of losses before becoming insolvent. Applying minimum capital adequacy ratios protects depositors and promotes the stability and efficiency of the financial system. Chart 1 shows the movement of the Capital Adequacy Ratio for Bangladesh's commercial banks from 1996 to 2020.

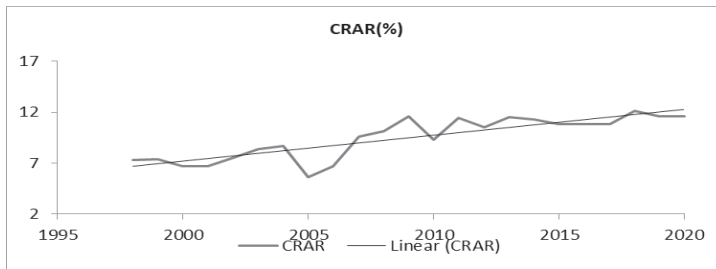


Chart 1: Capital to Risk-weighted Asset Ratio

(%):1998-2020 $\hat{Y} = 6.407 + .256\text{TIME}$, $R^2 = .727$, $F(1,21) = 56.008$, $P = .000$, $DW = 1.479$

Source & Note: Bangladesh Bank. Analysis by the Author.

The chart depicts the CRAR (%) of commercial banks from around 1998 to 2020, along with a linear trend line for reference. The CRAR shows a gradual upward trend over the period, as indicated by the linear fit. Early years (late 1990s–early 2000s) show CRAR values of 7–8%, close to the regulatory minimum at the time. By 2020, CRAR rises to around 12%, reflecting a strengthening of bank capital over two decades. There are noticeable short-term fluctuations, particularly around 2005–2010, where CRAR dips slightly below the trend line before recovering. These fluctuations could reflect macroeconomic shocks, bank-specific risk events, or regulatory changes affecting capital requirements. The upward trajectory suggests that commercial banks have been gradually improving their capital adequacy, likely in line with Basel II and III requirements. According to the Basel III guidelines implemented by Bangladesh Bank, commercial banks in Bangladesh are required to maintain a minimum Capital to Risk-weighted Asset Ratio (CRAR) of 10%, plus a Capital Conservation Buffer (CCB) of 2.50%. Despite improvement, the CRAR in 2020 (12%) is still moderate compared to regional peers, as noted in the following table 1, indicating scope

for further capital strengthening. The increasing CRAR supports the banking system’s enhanced resilience to absorb unexpected losses, reduce systemic risk, and promote financial stability.

The chart confirms a long-term improvement in commercial banks’ capital adequacy, with CRAR rising from 7% in the late 1990s to 12% by 2020, albeit with some volatility. While this trend is positive, Bangladesh’s commercial banks remain moderately capitalized relative to regional standards, highlighting ongoing regulatory and policy challenges to financial stability.

Table 1: CRAR for some Selected Countries

Country	CRAR (%)				
	2016	2017	2018	2019	2020
Bangladesh	10.8	10.8	10.5	11.6	11.6
India/a	13.3	13.9	13.7	15.1	15.8
Pakistan	16.2	15.8	16.2	17.0	18.6
Sri Lanka	15.6	15.2	15.1	16.5	16.5

Source & Note: Adapted from BB, FSR 2020; Data as of the end of September.

Table 2 presents the Capital to Risk-Weighted Assets Ratio (CRAR) for selected South Asian countries during 2016–2020. CRAR measures a bank’s capital adequacy relative to its risk-weighted assets and is a key indicator of the banking sector’s resilience under the Basel III international regulatory framework. A higher CRAR generally implies a stronger capacity of banks to absorb potential losses and maintain stability.

Bangladesh shows relatively lower capital adequacy compared with its regional peers throughout the period. The CRAR of Bangladesh Bank-regulated banks remained almost unchanged at 10.8% in 2016 and 2017, declined slightly to 10.5% in 2018, and then increased to 11.6% in both 2019 and 2020. Although this level meets the regulatory minimum requirement, it remains considerably below that of other South Asian banking systems, suggesting relatively weaker capital buffers.

In contrast, banks in India exhibit a consistent improvement in capital adequacy, with CRAR rising from 13.3% in 2016 to 15.8% in 2020. The upward trend reflects capital-strengthening efforts following banking sector reforms and the Reserve Bank of India’s regulatory tightening.

The banking sector of Pakistan demonstrates the highest capital adequacy among the countries considered, with CRAR increasing steadily from 16.2% in 2016 to

18.6% in 2020. This indicates strong capitalization and improved resilience of banks under the supervision of the State Bank of Pakistan.

Similarly, banks in Sri Lanka maintain relatively high and stable CRAR levels, ranging from 15.1% to 16.5% during the period, supported by the Central Bank of Sri Lanka's regulatory oversight.

Overall, the comparative evidence suggests that Bangladesh's banking sector maintains the lowest capital adequacy among the selected countries, indicating relatively limited capital buffers against risk. Strengthening bank capitalization, therefore, remains an important policy concern for ensuring financial stability in Bangladesh.

Banking Sector Performance

The capital adequacy performance scenario for Bangladesh's banking sector in 2022 is presented in Table 2. At the end of December 2022, out of the total 61 banks, 45 banks could maintain a CRAR of 12.50% and more, with the minimum regulatory requirement of 10% with a Capital Conservation Buffer (CCB) of 2.5%, in line with Basel III. 11 scheduled banks could not maintain the minimum required CRAR of 10%. Moreover, an additional 5 banks were not able to maintain the CCB of 2.50% with an existing CRAR of 10%. It is encouraging to see that 45 banks (73.8%) have a CRAR of 12.50% or above.

Table 2. Distribution of Banks by CRAR

CRAR Class	Number of Banks(%)
<0.10%	11 (18.0)
≥10.00- but<12.50%	5 (8.2)
≥12.50-but<15.00	16 (26.2)
≥15.00-but <20.00	14 (23.0)
≥20.00	15 (24.6)
All Class	61 (100.0)

Source & Note: BB. FSR 2022; Author's analysis

Table 2 provides information on CRAR for some selected countries. We see that the value of CRAR is much higher by several percentage point shown in the table.

2. Objectives

This paper examines the explanatory factors influencing the capital adequacy ratio (CAR) of commercial banks in Bangladesh. during the period 2010-2020.

3. Data and Methodology

Data on all bank-specific variables were obtained from the respective banks' websites. Annual data from all commercial banks for the 11-year sample period from 2010 to 2020 have been used to estimate a panel-data model. The panel variable, banks, was unbalanced. The data were compiled from Annual Reports and Financial Statements of individual banks, Annual Reports of the Financial Institution Division (FID), and publications of Bangladesh Bank and the Bangladesh Bureau of Statistics. Statistics from the Bangladesh Bureau of Statistics, Bangladesh Bank, and the Ministry of Finance have also been used, particularly for macroeconomic variables. Data from the ADB, OECD, World Bank, and IMF have also been used. All ratios are estimated by the author. The Pooled Ordinary Least Squares (OLS), GLS Random Effects (Group variable-Banks), and GLS-Fixed effect-Group variable-Banks models for panel data have been applied to estimate the effects of the explanatory variables. The regression equations have been estimated using STATA 14.

Variable Measurements and their Operationalizations

Dependent Variable: Capital Adequacy Ratio

Bank capital adequacy ratio has been measured as the ratio of capital fund to Risk-Weighted Assets.

To examine the relationship between the banks' capital adequacy ratios and explanatory variables, a standard regression model is used, defined as follows for observation (bank) i, with the capital adequacy ratio score as the dependent variable. This study extends equation (1) and estimates the following model:

Where
$$CAR_{it} = \alpha_0 + \beta X_{it} + \varepsilon_{it} \quad i = 1 \dots N \quad (1)$$

CAR_{it} is the capital adequacy ratio of i th bank in the period t

(α_0, β) is a vector of parameters

X_{it} is a vector of explanatory variables, ε_{it} is a stochastic error term

The descriptions of the variables and their measurements are given in Table 1.

Table 3. Description of the Variables Used in the Regression Models

Variable	Description	Proxy	Hypothesized Relationship
Dependent			
CARit	Capital to Risk-weighted Assets Ratio		Not applicable
Independent			
Bank-specific characteristics(internal determinants)			
SIZEit	Natural logarithm of Total Assets	Bank size	+
LTAit	Loan divided by Total Assets	Default risk	+
NPLit	Non-performing loans divided by Total Assets	Default risk	+
EQUITTAit	Total equity/Total assets		—
IRS/LSit	Lending spread: the difference between the interest rate on loans and the interest rate on deposits		+
LD/ADRIit	Advance to deposit ratio		+
EOAit	Net income/total Assets		+/-
NIMit	Net Interest margins		
CGRit	Credit growth		
Macroeconomic variable			
GDPGRt	Real GDP growth rate per cent in year t.	Business cycle	+/--
INFLt	CPI Inflation rate per cent in year t	Business cycle	+/-

Variable Definitions

$CAR_{i,t}$ = Capital to Risk-weighted Assets Ratio of bank i in year t

$SIZE_{i,t}$ = Natural logarithm of Total Assets of bank i in year t

$LTA_{i,t}$ = Loan/Total Assets of bank i in year t

$NPL_{i,t}$ = Non-performing loans/Total Assets of bank i in year t

$EQUITTA_{i,t}$ = Equity capital /Total Assets of bank i in year t

$LS_{i,t}$ = Lending spread: difference between interest rate on loans and interest rate on deposits of bank i in year t

$ADRI_t$ = Advance to deposit ratio of bank i in year t

$EOAI_t$ = Net income/total assets of bank I in year t.

$NIMIt$ = Net Interest margins of bank I in year t

$CGRIt$ = Credit growth rate of bank i in year t.

$GDPGR_t$ = Real GDP growth rate per cent.

$INFLt$ = CPI Inflation rate per cent in year t

4. Findings and Analysis

4.1 Descriptive Statistics of Study Variables

Table 4. Descriptive Statistics of Study Variables (N = 586)

Variable name	N	Mean	St. dev	Minimum	Maximum
CARit	586	11.64	27.43	-133.20	220.70
SIZEit	586	11.55	1.45	4.03	15.90
NPLit	586	9.81	15.63	0	100.00
LTAit	586	2.70	41.96	.04	1015.21
EQUITTAit	586	5.29	318.87	-3089.67	2837.21
IRS/LSit	586	4.74	1.85	-3.10	11.65
LD/ADRIit	586	88.96	61.74	2.08	1212.87
EOAIit	586	0.58	13.74	-139.08	158.66
NIMIt	586	2.53	20.05	-33.43	298.92
CGRit	586	11.10	1.43	3.56	14.93
GDPt	586	6.46	1.22	3.51	8.15
INFLt	586	6.75	1.52	5.44	10.91

Source & Note: Data source Bangladesh Bank; Analysis by the author

4. 2 Correlation Matrix of Study Variables

Table 5. Correlation Matrix of study variables (N=586)

	SIZE	NPL	LTA	EQTA	IRS	ADR	EOA	NIM	CGR	GDP
SIZE	1									
NPL	-.188	1								
LTA	-.189	.211	1							
EQTA	-.166	-.204	-.201	1						
IRS	-,109	.111	0.010	-0.059	1					
ADR	-.171	-.011	0.032	0.318	-0.046	1				
EOA	-.172	-.146	0.037	-0.157	-0.147	0.231	1			
NIM	-,386	-0.059	0.294	0.613	-0.032	0.275	0.592	1		
CGR	.887	-0.099	0.011	0.856	-0.050	-.014	-.105	-.224	1	
GDP	.006	0.039	0.061	0.037	0.097	0.042	0.022	0.074	0.044	1
INFL	-.086	0.0732	-0.041	-0.003	0.224	-.048	-.018	-.018	-.126	-.106

Source & Note: Author’s analysis. Any correlation coefficient higher than 0.105 is statistically significant at the 5 percent level.

Regression Analysis

Table 6: Regression Results of Capital Adequacy Ratio (CAR)

Independent Variables	Expected sign	Regression coefficient(standard error)		
		Pooled OLS	GLS Random Effects. Group variable(Banks)	GLS Fixed effect. Group variable(Banks)
Model		(1)	(2)	(3)
SIZEit	+	11.88*** (1.99)	6.76*** (1.83)	2.39 (1.78)
NPLit	-	-.54*** (.05)	.940* (.420)	-.027 (.08)
LTAit	+	.0003 (.0002)	.0003 (.0002)	.0003 (.0002)
EQTAit	-	.023*** (.004)	.015*** (.004)	.015*** (.004)
IRS it	+	-.99** (.45)	-1.03** (.423)	-1.17** (.40)
ADRIit	+	-.014 (.015)	-.001 (.03)	.02 (.01)
ROAIit	+	.17** (.07)	.111* (.06)	.10* (.05)
NIMit	+	-.20*** (.06)	-.145** (.06)	-.133** (.06)
CGRit	-	-18.77*** (1.83)	-16.18*** (1.70)	-16.71*** (1.66)
GDPIit	+/	1.10 (.65)	.88 (.53)	.69 (.49)
INFLit	+/-	-2.90*** (.53)	-2.70*** (.46)	-3.2*** (.45)
CONSTANT		109.70*** (10.28)	137.34** (12.27)	193.59*** (15.44)
R square		.5353	.4600	.2507
Sigma_u			9.8552	22.98
Sigma_e			13.8613	13.8613
rho			.3357	.7332
Wald Chi2(11)			323.00	
F (11,574)		60.11		
F (11,516)				25.76
P value		.0000	.0000	.0000
D-W Statistic				
N		586	586	586

Source & Note. Author's analysis. * Statistically significant at 10 percent level, ** statistically significant at 5 percent level, *** statistically significant at 1 percent level. The models were estimated by STATA 14

Bank Size

The Size of a bank has historically been a key determinant in the capital structure/level. Researchers have argued that large firms are less susceptible to bankruptcy because they tend to be more diversified than smaller firms. Bateni L. et al. (2014), in their study of 6 private Iranian Banks during the period 2006 – 2013, found that CAR is adversely affected by bank size, concluding that large Iranian banks have weaker supervisory control over their capital adequacy ratios and that large banks maintain a high-risk asset portfolio. Amidu M (2007) investigates the determinants of Capital Structure in Banks in Ghana and concludes that profitability, corporate tax, growth, asset structure, and size influence banks' capital structure decisions. Ghoshi et al. (2003) find that Indian public sector banks have not resorted to asset substitution across risk-weight categories, but instead have substituted low-risk government securities for high-risk loans to meet their capital requirements. This shows that capital regulation does influence the banks' decision-making. Bank Size is an important bank-specific determinant of bank profitability (Hirindu & Kushani, 2017). The natural logarithm of total assets is used as a proxy for the bank's size. The relationship between bank size and capital adequacy may be positive or negative. According to the results, Shingjergji and Hyseni (2015) found a positive relationship between bank size and capital adequacy ratio. On which they state that Albanian banks with higher total assets tend to have a higher capital adequacy ratio. The results in Table 5 show that bank size has a positive and significant effect on bank capital in the pooled OLS and GLS-random-effect models. But its effect on CAR was not statistically significant in the GLS fixed-effects model. Various studies across countries have shown both positive and negative effects on banks' capital adequacy. A study by Shingjergji and Hyseni (2015) on Albanian banks found that bank size positively affects the capital adequacy ratio. Almazari (2013), in his study of Saudi Arabian banks, found a positive relationship between bank size and capital adequacy. On the other hand, Bateni et al. (2014) found a negative relationship between bank size and capital adequacy in Iranian banks. Jim Wong, Ka-fai Choi, and Tom Fong (2005) conducted research on Hong Kong banks, and their estimation results show a statistically significant negative relationship between CAR and bank size, indicating an increase in capital adequacy.

Non-performing Loans NPLit

NPLit is a measure of non-performing loans. Rottke and Gentgen (2008) documented high levels of NPLs in banks' balance sheets during a banking crisis, when an economy experienced distressed debt cycles. Lin and Mei (2006) attributed the main cause of a bank failure to a large number of NPLs. The variable NPLit had a significant negative effect on the capital adequacy ratio in the pooled OLS model and a moderately significant ($P < .10$) positive effect

in the GLS-random effect model. Its effect on the capital adequacy ratio in the GLS-fixed effect model was statistically insignificant. The positive effect was statistically significant at the 5 percent level in models (1) and (2), but its effect on provisioning was highly significant($P < .01$) in model(3).

Total Loan Ratio LTA_{it}

Thampy (2004) explains the impact of capital adequacy regulation on loan growth. Since loans have the highest risk weight, a capital-constrained bank would want to conserve its capital by allocating fewer assets to loans. This trend becomes more severe as the capital constraint binds, as is the case for banks below the required capital level. However, for banks with high capital adequacy ratios, loan growth is little affected. He also shows that, in a capital-constrained environment, banks will reduce loan supply. It also provides an explanation for the high proportion of investments held by banks. The reduction in loan supply is greater for inefficient banks. The impact of higher capital standards on the supply of bank credit would be greater in economies with a bank-dependent or dominated financial system than in those with a capital markets-dominated system. Abdioglu and Ahmet (2011) investigate the determinants of capital adequacy in Turkish banks and find a positive relationship between asset quality and capital adequacy, particularly the loan-to-total-asset ratio. The Total Loan Ratio is the ratio of total loans to total assets and serves as a proxy for the bank's risk profile. Fernando and Ekanayake (2015) have found that a negative and significant relationship between loan loss provision and total loans in public licensed commercial banks. The loan-to-asset ratio(LTA) is a proxy for the bank's risk profile--the greater the loan extension, the higher the risk tolerance of bank managers (the alternative is to invest in risk-free government bonds(Ghosh, 2007). However, Dhakal (2015) found a significant, positive relationship with loan loss provisions. We would expect to have a positive relationship between the total loan ratio and the loan loss provision. The loan-to-asset ratio is the ratio of total loans to total assets. At the bank level, loans are assets with risk, and their large share of the bank's assets increases the bank's exposure to risks, especially credit risk. Thus, a high indicator value could also indicate deterioration in the quality of bank assets, with a negative effect on profitability. On the other hand, we consider bank loans to be the main source of income for a bank; thus, a high level of this indicator is expected to positively impact profitability, as the bank records growth in interest income. The LTA is a metric that measures the ratio of total loans outstanding to total assets. This ratio specifically helps investors gain a comprehensive analysis of a bank's portfolio. Banks with a moderately higher LTA get more of their income from loans and investments, whereas those with a lower LTA level derive more of their income from asset management, noninterest-earning sources, or trading. These banks with lower LTA are also

considered to achieve better results throughout any economic downturns. Our findings indicate that *LTA* has a significant positive impact on the capital adequacy ratio. The regression analysis results shown in Table 5 indicate that the variable *LTA* did not exert a significant influence on the capital adequacy ratio in any of the models considered.

Total Equity to Total Assets (EQTAit)

There are several ratios to assess a company's or a bank's leverage. Leverage ratios are important, particularly for banks, since they equate core capital to total assets. The Tier 1 capital ratio is used to calculate a bank's leverage relative to its total assets. Tier 1 assets are those that can be easily liquidated if, in a time of financial crisis, the bank needs capital. Thus, the bank's financial strength is measured. The BCBS proposed a leverage ratio as part of the Basel III reform package in 2010. The Basel III leverage ratio is calculated by dividing the capital measure by the exposure measure. The capital measure is known as Tier 1 capital, which has a leverage ratio requirement of at least 3%. When a bank's Tier 1 leverage ratio is higher, it's more likely to withstand negative shocks to its balance sheet. (Keka, 2021)

Our empirical findings show that the leverage ratio (EQTAit) has a highly significant positive impact ($P < .01$) on the capital adequacy ratio.

Spread between Lending and Deposit Rate (IRSit)

The variable *IRSit* had a significant ($P < 0.05$) negative effect on the capital adequacy ratio in all three models shown in Table 5.

Advance Deposit Ratio. ADRit

The variable *ADRit* did not exert any significant effect on the capital adequacy ratio in any of the models considered in Table 5.

Profitability (ROAit)

For the purposes of the study, ROA and NIM are used as proxies for profitability. The research conducted by Shingjergji and Hyseni (2015) on Albanian banks found that profitability has no significant impact on capital adequacy. Ahmet and Hasan (2011) state that profitability and the capital adequacy ratio are most likely positively related, because banks are expected to increase asset risk to achieve higher returns in most cases. This situation is also supported by the research of Mohammed T. et al. (2013), which shows that profitability has a significantly positive effect on the capital adequacy ratio. Therefore, this study expects a positive relationship between profitability and capital adequacy. The regression results given in Table 5 indicate that both ROA had a statistically significant positive effect on the capital adequacy ratio.

Profitability (NIMit)

Net interest margin is the ratio of net interest income to average earning assets. The ratio is used to assess a bank's management capabilities and its ability to generate net income. The greater the ratio, the more it affects the interest income earned on the bank's earning assets, as shown by Yohanna Karina and Herlanto (2014). The regression results given in Table 5 indicate that both ROA had a statistically significant positive effect on the capital adequacy ratio. The regression results given in Table 5 indicate that NIM had a statistically significant negative effect on the capital adequacy ratio.

Financial Development (CGRt)

The variable financial development measured by credit growth had a highly significant ($P < 0.01$) negative impact on the capital adequacy ratio in all the models shown in Table 5.

Growth of GDPt

The variable real growth rate of gross domestic product did not have any significant effect on the capital adequacy ratio in our analysis.

CPI Inflation (INFLt)

The CPI inflation rate had a highly significant negative effect ($P < 0.01$) on the capital adequacy ratio in all the models considered. The CPI inflation rate has a negative relationship with CAR, meaning that as inflation rises, banks' capital adequacy requirements decrease. High inflation increases economic uncertainty, so banks face higher capital requirements. The CPI inflation rate has a negative relationship with CAR, meaning that if inflation rises, banks' capital adequacy requirements decrease. High inflation increases uncertainty in the economy, and banks have more capital requirements

5. Conclusion

The paper contributes to further researchers taking into account the lack of studies within the scope of research on bank capital adequacy in Bangladesh, both at the aggregate and individual levels. New research could examine capital adequacy, disclose potential challenges to regulatory authorities, and raise their awareness of the need for deeper supervisory activities and for prompt amendments to prudential regulations. The main objective of the study is to empirically investigate the determinants of CAR in commercial banks. The study period covered 2010-2020, during which all 59 banks were considered. The study uses secondary data from banks' balance sheet statements and profit-and-loss accounts. Panel data regression is used in this study to analyze the relationships between bank-specific and macroeconomic variables and the capital adequacy ratio. The results show that bank size, equity-to-asset ratio, and earnings on assets had a

significant positive effect on the capital adequacy ratio, whereas nonperforming loans, interest rate spread, credit growth, net interest margin, and inflation rate had negative and statistically significant effects. The results show that bank size, equity-to-asset ratio, and earnings on assets had a significant positive effect on the capital adequacy ratio, whereas nonperforming loans, interest rate spread, credit growth, net interest margin, and inflation rate had negative and statistically significant effects. The commercial banks of Bangladesh, in order to improve the CAR, other than the obvious option of infusing capital, may concentrate on creating greater exposure to higher-rated customers, thereby lowering risk-weighted assets, improving the efficiency of earning assets, which in turn would translate to greater capital build-ups and thereby improvements in the CAR.

Reference

- Ahmad, R., Ariff, M., & Skully, M, 2009, "The Determinants of Bank Capital Ratios in A Developing Economy", *Asia-Pacific Financial Markets*, 15(3-4), 255-272.
- Alajmi, M & K. Alqasem(2015). Determinants of capital adequacy ratio in Kuwaiti banks. *Journal of Governance and Regulation / Volume 4, Issue 4, 2015, pp 315-322*
- Al-Sabbagh, N.M., Determinants of capital adequacy ratio in Jordanian banks, 2004, Yarmouk University.
- Al-Tamimi, K. and Fakhri, S. (2013). Determinants of Capital Adequacy in Commercial Banks of Jordan an Empirical Study. *International Journal of Academic Research in Economics and Management Sciences*, 2(4), 44-58.
- Anshu & Gakher, K. (2019). A Study of Macroeconomic Factors Influencing Capital Adequacy Ratio of Schedule Commercial Banks in India. *International Journal of Research and Analytical Reviews (IJRAR)* 6(2):868-876
- Asma, Tahraoui & Khaldi Khadidja(2015). Determinants of Capital Adequacy Ratio in Malaysia Islamic Banks (A Panel Data Analysis). *International Research Journal of Finance and Economics*. Issue 129. January, 2015. Pp 55-63
- Barua, Ratna(2018). Capital Adequacy of Indian Commercial Banks under Basel Regime – An Empirical Study. *Prajnan*, Vol. XLVII, No. 3, pp 283-306.
- BB. (2023). *Annual Report 2022-23*. Bangladesh Bank. Dhaka.

- BB. (2023). *Financial stability report 2022. Issue 11*. Bangladesh Bank. Dhaka
- BB. (2023). *Quarterly Financial Stability Assessment Report. Issue: 19, 2023 (III) July-September 2020*. Bangladesh Bank. Dhaka.
- BB. (2024). *Monthly Economic Trends*. March 2024. Bangladesh Bank. Dhaka
- BB (2024). *Major Economic Indicators:Monthly Update*. February 2024.
- BB (2024). *Bangladesh Bank Quarterly*, Oct-Dec, 2023
- BB.(2014). Guidelines on Risk Based Capital Adequacy (Revised Regulatory Capital Framework for banks in line with Basel III). Bangladesh Bank
- Bokhari, I H , S M Ali, & K Sultan. (2013). Determinants of Capital Adequacy Ratio in Banking Sector:An Empirical Analysis from Pakistan. *Academy of Contemporary Research Journal Volume 2(1):1-9*
- Büyüksalvarc, A, and Abdio_lu, H (2011), “Determinants of capital adequacy ratio in Turkish Banks: A panel data analysis”, *African Journal of BusinessManagement*, vol. 5, no. 27, pp.11199-11209.
- Dao, B. T. T. & K. A. Nguen. (2020). Bank Capital Adequacy Ratio and Bank Performance in Vietnam:A Simultaneous Equations Framework. / *Journal of Asian Finance, Economics and Business Vol 7 No 6 (2020) 039-046*
- Dao, B. T. T., & Nguyen, D. P. (2020). Determinants of Profitability in Commercial Banks in Vietnam, Malaysia and Thailand. *Journal of Asian Finance, Economics and Business*, 7(4), 133-143.
- Dao, T. T. B., & Nguyen, T. N. (2016). Determinant factors of capital adequacy ratio in Vietnamese commercial banks. *VNU Journal of Science: Economics and Business*, 32(2), 49-58.
- Das, A., & Ghosh, S. (2004). The relationship between Risk and Capital: Evidence from Indian public sector banks. Retrieved from <http://econwpa.repec.org/eps/ io/papers/0410/0410006.pdf>.
- El-Ansary, O. A., & H. M. Hafez(2015). Determinants of capital adequacy ratio: An empirical study on Egyptian banks. *Corporate Ownership & Control / Volume 13, Issue 1, 2015, pp 806-816*

- Gunawardhana, C. S. & Damayanthi, N. M. M. (2020). Factors Influencing the Capital Adequacy Ratios of Sri Lankan Banks- A Panel Data Analysis. *The Conference Proceedings of 11th International Conference on Business & Information ICBI, University of Kelaniya, Sri Lanka*. ISSN 2465-6399, (pp 210-224)
- Keqa , Flamur(2021). The determinants of banks' capital adequacy ratio: evidence from western Balkan countries. *Journal of Governance and Regulation / Volume 10, Issue 2, Special Issue, 2021, pp 352-360*
- Leila Bateni, H Vakilifard & F Asghari,(2014).The Influential Factors on Capital Adequacy Ratio in Iranian Banks. *International Journal of Economics and Finance*; Vol. 6, No. 11;
- Molyneux, P., & Thornton, J. (1992). Determinants of European bank profitability: A Note. *Journal of Banking and Finance*, 16, 1173–1178.
- Nuviyanti and Anggono, A. H. (2014). Determinants of Capital Adequacy Ratio (CAR) in 19 Commercial Banks. *Journal of Business and Management*, 3(7), 752-764.
- PhuongAnhNguyen,BichLeTran,MichelSimioni.(2021).Optimalcapitaladequacyratio: an investigation of Vietnamese commercial banks using two-stage DEA. *Cogent Business & Management*, 2021, 8 (1),pp.1-20. 10.1080/23311975.2020.1870796. hal-03125428
- Olarewaju, O. M., & Akande, J. O. (2016). An Empirical Analysis of Capital Adequacy Determinants in Nigerian Banking Sector. *International Journal of Economics and Finance*, 8(12), 132-142.
- Rastogi, A. B. & V. Rao.(2014).Capital Requirements for Indian Banks:An Empirical Analysis. South Asia Working Paper Series. No.31.November 2014. Asian Development Bank.
- Sarma, Mandira and Y. Nikaido(2007). Capital Adequacy Regime in India:An Overview. Indian Council for Research on International Economic Relations. ICRIER. Working Paper No. 196.
- Ünvan, Y., A.(2020). Determinants of Bank Capital Adequacy Ratio in Ghana . *Journal of Yasar University*, 2020, 15/58, 160-166

Employment Pattern of People Living in Tanguar Haor

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Faisal Ahmmed**

Abstract

Tanguar Haor is a vital wetland in northeastern Bangladesh that supports boro rice farming and commercial fisheries. Yet local employment remains highly vulnerable to hydrological and climate extremes. This study examines employment patterns among residents, focusing on available opportunities, seasonal challenges, and future prospects. A mixed-methods approach was used, combining a household survey of 234 household heads with key informant interviews, focus groups, and field observations. Results indicate that agriculture and fishing are the primary occupations, and most household heads, who are sole earners, work in low-paying, informal jobs. Seasonal unemployment and underemployment are widespread, especially during extended flooding, and limited education and skills hinder transitions to diversified or non-farm jobs. Households report low savings, heavy reliance on natural resources, and frequent losses from floods, storms, and disasters, which deepen livelihood insecurity. Despite these challenges, respondents see potential for employment diversification through local resources, including ecotourism, livestock and duck farming, fish processing, and heritage crafts—if policy support, infrastructure, and risk-reduction initiatives are improved. The study highlights the importance of tailored, integrated interventions that promote livelihood diversification, climate-resilient resource management, and better connectivity to strengthen employment stability in Tanguar Haor.

Keywords: *Employment Pattern · Seasonal Unemployment · Livelihood Vulnerability · Tanguar Haor · Wetland Economy*

Introduction

A haor is a wetland ecosystem located in northeastern Bangladesh, stretching across districts such as Sylhet, Sunamgonj, Mymensingh, Habiganj, Maulvi Bazar, Kishoreganj, and Netrokona. These areas include rivers, canals, baors,

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and beels. It is characterized as a bowl-shaped depression within swamp systems and the Floodplain Lake, filling with water extensively during the monsoon and mostly drying up afterward (Monwar et al., 2014). There are approximately 373 haor regions supporting about 19.37 million people in northeastern Bangladesh, covering roughly 858,000 hectares—about 43% of the total haor area (Master plan of haor areas, 2012).

Tanguar Haor is a distinctive wetland covering 10,000 hectares in Sunamgonj's northeastern district, near the Indian border at the base of the Khasi Hills. It is among Bangladesh's globally important haors, situated just 10-20 km northeast of Sunamgonj town. Despite its significance, it remains a remote area (Haque & Kazal, 2008). The Haor's fertile land makes it valuable for agriculture, and it boasts rich ecosystems and biodiversity. However, villagers face limited employment opportunities due to frequent flash floods and powerful waves. During such floods (April to October), the entire crop land is submerged for 6-7 months. Although ecologically rich, local residents live beneath the poverty line. Overfishing by leaseholders and growing population pressure have led to ecological decline (Hossain, 2013; Tima et al., 2021). Consequently, Bangladesh designated Tanguar Haor as an 'Ecological Critical Area (ECA)' in 1999, and it was listed as an international wetland under the Ramsar Agreement in 2000 for its natural resources (Haque & Kazal, 2008).

Rana et al. (2009) observed that haor lands are used for boro and robi crops, with beels serving as sites for fishing, bird hunting, and the collection of aquatic plants for food, fodder, and fuel. Rivers and canals facilitate fishing, boating, and transportation, while fallow lands are utilized for grazing, occasional cultivation, and gathering grass and fuelwood. There is considerable potential to create more employment by managing resources effectively in the Haor region. Tourism is also emerging as a promising employment sector. During winter, migratory birds visit the Tanguar Haor, boosting its natural beauty and attracting tourists (Banglapedia, 2003). Qualitative assessments by Ahmmed & Kashem (2008) and Rabby et al. (2011) indicate that agriculture and fishing are the primary occupations for Haor residents, with fishing being the second most significant livelihood activity. The labor market largely stalls during the 5 to 6 months of flooding, as people lack access to infrastructure and resources, making their livelihoods increasingly difficult. Earlier research reports show that average household income falls short of expenses, forcing families to borrow, while poor water and sanitation conditions prevail in haor areas (Alam, 2005). Mamun et al. (2013) highlighted that employment opportunities in Tanguar Haor are declining due to overextraction of resources, illegal fishing, agrochemical use, natural calamities, and high population density. An IUCN (2010) study found that communities in Tanguar Haor are highly socio-economically vulnerable, facing

threats from flash floods, hailstorms, and wave erosion that impact their lives, livelihoods, and environment. These disasters often force residents to migrate to cities in search of alternative employment. A mixed-methods study by the NFPCSP (2010) revealed that haor inhabitants are mostly illiterate, dependent on farming, and unemployed for approximately 6 months during the rainy season due to flooding. Nearly all research indicates that climate change and flash floods adversely affect the livelihoods of haor residents.

Although the Haor region contributes significantly to the national economy, residents face many hardships. The geography of Haor often limits residents' ability to hold full-time jobs. After the boro rice harvest, just before the monsoon, most people in the area become unemployed. The region floods, leaving fishing as the only livelihood option. While some NGOs have recently created limited employment opportunities, their impact remains minimal. Since the community is accustomed to agriculture, shifting to diverse occupations is challenging. Additionally, creating jobs during the rainy season is difficult, prompting many to migrate to cities or other areas in search of work. Lacking skills beyond agriculture, they often resort to low-paid daily labor, which cannot adequately support their families. Despite numerous studies on the living conditions of haor dwellers, several gaps persist. Most research centers on poverty, resource depletion, ecological risks, and broad livelihood patterns, with limited focus on detailed employment structures in Tanguar Haor—such as seasonal employment, diversity, challenges, and emerging opportunities. There is especially little empirical evidence on how employment varies across seasons, how households manage employment gaps, and the potential for new or unconventional jobs in this vital wetland. Therefore, this study aims to analyze the employment patterns of residents in Tanguar Haor, focusing on constraints and future prospects. Its specific objectives include:

- identify the nature and types of employment opportunities in the Tanguar Haor area.
- examine the key challenges and difficulties associated with employment in the Tanguar Haor area.
- explore the potential prospects for improving and diversifying employment in the Tanguar *Haor* area.

Methodology

Study Area and Sampling Site

This study used a sequential explanatory mixed-methods design comprising two distinct phases (Creswell et al., 2003). The first phase used a quantitative approach, and the second, a qualitative one. As Tanguar Haor is the second-

largest haor in Bangladesh after Hakaloki Haor (Figure 1), it covers 88 villages, 10 Mauzas, and 02 Upazilas, namely Dharmapasha and Tahirpur, in Sunamganj district. From there, 6 villages were purposively selected for data collection (Table 1).

Data Collection, Sampling Tools and Techniques

The study population comprised employed household heads aged 18 years and above in the selected villages, and a total of 234 respondents were surveyed using a standardized interview schedule (Table 1). For the qualitative phase, three techniques were used: direct observation, in-depth open-ended interviews, and the review of written documents. To obtain rich, detailed insights into employment-related issues, 12 key informant interviews (KIs) and 6 focus group discussions (FGDs) (group size: 4-10 persons; time span: 30-60 minutes) were conducted in the study areas, supported by checklists.

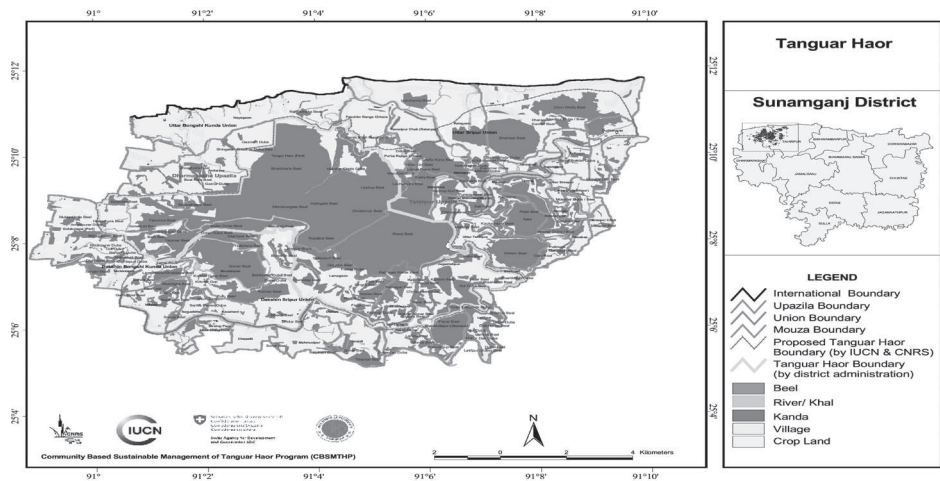


Figure 1. Location map of the Tanguar Haor Ramsar wetland in the north-eastern region of Bangladesh (Source: IUCN Bangladesh Country Office).

Table 1. Geographical Area Coverage, Sample Size and Tools used in this Study

Study area			Tools		
District	Upazila	Village	Households interview	FGD	KII
Sunamgonj	Dharmapasha	Antarpur	71	1	2
		Rajendrapur	40	1	2
		Mujrai	44	1	2
	Tahirpur	Golabari	29	1	2
		Jibionpur	18	1	2
		Jangail	32	1	2
		Total		234	6

Data Analysis

Qualitative data analysis entails classifying and interpreting linguistic or visual materials to understand the underlying and explicit structures of meaning and what they signify (Flick, 2013, p. 5). In the quantitative analysis, the data were manually edited, coded, organized, and compiled into a tabulation sheet. Descriptive statistics, including frequencies, percentages, and means, were calculated by hand to profile the entire sample and address questions about network composition.

Findings

Socio-Demographic Information of the Respondents

Household heads participated in the study, and, as expected, none were under 18. Most respondents were aged 33-37, with 13.24% aged 57 or older. The predominant religions are Islam (67.52%) and Hinduism (22.48%). A small group, about 10%, consists of indigenous communities like the Garo, Hajong, and Banai, who are Christians. In line with socio-cultural norms, Bangladeshi families are typically male-led; only 13.68% of households are headed by women, while 86.32% are headed by men. The literacy level among Tanguar Haor residents is very low due to poverty and their remote location. Participants noted that schools are far, and poor road conditions hinder regular attendance. Seasonal floods and natural disasters also disrupt schooling, often leading children to drop out. The uneducated population lacks the skills for alternative employment and needs better education and training.

Sources of Income, Monthly Income, Savings, Expenditure & Living Standard

The income of Tanguar Haor residents primarily depends on local resources, mainly agriculture and fishing. Their earnings fluctuate seasonally, with the highest income during the dry season when they can cultivate their lands. Since many respondents are uneducated or informally employed and lack written records, accurately assessing their family's income is challenging. Under the current market conditions, this income often falls short of covering basic needs. The study shows that the average monthly income is Tk 5,529, which remains inadequate for the respondents and their families. Some individuals earn more, mainly through remittances. Finding enough food, clothing, and shelter remains difficult due to income scarcity. Most spend their entire monthly income on essentials and debt repayment, and saving is largely unheard of. The community is generally unaware of personal bank savings, although many are familiar with local NGO savings schemes called 'Baro (12) takar Shamity', which they often participate in.

Nature and Employment Opportunities in the Tanguar Haor Area

Nature of Employment

The study reveals that residents of the Tanguar Haor area struggle to secure stable, year-round employment or income. Seasonal unemployment and underemployment are prevalent. Many respondents indicated they cannot find work daily and are often paid low wages due to the nature of their jobs. Environmental disasters and climate change negatively impact their employment and income. The geographical features of the Haor restrict occupational diversification, limiting earnings to two or three sectors. Crop diversification is also hindered by natural calamities, making full-time agricultural work impossible. The lack of higher education pushes most into the informal, temporary, and seasonal sectors. Consequently, seasonal unemployment remains a significant challenge. Since most people are involved in informal work—mainly agriculture and fishing as self-employed labor—they depend heavily on natural conditions.

Because most respondents work in the informal sector, working hours are not predetermined. Hours vary with the seasons and employers' needs. Respondents describe this as follows: we do not care about time when we harvest crops, catch fish, or irrigate farmland during the dry season; on the other hand, we go to the farm land late once winter disrupts us, and we stay even through the night once we catch fish during the peak season. However, laborers have to work long hours at their employers' discretion. Data show that their working hours range from 8 to 12 hours.

Main Occupation or Employment

The study found that fishing and agriculture are the main occupations for income. Although fish production is declining and fishers face various challenges, the Haor continues to naturally produce a wide range of local and indigenous fish varieties. Based on this geographical advantage, a large number of people from the fishing community have lived in the haor areas from time immemorial. Therefore, the fish sector can be considered a better source of income in the Haor area (Table 2).

Table 2. Main Occupations or Employment of the Respondents

Main Occupation or Employment	Name of the Villages						Total (Percent)
	Antarpur	Rajendrapur	Mujrai	Golab-ari	Jibionpur	Jangail	
Farmer	23	11	20	13	05	14	86 (36.75%)
Fisherman	22	14	16	10	09	11	82(35.04%)
Fish-related business	01	02	01	01		01	06 (02.56%)
Day Laborer	19	11	03	01	01	04	39 (16.67%)
Petty Business	01	01	01	01	01	01	06(02.56%)
Boatman	01	01	02				04 (01.71%)
Others	04	00	01	03	02	01	11(4.7%)
Total							234(100%)

Supportive or Secondary Employment

It was found that both males and females are engaged in joint rearing of cattle, ducks, and chickens for additional income. Small and seasonal businesses, such as weaving fish nets and mats, handicrafts, middleman ship, house making and repairing, day laboring, digging soil, and crushing stone, are commonly found as secondary sources of income that can offer additional income for families (Table 3).

Table 3. List of Secondary or Supportive Employment of the Respondents

Secondary Employment	Name of the Villages						Total (Percent)
	Antarpur	Rajendrapur	Mujrai	Golabari	Jibionpur	Jangail	
Cattle rearing	01	01	01	00	02	03	08 (06.15%)
Sewing/ Tailoring	01	01	02	00	00	00	04 (03.08%)
Poultry rearing	05	05	02	03	03	07	25 (19.23%)
Business of paddy	00	00	00	00	01	00	01 (0.77%)
Small trade	02	01	01	03	01	02	10 (07.69%)
House making	01	00	00	00	00	00	01 (0.77%)
Catching fish	41	17	13	14	13	18	113 (86.92%)
Labor	13	15	04	03	04	00	39 (30.00%)
Boatman	10	00	00	02	00	00	12 (09.23%)
Cultivation	06	01	04	01	05	00	17 (13.08%)
Digging soil	06	02	09	00	00	00	17 (13.08%)
Crushing stone	00	00	08	00	00	00	08(06.15%)
Mat weaving	00	00	00	00	00	11	11(08.46%)

* Multiple answers remaining

Employment Pattern During the Dry Season

Data show that the haor economy and livelihoods vary widely across seasons. Both survey respondents and FGD participants reported that their income increases during the dry season. The dry season is suitable for paddy production and other agricultural activities in the haor areas. People can also engage in fishing and related activities, and mobility becomes easier in this season. People can travel to distant places to earn income. Local residents earn additional income from work. Employment types during the dry season are shown in Table 4.

Table 4. Employment Pattern during Dry Season

Employment pattern during the dry Season	Name of the Villages						Total (Percent)
	Antarpur	Rajendrapur	Mujrai	Golabari	Jibionpur	Jangail	
Digging soil	03	02	05	00	00	01	11 (04.70%)
Mending house	01	00	00	00	00	00	01 (0.43%)
Building poultry firm	01	01	01	02	01	01	07 (02.99%)
Sewing quilt	01	00	02	00	00	00	03 (01.28%)
Fishing	67	40	44	29	18	27	225 (96.15%)
Carpenter	01	00	00	00	00	01	02 (0.85%)
Driving Motorcycle	64	25	10	08	04	19	130 (55.56%)
Weaving fishing net	00	00	02	00	00	00	02 (0.85%)
Tilling land	67	39	42	32	18	32	230 (98.29%)
Doing business	63	37	37	27	18	19	201 (85.90%)
Working as labor	05	01	03	00	01	01	11 (04.70%)
Rearing cattle	15	04	01	01	00	01	22 (9.40%)
Rowing boat	03	00	05	00	00	00	08 (3.42%)
Crushing stone	00	01	25	00	00	00	26 (11.11%)
Making boat	00	00	00	00	01	00	01 (0.43%)
Weaving mat	00	00	00	00	00	11	11 (04.7%)
Working in a shop	00	00	00	00	00	01	(0.43%)

* Multiple answers remaining

Employment Pattern During the Rainy Season

During discussions, some participants highlighted that flash floods are a major disaster impacting the main production sector, endangering the lives and livelihoods of Tanguar haor residents during the rainy season. The cultivated land is submerged for approximately six months each year, causing crop losses due to floods, hailstorms, and cyclones. Rice, in particular, suffers from flooding. Consequently, many people remain idle during this period without work. The

prices of local products increase sharply, limiting people’s ability to afford food and essentials. FGDs participants mentioned an unusual practice called “advance sale of labor,” where poor individuals are compelled to sell their labor at lower wages before the peak season. Some are forced to liquidate livestock and assets or take loans from microfinance institutions and moneylenders, who often charge high interest rates. Additionally, some are driven to migrate to cities seeking alternative employment. Table 5 details the types of employment available during the rainy season.

Table 5. List of Employment Patterns During Rainy Season

Employment pattern during the rainy season	Name of the Villages						Total (Percent)
	Antarpur	Rajendrapur	Mujrai	Golabari	Jibionpur	Jangail	
Mending house	02	00	00	00	00	00	02 (0.85%)
Sewing	02	00	01	00	00	00	03 (1.28%)
Crushing stone	00	00	08	00	00	00	08 (03.42%)
Fishing	71	40	41	29	19	21	221 (99.44%)
Rowing boat	64	36	28	28	18	19	193 (82.48%)
Earning from informal migration	69	33	19	24	08	15	168 (79%)
Rearing poultry	57	20	13	19	08	20	137 (58.55%)
Selling cattle	07	02	00	00	00	01	10 (4.27%)
Driving a <i>Troller</i> (engine-driven boat)	00	01	01	01	00	00	03 (01.28%)
Running a small trade (at home)	03	02	01	01	01	01	09 (03.85%)
Weaving mat	00	00	00	00	00	11	11 (04.70%)

* Multiple answers remaining

Employment Related Challenges and Difficulties

The study found seasonal variations in employment opportunities in the haor areas. Haor geography is critical and vulnerable to natural disasters, which usually occur during the rainy season. On the other hand, the dry season is suitable for paddy cultivation, but fishing opportunities decline. Therefore, fishers are at risk during this season, as are agricultural workers who face problems during the rainy season. The study’s findings are presented below, divided into two major seasons:

Employment-related Challenges and Difficulties During the Rainy Season

The rainy season typically signals a better outlook for fishing and related activities. However, severe floods and strong winds often hinder fishermen, making fish catching difficult and restricting travel to water bodies. As one fisherman explained, they must wait several months for the fish to mature. Meanwhile, farmers face severe challenges, as land flooding reduces agricultural output. Those raising cattle are frequently compelled to sell their livestock at reduced prices. The study found that roads and farmland also become submerged during the dry season, preventing cultivation and leaving laborers without work. Farmers are unable to leave their homes to seek employment because they need to protect their property from disasters. Only a few boats are used for transportation, which is expensive and risky. The survey found that 99.57% of respondents identified flash floods as the primary cause of income loss during the rainy season (see Table 6).

Table 6. Employment-related Challenges and Difficulties during Rainy Season

The problems are in the income-generating activities in the rainy season	Name of the Villages						Total (Percent)
	Antarpur	Rajendrapur	Mujrai	Golabari	Jibionpur	Jangail	
Flash flood	70	40	44	29	18	32	233 (99.57%)
Decreased rate of fish production	57	36	38	23	16	25	195(83.33%)
Bad transportation and communication	63	38	27	28	17	19	192 (82.05%)
High transport cost	31	08	16	19	19	12	105 (44.87%)
Lack of funds for leasing water bodies	25	01	21	20	07	06	80 (34.19%)
Limited access for fishing	21	18	27	17	06	08	97(41.45%)
Damage to crops	50	36	37	19	13	29	184 (78.63%)
No alternative employment opportunity	07	05	04	02	09	15	42(17.95%)

* Multiple answers remaining

Employment-related Challenges and Difficulties During the Dry Season

Though the dry season creates opportunities for farmers, people whose livelihoods depend on occupations during the rainy season are at risk. Most respondents have mentioned that dryness is becoming a major problem in cultivated land. Drought is a problem that reduces paddy production during this season, one of the key informants noted. FGD participants mentioned that during the dry season, the

size of the haor water body shrinks, leaseholders impose restrictions on open fishing, and, as a result, poor fishers cannot catch fish who are not leaseholders. This creates massive seasonal unemployment among fishers. Table 7 presents problems with income-generating activities (IGA) during the dry season.

Table 7. Employment-related Challenges and Difficulties During the Dry Season in the Tanguar Haor area

The Problems are in the income-generating activities during the dry season	Name of the Villages						Total (Percent)
	Antarpur	Rajendrapur	Mujrai	Golabari	Jibionpur	Jangail	
Dryness/Drought	68	40	38	29	18	22	215 (91.88%)
The number of fish is decreasing	30	36	38	29	16	29	178(76.07%)
Highly travelling cost	62	26	31	27	18	29	193 (82.48%)
Seasonal diseases of poultry and cattle	01	02	00	01	00	02	06(2.56%)
Legal barrier for fishing	03	02	04	02	02	03	16 (06.84%)
Having no transportation for going to work place	01	03	05	02	01	01	13 (05.56%)
Insufficient and low quality of travelling vehicle	08	07	03	05	03	02	28 (11.97%)
Lack of scope of alternative livelihood	15	18	23	13	17	05	91(38.89%)

* Multiple answers remaining

Disaster, Climate Change and Employment

Due to climate change, people in this area face multiple challenges, including income losses from agricultural production. The study revealed that people in Tanguar Haor face various types of disasters that affect the haor’s economy and employment opportunities (Table 8).

Table 8. Perceptions of the Haor People About Climate Change in the Study Area

Observation of the Haor People about Climate Change	Name of the Villages						Total (Percent)
	Antarapur	Rajendrapur	Mujrai	Golabari	Jibionpur	Jangail	
Rainfall is decreasing day by day	00	00	00	02	00	00	02 (0.85%)
Decreasing of fish in the haor	37	14	19	06	00	13	89 (38.03%)
Scorching heat	30	19	02	02	06	09	68 (29.06%)
The depth of the bills or rivers is decreasing	23	18	01	00	01	07	50 (21.37%)
Various aquatic decreasing	08	04	12	08	00	08	40 (17.09%)
Flood in advance	50	35	18	18	10	09	140 (59.83%)
Drought out of season	44	26	06	07	05	09	97 (41.45%)
Hailstorm out of season	07	01	02	02	01	00	13 (05.56%)
Storm is out of season	26	10	05	06	09	10	66 (28.21%)
Decreasing Hijol & Coros trees	19	11	00	01	02	02	35 14.96%)
Destruction of the ecosystem	02	01	00	01	01	00	05 (02.14%)
Changing of the time of season	02	00	22	09	10	06	49 (20.94%)
Irregular rainfall	01	01	18	22	10	20	72 (30.77%)
Decreasing aquatic plants & animal	04	03	06	00	01	01	15 (06.41%)

* Multiple answers remaining

Prospects of Employment

Despite having various challenges, the prospect of employment in the Tanguar Haor area is high due to its rich natural resources. Key informants, FGD participants, and survey respondents mentioned that multiple employment opportunities could be created here. The following table depicts the prospects of multiple employment in the Tanguar Haor.

Table 9. Prospects of multiple employments in the Tanguar Haor area

Prospects of multiple employments	Name of the Villages						Total & Percent (%)
	Antarpur	Rajendrapur	Mujrai	Golabari	Jibionpur	Jangail	
Agriculture-based factory/ industry	00	00	06	00	00	00	06 (02.56%)
Duck farm	00	00	00	02	00	03	05 (02.14%)
Import of coal	00	00	18	00	00	00	18 (07.69%)
Murta plants culturing(to weave Shital Pati or cool mats)	00	00	11	00	00	07	18 (07.69%)
Tourism area	50	36	25	17	13	16	157 (67.09 %)
Producing goods based on the demand of tourists	05	00	00	08	01	00	14 (05.98%)
Creation of a market for the cottage industry	60	30	17	10	13	12	142 (60.68%)
Production of agricultural goods	18	13	02	02	02	01	38 (18.24%)
Fishing & fish related trade	26	13	10	12	04	12	77 (32.91%)
Cattle rearing	02	04	03	05	03	03	20 (08.55%)

* Multiple answers remaining

According to experts, tourism has significant potential, particularly during the rainy season and winter. Both of the seasons have special beauty. Once the harbor is flooded, the beauty is enormous, resembling a sea, and water rides on the water bodies can be attractive to travelers. Tourism can create employment opportunities, such as boatmanship and crafts, as well as supportive businesses related to tourism. Hoar becomes a haven for migratory and residential birds during winter, and a huge number of travelers come from different parts of Bangladesh. Multiple tourism arrangements can increase employment opportunities. The following pictures show the natural views of the haor areas, which may attract tourists.

Respondents also noted significant opportunities to create various types of employment by establishing an industry based on local resources. According to key informants, the fish processing and glass industries can be established, as raw materials are available in the Haor areas. According to FGD participants, the industry can create employment for many people in the Haor area. Most of the respondents suggested that effective action should be taken to promote the export of coal, the rearing of ducks, the cultivation of purls, the rearing of poultry, and the

rearing of cattle, so that people may be engaged in different employments. One of the key informants opined that duck rearing can be a highly profitable source of employment for haor dwellers, as the area is flooded for about half the year. Many also suggest government attention to establishing large-scale livestock farming, such as milk vita. They argue that unused government land can be used for livestock grazing, and that this industry can create significant employment for local people. Mat weaving can be another important source of income. Recently, UNESCO declared the Mat of Sylhet (Sheetal Pati) a heritage site, which has increased its demand both in the national and international markets. If people are supported with training and logistics, a good number of employment opportunities can be created, and the country can earn foreign currency by exporting mats. Figure 2 shows the prospects for seasonal employment in the Tangaur Haor wetland areas, including the cultivation of Murta plants to weave Shital Pati (cool mats), rearing ducks and cattle, etc.

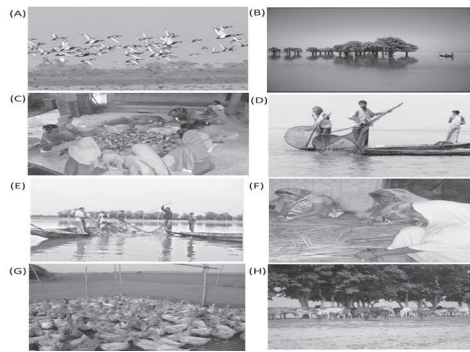


Figure 2. Potential prospects of seasonal employments in the Tangaur Haor Wetland Areas of Bangladesh

Above figure 2 shows (A-B) potential prospective tourism area; (C) Women's involvement in post-harvest handling of fishing; (D-E) Fishing operation; (F) Women weave Shital Pati (cool mats) using Murta plants; (G) Duck rearing; (H) Cattle grazing in the haor basin during the dry season.

Conclusion

Although the Tangaur Haor is rich in natural resources, the villagers in this area are dreadfully poor, and their socioeconomic conditions are extremely miserable. Agriculture and fisheries are the primary sources of income for the people in the Haor areas. However, both occupations are at serious risk from natural disasters and climate change. In line with the study objectives, the findings show that year-round employment opportunities are scarce, livelihood options are weakly diversified, and seasonal unemployment and underemployment are pervasive, particularly during the prolonged inundation period. The people of the study area express aspirations for positive change in their locality and believe that the

opportunity for full employment can ensure their overall well-being. Respondents consistently emphasize the need for multiple, locally adapted employment options that respect the geography, traditions, skills, and climate risks of the haor context, alongside improved road and transport infrastructure to connect workers to markets and services. First, promote diversified, nature-compatible livelihoods - such as eco-tourism, duck and livestock rearing, fish processing, and heritage crafts (e.g., Shital Pati) - through targeted training, start-up finance, and market development. Second, reform and strengthen resource and disaster governance in haor areas, including more equitable fisheries access, climate-resilient agricultural support, and investment in all-weather connectivity and basic services. Third, design integrated employment programs that deliberately engage both men and women - linking skills development, micro-enterprise support, and social protection - to reduce seasonal joblessness and enhance the resilience of Tanguar Haor communities.

References

- Alam (2005). "Socio-Economic Conditions of Haor Fishermen A Field Level Study." BRAC University Journal, Vol. II, No. 1, 2005, pp. 57-63
- Ahmmed & Kashem (2008). "Understanding the Nature of Community and Fisherfolk's Access in Water Bodies of Haor Areas at Sunamgonj District: A Case study on Metergaon Ganger Aga." Campaign for Sustainable Rural Livelihoods-CSRL Haor Group. Institute of Development Affairs-IDA. Shahjalal Upashahar, Sylhet, Bangladesh.
- Banglapedia (2003). The national Encyclopedia of Bangladesh, Banglapedia Trust, The Asiatic Society of Bangladesh.
- Chowdhury, (undated). "The state of Community Based Sustainable Management of Tanguar Haor, What measures are to be taken? ". <http://www.kadinst.hku.hk/sdconf10/Papers/PDF/p35.pdf>
- Haque &, Kazal (2008), "Rich Resources, Poor People The paradox of living in Tanguar Haor. https://cmsdata.iucn.org/downloads/rich_resources__poor_people__the_paradox_of_living_in_tanguar_haor.pdf.
- Hossain, M. M. (2013). "Evaluating the performance of co-management organizations (CMOs) in sustainable benefits sharing in Tanguar haor, Bangladesh. In: Co-Managed and Climate Resilient Ecosystems, Mustafa, M.G., Khan, N.A., Akhtaruzzaman, A.F.M., Harun, A.K.Y. and Chowdhury, R.M. (eds.) (pp. 182-

201). USAID's IPAC Project, IRG and the WorldFish, Dhaka, Bangladesh.

International Union for Conservation of Nature [IUCN], (2010). "Disaster Risk Reduction (DRR) on Tanguar Haor." IUCN Bangladesh Country Office, 13th December 2010

International Union for Conservation of Nature [IUCN], (2012). "Biodiversity of Tanguar Haor: A Ramsar Site of Bangladesh." Volume –II: Flora

Islam, M.S., Hossain, M.S., Hoque, M.E., Tusher, T. R. & M. H. Kabir (2014). "Study on Natural Resource Management in Relation with Socio-Economic Status at Tanguar Haor in Sunamgonj District of Bangladesh" Bangladesh J. Environ. Sci., Vol. 26: 59-66.

Mahadi, M. S. A., R. Khanum & K. Akhi, (2014). "Participation in Livestock and Poultry Rearing: A Study on *Haor* Women in Bangladesh." J. Chem. Bio. Phy. Sci. Sec. D, Aug. 2014 – Oct. 2014; Vol.4, No.4; 3850-3860.

Master Plan of Haor Areas, Volume -II, Investment Project Portfolio (April- 2012).

Governments of the People Republic of Bangladesh, Ministry of Water Resources, Bangladesh Haor and Wetland Development Board.

Mamun, Roy, Rahaman, Jahan & Islam (2013). "Status of Fisheries Resources and Water Quality of Tanguar Haor". J. Environ. Sci. & Natural Resources, 6 (1): 103-106, 2013, ISSN 1999-7361

Monwar, M. M., Mustafa, M. G., Khan, N. A., Hossain, M. S., Hossain, M. M., Majumder, M. K., ... & Alam, M. S. (2014). Indigenous adaptation practices for the development of climate resilient ecosystems in the Hail Haor, Bangladesh. *Global Social Welfare*, 5(2), 125-136.

Oxfam GB, Bangladesh (2013). "Duck Value Chain in Coastal and Haor areas in Bangladesh." GM ark Consulting Limited, Suite 604, House 145, Road 03, Block A, Niketan Gulshan 1, Dhaka, Bangladesh.

Rabby et al. (2011). "What offers solution to the poverty reduction of the Haor people in Bangladesh? Seasonal migration or a new in shore economic livelihood policy." African Journal of Business Management Vol. 5(23), pp. 9979-9991, 7 October, 2011.

Rahman & Salam (2008). "Essential Services of Haor Areas and Way Forward." DEVELOPMENT WHEEL (DEW), 13-A/4-A (3rd floor), Block-B, Babar Road Mohammadpur, Dhaka-1207, Bangladesh.

Rana MP, Chowdhury MSH, Sohel MSI, Akhter S & Koike M, (2009). Status and socio-economic significance of wetland in the tropics: a study from Bangladesh. *iForest* 2:

Sarma (2010). “*Scenario of haor vulnerabilities and other obstacles for sustainable livelihood development in Nikli Upazila.*” J. Bangladesh Agril. Univ. 8(2): 283–290, 2010

The National Food Policy Capacity Strengthening Programme [NFPCSP], (2010). “*Food Security Strategies of The People Living in Haor Areas: Status and Prospects*” <http://library.sust.edu:8081/handle/123456789/177>

Tima, T.A.; Schneider, P.; Chanda, S.K.; Mozumder, M.M.H.; Hossain, M.M.; Begum, A.; Shamsuzzaman, M.M. (2021). *Analyses Implementation Realities of Legal Frameworks for Sustainable Management of Tanguar Haor Fisheries Resources in Bangladesh. Sustainability, 13*, 8784. doi: 10.3390/su13168784

Impact of Parental Migration on School Attendance and Child Labor in Bangladesh

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Abstract

This paper examines the relationship between parental migration and child outcomes in Bangladesh, focusing on school attendance and child labor. Using nationally representative longitudinal household data for 2008 and 2014, we exploit within-household variation with household, village, and time fixed effects. The results reveal substantial heterogeneity by gender and birth order. Parental migration is associated with lower school attendance and higher labor participation among eldest sons, while effects for other children are limited or statistically insignificant. We find no robust association between remittance income and household child labor hours, or between remittance income and education expenditure per child. These findings highlight the role of intra-household adjustments in migrant families and point to potential vulnerabilities among eldest sons, with implications for child welfare policies in migrant-sending households in Bangladesh.

Keywords: Child labor · school attendance · parental migration · Bangladesh

JEL Classification: F 22 · I 21 · J 61 · J 82

Introduction

International migration and remittances have become a central component of development finance. Remittance flows to low- and middle-income countries are estimated to have reached approximately USD 685 billion in 2024, exceeding foreign direct investment and official development assistance (World Bank, 2024). Bangladesh is among the largest recipients globally, with remittance inflows exceeding USD 30 billion in 2025 according to central bank data (Bangladesh Bank, 2025). These flows account for a substantial share of foreign exchange earnings and play a critical role in household welfare and macroeconomic stability.

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While migration and remittances are widely associated with poverty reduction and improved consumption, their implications for intra-household outcomes, particularly the human capital of the left-behind family's children, remain ambiguous (Yang, 2008; Zhang, Behrman, Fan, Wei, & Zhang, 2014).

The literature on parental migration and child outcomes highlights two competing mechanisms, but provides no clear consensus on their net effect. On the one hand, migration may improve child welfare through remittance income by relaxing household liquidity constraints and enabling greater investment in schooling and human capital (Yang, 2008; Acosta, 2011; Ambler et al., 2021). On the other hand, parental absence may disrupt intra-household time allocation and supervision, increasing children's labor participation and reducing time devoted to education (Antman, 2011; McKenzie & Rapoport, 2011; Dinkelman & Mariotti, 2021).

A growing empirical literature attempts to quantify these competing forces, but the evidence remains mixed and highly context-specific. For instance, using panel data from Mexico, Antman (2011) documents that paternal migration is associated with reduced study time and increased labor supply among children, particularly boys aged 12–15, suggesting that labor substitution within the household may dominate income effects. In contrast, other studies exploiting exogenous variation in remittances—such as exchange rate shocks—find positive effects on schooling and reductions in child labor (Yang, 2008; Alcaraz et al., 2012). What this body of work makes clear is not a single average effect, but substantial heterogeneity across gender, age, and household structure, pointing to the importance of intra-household allocation mechanisms rather than purely income-driven responses.

Despite these insights, two key limitations remain in the existing literature. First, identification is a persistent challenge. Migration decisions are endogenous to household characteristics and shocks that may also directly affect child outcomes, making it difficult to isolate causal effects. While some studies employ instrumental variables or natural experiments, many rely on cross-sectional comparisons or imperfect instruments, raising concerns about both internal validity and external applicability. Second, much of the empirical work—particularly in developing country contexts—relies on comparisons between migrant and non-migrant households, which confound migration effects with underlying differences in preferences, resources, and constraints.

These limitations are particularly pronounced in Bangladesh. Existing evidence is sparse and largely based on cross-sectional or localized data. For example, Kuhn (2006) finds a positive association between parental migration and

schooling using data from a single sub-district, but the analysis relies on cross-sectional OLS and does not address selection into migration. More recent work using panel data has focused primarily on the determinants of migration rather than its consequences (Kikkawa & Otsuka, 2020), leaving the dynamics of child outcomes in migrant households relatively underexplored. As a result, there is limited evidence on how child outcomes adjust within households over time as migration status changes.

This paper contributes to the literature by shifting the focus from cross-household comparisons to within-household variation over time. By exploiting panel data and incorporating household fixed effects, the analysis accounts for time-invariant unobserved heterogeneity—such as parental preferences for education or persistent wealth differences—that may jointly influence migration decisions and child outcomes. While this approach does not fully resolve endogeneity concerns arising from time-varying shocks, it provides a more credible characterization of the relationship between migration and child outcomes than cross-sectional comparisons. In addition, the paper documents systematic heterogeneity by gender and birth order, highlighting the role of intra-household labor reallocation—particularly the disproportionate burden borne by eldest sons—which remains underexplored in the existing literature.

The remainder of the paper is organized as follows: The next section presents the data and descriptive statistics. Empirical strategies are described in Section 3, followed by the investigation of the main outcomes by analyzing the empirical results. The paper concludes with Section 5, which focuses on policy implications and possible extensions of the research.

2. Conceptual Framework

To guide the empirical analysis, this section outlines a simple framework linking parental migration to child outcomes through intra-household allocation decisions. The framework draws on standard models of household behavior, in which families allocate resources and time among members to maximize a joint objective subject to budget and time constraints (Becker, 1981), as well as on collective models in which allocation reflects the roles and responsibilities of individual members. Parental migration affects household decisions through two opposing channels. On the one hand, remittance income relaxes budget constraints and may increase investment in children's human capital, including schooling. On the other hand, the absence of a parent—often the primary earner—reduces the available adult labor force and may shift household responsibilities to children. The net relationship between migration and child outcomes is therefore theoretically ambiguous and depends on how households adjust along these margins.

A key implication of this framework is that these adjustments are unlikely to be uniform across children. Differences in age, gender, and social roles shape how households reallocate time and responsibilities. In many developing country contexts, including rural Bangladesh, the eldest son is often expected to assume greater economic responsibility in the absence of a parent. This pattern is consistent with intra-household specialization, where tasks are assigned based on relative capacity and social norms. Following parental migration, the household faces a trade-off between increased income from remittances and the loss of adult labor. While additional income may support schooling, the absence of a parent increases the household's need for labor. Given differences in capacity and social expectations, households may rely more heavily on older children—particularly eldest sons—to compensate for the missing labor. As a result, the reallocation of time away from schooling and toward work is expected to be more pronounced for this group relative to their siblings.

Importantly, this framework emphasizes that observed outcomes reflect a combination of economic incentives and household institutional norms. The empirical analysis that follows is therefore designed to document these differential patterns, rather than to identify causal effects of migration.

3. Data

This study uses longitudinal household survey data from rural Bangladesh collected by the Bangladesh Institute of Development Studies (BIDS), the International Rice Research Institute (IRRI), and the Bangladesh Rural Advancement Committee (BRAC). The survey uses a sample of households across multiple rounds (1988, 2000, 2004, 2008, and 2014) at the rural level and covers 62 villages in 57 districts. The sample is constructed using a multistage stratified random sampling design that covers villages across all major regions of Bangladesh. The original sample of 1,240 households in 1988 was expanded over successive waves to 2,843 households in 2014, primarily due to household splitting and panel follow-up of original households and their descendants. We focus on the 2008 and 2014 waves, which contain detailed information on migration and remittances. The survey collects rich information on household demographics, income and expenditure, labor supply, education, and migration. Migration modules include migrant numbers, remittance flows, and migration costs. The analysis is restricted to households observed in both 2008 and 2014 with children aged 6–17. The sample is rural, which is important given the prevalence of both migration and child labor in rural Bangladesh. Attrition between these waves is relatively low (around 10%), consistent with other panel surveys in similar contexts (Kikkawa & Otsuka, 2020). The survey evaluated poverty and income dynamics in rural Bangladesh by collecting data on various aspects of the rural economy, including income & expenditure, the labor market,

rural infrastructure, poverty, gender, and education over more than two decades. Further, it collected information on household migration, including the number of migrants, the amount of remittances sent, the cost of migration, the source of the migration cost, and information on social networking. However, detailed information on migration was absent in the initial studies, which is why this study analyzes data from the 2008 and 2014 surveys. The study focuses on families with children aged 6 to 17 residing in households with at least one parent who is an international migrant. A potential concern with the survey is that it only captures data from rural areas of Bangladesh, potentially overlooking characteristics of international migration from urban areas. Another common issue in longitudinal surveys is attrition. As mentioned earlier, the attrition rate for this data set is only 10% from 2008 to 2014, which may be considered reasonable. Moreover, this paper uses data from households that appear in both surveys in 2008 and 2014.

Table A1 presents summary statistics for children aged 6 to 17 and their households in 2008 and 2014, comparing migrant and non-migrant households. A household is classified as migrant if at least one parent is an international migrant. School attendance is a binary indicator equal to 1 if the child is currently enrolled, while child labor is a binary indicator of participation in income-generating activities outside the household. School attendance increased over time for both groups, with higher enrollment rates among children in migrant households in 2014. Female children have higher attendance rates than male children, particularly in migrant households. In contrast, child labor is more prevalent among boys and among children in non-migrant households. These descriptive patterns suggest that differences in schooling and labor outcomes may vary by gender and household migration status.

Migrant households differ systematically from non-migrant households. They are more likely to have smaller family sizes and exhibit higher levels of parental education and income. Remittance-receiving households have higher per capita income but may differ in asset composition, including land ownership. These differences underscore the importance of accounting for both observed and unobserved heterogeneity when examining the relationship between migration and child outcomes. Migrant households also appear more likely to be female-headed. This pattern is consistent with the composition of international migration from Bangladesh, where migrants are predominantly male. As a result, when fathers migrate abroad, spouses often assume the role of household head in their absence.

Migrant households differ systematically from non-migrant households along several observable dimensions. They are significantly more likely to be female-headed (93–95 percent, compared to 11–13 percent among non-migrant

households) and exhibit smaller household sizes (3.6–3.8 members versus 4.5–5.0). Parental human capital is also higher in migrant households: fathers have, on average, 5.7–6.0 years of schooling compared to 4.1–4.6 years in non-migrant households, with similar differences for mothers. These households receive substantial remittance inflows—approximately BDT 200,000 annually on average—which is reflected in higher per capita income, which is comparable with the national level survey in 2013 conducted by the Bangladesh Bureau of Statistics (BBS)¹. Despite higher income levels, migrant households tend to hold fewer land assets in later periods (0.22 acres versus 0.42 acres in 2014) and are more likely to be located in relatively better-connected villages with greater access to electricity. Taken together, these patterns point to non-random selection into migration along both economic and demographic dimensions, underscoring the importance of controlling for household heterogeneity in empirical analysis.

4. Empirical Strategy

We examine the relationship between parental migration and child outcomes, specifically school attendance and child labor, using the following specification:

$$Y_{ijt} = \beta_1 M_{jt} + \beta_2 X_{ijt} + \alpha_j + \delta_t + \varepsilon_{ijt} \dots \dots \dots (1)$$

Where, Y_{ijt} is (i) the dummy for school attendance of the i -th child in j -th household at the time t (ii) dummy for child labor of the i th child in the j th household at time t . M_{jt} is a binary indicator which takes the value of one if any one of the parents is a foreign migrant in the household j at time t and zero otherwise.² X_{ijt} is a vector of child- and household-level controls, including the child's age and its square, family composition³, parental education, land ownership, and village-level characteristics such as access to electricity. Household fixed effects α_j capture time-invariant unobserved heterogeneity, while δ_t denotes survey year fixed effects.

The empirical specification is motivated by two competing mechanisms emphasized in the literature. On the one hand, migration may improve child outcomes by increasing remittance income, thereby relaxing liquidity constraints. On the other hand, parental absence may increase children's labor supply or

¹ Bangladesh Bureau of Statistics (BBS). Report on the use of remittances (SUR), 2013. www.bbs.gov.bd

² The analysis focuses on international migration only, as domestic migrants in Bangladesh are typically less absent from the household and do not generate comparable income gains. Consistent with this distinction, Francine D. Blau Antman (2010) finds no significant effect of domestic migration on children's schooling.

³ Family income is excluded from the baseline specification. In auxiliary regressions, its coefficient is small and statistically insignificant. Moreover, income is likely endogenous to migration and child outcomes, as remittances directly affect household resources, making it a potential "bad control."

reduce schooling due to the reallocation of household responsibilities. As a result, the net relationship between migration and child outcomes is theoretically ambiguous.

A key empirical challenge arises from the endogenous nature of migration decisions. Households that send migrants may differ systematically from those that do not along both observed and unobserved dimensions. In addition, migration and child outcomes may be jointly determined. To address these concerns, we exploit the panel structure of the data and include household fixed effects, which absorb time-invariant unobserved characteristics. Identification is therefore based on within-household variation in migration status over time. While this approach mitigates bias arising from fixed unobservables, it does not fully address concerns about time-varying unobserved factors or reverse causality. Accordingly, the estimates should be interpreted as conditional associations rather than causal effects.

Given the binary nature of the main outcomes, a natural alternative is to use nonlinear models such as logit or probit. However, we estimate equation (1) using a linear probability model (LPM) for two main reasons. First, the inclusion of household fixed effects in nonlinear models leads to the incidental parameters problem, which can bias estimates in short panels such as ours with only two periods. Second, the LPM provides coefficients that are directly interpretable as changes in probabilities and allows for straightforward inclusion of multiple fixed effects and interaction terms. While the LPM may generate predicted probabilities outside the [0,1] range, this limitation is less concerning in our context, given the focus on average partial associations rather than individual predictions. Robust standard errors are used to account for heteroskedasticity.

Role of Remittances

The baseline specification focuses on parental migration M_{jt} as the primary variable of interest. Remittances are not included as a control in this specification because they are likely to be endogenous and lie on the causal pathway between migration and child outcomes. Controlling for remittances would therefore risk introducing “bad control” bias by conditioning on a post-migration outcome.

Instead, we treat remittance variables as complementary outcomes and estimate separate specifications to examine potential income channels. Specifically, we estimate models where the dependent variables are (i) education expenditure per child and (ii) child labor hours within the household, using both a remittance-receiver indicator and the logarithm of remittance income:

$$\ln Z_{jt} = \beta_1 R_{jt} + \beta_2 \ln Y_{jt} + \beta_3 X_{jt} + \beta_4 CH_{ijt} + \alpha_j + \delta_t + u_{jt} \dots \dots \dots (1)$$

where Z_{jt} represents household-level outcomes such as education expense and child labor hour per week, and R_{jt} is a binary indicator equal to one if the household receives international remittances, and zero otherwise. Y_{jt} denotes the logarithm of remittance income received in the previous year. The vector X_{jt} includes household-level characteristics, while CH_{ijt} captures child-specific characteristics. Household fixed effects α_j control for time-invariant unobserved heterogeneity, and δ_t represents survey year fixed effects.

In this framework, remittances are best interpreted as a mediating channel through which parental migration may influence household decisions, rather than as an independent treatment. Migration generates remittances, which in turn may affect resource allocation and child outcomes. Accordingly, these specifications should be interpreted as descriptive relationships that provide insight into potential income effects, rather than as structural mediation models. Since remittances are jointly determined with migration and other household decisions, the estimates do not isolate causal mediation effects but instead complement the main analysis by characterizing associated patterns.

5. Empirical Results

Table A2 reports estimates of the relationship between parental migration and school attendance for children aged 6-17. The first three columns show the result for all children. The fourth and fifth columns present the results for males and females, respectively. The first column presents the results with multiple covariates and without any fixed effects. In specifications without fixed effects, parental migration is positively but insignificantly associated with school attendance. However, once household and village fixed effects are introduced, the coefficient becomes negative, suggesting that within-household changes in migration status are associated with a decline in school attendance of approximately 5 percentage points. Disaggregating by gender reveals substantial heterogeneity. Parental migration is associated with a significant reduction in school attendance among boys (-17 percentage points), while the corresponding estimate for girls is positive but statistically insignificant. These patterns are consistent with differential intra-household responses by gender. Table A3 further examines heterogeneity by birth order. The estimates indicate that the decline in schooling is concentrated among eldest sons, for whom parental migration is associated with a reduction in school attendance of approximately 30 percentage points. In contrast, the effect for eldest daughters is small and statistically insignificant. No meaningful association is observed for younger sons. Additional specifications show no significant relationship between non-parental migration and schooling outcomes. Estimates based on remittance income suggest a negative association between schooling and the eldest sons, though these results should be interpreted cautiously.

Table A4 presents results for child labor. In baseline specifications without fixed effects, parental migration is weakly associated with lower child labor participation. This relationship reverses once household and village fixed effects are included, indicating that parental migration is associated with an increase in child labor of approximately 5 percentage points. As with schooling, the effects are concentrated among boys: parental migration is associated with a 16 percentage-point increase in labor participation among boys, while the estimate for girls is negative and statistically insignificant. Table A5 shows that this increase in labor supply is driven primarily by the eldest sons. Parental migration is associated with a 28 percentage-point increase in child labor among eldest sons, with no significant effects on other children. Non-parental migration remains unrelated to child labor outcomes. Remittance income is positively associated with labor supply for eldest sons, although the magnitude is modest.

Tables A6 and A7 examine potential income channels. The first and second column of Table A6 shows results for the remittance receiver with village and household fixed effects, respectively. Cross-sectional estimates suggest that remittance-receiving households spend more on education and allocate less time to household child labor. The result indicates that remittance receiver families spend almost (89% higher) double in education expenses per child compared to those of non-remittance receivers. However, these relationships disappear once household fixed effects are included. Similarly, continuous measures of remittance income are not robustly associated with either education expenditure or child labor hours. These findings suggest that income effects alone are unlikely to explain the observed patterns in schooling and labor outcomes.

Taken together, the results reveal substantial heterogeneity in the relationship between parental migration and child outcomes. The negative association with schooling and positive association with labor supply are concentrated among eldest sons, while effects for other children are limited. These patterns are consistent with intra-household labor reallocation in response to parental absence. Girls' school enrollment at both the primary and secondary levels is higher than that of boys in Bangladesh. Moreover, it is a customary practice in Bangladesh, especially in rural areas, that the eldest son takes the responsibility to earn money in the absence of their fathers. At the same time, the absence of robust effects of remittance income suggests that income gains do not fully offset these adjustments.

These findings should not be interpreted as evidence that migration is associated with worse outcomes for all children in migrant households. Rather, they indicate that changes in migration status are associated with uneven adjustments within the household, with certain members—particularly eldest sons—bearing

a disproportionate share of the response. The absence of robust remittance effects further suggests that income gains do not fully offset these adjustments. Consistent with the empirical strategy, all estimates are interpreted as conditional associations rather than causal effects.

6. Conclusion

This paper examines the relationship between parental migration and child outcomes in Bangladesh, focusing on school attendance and child labor. Using longitudinal household data and household fixed effects, we document substantial heterogeneity in outcomes by gender and birth order. The results indicate that parental migration is associated with a decline in school attendance and an increase in labor participation among eldest sons, while effects for other children are limited. In contrast, no robust relationship is found between remittance income and either education expenditure or child labor hours. These patterns suggest that intra-household reallocation in response to parental absence may play a more prominent role than income gains in shaping child outcomes. The findings are consistent with a growing body of evidence highlighting gender- and age-specific responses to migration, as well as with models of household decision-making that posit that resource allocation reflects both economic incentives and social norms. In particular, the concentration of effects among eldest sons points to the role of substitution in household labor supply when adult members migrate.

From a policy perspective, the results caution against viewing migration as uniformly beneficial for all household members. Targeted interventions to sustain school participation—particularly among older boys in migrant households—may help mitigate potential adverse effects. At the same time, the absence of strong income effects suggests that policies focusing solely on remittance utilization may be insufficient to address these outcomes. Finally, given the potential for remaining endogeneity, the estimates should be interpreted as conditional associations. Future research that leverages exogenous variation in migration or exploits more detailed data on intra-household decision-making would be valuable in identifying the underlying mechanisms and establishing causal effects.

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References

- Acosta, P. (2011). School attendance, child labour, and remittances from international migration in El Salvador. *Journal of Development Studies*, 47(6), 913–936.
- Acosta, P. A., Baerg, N. G., & Mandelman, F. S. (2009). Financial development, remittances, and real exchange rate appreciation. *Economic Review*, 94(1), 1–12.
- Alcaraz, C., Chiquiar, D., & Salcedo, A. (2012). Remittances, schooling, and child labor in Mexico. *Journal of Development Economics*, 97(1), 156–165.
- Ambler, K., Aycinena, D., & Yang, D. (2021). Channeling remittances to education: A field experiment among migrants from El Salvador. *Journal of Development Economics*, 152, 102686.
- Antman, F. M. (2010). Adult child migration and the health of elderly parents left behind in Mexico. *American Economic Review*, 100(2), 205–208.
- Antman, F. M. (2011). The intergenerational effects of paternal migration on schooling and work. *Journal of Development Economics*, 96(2), 200–208.
- Antman, F. M. (2012). Gender, educational attainment and the impact of parental migration. *Journal of Population Economics*, 25(4), 1187–1214.
- Bangladesh Bank. (2025). Wage earners' remittance inflow data. <https://www.bb.org.bd/en/index.php/econdata/wageremittance>.
- Becker, G. (1981). *A Treatise on the Family*. Harvard University Press.
- Dinkelman, T., & Mariotti, M. (2021). The long-run effects of labor migration on children. *American Economic Review Papers & Proceedings*, 111, 287–292.
- Kikkawa, A., & Otsuka, K. (2020). The changing landscape of international migration. *Oxford Development Studies*, 48(3), 222–239.
- Kuhn, R. (2006). The effects of fathers' and siblings' migration on children's schooling. *Asian Population Studies*, 2(1), 69–92.
- McKenzie, D., & Rapoport, H. (2011). Can migration reduce educational attainment? *Journal of Population Economics*, 24(4), 1331–1358.
- Taylor, J. E. (1992). Remittances and inequality reconsidered. *Journal of Policy Modeling*, 14(2), 187–208.

World Bank. (2024). Personal remittances, received (current US\$) – Bangladesh. <https://data.worldbank.org/indicator/BX.TRF.PWKR.CD.DT?locations=BD>

Yang, D. (2008). International migration, remittances and household investment. *Economic Journal*, 118(528), 591–630.

Zhang, H., Behrman, J. R., Fan, C. S., Wei, X., & Zhang, J. (2014). Does parental absence reduce cognitive achievements? *Journal of Development Economics*, 111, 181–195

Appendix

Table A 1. Characteristics of the Children Aged 6 to 17 Years Old and their Corresponding Households for the Year 2008 and 2014

	Migrant	2008 Non- migrant	Difference	Migrant	2014 Non- migrant	Difference
	(1)	(2)	(2-1)	(4)	(5)	(5-4)
Child characteristics (age 6-17 years)						
School attendance	0.88	0.80	0.07	0.94	0.85	0.089***
School attendance (male)	0.84	0.75	0.09	0.87	0.79	0.08
School attendance (female)	0.90	0.86	0.04	1.00	0.91	0.09***
Child labor	0.13	0.18	-0.06	0.05	0.11	-0.064***
Child labor (male)	0.15	0.23	-0.08	0.11	0.16	-0.05
Child labor (female)	0.10	0.13	-0.03	0.00	0.06	-0.06***
Child age	10.5	11.45	-0.945***	11.12	11.63	-0.50
Child sex (male)	0.52	0.53	-0.01	0.47	0.54	-0.06
Education expense per child per year ^c	3.21	2.08	1.13***	7.87	4.61	3.26***
Observation	88	2244		99	1716	
Household Characteristics						
Age of the HH head	32.63	48.55	-15.92***	35.46	49.06	
Household size	3.78	5.05	-1.27***	3.57	4.51	
Dummy for female head	0.95	0.11	0.838***	0.93	0.13	
Father education	6.02	4.08	1.93**	5.7	4.6	
Mother education	5.09	2.98	2.10***	5.48	3.83	
Number of children	1.49	1.15	0.338***	1.62	0.99	
Foreign remittance	112.83	13.03	99.79***	201.77	27.47	
Income per capita	42.94	19.28	23.65***	74.9	43.82	
Cultivable land	0.33	0.46	-0.13	0.22	0.42	
Village characteristics						
Distance from Upazila HQ	5.81	7.2	-1.39*	5.12	5.42	
Access to electricity	78.56	68.4	10.15***	0.95	0.89	
Observation	59	1951		61	1762	

Notes: The table presents characteristics of children aged 6-17 in 2008 and 2014. Migrant households include those with at least one parent who has migrated abroad. Non-migrants include non-parental migrants and non-migrant households. The 3rd and 6th columns show the difference between migrant and non-migrant characteristics. ***p<0.001, **p<0.01, *p < 0.05.^c Prices are adjusted to the 2010 level by using CPI from World Development Indicators (WDI)

Table A 2. Impact of the Parental Migration on School Attendance

	All Children			Male	Female
	School attendance	School attendance	School attendance	School attendance	School attendance
	(1)	(2)	(3)	(4)	(5)
Parental migration	0.0395 (0.0206)	-0.0616 (0.0443)	-0.0622 (0.0446)	-0.174* (0.0717)	0.0489 (0.0461)
Age of the child	0.127*** (0.0130)	0.119*** (0.0134)	0.119*** (0.0135)	0.103*** (0.0237)	0.109*** (0.0218)
Age of child square	-0.0070*** (0.0006)	-0.0069*** (0.0006)	-0.0069*** (0.0006)	-0.0067*** (0.0010)	-0.0059*** (0.0010)
Father education	0.0046** (0.0016)	0.0108 (0.0073)	0.0105 (0.0075)	0.0238 (0.0163)	0.00151 (0.0035)
Mother education	0.0096*** (0.0019)	-0.0003 (0.0067)	-0.0001 (0.0068)	-0.0089 (0.0162)	-0.0026 (0.0048)
No of children	-0.0124* (0.0053)	0.00293 (0.0107)	0.00266 (0.0109)	0.0194 (0.0172)	-0.0288* (0.0140)
Cultivable land	0.0233** (0.0084)	-0.0384 (0.0392)	-0.0405 (0.0411)	-0.0151 (0.0695)	-0.0369 (0.0534)
Access to electricity	-0.0452** (0.0169)	0.0728 (0.0454)	0.065 (0.0478)	0.114 (0.0798)	0.083 (0.0495)
HH & year fixed effect	NO	YES	--	--	--
HH, village & year FE	NO	--	YES	YES	YES
Number of observations	4022	3666	3666	1658	1376

Notes: Parental migration equals 1 if either parent is a foreign migrant. The first three columns show the results for all children, where the first column shows the results without any fixed effects. The second and third columns present the results after adding household and year fixed effects and household, village, and year fixed effects, respectively. The fourth column presents the results for the son, while the fifth column presents the results for the daughters. Robust standard errors clustered at the household level are in parentheses. ***p<0.001, **p<0.01, *p<0.05.

Table A 3. Impact of the Parental Migration on School Attendance of the Eldest Son

	For the eldest son				For the eldest daughter	For son except eldest
	School attendance	School attendance	School attendance	School attendance	School attendance	School attendance
	(1)	(2)	(3)	(4)	(5)	(6)
Parental migration	-0.303*				-0.0319	-0.0537
	(0.125)				(0.0685)	(0.0709)
Remittance receiver		-0.324**				
		(0.099)				
Non-Parental migration			-0.220			
			(0.135)			
Log of remittance income ^a				-0.0281**		
				(0.008)		
Other control	YES	YES		YES	YES	YES
Village, Household & year FE	YES	YES		YES	YES	YES
Number of observations	596	596	596	596	414	498

Notes: Parental migration equals 1 if either parent is a foreign migrant. The remittance receiver takes the value one if the household receives foreign remittances. Non-parental migration takes the value of 1 if any member other than parents is an international migrant. Age of child, age of child square, parents’ education, number of children, cultivable land, and access to electricity are used as control variables. Robust standard errors clustered at the household level are in parentheses. ***p<0.001, **p<0.01, *p<0.05.

^a We add one with all remittance income to include zero remittance income.

Table A 4: Impact of the Parental Migration on Child Labor

		For all children		For son	For daughter
	Dummy for child labor	Dummy for child labor	Dummy for child labor	Dummy for child labor	Dummy for child labor
	(1)	(2)	(3)	(4)	(5)
Parental migration	-0.0258	0.0603	0.0609	0.160*	-0.0551
	(0.0199)	(0.0427)	(0.0430)	(0.0701)	(0.0437)
Age of child	-0.115***	-0.110***	-0.110***	-0.104***	-0.0788***
	(0.0117)	(0.0125)	(0.0126)	(0.0219)	(0.0184)
Age of child square	0.0066***	0.0066***	0.0066***	0.0069***	0.0046***
	(0.0005)	(0.0006)	(0.0006)	(0.0010)	(0.0009)
Father education	-0.0036*	-0.0102	-0.0099	-0.0241	0.00114
	(0.0015)	(0.0073)	(0.0074)	(0.0163)	(0.0030)
Mother education	-0.0090***	0.0011	0.0008	0.0105	0.00331
	(0.0018)	(0.0064)	(0.0066)	(0.0161)	(0.0045)
No. of children	0.0117*	-0.0013	-0.0009	-0.0204	0.0253
	(0.0050)	(0.0104)	(0.0105)	(0.0162)	(0.0130)
Cultivable land	-0.0187*	0.0333	0.0363	0.023	0.0087
	(0.0079)	(0.0405)	(0.0425)	(0.0728)	(0.0563)
Access to electricity	0.0342*	-0.0521	-0.0441	-0.105	-0.066
	(0.0157)	(0.0465)	(0.0488)	(0.0833)	(0.0434)
HH & year fixed effect	NO	YES	--	--	--
HH, village & year fixed effect	NO	--	YES	YES	YES
N	4022	3666	3666	1658	1376

Notes: Parental migration takes value one if one of the parents is foreign migrant. First three column shows result for all children, where first column shows result without any fixed effect. Second and third column present result after adding household & year fixed effect and household, village & year fixed effect respectively. Fourth column presents result for son while fifth column shows result for daughters. Robust standard errors clustered at household level are in parentheses. ***p<0.001, **p<0.01, *p<0.05.

Table A 5. Impact of the Parental Migration on Child Labor of the Eldest Son

	For the eldest son				For the eldest daughter	For son except eldest
	School attendance	School attendance	School attendance	School attendance	School attendance	School attendance
	(1)	(2)	(3)	(4)	(5)	(6)
Parental migration	0.288*				0.0263	0.0251
	(0.111)				(0.0616)	(0.0677)
Remittance receiver		0.326**				
		(0.117)				
Non-Parental migration			0.224			
			(0.16)			
Log of remittance income ^a				0.0285**		
				(0.010)		
Other control	YES	YES		YES	YES	YES
Village, Household & year FE	YES	YES		YES	YES	YES
Number of observations	596	596	596	596	414	498

Notes: Parental migration equals 1 if either parent is a foreign migrant. The remittance receiver takes the value of one if the household receives foreign remittances. Non-parental migration takes the value of 1 if any member other than parents is an international migrant. Age of child, age of child square, parents’ education, number of children, cultivable land, and access to electricity are used as control variables. Robust standard errors clustered at the household level are in parentheses. ***p<0.001, **p<0.01, *p<0.05.

^a We add one with all remittance income to include zero remittance income.

Table A 6. Impact of the Remittance Income on Education Expense per Child Per Year

	Education Expense per child			
	(1)	(2)	(3)	(4)
Remittance receiver	0.894*** (0.160)	-0.159 (0.403)		
Log of remittance income ^a			0.0771*** (0.013)	-0.0114 (0.034)
Age of HH head	0.0084 (0.008)	-0.0011 (0.024)	0.0083 (0.008)	-0.0012 (0.024)
Dummy for female HH head	0.094 (0.231)	0.224 (0.599)	0.0871 (0.230)	0.21 (0.590)
Father education	0.0813*** (0.017)	-0.0559 (0.051)	0.0814*** (0.017)	-0.0559 (0.051)
Mother education	0.0978*** (0.021)	0.0303 (0.042)	0.0975*** (0.021)	0.0303 (0.042)
Number of children	0.0562 (0.067)	-0.0387 (0.098)	0.0574 (0.067)	-0.0385 (0.098)
Household size	0.121** (0.039)	0.153 (0.084)	0.120** (0.039)	0.154 (0.084)
Access to electricity	0.143 (0.249)	0.663* (0.321)	0.139 (0.249)	0.662* (0.321)
Village & year fixed effect	YES		YES	
HH & year fixed effect		YES		YES
N	2092	1403	2092	1403

Notes: The remittance receiver takes the value of 1 if the household receives remittances. The outcome is the log of education expenses per child per year. The first and second columns show the results for the remittance receiver with village and household fixed effects, respectively. The third and fourth columns present results for the log of remittance income with village and household fixed effects, respectively. Robust standard errors clustered at the household level are in parentheses. ***p<0.001, **p<0.01, *p<0.05.

^a We add one with all remittance income and education expense to include zero remittance income and zero education expense, respectively.

Table A 7. Impact of Remittance Income on Child Labor Hours inside the Household

	Log of child labor hour per week (1)	Log of child labor hour per week (2)	Log of child labor hour per week (3)	Log of child labor hour per week (4)
Remittance receiver	-0.0530* (0.0217)	-0.0573 (0.0574)		
Log of remittance income			-0.0046* (0.0018)	-0.0045 (0.0048)
Age of HH head	-0.0009 (0.0007)	0.0049 (0.0029)	-0.0009 (0.0007)	0.0049 (0.0029)
Father education	-0.00599* (0.0027)	-0.0009 (0.0091)	-0.00599* (0.0027)	-0.0009 (0.0091)
Mother education	0.0014 (0.0029)	-0.0044 (0.0090)	0.0014 (0.0029)	-0.0044 (0.0090)
Dummy for female head	0.0875* (0.0365)	0.1340 (0.0967)	0.0878* (0.0364)	0.1310 (0.0965)
Number of children	0.0065 (0.0077)	0.0025 (0.0158)	0.0064 (0.0077)	0.0024 (0.0158)
Household size	0.0019 (0.0042)	-0.0048 (0.0139)	0.0020 (0.0043)	-0.0048 (0.0139)
Village & year fixed effect	YES		YES	
Number of observations	2039	1323	2039	1323

Notes: The remittance receiver takes the value of 1 if the household receives remittances. The first and third columns show the results of the incidence receiver with village and household fixed effects, respectively. Robust standard errors clustered at the household level are in parentheses. ***p<0.001, **p<0.01, *p<0.05.

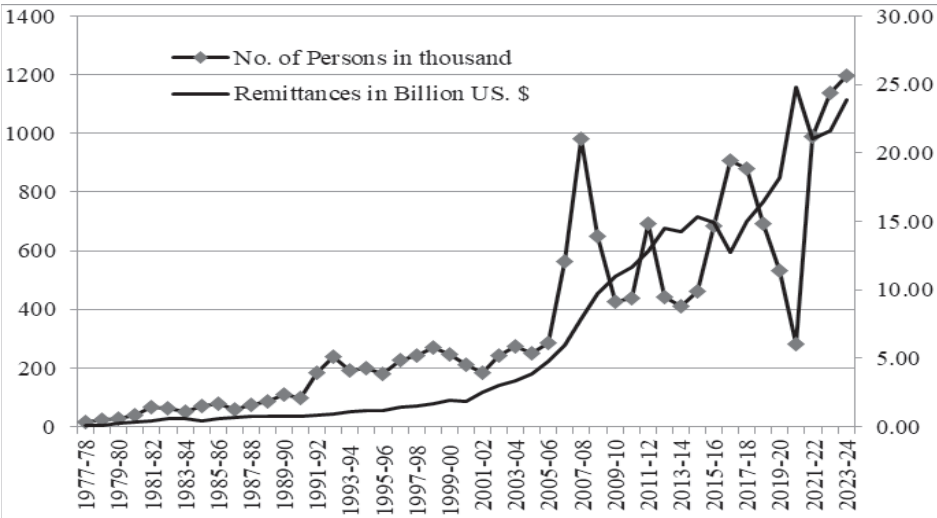


Figure A 1. Trend of Remittances and Number of Foreign Migration in Bangladesh during the Period 1977-2024

Source: Statistics Department, Bangladesh Bank, BMET, Bangladesh, 2025

Does Military Spending Impede Economic Growth? ARDL and Causality Analysis for Bangladesh

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Nourush Jahan**

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Abstract

This study investigates the causal relationship between military expenditure and economic growth in Bangladesh using data from 1980 to 2022. Aligning with methodologies employed in similar studies conducted in other countries, the study utilizes Granger causality tests and ARDL bound testing for cointegration analysis. The study findings reveal an inverse correlation between defense spending and economic growth, as well as at least one long-run equilibrium relationship among the variables. Specifically, the study finds a unidirectional causal link from military expenditure to economic growth. The results hold significant implications for policymakers, suggesting that reducing defense spending could potentially stimulate economic expansion.

Keywords: *ARDL boundy · test · Bangladesh · Economic Growth · Granger Causality · Military Expenditures*

1. Introduction

The relationship between military spending and economic development, particularly in less developed countries, has garnered significant attention since Benoit's (1978) seminal findings. Benoit's research, suggesting a positive influence of higher military expenditures on economic growth, sparked considerable debate in the field. Subsequent studies have examined various mechanisms through which defense spending affects economic growth, including demand, supply, and security effects (Dunne et al., 2005). Despite extensive research to date, the literature offers mixed results on the true impact of military expenditure on economic growth.

This study focuses on Bangladesh as a case study to reexamine the interrelationship

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between military spending and economic growth. Initially established to defend against external aggression following the brutal experience of the 1971 liberation war, the Bangladesh military faces relatively minimal threats presently and in the foreseeable future. With well-defined borders with India and Myanmar, the majority of which are peaceful, military conflict is unlikely. Additionally, there are no significant disagreements between Bangladesh and India that might escalate into military conflicts with other nations. Instead, Bangladesh has focused on developing military capabilities to foster peace, such as participating in UN peacekeeping missions, rather than engaging in external military adventurism or conflicts (Choudhury, 2014). Despite this stable security environment, Bangladesh has witnessed a rise in military expenditures in recent years. Military expenditure in Bangladesh has been on an upward trajectory since 2008, reaching a high of USD 4.97 billion in FY 2021-22. According to the Stockholm International Peace Research Institute (SIPRI), Bangladesh experienced the second-largest relative growth in military spending between 2008 and 2017. In 2017, Bangladesh ranked third among South Asian countries in defense expenditure as a percentage of government spending, according to SIPRI data (Figure 1). Notably, the Bangladeshi military shares similar commercial objectives with Pakistan, with involvement in various industries including food, apparel, electronics, real estate, shipbuilding, maritime construction, and travel, as reported by the BBC. Furthermore, there have been reports that top military officers have received illegal loans from Trust Bank and Ansar VDP Bank, both affiliated with the military. The Bangladesh Army's economic ventures extend to power plants, highways, infrastructure, and bridge projects, amassing billions of dollars in private assets, according to BBC research (Smith, 2018).

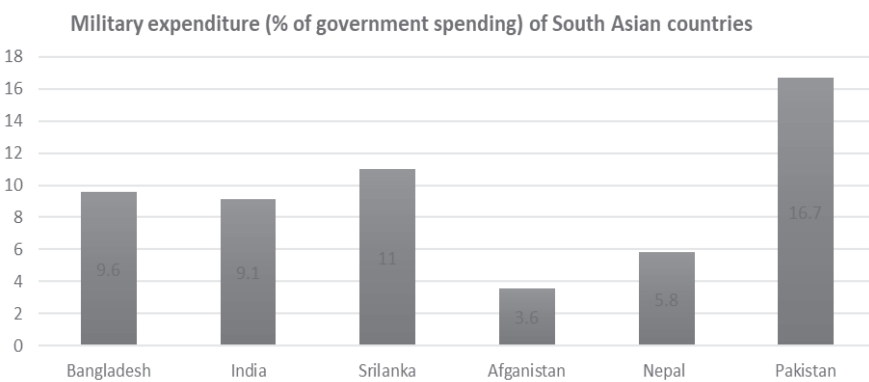


Figure 1. Military Expenditure (% of government spending) of South Asian Countries

Muravska (2012) argues that incorporating profit motives into non-profit organizations, such as the Bangladesh Armed Forces, detracts from their official duties, undermining institutional cohesion and professional integrity. This

focus on business ventures diminishes the military's proficiency and exposes the country to domestic and international threats, as funding for these ventures is sourced from the army welfare trust, which is intended to support retired army personnel. Similarly, the military procurement system in Bangladesh, like in many developing countries, is shrouded in secrecy. As part of its Forces Goal 2030, a military modernization strategy initiated by the Government of Bangladesh, the country seeks international partners for affordable defense systems to fund Special Operations Forces and emergency assistance. However, Delavallade (2006) highlights the military procurement system's susceptibility to corruption. Moreover, according to SIPRI's (2018) report, the international arms trade and arms procurement conventions in Asia, Africa, and the Middle East are vulnerable to significant risks of waste and corruption. Additionally, what were once considered non-traditional security (NTS) challenges, such as international criminal activity, terrorism, humanitarian crises, climate change, and public health emergencies, are now viewed as essential national security concerns (Walsh, 2011). Given these concerns, it is evident that the government's heavy military expenditure can be questioned on various grounds. The secrecy of the procurement system and the dominance of business interests raise the specter of corruption for personal gain, potentially jeopardizing national sovereignty and security. However, despite the negative implications associated with high military spending, the critical importance of national security and emerging non-traditional threats cannot be ignored. In light of these considerations, this study aims to address the following research questions:

1. What impact does military spending have on economic growth?
2. What is the direction of causality between the variables of interest?

The subsequent sections of the paper are structured as follows: Section 2 reviews existing literature on the relationship between the variables of interest and identifies research gaps; Section 3 discusses the data sources and methodological considerations employed to establish causal connections between the variables; Section 4 presents the empirical findings of the study; and Section 5 offers policy recommendations based on the research findings.

2. Literature Review

Benoit's (1978) seminal work initiated the exploration of the relationship between defense spending and economic growth. Subsequent academic endeavors have examined the presence and direction of causation between these two variables, either focusing on specific countries or analyzing a broad array of nations. Current literature examines the Keynesian and Neoclassical approaches as the primary frameworks through which defense spending may influence economic growth rates. The Keynesian perspective emphasizes aggregate demand, positing that

an increase in defense spending raises aggregate demand, thereby stimulating output and employment growth. Thus, defense spending is seen as conducive to economic expansion. In contrast, the Neoclassical viewpoint prioritizes aggregate supply. It argues that military investment diverts productive resources, particularly human capital, away from potential civilian sector investments. Moreover, there may be a “distortion effect,” in which military expenditure disrupts other expenditures and compromises resource allocation efficiency, potentially through price inflation and the encouragement of rent-seeking behavior. Consequently, the Neoclassical framework anticipates a negative impact of defense spending on economic growth. However, the literature presents a spectrum of findings regarding the relationship between economic growth and defense spending, influenced by factors such as methodology, sample size, and the selection of nations. Below, we present a summary of some of these analyses.

2.1 Positive Relationships

Defense spending has been identified as a potential contributor to human capital development, particularly in the health and education sectors (Ram, 1995). This is especially true in emerging nations, where defense personnel and conscripts often undergo rigorous physical training and acquire a range of skills (Benoit, 1978). Moreover, greater defense expenditures are believed to stabilize a nation’s political unrest, strengthening its defenses against both internal and external threats, which in turn can foster enhanced investment and market functioning (Dunne et al., 2005). Consequently, military spending may increase output, provided it enhances national security. Technological advancement plays a significant role in shaping the relationship between defense spending and economic growth. Mueller and Atesoglu (1993) incorporate this aspect, dividing the impact of defense spending into two parts: the relative size of the defense sector and the change in the pace of defense spending. Their estimates suggest that changes in defense spending positively and significantly affect the economy’s growth rate, with each component of defense spending exerting noteworthy effects individually.

In examining the relationship between defense spending and economic growth, Dunne et al. (2001) utilize standard Granger causality tests and VAR Granger causality methods to account for cointegration. While conventional Granger causality tests suggest a positive impact of increased military spending on Greece’s economic growth, this conclusion is challenged when VAR modeling is used to account for cointegration among the variables. Atesoglu (2002) employs cointegration analysis in the US context, finding that an increase in defense spending is associated with higher US GDP. Cuaresma and Reitschuler (2004) allow for a non-linear relationship between defense spending and growth in the United States, using an expanded version of the Barro and Sala-i-Martin

(1995) framework. Aizenman and Glick (2006) uncover intriguing findings by elucidating the nonlinear connections among defense investment, foreign threats, corruption, and growth, indicating that defense spending accelerates growth in the face of external threats.

Jalil et al. (2016) use an ARDL approach to examine the long-term link between military spending and economic growth in Pakistan and India. They initially find a positive relationship, but as both economies reach critical points, the net effect becomes negative. Yolcu et al. (2017) employ the PSTR model to investigate this relationship for Turkey and Middle Eastern countries, revealing an asymmetric relationship between military expenditure and economic growth. Ahmed and Naslmosavi (2017) find a favorable association between military spending and economic growth across five SAARC countries, while Ajmair et al. (2018) examine Pakistan and find significant positive short-run effects of military expenditure on economic growth. Desli et al. (2017) investigate the dynamic relationship between military spending and economic growth across 138 nations from 1988 to 2013. Their findings suggest little evidence of short- or long-term causality from military spending to overall economic growth, except in developing nations, where a long-term positive correlation is observed.

2.2 Negative Relationships

Manamperi (2016) has uncovered significant adverse effects for Turkey in both the short- and long-term. Zhao et al. (2017) used Granger causality tests and generalized impulse response functions based on vector error correction models (VECMs) to identify similar negative effects of defense spending on economic growth for the period 1952 to 2012 in China. Shahbaz et al. (2013) aimed to explore the relationship between military spending and economic growth in Pakistan from 1972 to 2008. Their study confirmed the cointegration of interest rates, military spending, government spending, and economic growth, revealing a negative impact of military spending on Pakistan's economic growth. Government non-military spending positively influenced economic growth, while real interest rates showed an inverse relationship with economic growth. Klein (2004) focused on Peru during 1970–1996 and demonstrated a significant crowding-out effect of defense spending using a Deger-type simultaneous equations model (Deger, 1985). Dunne and Nikolaidou (2001) examined Greece's case from 1960 to 1996, utilizing a set of four equations estimated through two-stage least squares (2SLS) and ordinary least squares (OLS). They found a substantial negative impact of defense spending on economic growth, both directly and indirectly through savings and trade balance. The use of time series data with varying horizons, sample sizes, socioeconomic conditions, and geographical locations across countries, along with diverse theoretical frameworks guiding distinct econometric specifications, makes meaningful

comparisons unattainable (Desli et al., 2017). Consequently, researchers have turned to panel studies to ensure more representative decision-making. For instance, Ismail (2017) investigated the connection between economic expansion in South Asia and military spending using a panel fixed-effect model. While empirical findings suggested a positive association between the variables of interest, the impact was less significant than when scarce resources were allocated to non-military purposes. The study concluded that increasing military spending to stimulate economic growth is ineffective and inefficient. Dunne and Tian (2015) used a balanced panel of 106 nations covering 1988–2010, accounting for nonlinearity and group heterogeneity. Their results indicated a short- and long-term negative impact of military spending on growth, supported by subgroup analysis. However, the body of research on the subject remains insufficient to draw firm conclusions regarding the actual relationship between military spending and economic expansion. Reviewing 170 studies, Dunne and Tian (2013) found that a growing body of recent research suggests that military spending has a detrimental impact on economic growth.

2.3 Insignificant Relationships

Biswas and Ram (1986) observed that in 80% of the nations studied, there was no statistically significant correlation between defense spending and economic growth, whereas Chowdhury (1991) found no correlation in 55% of the countries. Mintz and Stevenson (1995) utilized a multisector model based on neoclassical growth theory to investigate the external effects of defense spending across 103 nations. Their analysis revealed that while nonmilitary spending positively affects growth in many nations, military spending generally has a minimal effect on overall growth, with only about 10% of cases showing a significant boost. Huang and Mintz (1991) examined U.S. economic data from 1952 to 1988 to reassess the coefficients for the externality component of military spending. They compared their findings with those of Mueller and Atesoglu (1993) and Alexander (1990) and found no discernible externality effect of military spending on economic growth, according to their calculations. Additionally, Mintz and Huang (1990) investigated the direct and indirect effects of reduced U.S. military spending on economic growth using a two-equation model. Their study suggested that defense expenditure has a delayed, indirect impact on growth, with effects becoming apparent approximately 5 years after the spending reduction. Gerace (2002) conducted a spectral study of the growth rates of U.S. government spending, both military and nonmilitary, and GDP from 1951 to 1997. His findings indicated that military spending does not fluctuate counter-cyclically with real GDP growth rates, unlike non-military spending. Similar conclusions were drawn by Kinsella (1990) and Payne and Ross (1992) in their studies of the U.S. context. Heo (2010) analyzed the relationship between

defense spending and growth in the U.S. from 1954 to 2005 using the Feder-Ram and augmented Solow models, finding no discernible impact of defense spending on the economy. Habibullah et al. (2008) investigated the connection between military spending and economic growth in various Asian countries from 1989 to 2004. Their empirical findings, using the panel error-correction technique, suggested by Pesaran et al. (1999), indicated no correlation between defense spending and economic growth in the Asian countries studied. Abu-Qarn (2010) examined the causal connection between military spending and economic growth for the four adversaries of the Israeli-Arab conflict from 1960 to 2004 using causality tests. The analysis concluded that there is little to no causal association between economic growth and defense spending.

2.4 Research Gap

Upon examination of the existing literature, it is evident that several panel and cross-sectional studies have included Bangladesh among their sample countries. However, there is a notable absence of time-series studies specifically examining military expenditure in Bangladesh. The present study aims to address this gap by investigating the relationship between military expenditure and economic growth in Bangladesh, thus contributing to the existing body of research.

3. Data and Methods

3.1 Data Sources

The data used in this research were sourced from two main repositories: the Stockholm International Peace Research Institute (SIPRI) and the World Development Indicators (WDI). SIPRI is highly esteemed in defense literature for its transparent, easily accessible data available on its website, which ensures clarity and reliability. Significantly, SIPRI maintains consistency in defining military expenditure across different time periods and countries (Malizard, 2016). Conversely, data on variables such as GDP, real interest rates, and gross fixed capital formation (used as a proxy for investment) were obtained from the World Development Indicators (WDI).

Table 1. List of Variables and their Sources

Variables	Sources
GDP (constant 2015 US\$) [lngdp]	World Development Indicator
Military expenditure (constant 2021 US\$) [lnmex]	Stockholm International Peace Research Institute (SIPRI)
Real interest rate [lnrin]	World Development Indicator
Gross Fixed Capital Formation (% of GDP) [lninv]	World Development Indicator

3.2 The Model

This study employs a model akin to that of Feder (1983) to evaluate the relationship between military spending and economic growth. Feder's concept has been utilized by Biswas and Ram (1986), Ram (1986, 1995), and numerous subsequent studies. Linear variable specification often yields inefficient outcomes in developing economies (Karagol, 2006). Hence, a log-linear specification, which provides direct elasticities, is preferred for more reliable results (Sezgin, 2004). The empirical equation used is as follows:

$$\ln gdp_t = \alpha_1 + \alpha_2 \ln mex_t + \alpha_3 \ln inv_t + \alpha_4 \ln r_t + \mu_t \quad (1)$$

In the equation, $\ln gdp_t$ represents real GDP (a proxy for economic growth), $\ln mex_t$ denotes military expenditure, $\ln inv_t$ signifies investment, and $\ln r_t$ represents the real interest rate. The residual term, μ_t is assumed to follow a normal distribution.

Economic analysis frequently indicates the existence of a stable, long-term relationship among specific variables, suggesting that their means and deviations remain constant over time. This stable relationship is captured using a fundamental econometric technique called cointegration. Various methods exist for conducting cointegration testing, including the residual-based Engle and Granger (1987) test, the Gregory and Hansen (1996) test, the Johansen (1988) test, and the Johansen and Juselius (1990) test. In recent years, the autoregressive distributed lag (ARDL) approach pioneered by Pesaran and Shin (1998) and Pesaran et al. (2001) has gained attention. The ARDL model offers distinct advantages, particularly its application independence compared to other cointegration methods, which require similar degrees of integration for all variables. Unlike these methods, the ARDL technique does not necessitate the use of Augmented Dickey-Fuller unit root tests or autocorrelation function tests when assessing the order of integration. It also addresses the issue of limited sample size. Furthermore, ARDL models incorporate an error correction term in their lagged periods, fully capturing both the long- and short-run relationships among the variables under study. Since the error-correction term in the model is not subject to restricted error-correction, ARDL is considered an unconstrained error-correction model (UECM), thereby eliminating endogeneity issues commonly associated with other methods (Jalil et al., 2016). In this study, we applied the ARDL bound-testing method of estimation proposed by Pesaran et al. (2001), including the error-correction (EC) version of the ARDL model, to analyze the effects of military spending on GDP. We estimated the following unrestricted error correction model (UECM) within the ARDL framework:

$$\begin{aligned} \Delta \ln gdp_t = & \alpha_0 + \sum_{i=1}^p \alpha_i \Delta \ln gdp_{t-i} + \sum_{j=0}^q \alpha_j \Delta \ln mex_{t-j} \\ & + \sum_{l=0}^m \alpha_k \Delta \ln inv_{t-l} + \sum_{n=0}^n \alpha_i \Delta \ln rin_{t-n} + \alpha_G \ln gdp_{t-1} + \alpha_M \ln mex_{t-1} + \alpha_K \ln inv_{t-1} \\ & + \alpha_R \ln rin_{t-1} + \mu_i \end{aligned} \quad (2)$$

where, $\ln gdp$, $\ln mex$, $\ln inv$ and $\ln rin$ are gross domestic product, military expenditures, investment, and real interest rate in log form, respectively, Δ is the operator of first-difference, and p, q, m, n are lag length. The null for no co-integration among variables: $H_0: \alpha_G = \alpha_M = \alpha_K = \alpha_R = 0$ against the alternative $H_1: \alpha_G \neq \alpha_M \neq \alpha_K \neq \alpha_R \neq 0$ is tested by comparing the calculated F-statistic with LCB (lower critical bound) and UCB (upper critical bound) tabulated by Narayan (2005). According to Narayan (2005), CVs from Pesaran et al. (2001) created for bigger sample sizes shouldn't be applied to smaller ones. CVs of the F test are reported by Narayan (2005) for sample sizes ranging from 30 to 80 observations. The 99%, 95%, and 90% critical values from Narayan (2005) are presented in Tables 5 and 6 for this sample of 43 observations. If the observed F-statistic value exceeds the upper critical value, then we perceive the presence of cointegration by rejecting the null hypothesis of no cointegration. If it is below the lower critical value, we conclude that there is no cointegration. Lastly, if it falls between the upper and lower critical bounds, we conclude the test as inconclusive. Optimal lag length selected using SBC criteria. The aim is to estimate the short-run dynamics and derive the error-correction coefficient from the validated long-run model. The specification of the error correction model is

$$\begin{aligned} \Delta \ln gdp_t = & \alpha_0 + \sum_{i=1}^p \alpha_i \Delta \ln gdp_{t-i} + \sum_{j=0}^q \alpha_j \Delta \ln mex_{t-j} + \sum_{l=0}^m \alpha_k \Delta \ln inv_{t-l} + \sum_{n=0}^n \alpha_i \Delta \ln rin_{t-n} + \varphi ECM_{t-1} \\ & + \vartheta_t \end{aligned} \quad (3)$$

Where ECT_{t-1} represents the error correction term resulting from the established long-run equilibrium relationship, while φ denotes the parameter indicating the speed at which the system adjusts to the equilibrium level following a shock. The coefficient of ECT_{t-1} must exhibit a negative and statistically significant value to ensure that the dynamics of the system converge towards the long-run equilibrium. Both stability and diagnostic tests are performed to ensure the model fits the data well. The diagnostic test looks at the selected model's serial correlation, functional form, normality, and heteroscedasticity. According to Pesaran and Smith (1998), stability tests should be used. Cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) are other names for this method. Plotting of the CUSUM and CUSUMSQ data against the break points is done iteratively. It is not possible to reject the null hypothesis that the presented regression has stable coefficients if the plots of the CUSUM and CUSUMSQ

statistics remain within the critical bounds of the 5% level of significance. Next, this study deployed the Pair-wise Granger causality test to determine the direction of causality.

3.3 Causality Analysis

Cointegration analysis implies that there is at least one-way causality. However, it is meaningless to detect the direction of causality between the parameters. Thus, the Granger test for causality has been undertaken in this investigation. The variables must be integrated in the same sequence in order to estimate Granger causality using the VEC model. Regrettably, two of the four variables in this study are $I(1)$ while the other two are stationary at the level, i.e. $I(0)$. As a result, Granger causality based on the VEC environment cannot be used in this study due to the current circumstances. In this scenario, following Jalil et al. (2016), this study has employed pairwise Granger causality to test the direction of causation between the dependent and independent variables. Pairwise Granger causality, in a bivariate environment, estimates the following two equations:

$$Y_t = \sum_{j=1}^m \alpha_j Y_{t-j} + \sum_{i=1}^n \beta_i X_{t-i} + D_t + \varepsilon_t \quad (4)$$

$$X_t = \sum_{j=1}^m \alpha_j X_{t-j} + \sum_{i=1}^n \beta_i Y_{t-i} + D_t + \mu_t \quad (5)$$

for all possible pairs of (x, y) series in the group. The reported F -statistics are the Wald statistics for the joint hypothesis: $\beta_1 = \beta_2 = \dots \beta_n = 0$ for each equation.

4. Findings and Discussion

4.1 Unit Root Test

This study has conducted both the Augmented Dickey-Fuller and Phillips-Perron unit root tests to assess robustness. Figure 2-5 below shows the graphical representation of the variables under study. From the figure, it is evident that all variables show a positive trend. Owing to this scenario, the null hypothesis of each test is represented as ‘the series has both a constant and a linear trend’. The results of these two tests are shown in the following tables.

Table 2. Unit Root Test

Variables	ADF test		Phillips-Perron Test			
	Level		Level		First difference	
	Trend & intercept	Decision	Trend & intercept	Decision	Trend & intercept	Decision
Lngdp	-4.428***	I (0)	-9.024***	I (0)		
Lnmx	-3.250*	I (0)	-2.373	I (1)	-4.563***	I (0)
Lninv	-4.124**	I (0)	-2.106	I (1)	-5.993***	I (0)
Lnrin	-4.991***	I (0)	-4.892***	I (0)		

N.B: *, **, and *** resemble the 10%, 5%, and 1% level of significance, respectively.

Table 2 shows that all variables are non-stationary at the level when using the ADF test. However, the Phillips-Perron test for a unit root yields somewhat different results. The military expenditure and investment variables are not stationary at the level but become stationary after first differencing. Therefore, we need to perform the ARDL bound testing approach.

4.2 Cointegration Test

The first task is to identify the optimal lag length. Pesaran et al (1999) warn that selecting the lower limit of the lag length to prevent the conditional ECM from being over-parameterized and the upper limit of the lag length to lessen the serial correlation issue must be done in moderation. Because SBC is parsimonious, choosing lag structure through it is traditionally recommended. Because it requires the fewest parameters among all other lag selection criteria, empirical researchers refer to it as a strict algorithm (Jalil et al., 2016). Taking the above suggestions into account, this study used an unrestricted vector autoregressive model to determine the optimal number of lags.

Table 3. Selection of Optimal Lag Length

Lag	LogL	LR	FPE	AIC	SBC	HQ
0	-95.40843	NA	0.001693	4.970422	5.13931	5.031486
1	36.40497	230.6735*	5.20E-06	-0.820248	0.024191*	-0.514926*
2	53.02147	25.75557	5.18e-06*	0.851073*	0.668918	-0.301493
3	63.35332	13.94799	7.35E-06	-0.567666	1.627877	0.226173

Table 3 shows that the upper limit of lags is 2 according to AIC and 1 according to SBC. Therefore, in the next stage, the ARDL bound test will be performed with lag 1, as confirmed by the SBC (due to its parsimonious nature).

Table 4. Bound Testing To Cointegration [based on SBC]

Estimated model	$lnrgdp_t = f(lninv_t, lnmilex_t, realin_t)$	
Optimal lag structure (based on SBC)	(1, 0, 1, 0)	
F-statistics	6.499***	
Significance level	Lower bound	Upper bound
1%	4.428	6.250
5%	3.202	4.544
10%	2.660	3.838
R^2	0.99994	
Adjusted R^2	0.99993	
Decision	Cointegration	

Critical bounds for the F-statistics apply to 35 observations with an unrestricted intercept and no trend (Narayan, 2005). Critical values (T = 40)

To ascertain the presence of a long-run relationship, we examine the estimated F-statistics of equation 2, as presented in Table 4. The results indicate that the model contains at least one cointegrating vector when lngdp is used as the dependent variable. However, it's essential to consider potential endogeneity issues in the association between military spending and economic growth. To address this concern, we employ a method proposed by Ang (2010) within the ARDL framework. This method involves testing for cointegration by regressing the major independent variable on the other variable, as suggested by Ang (2011). Specifically, we conduct a cointegration test using military spending as the dependent variable. The results of this test reveal that, at the 5% and 10% levels of significance, lnmx exhibits an F-statistic below the lower bound of critical values. This suggests there may be no evidence of endogeneity in the relationship between military spending and economic growth.

Long-run Results

Based on the findings presented in Table 4, we proceed with the ARDL model with lngdp as the dependent variable. Before estimating the long-run model and determining the coefficients of the regressors and the error-correction term, it is crucial to select the optimal lags for the ARDL model. In ARDL cointegration analysis, researchers often select models based on both the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) criteria (Ahmed et al., 2013). In this study, we employ the lags chosen by the BIC criterion. The subsequent tables present the results of this analysis.

Table 5: Estimated Long Run Coefficients using the ARDL Approach based on SBIC

Dependent variable: lngdp			
Regressor	Coefficient	Standard Error	T-ratio [Prob]
Lnmx	-0.00692***	0.0024415	-2.8378 [0.007]
Lninv	0.33640***	0.0061770	54.4596 [0.000]
Lnrin	0.00032***	0.0001087	2.9851 [0.000]
F-stat = 4.68			

N.B: *, **, and *** indicates 10%, 5%, and 1% level of significance, respectively.

Table 5 illustrates the significant relationships between *lnmlex*, *lninv*, *realin*, and *lnrgdp*. Specifically, *lnmlex*, *lninv*, and *realin* exhibit significant effects on *lnrgdp* at the 1% level of significance. Notably, a 1% increase in military expenditure, as indicated by *lnmlex*, corresponds to a decrease of approximately 0.692% in economic growth, holding other variables constant. This finding is consistent with prior research by scholars such as Abu-Bader & Abu-Qarn (2003), Manamperi (2016), and others, suggesting an inverse relationship between defense spending and economic growth, implying that the defense industry lacks beneficial externalities or spin-offs for the economy (Dunne & Nikolaidou, 2001). Moreover, investment emerges as a key driver of economic growth, exerting a substantial positive impact. The significant influence of investment on growth underscores its pivotal role in economic performance. Thus, the negative impact of military spending on economic performance may be attributed to its crowding-out effect on investment, indicating an indirect impact of military expenditure on growth through investment (Mintz & Huang, 1990). On the other hand, real interest rates exhibit a minimal positive impact on economic growth. While the impact is small, it remains highly significant. This suggests that higher interest rates may attract new investment, both through higher savings and through foreign direct investment, thereby potentially contributing to economic growth. However, given the significant but small impact rate, careful consideration of the implications of military expenditure on economic growth is warranted (Mintz & Huang, 1990).

Short-run Dynamics

The following table presents the short-run model estimates in panel A, while the results of the diagnostic tests are shown in panel B.

Table 6. Short-run Results

Panel A			Panel B		
ARDL (1,0,1,2) based on SBC			Diagnostics Tests		
Regressor	Coefficient	T-ratio [prob]		F-stat	[prob]
Dlnmex	-0.00153	-2.6528[0.012]	Serial Correlation	1.6215	0.211
Dlninv	-0.34857	-112.24[0.000]	Heteroscedasticity	8.2258	0.007
Drin	-0.22164	3.0670[0.004]	Functional form	1.6181	0.000
Ecm (-1)	-0.22164	-4.4945[.000]		LM-version	[Prob]
			Normality	1.8211	0.402

Table 6 highlights significant findings regarding the impact of various factors on economic growth. The first lag of lnmx is significant at the 5% level, negatively affecting short-term economic growth. Similarly, the investment's first lag is significant at the 1% level and exerts a negative influence on economic growth. Real interest rates negatively impact economic growth in the short term as well. However, the ECM term emerges as the most crucial component, signifying a projected convergence process in long-term economic growth trends and other macroeconomic indicators. Its negative sign indicates a corrective adjustment process, with approximately 22% of previous-year disequilibrium addressed in the current year. Moreover, the stability of long-run coefficients, combined with short-run dynamics to generate the error-correction term, is discussed. To address this, the CUSUM and CUSUMQ tests developed by Brown et al. (1975) have been applied to the residuals of each model. If the cumulative sum crosses critical lines, the model is deemed unstable according to the CUSUM test. Similarly, instability occurs when CUSUMQ, based on squared recursive residuals, crosses critical lines. Figure 6 illustrates the CUSUM and CUSUMQ of the SBIC-based model. Examining the two figures plainly shows that both models pass the parameter stability test.

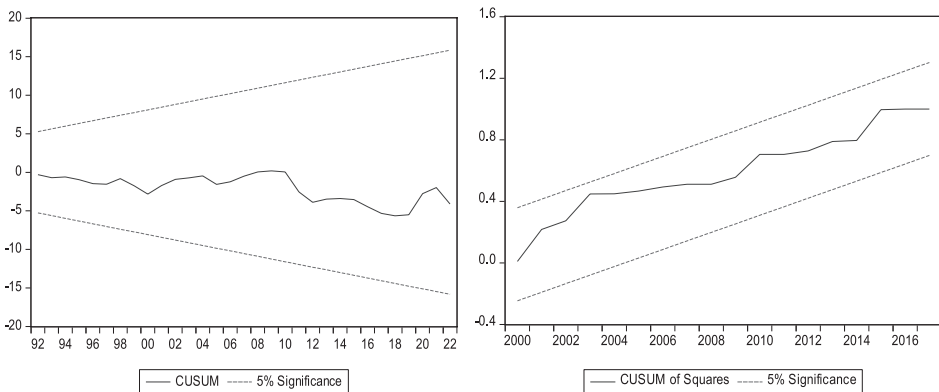


Figure 2. CUSUM and CUSUMQ

4.3 Granger Causality Test

It is widely recognized that Granger causality is typically observed when a long-term relationship exists between the variables, at least in one direction. To identify causally related variables, researchers commonly employ a pairwise Granger causality test proposed by Engle and Granger (1987). This method has been utilized in prior studies, including those conducted by Jalil et al. (2016) and Manamperi (2016), to determine the direction of causality between military spending and economic growth. The results of the Granger causality test (equations 4-5) are presented in the following table.

Table 7. Granger Causality Test Results

Null Hypothesis	Observation	F-Statistic	Prob.
<i>lnmex</i> does not Granger-cause <i>lngdp</i>	41	5.06128	0.0116
<i>lngdp</i> does not Granger-cause <i>lnmex</i>		0.81953	0.4487
<i>lninv</i> does not Granger-cause <i>lngdp</i>	41	1.54318	0.2275
<i>lngdp</i> does not Granger-cause <i>lninv</i>		1.63318	0.2094
<i>lnrin</i> does not Granger-cause <i>lngdp</i>	41	4.26413	0.0218
<i>lngdp</i> does not Granger-cause <i>lnrin</i>		0.44137	0.6466
<i>lnmex</i> does not Granger-cause <i>lninv</i>	41	5.78598	0.0066
<i>lninv</i> does not Granger Cause <i>lnmex</i>		0.87348	0.4262
<i>lnrin</i> does not Granger Cause <i>lninv</i>	41	3.86680	0.0301
<i>lninv</i> does not Granger Cause <i>lnrin</i>		0.50421	0.6082
<i>lnrin</i> does not Granger Cause <i>lnmex</i>	41	0.74204	0.4833
<i>lnmex</i> does not Granger Cause <i>lnrin</i>		0.46005	0.6349

Table 7 shows unidirectional Granger causality running from military expenditure to economic growth. There is no causality running between economic growth and investment. The real interest rate Granger-causes economic growth, but economic growth does not Granger-cause the real interest rate. Military expenditure Granger-causes investment by building military infrastructure and enhancing capacity. But investment does not Granger-cause military expenditures. There is a unidirectional Granger causality running from real interest rate to economic growth, while there is no causal relation running from investment to real interest rate. Lastly, there is no causality running between the real interest rate and military expenditures.

5. Conclusion and Policy Recommendations

In this study, we examined the relationship and direction of causation between military spending and economic growth in Bangladesh over the period 1980–2022. Using time-series data and the ARDL bounds test for cointegration, as

well as Pairwise Granger causality, we sought to shed light on this complex relationship. The results of the ARDL bounds test revealed the presence of at least one cointegrating vector, indicating a long-run relationship between military spending and economic growth in Bangladesh. Interestingly, our findings suggest that military expenditure has a negative impact on economic growth in the long run, aligning with prior research conducted by scholars such as Abu-Bader & Abu-Qarn (2003), Manamperi (2016), Hou & Chen (2013), and others. Contrastingly, investment and real interest rates positively affected economic growth, underscoring their importance in driving economic expansion. Furthermore, the error-correction term (-0.221) indicated that approximately 22% of the disequilibrium from the previous year was corrected in the current year, suggesting a rapid adjustment in the relationship following a shock. Using pairwise Granger causality testing, we found a short-term, unidirectional negative relationship between military spending and economic growth. This implies that reducing Bangladesh's defense budget could bolster economic health, leading to a "peace dividend" if the resources were redirected to more productive sectors. However, it is important to acknowledge the role of security concerns in dictating the military burden. As long as increased military spending enhances national security, it may contribute to output growth, as Dunne et al. (2005) note. Given Bangladesh's commitment to maintaining friendly relations with its neighbors, increased military spending may not necessarily translate into economic well-being, as it could deter investment without substantially improving security. Thus, policymakers face a delicate balance between security needs and economic priorities in allocating resources effectively.

References

- Abu-Bader, S., & Abu-Qarn, A. S. (2003). Government expenditures, military spending and economic growth: causality evidence from Egypt, Israel, and Syria. *Journal of Policy Modeling*, 25(6-7), 567-583.
- Abu-Qarn, A. (2010). The Defense-growth nexus: An application for the Israeli-Arab conflict.
- Ahmed, M. U., Muzib, M., & Roy, A. (2013). Price-wage spiral in Bangladesh: Evidence from ARDL bound testing approach. *International Journal of Applied Economics*, 10(2), 77-103.
- Ahmed, N., & Naslmosavi, S. (2017). Military Expenditure and Economic Growth in SAARC Countries: Pooled and Panel Data Analysis. *Journal of Applied Finance and Economic Policy*, 1(1), 1-7.

- Aizenman, J., & Glick, R. (2006). Military expenditure, threats, and growth., *Journal of International Trade & Economic Development*, 15(2), 129-155.
- Ajmair, M., Hussain, K., Abbassi, F. A., & Gohar, M. (2018). The Impact of Military Expenditures on Economic Growth of Pakistan. *Applied Economics and Finance*, 5 (2), 41-48.
- Al-Beruni, R. (2017). What strategic defense looks like. Dhaka Tribune. Retrieved from <https://www.dhakatribune.com/opinion/op-ed/2017/10/20/strategic-defense-looks-like>
- Ang, J. B. (2010). Finance and inequality: the case of India. *Southern Economic Journal*, 76(3), 738-761.
- Ang, J. B. (2011). Financial development, liberalization and technological deepening. *European Economic Review*, 55(5), 688-701.
- Atesoglu, H. S. (2002). Defense Spending Promotes Aggregate Output in the United States--Evidence from Cointegration Analysis. *Defence and peace economics*, 13(1), 55-60.
- Benoit, E. (1978). Growth and defense in developing countries. *Economic development and cultural change*, 26 (2), 271-280.
- Biswas, B., & Ram, R. (1986). Military expenditures and economic growth in less developed countries: An augmented model and further evidence. *Economic development and cultural change*, 34(2), 361-372.
- Brown, R. L., Durbin, J., & Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society. Series B (Methodological)*, 149-192.
- Chang, H.-C., Huang, B.-N., & Yang, C. W. (2011). Military expenditure and economic growth across different groups: A dynamic panel Granger-causality approach. *Economic Modelling*, 28(6), 2416-2423.
- Chowdhury, A. R. (1991). A causal analysis of defense spending and economic growth. *Journal of Conflict Resolution*, 35(1), 80-97.
- Cuaresma, J. C., & Reitschuler, G. (2004). A non-linear defence-growth nexus? Evidence from the US economy. *Defence and peace economics*, 15(1), 71-82.
- Deger, S. (1985). Human resources, government education expenditure, and the military burden in less developed countries. *The Journal of Developing Areas*, 20(1), 37-48.
- Desli, E., Gkoulgkoutsika, A., & Katrakilidis, C. (2017). Investigating the dynamic interaction between military spending and economic growth. *Review of Development Economics*, 21(3), 511-526.

- Dunne, J. P., Smith, R. P., & Willenbockel, D. (2005). Models of military expenditure and growth: A critical review. *Defence and peace economics*, 16(6), 449-461.
- Dunne, J. P., & Tian, N. (2013). Military expenditure and economic growth: A survey. *The Economics of Peace and Security Journal*, 8(1).
- Dunne, J. P., & Tian, N. (2015). Military expenditure, economic growth and heterogeneity. *Defence and peace economics*, 26(1), 15-31.
- Dunne, P., & Nikolaidou, E. (2001). Military expenditure and economic growth: A demand and supply model for Greece, 1960–96. *Defence and peace economics*, 12(1), 47-67.
- Dunne, P., Nikolaidou, E., & Vougas, D. (2001). Defence spending and economic growth: a causal analysis for Greece and Turkey. *Defence and peace economics*, 12(1), 5-26.
- Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, 251-276.
- Feder, G. (1983). On exports and economic growth. *Journal of development economics*, 12(1-2), 59-73.
- Gerace, M. P. (2002). US Military Expenditures and Economic Growth: Some Evidence from Spectral Methods. *Defence and peace economics*, 13(1), 1-11. doi:10.1080/10242690210966
- Gregory, A. W., & Hansen, B. E. (1996). Practitioners corner: tests for cointegration in models with regime and trend shifts. *Oxford bulletin of Economics and Statistics*, 58(3), 555-560.
- Habibullah, M. S., Law, S.-H., & Dayang-Afizzah, A. (2008). Defense spending and economic growth in Asian economies: A panel error-correction approach.
- Hendry, D. F., Pagan, A. R., & Sargan, J. D. (1984). Dynamic specification. *Handbook of econometrics*, 2, 1023-1100.
- Heo, U. (2010). The relationship between defense spending and economic growth in the United States. *Political Research Quarterly*, 63(4), 760-770.
- Hou, N., & Chen, B. (2013). Military Expenditure and Economic Growth in Developing Countries: Evidence from System Gmm Estimates. *Defence and peace economics*, 24(3), 183-193. doi:10.1080/10242694.2012.710813
- Huang, C., & Mintz, A. (1991). Defence expenditures and economic growth: The externality effect. *Defence Economics*, 3 (1), 35-40. doi:10.1080/10430719108404713
- Ismail, S. (2017). Military Expenditure and Economic Growth in South Asian Countries: Empirical Evidences. *International Journal of Economics and Financial Issues*, 7 (3), 318-325.

- Jalil, A., Abbasi, H. K. N., & Bibi, N. (2016). Military expenditures and economic growth: allowing structural breaks in time series analysis in the case of India and Pakistan. *Quality & Quantity*, 50(4), 1487-1505.
- Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, 12(2-3), 231-254.
- Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52(2), 169-210.
- Karagol, E. (2006). The relationship between external debt, defence expenditures and GNP revisited: The case of Turkey. *Defence and peace economics*, 17 (1), 47-57.
- Kinsella, D. (1990). Defence spending and economic performance in the United States: a causal analysis. *Defence and peace economics*, 1(4), 295-309.
- Klein, T. (2004). Military expenditure and economic growth: Peru 1970–1996. *Defence and peace economics*, 15(3), 275-288.
- Lebovic, J. H., & Ishaq, A. (1987). Military burden, security needs, and economic growth in the Middle East. *Journal of Conflict Resolution*, 31(1), 106-138.
- Malizard, J. (2016). Military expenditure and economic growth in the European Union: Evidence from SIPRI's extended dataset. *The Economics of Peace and Security Journal*, 11(2).
- Manamperi, N. (2016). Does military expenditure hinder economic growth? Evidence from Greece and Turkey. *Journal of Policy Modeling*, 38(6), 1171-1193.
- Mintz, A., & Huang, C. (1990). Defense expenditures, economic growth, and the “peace dividend”. *American Political Science Review*, 84(4), 1283-1293.
- Mintz, A., & Stevenson, R. T. (1995). Defense expenditures, economic growth, and the “peace dividend” A Longitudinal Analysis of 103 Countries. *Journal of Conflict Resolution*, 39(2), 283-305.
- Mueller, M. J., & Atesoglu, H. S. (1993). Defense spending, technological change, and economic growth in the United States. *Defence and peace economics*, 4(3), 259-269.
- Muravska, K. G. J. (2012). Military-owned businesses: corruption & risk reform. Retrieved from UK: http://ti-defence.org/wp-content/uploads/2016/03/2012-01_Military_Owned_Businesses.pdf
- Narayan, P. K. (2005). The saving and investment nexus for China: evidence from cointegration tests. *Applied economics*, 37 (17), 1979-1990.
- Payne, J. E., & Ross, K. L. (1992). Defense spending and the macroeconomy. *Defence and peace economics*, 3(2), 161-168.

- Pesaran, M. H., & Shin, Y. (1998). An autoregressive distributed-lag modelling approach to cointegration analysis. *Econometric Society Monographs*, 31, 371-413.
- Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, 94(446), 621-634.
- Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289-326.
- Ram, R. (1986). Government size and economic growth: A new framework and some evidence from cross-section and time-series data. *The American Economic Review*, 76(1), 191-203.
- Ram, R. (1995). Defense expenditure and economic growth. *Handbook of defense economics*, 1, 251-274.
- Scheetz, T. (1991). The macroeconomic impact of defence expenditures: Some econometric evidence for Argentina, Chile, Paraguay and Peru. *Defence Economics*, 3(1), 65-81. doi:10.1080/10430719108404715
- Sezgin, S. (2004). An empirical note on external debt and defence expenditures in Turkey. *Defence and peace economics*, 15(2), 199-203.
- Shahbaz, M., Afza, T., & Shabbir, M. S. (2013). Does defence spending impede economic growth? Cointegration and causality analysis for Pakistan. *Defence and peace economics*, 24(2), 105-120.
- Stockholm International Peace Research Institute (2018). Why arms procurement goes wrong. <https://www.sipri.org/yearbook/2018>.
- Smith, R. (2018, March 10). The Trouble with Bangladesh's Military. *The Diplomat*. Retrieved from <https://thediplomat.com/2018/03/the-trouble-with-bangladeshs-military/>
- Walsh, E. (2011). Non-traditional security threats in Asia: Finding a regional way forward. Retrieved from <http://www.eastasiaforum.org/2011/06/04/non-traditional-security-threats-in-asia-finding-a-regional-way-forward/>
- Yolcu K. D., Yildirim, J., & Öcal, N. (2017). Military expenditure and economic growth in Middle Eastern countries and Turkey: a non-linear panel data approach. *Defence and peace economics*, 28(6), 719-730.
- Zhao, L., Zhao, L., & Chen, B.-F. (2017). The interrelationship between defense spending, public expenditures, and economic growth: Evidence from China. *Defence and peace economics*, 28(6), 703-718.

The Effects of Industrialization, Energy Consumption and Economic Growth on Carbon Emissions in Bangladesh

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Abstract

The economy of Bangladesh has been growing rapidly over the last few decades. In its pursuit of economic growth, industrialization has played a formidable role. Consequently, the rapid industrialization has led to huge energy demand, causing Bangladesh to rely heavily on fossil fuels, resulting in significant carbon emissions. This paper investigates the effects of industrialization, economic growth, and energy consumption on carbon emissions in Bangladesh from 1974 to 2019 using the Auto Regressive Distributed Lag (ARDL) model. The estimated long-run coefficient for industrialization is positive, suggesting that industrialization is associated with higher carbon emissions in Bangladesh. The long-run coefficient of energy consumption is positive, confirming the positive long-term relationship between energy consumption and carbon emissions. The long-run coefficient on economic growth is positive but statistically insignificant, suggesting that economic growth has no detrimental effect on carbon emissions. As a country vulnerable to climate change, Bangladesh needs to adopt energy-efficient technology and an energy mix for its industrialization rather than relying solely on fossil fuels.

Keywords: *ARDL · industrialization · fossil fuel · reducing CO₂ · GDP · RMG · urbanization*

1. Introduction

Every country all over the world aspires to higher economic growth. The apparent desire for higher economic growth has led to raising the levels of CO₂ emissions as well as other greenhouse gases in the atmosphere (Ahmad et al., 2016). The intensifying trend of global economic activity over the past few decades has been reflected in industrialization and in the considerable consumption of energy sources such as coal, natural gas, and oil for energy and transportation. Therefore, reducing the emissions of CO₂ and other gases in the atmosphere and improving the quality of the environment has become a global concern in order to mitigate the adverse effects of climate change and ensure sustainable

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development (Begum et al., 2015; Raihan & Said, 2022).

Bangladesh is emerging as one of the world's rapidly growing economies (Bangladesh Planning Commission, 2022). Over the last couple of years, Bangladesh's economy has been growing at an average annual rate of 6.0 percent. The GDP growth rate in Bangladesh has accelerated since the early 1990s. Bangladesh's GDP is usually classified into three broad categories: agriculture, industries, and services. Over the last couple of years, the share of industry in Bangladesh's GDP has steadily increased, making a huge contribution to the country's economic growth. According to the Bangladesh Bureau of Statistics (BBS), the industry sector's share of GDP reached 35.5 percent in FY'22, up from 14.7 percent in FY'73 (BBS, 2022). However, rapid industrialization and accelerated economic growth come at the cost of environmental degradation, as they necessitate high consumption of fossil fuels such as crude petroleum, coal, and natural gas. In Bangladesh, due to limited green energy alternatives, crude and refined petroleum, along with natural gas, serve as the primary inputs for the transportation sector, manufacturing plants, and electricity generation. In 2021, the country's energy portfolio was over 99% fossil fuels, consisting of natural gas, oil, diesel, and coal (BP Statistical Review of World Energy, 2022). Over the last three decades, massive industrialization, especially the rapid growth of the RMG and leather industries, has occurred in Bangladesh without regard for environmental issues. Most RMG and leather factories lack effluent treatment plants and discharge waste into surrounding areas, causing significant environmental degradation near major cities such as Dhaka, Chattogram, Gazipur, and Narayanganj. With the rise in industries, the increase in energy combustion plants comes at the expense of environmental quality. There is a strong relationship between the consumption of these energy sources and carbon emissions across countries (Rahman & Kashem, 2017). Moreover, the rapidly growing industrialization in Bangladesh is contributing to this process, driven by the poor treatment of waste by backwardly linked industries in the RMG sector (Rahman & Kashem, 2017).

The acceleration of industrialization and the rapid increase in energy consumption from fossil fuels are leading to rapid environmental degradation. Besides, Bangladesh has been facing challenges stemming from rapid economic growth during its early development phases, as well as from climate change driven by increased greenhouse gas emissions. According to data from the International Energy Agency (IEA), Bangladesh emitted approximately 11.42, 20.95, 49.9, and 81.97 million tons of CO₂ in 1990, 2000, 2010, and 2018, respectively. The CO₂ emissions in 2018 were 617.78% higher than in 1990. The CO₂ emissions in Bangladesh during this period were primarily due to its heavy reliance on fossil fuels for energy consumption. Figure 1 and Table 1 show the positive

relationship among the per capita GDP, per capita industrial growth, and energy consumption.

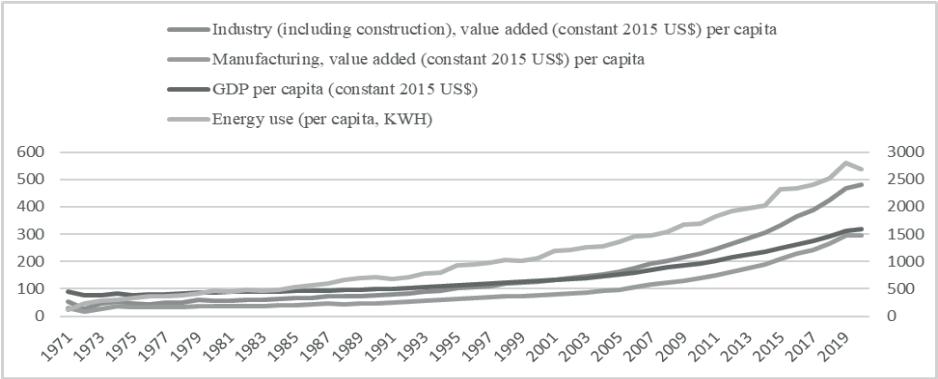


Figure 1. Relationships of Per Capita GDP, Per Capita Energy use & Per Capita Industrial Production

Source: WDI (March 2024), Our World in Data.

Table 1. Trends of Variable of Interest

Year	GDP per capita (constant 2015 US\$)	Industry value added (constant 2015 US\$) per capita	Manufacturing value added (constant 2015 US\$) per capita	Energy use (KWH) per capita	Population, total (Million)
1971-1980	411.65	48.53	32.32	327.64	75.69
1981-1990	462.47	66.91	41.94	564.59	96.87
1991-2000	569.83	103.50	64.16	893.06	118.96
2001-2010	795.77	174.93	105.30	1416.06	140.93
2011-2020	1291.48	355.78	221.18	2280.53	158.83

Source: WDI (March 2024), Our World in Data.

The data presented in Table 1 and Figure 1 indicate that GDP growth, industrial production, energy usage, and carbon dioxide emissions display synchronized patterns over the time period analyzed. Bangladesh is facing alarming levels of pollution and environmental health risks, and it disproportionately affects the poor, children under five, the elderly, and women (World Bank, 2023). Though Bangladesh is recognized as one of the fastest-growing economies, very little attention is paid to the environmental impact of this rapid growth. Moreover, Bangladesh aspires to become a middle-income country by 2031 and to fulfill the SDGs, so transitioning to renewable energy is essential for industrialization while balancing economic growth and environmental protection.

Several Studies such as Amin et al. (2012), Shahbaz et al. (2014), Murad et al. (2015), Ahad & Khan (2016), Alom et al. (2017), Islam et al. (2017), Sharmin & Tareque (2018), Nomani et al. (2022), Rahman et al. (2021), Raihan et al. (2022) and Islam et al. (2023) examined the impact of GDP growth, industrialization, and energy use on carbon emissions in the context of Bangladesh. However, these studies suggest no clear consensus on these issues. In this context, this study investigates the short- and long-run effects of industrialization, energy use, and GDP growth on CO₂ emissions in Bangladesh to inform appropriate policy recommendations.

The remaining part of the paper is organized as follows: Section two provides a literature review; Section three elaborates on the data, model, and methodology employed; Section four presents the estimation results; Section five discusses the results; and Section six outlines the conclusions and policy implications.

2. Literature Review

Carbon dioxide (CO₂) emissions are strongly influenced by industrialization, energy consumption, and a country's economic development, as measured by GDP. Past empirical research has shown that industrialization and CO₂ emissions are positively related, meaning that as industrialization increases, CO₂ emissions rise. On the same note, it has also been established that energy consumption has a positive impact on CO₂ emissions, implying that increasing energy consumption increases CO₂ emissions. Also, GDP growth has been linked to increased CO₂ emissions, meaning that as the economy grows, so do CO₂ emissions.

Over the last few decades, numerous empirical studies have examined the relationship between environmental degradation and economic variables, such as globalization, industrialization, economic growth, energy use, financial development, urbanization, and foreign direct investment, across countries and regions. The initial influential work was developed by Griffin & Schiffel (1972) which focused on the environmental Kuznets curve and addressed the nexus between GDP growth and CO₂ emissions. Later on, Grossman & Krueger (1991) updated the relationship between GDP growth and CO₂ emissions.

Several empirical studies have examined the relationship between economic growth and environmental degradation at the country level. Studies such as Selden & Song (1994), Galeotti et al. (2009), Saboori et al. (2012), Fujii & Managi (2013), Wang & Liu (2017), and He et al. (2017) provided empirical evidence on the validity of the EKC hypothesis. On the contrary, studies such as Zou (2018), Mansoor & Sultana (2018), Huang (2021), Uddin et al. (2022), and Sheik & Hassan (2023) did not find the relationship between GDP growth and CO₂ emissions.

Other areas of contemporary literature focus on the role of industrialization in rising CO₂ emissions, both in developed and developing countries. Numerous studies examine the link between industrialization and environmental degradation. However, there is no clear consensus. The empirical findings of Mahmood et al. (2020) for Saudi Arabia, Ullah et al. (2021) for Pakistan, Ayitehgiza (2020) for Ethiopia, Rauf et al. (2020) for 65 Belt and Road Initiative countries, and Samreen & Majeed (2020) For 89 countries, it is concluded that industrialization negatively affects environmental quality. On the other hand, the results of Chowdhury et al. (2020) for 92 economies, Hong et al. (2019) for South Korea, Li et al. (2019) for China, and Congregado et al. (2016) for the United States proved that industrialization improves environmental quality.

In the empirical literature, some studies emphasize energy consumption as a driver of CO₂ emissions. Studies such as Soytas & Sari (2009); Halicioglu (2009); Zhang & Cheng (2009); Wang et al. (2011); Begum et al. (2015); Ahmad et al. (2016); Mirza & Kanwal (2017); Dogan & Aslan (2017); Acheampong (2018) assessed the impact of the energy consumption on carbon emissions. The outcomes have reported mixed evidence; the relationship varies from region to region.

The above-mentioned empirical literature on forging suggests no consensus on the impact of industrialization, energy use, and GDP growth on CO₂ emissions.

In Bangladesh, several studies have examined the effects of GDP growth, industrialization, and energy consumption on CO₂ emissions. However, there is no clear consensus on this issue.

Amin et al. (2012) examined the relationship among energy use, economic growth, and CO₂ emissions in Bangladesh for the period of 1976 to 2017. This study found no causal relationship between economic growth and CO₂ emissions in Bangladesh. Moreover, the findings of this research suggested that industrialization may not necessarily lead to increased CO₂ emissions.

Shahbaz et al. (2014) examined the relationship among Industrialization, electricity consumption, and CO₂ emissions in Bangladesh from the period of 1975 to 2010. The paper finds that economic growth is the cause of CO₂ emissions in Bangladesh.

Murad et al. (2015) studied the causality between carbon emission and industrial production in the case of Bangladesh using the VECM method for the period of 1990 to 2007, and also found no causal relationship between industrial production and CO₂ emissions in Bangladesh.

Ahad & Khan (2016) investigated the effects of globalization, industrial production, energy consumption, and economic growth on environmental degradation in Bangladesh between 1972 and 2015. This study concluded that environmental degradation is positively related to energy consumption.

Alom et al. (2017) studied energy use, CO₂ emissions, urbanization, and financial development in Bangladesh between the years 1985 and 2015. The study's authors established a unidirectional causal relationship between industrial value addition and CO₂ emissions in Bangladesh.

Islam et al. (2017) analyzed the question of whether there is any relationship or correlation between carbon emission (CO₂), GDP, industrial production, and energy consumption in Bangladesh from 1998 to 2013. It concludes that the effect of industrial production and GDP per capita on carbon emissions is significant. Another reason mentioned in this paper is that economic growth increases energy consumption and, therefore, CO₂ emissions in Bangladesh.

Sharmin & Tareque (2018) It investigated the impact of economic growth, globalization, industrialization, energy intensity, and urbanization on Bangladesh's per capita CO₂ emissions using data from 1980 to 2014. The causality test and long-run estimated results suggested that growth drives energy consumption in Bangladesh, which ultimately leads to higher CO₂ emissions. Furthermore, the results indicate that, in the long run, more than 60 percent of Bangladesh's CO₂ emissions stem from energy intensity, urbanization, industrialization, and growth.

Nomani et al. (2022) studied industrial development and climate change in Bangladesh and found that unplanned industrialization has become the main cause of environmental pollution, leading to air, water, and soil pollution and negatively affecting people living near industrial areas.

Rahman et al. (2021) estimated the Environmental Kuznets Curve (EKC) hypothesis of Bangladesh in 1972-2013, with the Fully Modified Ordinary Least Squares (FMOLS) approach, and reported that energy consumption and economic growth have a positive relationship, which in turn increases pollution. The consumption of non-renewable energy was cited as the major source of pollution in Bangladesh.

Raihan et al. (2022) examined the nexus between carbon emission, economic growth, renewable energy consumption, urbanization, industrialization, technological innovation, and forest area in Bangladesh in the period between 1972 and 2018. This paper found that industrialization, urbanization, and economic growth are the drivers of carbon emissions in Bangladesh.

Islam et al. (2023) investigates the Environmental Kuznets Curve (EKC) hypothesis in Bangladesh using data from 1986 to 2014 and found that, in the long run, income has a very modest negative effect on the environment and pollution, and energy consumption is found to be a significant contributor to carbon dioxide emissions in Bangladesh, especially in the short run.

Faruq et al. (2024) examines the EKC hypothesis for Bangladesh between 1974 and 2018. This research found evidence of a long-term association among per capita CO₂ emissions, per capita GDP, energy consumption, and financial development.

Insights from the previously mentioned empirical literature suggest disagreement about the impact of GDP growth, industrialization, and energy consumption on CO₂ emissions in Bangladesh. To bridge the gap in the literature, this study aims to investigate the short- and long-run effects of industrialization, energy consumption, and GDP growth on carbon emissions in Bangladesh during the period 19974 to 2019.

3. Data, Model and Methodology

3.1 Data

This study uses yearly time-series data from 1974 to 2019. The relevant data, such as industry value added (constant 2015 USD) used as a proxy of industrialization, per capita GDP (constant 2015 USD) used as a proxy of economic growth, per capita energy use (KWH), is used as energy consumption, and CO₂ emissions per capita are used as carbon emissions. The data used in this paper are drawn from several sources, including the World Development Indicators (WDI) of the World Bank, Our World in Data, the Emission Database for Global Atmospheric Research (EDGAR), and the International Energy Agency (IEA) Statistics.

3.2 Model

There are several studies examining the impact of industrialization, GDP growth, and energy use on carbon dioxide emissions at the country, regional, and global levels. This study employs the following linear model based on existing literature, such as Rahman & Kashem (2017) and Shahbaz et al. (2014) where carbon emission is a function of industrialization, energy use, and GDP growth:

$$CO_{2t} = f(ind_t, eng_t, gdp_t) \dots \dots \dots (1)$$

Where, CO_{2t} is carbon emission per capita, ind_t is industrialization (industry value added), eng_t is energy use per capita and gdp_t is per capita GDP. The mathematical form of equation (1) can be written in the following form:

By taking the logarithm for all variables used in the model can be written in the following form:

$$\begin{aligned} CO_{2t} &= \alpha_0 + \alpha_1 ind_t + \alpha_2 eng_t + \alpha_3 gdp_t \\ &+ \mu_t \dots \dots \dots (2) \end{aligned}$$

All variables are transformed to natural logarithms for analysis of the estimated parameter.

$$lnco_{2t} = \beta_0 + \beta_1 lnind_t + \beta_2 lneng_t + \beta_3 lngdp_t + \varepsilon_t \dots \dots \dots (3)$$

ARDL representation suggested by Pesaran et al. (2001), the equation (3) is as follows:

$$\begin{aligned} \Delta lnco_{2t} &= \alpha_0 + \sum_{i=1}^p \beta_{1i} \Delta lnco_{2t-i} + \sum_{i=0}^q \beta_{2i} \Delta lnind_{t-i} + \sum_{i=0}^r \beta_{3i} \Delta lneng_{t-i} \\ &+ \sum_{i=0}^m \beta_{4i} \Delta lngdp_{t-i} + \beta_5 lnco_{2t-1} + \beta_6 lnind_{t-1} + \beta_7 lneng_{t-1} \\ &+ \beta_8 lngdp_{t-1} + \varepsilon_t \dots \dots \dots (4) \end{aligned}$$

The error correction form of equation (4) is as follows:

$$\begin{aligned} \Delta lnco_{2t} &= \alpha_1 + \sum_{i=1}^p \beta_{1i} \Delta lnco_{2t-i} + \sum_{i=0}^q \beta_{2i} \Delta lnind_{t-i} + \sum_{i=0}^r \beta_{3i} \Delta lneng_{t-i} \\ &+ \sum_{i=0}^m \beta_{4i} \Delta lngdp_{t-i} + \gamma ec_{t-1} + \varepsilon_t \dots \dots \dots (5) \end{aligned}$$

3.3 Estimation Strategy

This study used time-series data to investigate the impact of industrialization, energy use, and GDP growth on carbon emissions in Bangladesh. It is widely recognized that financial time series data are non-stationary. Therefore, it is necessary to test the data for stationarity. Firstly, this study tests the stationarity of the variables, including the log of carbon emissions (lnCO₂), the log of industrialization (lnind), the log of energy use (lneng), and the log of GDP (lngdp), to avoid spurious regression. To test for stationarity, this paper employed the ADF test (Dickey & Fuller, 1979) and the PP test (Phillips & Perron, 1988). Secondly, based on the results of stationarity testing, this study employed the Auto Regressive Distributed Lag (ARDL) model proposed by Pesaran et al. (2001). Thirdly, to test whether the variables are co-integrated or not in the long run, the ARDL bound test approach is used.

3.4 The ARDL Model Estimation Process

Step 1: Check the stationarity of the variables such as $\ln\text{CO}_2$, $\ln\text{ind}$, $\ln\text{eng}$, and $\ln\text{gdp}$ by using the ADF and PP tests.

Step 2: as some of the variables are $I(0)$ and some are $I(1)$, which allows us to estimate the ARDL model.

Step 3: Select the optimal lag for the ARDL model.

Step 4: Based on the optimal lag, the best ARDL model is selected.

Step 5: Test for cointegration among the model's variables using the ARDL bound test.

Step 6: If the variables are cointegrated, estimate the short-run and long-run parameters.

Step 7: check several diagnostic tests for heteroskedasticity (Breusch-Pagan-Godfrey test), serial correlation (Breusch-Godfrey LM test), normality (J-B test), and stability (CUSUM and CUSUM of squares test).

This study uses the ARDL model due to several advantages. Firstly, this approach is a well-suited method when the variables have mixed orders of integration, especially, $I(0)$ or $I(1)$. Additionally, this method is appropriate and provides a more precise estimate for small samples.

4. Estimation Results

4.1 Graphical Representations of the Data

To understand the features of the time series data, such as the presence and direction of trends, structural breaks, and stationarity, the primary step is to inspect the graphical presentation of the data. The graphical presentation of the variables $\ln\text{ind}$, $\ln\text{gdp}$, $\ln\text{co}_2$, and $\ln\text{eng}$ is shown in Figure 2. It is evident from Figure 2 that each variable has an intercept and a deterministic trend.

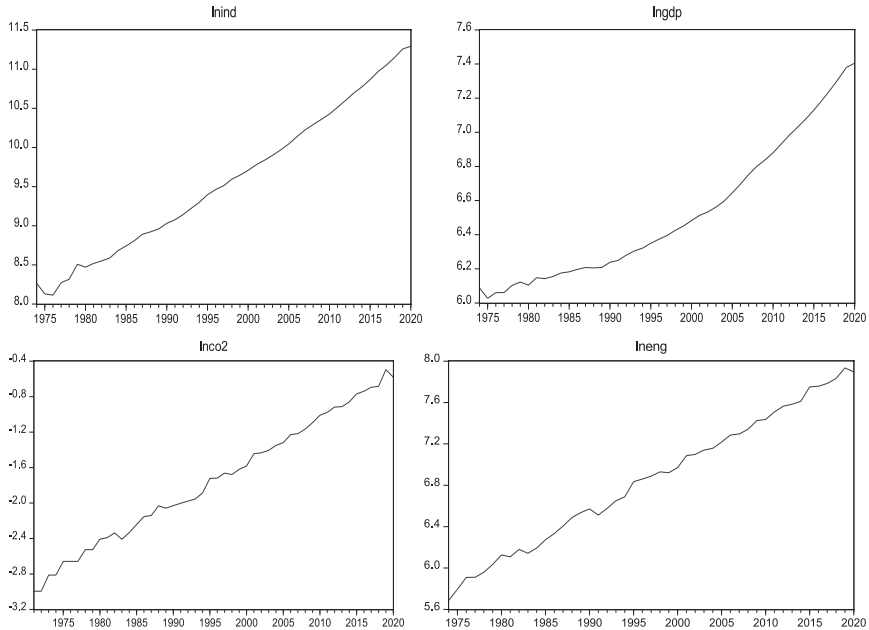


Figure 2. Graphical Representation of the Data

4.2 Unit Root Test Results

The ADF unit root test results are presented in Table 2. The unit root test results indicate that the variables, such as carbon emissions and energy use, are $I(0)$ stationary at the level, while industrialization and GDP variables are $I(1)$ stationary at their first difference. Similarly, the unit root test results for the PP test are reported in Table 3 and indicate the same specification as the ADF test. The variables carbon emissions and energy use are stationary at their levels, while the industrialization and GDP variables are stationary in first differences.

Table 2. Augmented Dicky-Fuller Unit Root Test Results

Variables	Model	Level	First Difference	Integration
lnCO ₂	intercept & trend	-5.391* [0.00]	...	I(0)
Lnind	intercept & trend	-1.998 [0.587]	-4.816* [0.00]	I(1)
Lneng	intercept & trend	-4.930* [0.00]		I(0)
Lngdp	intercept & trend	0.426 [0.99]	-13.463* [0.00]	I(1)

* = significance at 1% level, P values are in parenthesis.

Table 3. Phillips-Perron Unit root test results

Variables	Model	Level	First Difference	Integration
lnCO ₂	intercept & trend	-5.379* [0.00]	...	I(0)
Lnind	intercept & trend	-1.633 [0.764]	31.209* [0.00]	I(1)
Lneng	intercept & trend	-4.771* [0.00]		I(0)
Lngdp	intercept & trend	1.123 [0.99]	12.623* [0.00]	I(1)

* = significance at 1% level, P values are in parentheses.

The unit root test results reported in Tables 2 and 3 indicate that the variables in equation 3 have mixed integration orders. That’s why the ARDL model is appropriate for examining the short and long-run relationships among the variables used in the study.

4.3 ARDL Bound Test Results

Table 4 presents the ARDL bound test results. The value of the F-statistic is 39.38, which is higher than the upper bound value of 4.66 at 1% level. The results of the F-Bound test indicate the presence of a long-run equilibrium relationship among the model’s variables.

Table 4. The ARDL Bounds Test Results

F-Bounds Test		Null Hypothesis : No linear relationship		
Test Statistic	Value	Significance	I(0)	I(1)
F-statistic	39.38	10%	2.37	3.2
K	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

4.4 Long-run Results

The long-run results are presented in Table 5. The results imply that the relationship between industrialization and carbon emissions is positive and significant at 5% level. The estimated coefficient for industrialization (lnind) is 0.19, implying that a 1% increase in industrialization would raise carbon emissions by 0.19%.

Table 5. Long-run Results

Dependent Variable: $\ln\text{CO}_2$				
Independent Variables	Coefficient	Std. Error	t-Statistic	Prob.
$\ln\text{ind}$	0.198*	0.097	2.048	0.047
$\ln\text{eng}$	0.688*	0.100	6.875	0.000
$\ln\text{gdp}$	0.088	0.080	1.103	0.276
C	-8.839*	0.228	-38.779	0.000

* = significance at 1% level

Moreover, the results also affirm the positive long-term relationship between energy consumption and carbon emissions. This result is significant at 1% level. The coefficient on energy consumption ($\ln\text{eng}$) is 0.69, implying that a 1% increase in energy consumption ultimately increases carbon emissions by 0.69%. This finding also reveals the pivotal role of energy sources in shaping environmental outcomes in Bangladesh. Furthermore, the coefficient on GDP is 0.09, which is positive and indicates that economic growth and carbon emissions are positively related. The positive coefficient indicates that economic growth may increase carbon dioxide emissions; however, the result is not statistically significant.

4.5 Short-run Results

The estimated short-run result is presented in Table 6. The ARDL (1,1,0,0) is selected as the best model based on the estimation results.

Table 6. Short-run Results

Dependent Variable: $\ln\text{CO}_2$				
Independent Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	-9.145	0.925	-9.887	0.000
$\ln\text{ind}(-1)$	0.205	0.105	1.963	0.057
$\ln\text{eng}$	0.712	0.121	5.898	0.000
$\ln\text{gdp}$	0.091	0.082	1.115	0.271
ECM_{t-1}	-1.035	0.070	-14.719	0.000

$$\text{ECM} = \ln\text{CO}_2 - (0.20*\ln\text{ind} + 0.69*\ln\text{eng} + 0.09*\ln\text{gdp} - 8.84)$$

The short-run estimation results in Table 6 indicate that industrialization has a positive and significant impact on carbon emissions at the 10% level. Moreover, energy consumption has a positive and statistically significant (at 1% level)

impact on carbon emission in Bangladesh. On the other hand, economic growth has a positive impact on carbon emissions, but the effect is significant only overall. The value of the error correction term is 1.03, which is negative and greater than 1.0, and implies the oscillatory convergence to the long-run equilibrium (Narayan & Smyth, 2006).

4.6 Diagnostic Test Results

It is imperative to test the diagnostic tests to assess the model’s validity. To do so, this study employed the Breusch-Pagan-Godfrey test for heteroscedasticity, the Breusch-Godfrey test for serial correlation, the J-B test for normality, and the CUSUM and CUSUM of square test for stability, and the results are presented in Table 7. The results of the heteroscedasticity test indicate that the model error is not significantly heteroscedastic and is therefore homoscedastic. The LM test indicates that there is no autocorrelation among the model’s variables. The CUSUM and CUSUM of squares tests are used to assess the model’s stability, and the results indicate that both are stable over the period.

Table 7. Diagnostic Test Results

Diagnostic Tests		
	Coefficients	Prob
Heteroskedasticity Test (Breusch-Pagan-Godfrey)	0.345	0.882
Serial Correlation LM Test (Breusch-Godfrey)	0.426	0.656
Normality Test (J-B)	0.216	0.897
Cusum test	Stable	
Cusum of square test	Stable	

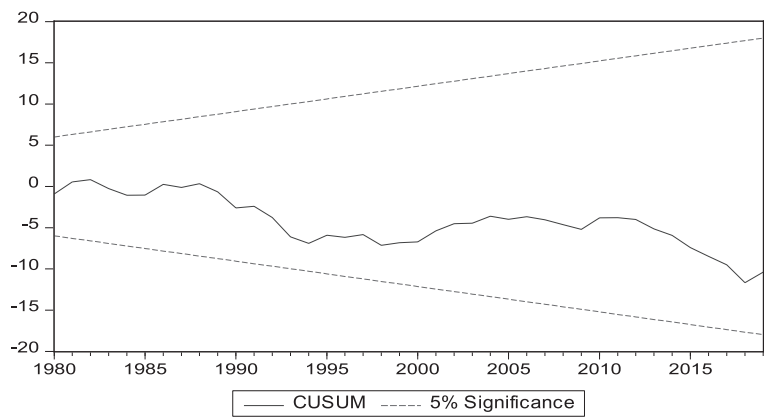


Figure 3.

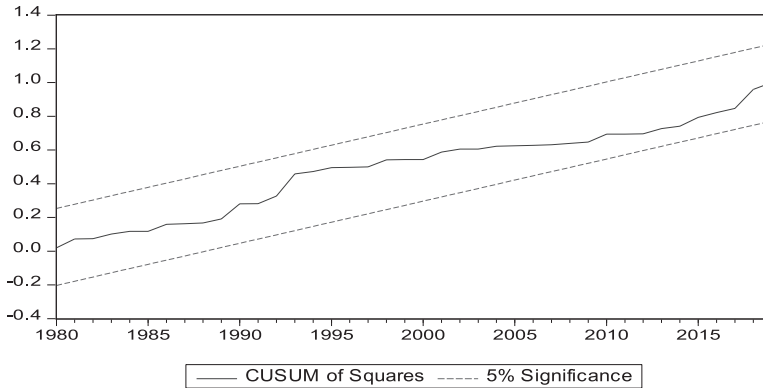


Figure 4.

5. Discussions

The short and long-run results indicate that the coefficient of industrialization is positive and significant. The coefficient on industrialization ($\ln ind$) is positive and significant, indicating that industrial production significantly worsens environmental quality, holding other factors constant. In the long run, a 1.0 percent increase in industrial output results in a 0.19 percent increase in carbon emissions in Bangladesh during the period under consideration. The reason is that over the last three decades, massive industrialization, especially the increasing number of RMG industries and leather industries, has increased in Bangladesh without consideration of environmental issues. Most RMG and leather factories lack effluent treatment plants and discharge waste into surrounding areas, causing significant environmental degradation near major cities such as Dhaka, Chattogram, Gazipur, and Narayanganj. Moreover, as the number of industries grows, the expansion of energy combustion plants comes at the expense of environmental quality. This finding is consistent with those of Murad et al. (2015), Alom et al. (2017), and Islam et al. (2017), but contradicts the finding of Amin et al. (2012) for Bangladesh.

The coefficients on energy consumption ($\ln eng$) in the short and long run are positive and significant at the 1% level. In the long run, the coefficient is 0.69, indicating that a 1.0 percent increase in CO₂ emissions from energy consumption results in a 0.69 percent increase, while other factors remain constant. This finding implies that increased energy consumption leads to higher CO₂ emissions. The finding is similar to the findings of Ahad & Khan (2016), Islam et al. (2017), Sharmin & Tareque (2018), Rahman et al. (2021) and Faruq et al. (2024). Moreover, the finding is supported by the fact that heavy reliance on fossil fuels for energy ultimately degraded environmental quality. Bangladesh's energy portfolio was over 99 percent fossil fuels, consisting of natural gas, oil, and coal in 2021 (BP Statistical Review of World Energy, 2022).

The coefficient of GDP growth ($\ln GDP$) is positive in both the short and long run, but not significant. This finding is consistent with the findings of Amin et al. (2012) and Islam et al. (2017) but contradicts the findings of Shahbaz et al. (2014) and Sharmin & Tareque (2018) for Bangladesh. Economic activities in Bangladesh contribute to environmental degradation by using non-renewable energy sources such as gas, oil, and coal, thereby increasing CO₂ emissions.

6. Conclusion and Policy Recommendations

This paper investigates the impact of industrialization, energy use, and economic growth on carbon emissions in Bangladesh between 1974 and 2019. To do so, this study employed the ARDL estimation strategy to examine the short- and long-run impacts of industrialization, energy use, and economic growth on carbon dioxide emissions. The results of this study reveal that the variables are co-integrated in the long run, with positive impacts of energy consumption and industrialization on carbon dioxide emissions. However, in the long run, economic growth has no impact on carbon dioxide emissions. These findings highlight the need for sustainable development strategies that account for the environmental impacts of industrialization, energy use, and economic growth in Bangladesh. Moreover, Bangladesh needs to implement measures to reduce CO₂ emissions, such as promoting environmentally friendly industrial policies, adopting clean energy sources, and improving energy efficiency, to mitigate the negative environmental impacts of industrialization and energy use.

Given the detrimental effects of raw industrialization and energy use, the Government of Bangladesh should implement regulatory measures to mitigate environmental degradation. First, the government should mandate that all factories install and use effluent treatment plants and that none discharge untreated waste into the environment. Second, the government may encourage and offer incentives to industries to adopt energy-efficient technologies. Third, there is a need to reduce dependence on fossil fuels and to exploit renewable energy sources such as solar and wind power. Fourth, there is a need for comprehensive reform of Bangladesh's energy system to reduce fiscal spending and enhance efficiency. The existing energy subsidy mechanisms in Bangladesh incentivize inefficient and excessive energy consumption and also exacerbate the government's fiscal burden. Fifth, a sustainable, eco-friendly development model is required to ensure an energy mix and a more sustainable environment. Finally, to promote sustainable economic growth and strengthen energy security, regional cooperation and integration are necessary.

Special Notes: The views expressed here are the author's own and do not necessarily reflect the views of Bangladesh Bank.

References

- Acheampong, A. O. (2018). Economic growth, CO₂ emissions and energy consumption: What causes what and where? *Energy Economics*, 74, 677–692.
- Ahad, M., & Khan, W. (2016). Does Globalization Impede Environmental Quality in Bangladesh? The Role of Real Economic Activities and Energy Use. *MPRA*.
- Ahmad, A., Zhao, Y., Shahbaz, M., Bano, S., Zhang, Z., Wang, S., & Liu, Y. (2016). Carbon emissions, energy consumption and economic growth: An aggregate and disaggregate analysis of the Indian economy. *Energy Policy*, 96, 131–143.
- Al-Mulali, U., & Ozturk, I. (2015). The effect of energy consumption, urbanization, trade openness, Industrial output, and the political stability on the environmental degradation in the MENA (Middle East and North Africa) region. *Energy*, 84, 382–389.
- Alom, K., Uddin, A. M., & Islam, N. (2017). Energy Consumption, CO₂ Emissions, Urbanization and Financial Development in Bangladesh: Vector Error Correlation Model. *Journal of Global Economics, Management and Business Research*, 9(4), 178–189.
- Amin, S. Bin, Ferdaus, S. S., & Porna, A. K. (2012). Causal Relationship among Energy Use, CO₂ Emissions and Economic Growth in Bangladesh: An Empirical Study. *World Journal of Social Sciences*, 2(4), 273–290.
- Ayitehgiza, M. A. (2020). Urbanization, economic growth and industrial structure on carbon dioxide emissions: empirical evidence from Ethiopia. *International Journal of Scientific and Research Publications*, 10(8), 947–954.
- Bangladesh Bureau of Statistics. (2022). *Fifty Years of National Accounts of Bangladesh*.
- Bangladesh Planning Commission. (2022). *8th Five-Year Plan*.
- Begum, R. A., Sohag, K., Mastura, S., Abdullah, S., & Jaafar, M. (2015). CO₂ emissions, energy consumption, economic and population growth in Malaysia. *Renewable Sustainable Energy Reviews*, 41, 594–601.
- BP Statistical Review of World Energy (2022).
- Chowdhury, M. A. F., Shanto, P. A., Ahmed, A., & Rumana, R. H. (2020). Does foreign direct investments impair the ecological foot-print? New evidence from the panel quantile regression. *Environmental Science and Pollution Research*, 28, 14372–14385.

- Congregado, E., Feria-Gallardo, J., Golpe, A. A., & Iglesias, J. (2016). The environmental Kuznets curve and CO₂ emissions in the USA. *Environmental Science and Pollution Research*, 23(18), 18407–18420.
- Dickey, D. A., & Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series With a Unit Root. *Journal of the American Statistical Association*, 74(366), 427–431.
- Dogan, E., & Aslan, A. (2017). Exploring the relationship among CO₂ emissions, real GDP, energy consumption and tourism in the EU and candidate countries: Evidence from panel models robust to heterogeneity and cross-sectional dependence. *Renewable and Sustainable Energy Reviews*, 77, 239–245.
- Faruq, O., Talukder, S., Hashem Katha, E., & Kabir Shaeba, M. (2024). Validity of the environmental Kuznets Curve in Bangladesh under the role of financial development. In *Theoretical and Applied Economics: XXXI*, 4, 195-212.
- Fujii, H., & Managi, S. (2013). Which industry is greener? An empirical study of nine industries in OECD countries. *Energy Policy*, 57, 381–388.
- Galeotti, M., Manera, M., & Lanza, A. (2009). On the robustness of robustness checks of the environmental kuznets curve hypothesis. *Environmental and Resource Economics*, 42(4), 551–574.
- Griffin, J. M., & Schiffel, D. D. (1972). Compatibles: Economic growth and environmental quality. *Battelle Res Outlook*, 4(2), 12–15.
- Grossman, G. M., & Krueger, A. B. (1991). *Environmental Impacts of a North American Free Trade Agreement* (NBER Working Paper Series No 3914).
- Halicioglu, F. (2009). An econometric study of CO₂ emissions, energy consumption, income and foreign trade in Turkey. *Energy Policy*, 37(3), 1156–1164.
- He, Z., Xu, S., Shen, W., Long, R., & Chen, H. (2017). Impact of urbanization on energy related CO₂ emission at different development levels: Regional difference in China based on panel estimation. *Journal of Cleaner Production*, 140(Part 3), 1719–1730.
- Hong, S., Lee, Y., Yoon, S. J., Lee, J., Kang, S., Won, E.-J., Hur, J., Khim, J. S., & Shin, K.-H. (2019). Carbon and nitrogen stable isotope signatures linked to anthropogenic toxic substances pollution in a highly industrialized area of South Korea. *Marine Pollution Bulletin*, 144, 152–159.

- Huang, Z. (2021). Analyze the Relationship Between CO2 Emissions and GDP from the Global Perspective. *Proceedings of the 2021 International Conference on Financial Management and Economic Transition (FMET 2021)*.
- Islam, M. K., Rahman, K. S., & Fairouz, S. (2023). Effect of Economic Growth on the Environment in Bangladesh. *International Journal of Research and Innovation in Social Science*, VII(IV), 830–845.
- Islam, Md. Z., Ahmed, Z., Saifullah, Md. K., Huda, S. N., & Al-Islam, S. M. (2017). CO2 Emission, Energy Consumption and Economic Development: A Case of Bangladesh. *Journal of Asian Finance Economics and Business*, 4(4), 61–66.
- Li, M., Li, L., & Strielkowski, W. (2019). The Impact of Urbanization and Industrialization on Energy Security: A Case Study of China. *Energies*, 12(11), 2194.
- Liu, X., & Bae, J. (2018). Urbanization and industrialization impact of CO2 emissions in China. *Journal of Cleaner Production*, 172, 178–186.
- Mahmood, H., Alkhateeb, T. T. Y., & Furqan, M. (2020). Industrialization, urbanization and CO2 emissions in Saudi Arabia: asymmetry analysis. *Energy Reports*, 6, 1553–1560.
- Mansoor, A., & Sultana, B. (2018). Impact of Population, GDP and Energy Consumption on Carbon Emissions: Evidence from Pakistan Using an Analytic Tool IPAT. *Asian Journal of Economics and Empirical Research*, 5(2), 183–190.
- Mirza, F. M., & Kanwal, A. (2017). Energy consumption, Carbon emissions and economic growth in Pakistan: Dynamic Causality analysis. *Renewable and Sustainable Energy Reviews*, 72, 1233–1240.
- Murad, Md. W., Abdullah, A., Boyle, S., & Amaro, C. R. (2015). Forecasting carbon emission and industrial production using VECM :The case of Bangladesh. *The Journal of Developing Areas*, 49(6), 75–88.
- Narayan P. K., & Smyth R. (2006). What Determines Migration Flows from Low-Income to High-Income Countries? An Empirical Investigation of Fiji-U.S. Migration 1972-2001. *Contemporary Economic Policy*, 24(2), 332–342.
- Nomani, S., Rasel, Md., & Reedoy, I. K. Md. (2022). Industrial Development and Climate Change: A Case Study of Bangladesh. *Indonesian Journal of Innovation and Applied Sciences*, 2(1), 68–79.
- Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics*, 16, 289–326.

- Phillips, P. C. B., & Perron, P. (1988). Testing for a Unit Root in Time Series Regression. *Biometrika*, 75(2), 335–346.
- Rahman, M. M., & Kashem, M. A. (2017). Carbon emissions, energy consumption and industrial growth in Bangladesh: Empirical evidence from ARDL cointegration and Granger causality analysis. *Energy Policy*, 110, 600–608. <https://doi.org/10.1016/j.enpol.2017.09.006>
- Rahman, M. M. R., Karim, A. A. M. E., Ahmed, Z., & Acet, H. (2021). Environmental Kuznets Curve (EKC) for Bangladesh: Evidence from Fully Modified OLS Approach. *Journal of Emerging Economies and Policy*, 6(2), 5–14.
- Raihan, A., Muhtasim, D. A., Farhana, S., Hasan, M. A. U., Pavel, M. I., Faruk, O., Rahman, M., & Mahmood, A. (2022). Nexus between economic growth, energy use, urbanization, agricultural productivity, and carbon dioxide emissions: new insights from Bangladesh. *Energy Nexus*, 8.
- Raihan, A., & Said, M. N. M. (2022). Cost–Benefit Analysis of Climate Change Mitigation Measures in the Forestry Sector of Peninsular Malaysia. *Earth Systems and Environment*, 6, 405–419.
- Rauf, A., Liu, X., Amin, W., Rehman, O. U., Li, J., Ahmad, F., & Bekun, F. V. (2020). Does sustainable growth, energy consumption and environment challenges matter for Belt and Road Initiative feat? A novel empirical investigation. *Journal of Cleaner Production*, 262(4), 121344.
- Saboori, B., Sulaiman, J., & Mohd, S. (2012). Economic growth and CO2 emissions in Malaysia: A cointegration analysis of the environmental kuznets curve. *Energy Policy*, 51, 184–191.
- Samreen, I., & Majeed, M. T. (2020). Spatial econometric model of the spillover effects of financial development on carbon emissions: a global analysis. *Pakistan Journal of Commerce and Social Sciences*, 14(2), 569–602.
- Selden, T. M., & Song, D. (1994). Environmental quality and development: Is there a kuznets curve for air pollution emissions? *Journal of Environmental Economics and Management*, 27(2), 147–162.
- Shahbaz, M., Uddin, G. S., Rehman, I. U., & Imran, K. (2014). Industrialization, electricity consumption and CO2 emissions in Bangladesh. *Renewable and Sustainable Energy Reviews*, 31, 575–586.

- Sharmin, M., & Tareque, M. (2018). Econometric Analysis of the Effect of Economic Globalization, Energy Intensity, Urbanization, Industrialization and Growth on CO2 Emissions of Bangladesh. *Managing Global Transitions*, 16(4), 335–354.
- Sheikh, A., & Hassan, O. I. (2023). Impact of Economic Growth, Energy use and Research and Development Expenditure on Carbon Emissions: An Analysis of 29 OECD Countries. *International Journal of Energy Economics and Policy*, 13(1), 454–464.
- Soytas, U., & Sari, R. (2009). Energy consumption, economic growth, and Carbon emissions: Challenges faced by an EU candidate member. *Ecological Economics*, 68(6), 1667–1675.
- Uddin, M., Ahamad, S., Ehigiamusoe, K. U., & Rashid, Md. H.-U. (2022). Impacts of Energy Consumptions, Economic Growth, ICT, Military Expenditure, and Tourism on CO2 Emissions: Evidence from G20 Countries. *Research Square*.
- Ullah, S., Ahmad, W., Majeed, M. T., & Sohail, S. (2021). On the asymmetric effects of premature deindustrialization on CO2 emissions: evidence from Pakistan. *Environmental Science and Pollution Research*, 28, 66772–66786.
- Wang, S., & Liu, X. (2017). China's city-level energy-related CO2 emissions: Spatiotemporal patterns and driving forces. *Applied Energy*, 200, 204–214.
- Wang, S. S., Zhou, D. Q., Zhou, P., & Wang, Q. W. (2011). CO2 emissions, energy consumption and economic growth in China: A panel data analysis. *Energy Policy*, 39(9), 4870–4875.
- World Bank. (2024). *World Development Indicator*.
- Zhang, X.-P., & Cheng, X.-M. (2009). Energy consumption, Carbon emissions, and economic growth in China. *Ecological Economics*, 68(10), 2706–2712.
- Zhou, X., Zhang, J., & Li, J. (2013). Industrial structural transformation and carbon dioxide emissions in China. *Energy Policy*, 57, 43–51.
- Zou, X. (2018). An analysis of the effect of carbon emission, GDP and international crude oil prices based on synthesis integration model. *International Journal of Energy Sector Management*, 12(4), 641–655.

Exchange Rate Depreciation and Its Connection to Falling Reserves in Bangladesh: Evaluating the Domino Effect

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Abstract

This study examines the relationship between exchange rate depreciation and foreign exchange reserves in Bangladesh, with particular attention to whether declining reserves exert systematic pressure on the exchange rate—often described as a “domino effect.” Using annual data from 1973 to 2022 and applying the Autoregressive Distributed Lag (ARDL) bounds testing approach, the analysis evaluates both short- and long-run dynamics among the exchange rate, inflation, per capita GDP, and foreign exchange reserves. The results indicate strong short-run persistence in exchange rate movements, while the effects of inflation and reserves on exchange rate depreciation are statistically weak. Per capita GDP exhibits short-run significance, though this relationship does not persist in the long run. The bounds test confirms the existence of a long-run equilibrium relationship among the variables; however, the estimated long-run coefficients are not statistically significant, suggesting that reserves have limited explanatory power for sustained exchange rate depreciation. The findings do not provide strong empirical support for a reserve-driven “domino effect” in the Bangladeshi context. Instead, the results suggest that exchange rate dynamics are influenced more by internal persistence than by reserve depletion alone. The study contributes to the literature by offering evidence from a long-horizon time-series analysis and highlights the importance of cautious interpretation when linking reserve movements directly to exchange rate depreciation in emerging economies.

Keywords: Exchange rate depreciation · reserves · ARDL model · Economic stability · Domino effect · Bangladesh

1.0 Introduction

Exchange rate depreciation and the management of foreign exchange reserves are central issues for macroeconomic stability in emerging economies (Aizenman & Marion, 2003; Cheung & Ito, 2009). For countries operating under managed

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or semi-flexible exchange rate regimes, foreign exchange reserves serve as an important buffer against external shocks, facilitate international trade payments, and help stabilize market expectations (Lee & Yoon, 2020). A widely held assumption in both policy discussions and academic debates is that declining reserves may exert pressure on the exchange rate, potentially triggering further depreciation through a self-reinforcing mechanism often described as a “domino effect” (Bação et al., 2012).

In Bangladesh, heightened exchange rate volatility in recent years has coincided with a notable decline in foreign exchange reserves (Bangladesh Bank, 2023). These developments have renewed interest in understanding whether reserve depletion systematically contributes to exchange rate depreciation or whether exchange rate movements are primarily driven by other macroeconomic forces. While descriptive accounts frequently associate falling reserves with currency depreciation, such associations do not necessarily establish a stable or causal relationship, particularly over the long run (Narayan & Smyth, 2006; Lee & Yoon, 2020). This highlights the need for rigorous empirical investigation rather than relying solely on crisis narratives.

The fiscal year ending in June 2023 marked a period of heightened external vulnerability for Bangladesh, characterized by significant pressure on the domestic currency and a decline in foreign exchange reserves. The global commodity and energy price shocks following the Russia–Ukraine conflict increased import costs for import-dependent economies such as Bangladesh, thereby intensifying demand for foreign currency and placing sustained pressure on reserve holdings. During this period, Bangladesh Bank experienced a notable contraction in foreign exchange reserves, which declined by approximately USD 10.52 billion (25.39 percent) between June 2022 and June 2023 (Bangladesh Bank, 2023). At the same time, the nominal exchange rate of the Taka against the US dollar depreciated sharply, rising by Tk 23, representing a cumulative depreciation of 26.75 percent since March 2022 (Bangladesh Bank, 2023). These developments underscore the importance of empirically examining whether reserve depletion systematically contributes to exchange rate depreciation or whether both variables respond jointly to broader macroeconomic shocks.

From a theoretical perspective, the reserve–exchange rate linkage is commonly framed around a central bank’s capacity to intervene in the foreign exchange market and maintain confidence (Heller, 1976; Aizenman & Marion, 2003). A decline in reserves may weaken this capacity, potentially increasing vulnerability to speculative pressures and exchange rate depreciation. This intuition underpins the so-called “domino effect,” in which reserve depletion initiates a chain reaction that leads to sustained currency weakness (Bação et al., 2012). However,

whether this mechanism operates in practice is ultimately an empirical question and may depend on country-specific characteristics, including exchange rate arrangements, macroeconomic fundamentals, and the persistence of exchange rate dynamics (Cheung & Ito, 2009).

Empirical evidence on the relationship between foreign exchange reserves and exchange rates remains mixed. Some studies find that reserve adequacy plays a stabilizing role, while others report weak or insignificant effects once broader macroeconomic conditions are taken into account (Narayan & Smyth, 2006; Cheung & Ito, 2009). In the case of Bangladesh, existing research has largely focused on reserve accumulation, remittance inflows, trade performance, or monetary variables, with relatively limited attention given to directly testing whether reserve depletion exerts systematic pressure on exchange rate depreciation over a long time horizon (Chowdhury et al., 2014; Khan & Amin, 2021).

Against this backdrop, the present study investigates the relationship between exchange rate depreciation and foreign exchange reserves in Bangladesh using annual data from 1973 to 2022. Rather than offering a broad assessment of crisis consequences or policy effectiveness, the study adopts a focused empirical approach. Using the Autoregressive Distributed Lag (ARDL) bounds testing framework (Pesaran et al., 2001), the analysis examines both short-run dynamics and long-run relationships among the nominal exchange rate, inflation, per capita GDP, and foreign exchange reserves. This approach is well-suited for exploring long-run equilibrium relationships in small samples with variables integrated of mixed orders.

The contribution of this study is twofold. First, it provides long-horizon empirical evidence on the reserve–exchange rate relationship in Bangladesh using an econometric framework appropriate for time-series data with mixed integration properties. Second, it offers a direct empirical test of the reserve-driven “domino effect” hypothesis within a country-specific context. By doing so, the study clarifies whether declining reserves alone can explain exchange rate depreciation or whether exchange rate movements are better characterized by internal persistence and broader macroeconomic conditions.

The remainder of the paper is organized as follows. Section 2 reviews the relevant theoretical and empirical literature. Section 3 describes the data sources and econometric methodology. Section 4 presents and discusses the empirical results. Section 5 concludes with a summary of findings, limitations of the analysis, and cautiously derived policy implications.

2.0 Literature Review

2.1 Theoretical Perspectives on Exchange Rates and Foreign Exchange Reserves

Foreign exchange reserves play a critical role in the macroeconomic management of open economies, particularly in stabilizing exchange rates and mitigating external shocks. Traditional theories emphasize the precautionary motive for reserve accumulation, whereby countries hold reserves to smooth external imbalances, stabilize exchange rates, and maintain market confidence (Heller, 1976; Aizenman & Marion, 2003). Within this framework, declining reserves may weaken a central bank's capacity to intervene in foreign exchange markets, thereby increasing vulnerability to exchange rate depreciation.

The conceptual idea often described as a “domino effect” builds on this intuition. In this context, reserve depletion may initiate a sequence of adverse outcomes: reduced intervention capacity, deteriorating market confidence, speculative pressures, and ultimately sustained exchange rate depreciation (Bação et al., 2012). While this mechanism is frequently invoked in policy discussions, it is not automatic and depends on country-specific factors such as exchange rate regimes, capital mobility, and macroeconomic fundamentals. As such, the relevance of the domino effect remains an empirical question rather than a theoretical certainty.

Inflation and real economic activity are also closely linked to exchange rate dynamics. The quantity theory of money suggests that reserve accumulation, if not sterilized, may expand the money supply and generate inflationary pressures, indirectly influencing exchange rates (Heller, 1976). Conversely, under floating or managed exchange rate regimes, the relationship between reserves, inflation, and exchange rates may be weak or unstable, particularly when central banks pursue inflation-targeting or discretionary monetary policies (Steiner, 2017).

2.2 Empirical Evidence on Reserves, Exchange Rates and Inflation

Empirical studies examining the relationship between foreign exchange reserves and exchange rates have produced mixed results. Cross-country analyses often find that higher reserve levels are associated with greater exchange rate stability, particularly in emerging economies (Cheung & Ito, 2009). However, other studies report that once macroeconomic fundamentals are accounted for, the direct effect of reserves on exchange rate movements becomes statistically insignificant (Lee & Yoon, 2020).

Research using time-series techniques such as cointegration and ARDL models has further highlighted the complexity of this relationship. Narayan and Smyth (2006), for example, identify a long-run relationship between exchange rates

and reserves in China, while emphasizing that short-run dynamics may differ substantially from long-run equilibrium behavior. Similar findings are reported for several developing economies, where reserves influence exchange rates only under specific conditions or during periods of heightened external stress.

The relationship between inflation and reserves has also attracted considerable attention. Studies focusing on developing economies such as Pakistan, Nigeria, Vietnam, and Sri Lanka suggest that reserve accumulation can have inflationary consequences if not accompanied by effective monetary sterilization (Chaudhry et al., 2011; Akpan, 2016; Phung Nguyen et al., 2019). However, other empirical evidence indicates that the inflationary impact of reserves is weak or context-dependent, particularly in economies with evolving monetary frameworks (Ariyasinghe & Cooray, 2021).

Economic activity, often proxied by per capita GDP, is another factor influencing exchange rate dynamics. Higher income levels may increase import demand and foreign currency requirements, potentially exerting depreciation pressure, while simultaneously reflecting improved productive capacity and export potential. As a result, the net effect of economic growth on exchange rates remains ambiguous and warrants empirical investigation.

2.3 Evidence from Bangladesh and Related Economies

In the context of Bangladesh, existing studies have primarily focused on the determinants of foreign exchange reserves rather than directly examining their interaction with exchange rate depreciation. Chowdhury et al. (2014) identify a long-run relationship among reserves, exchange rates, remittances, the money supply, and per capita GDP, highlighting the importance of macroeconomic fundamentals in shaping reserve dynamics. Similarly, Khan and Amin (2021) emphasize the role of trade openness and remittance inflows in shaping reserve accumulation in Bangladesh.

While these studies provide valuable insights, they largely treat exchange rates as explanatory variables rather than outcomes influenced by reserve movements. Moreover, much of the Bangladesh-focused literature does not explicitly test whether reserve depletion generates systematic exchange rate pressure consistent with the domino effect hypothesis. Comparable studies from other developing economies suggest that the reserve–exchange rate relationship is highly context-specific and sensitive to data frequency, sample period, and econometric specification (Arize et al., 2004; Ali et al., 2018).

2.4 Research Gap and Contribution

Despite a growing body of literature on foreign exchange reserves and exchange rate dynamics, several gaps remain. First, there is limited empirical evidence

directly testing the reserve-driven domino effect hypothesis using long-horizon time-series data for Bangladesh. Second, existing studies often focus either on reserve accumulation or exchange rate determination in isolation, without jointly examining their dynamic interaction. Third, relatively few studies employ the ARDL bounds testing approach to explore both short-run and long-run relationships in the Bangladeshi context.

This study seeks to address these gaps by applying an ARDL framework to annual data from 1973 to 2022 to examine whether declining reserves exert systematic pressure on exchange rate depreciation in Bangladesh. By explicitly testing the existence and strength of both short-run and long-run relationships, the study contributes to a more nuanced understanding of reserve–exchange rate dynamics and clarifies the empirical relevance of the domino effect hypothesis in an emerging economy setting.

3.0 Methodology

3.1 Sources & Description of Data

The World Development Indicator publications (WDI, 2023) are the data sources for this study. Data on the exchange rate (ER), Inflation (IN), per capita GDP (PGDP), and Reserves (RE) are collected annually from 1973 to 2022. We used the exchange rate as the dependent variable and the remaining variables as explanatory variables. All variables in the study were converted to logarithms before the tests were performed, allowing elasticities to be calculated. The exchange rate series is strictly positive throughout the sample period, allowing for meaningful elasticity interpretation. Annual data are employed due to data availability constraints for earlier years; however, it is acknowledged that annual frequency may limit the ability to capture short-term crisis dynamics. The focus of the analysis is therefore on long-run relationships and medium-term adjustments rather than high-frequency market fluctuations. The Augmented Dicky Fuller (ADF) test, Autoregressive Distributed Lag (ARDL), and other crucial tests associated with the ARDL model, such as the normality test, serial correlation test, heteroscedasticity test, model specification test, and parameter stability test, were also carried out. The results of the aforementioned tests will enable us to recommend an appropriate policy framework for Bangladesh's ongoing exchange rate depreciation and its connection to falling reserves.

3.2 Methods

According to Nelson and Plosker (1982), the utilization of time series data may lead to misleading results if unit root issues are present, hence hindering the achievement of our research objectives. Consequently, prior to conducting the autoregressive distributed lag (ARDL) analysis, it is necessary to assess the presence of a unit root in order to ascertain the validity of the model. The

Augmented Dickey-Fuller (ADF) test is widely used to detect the presence of a unit root. The subsequent statement presents an illustration of an ADF equation:

$$\Delta Y_t = \alpha + \beta t + \delta Y_{t-1} + \lambda_t \sum_{i=1}^n \Delta Y_{t-i} + u_t$$

Cointegration is a term used to describe the presence of a stationary linear combination or long-term relationship between variables. There are several methods available for examining variable cointegration, with the ARDL bounds test being a widely utilized approach due to its ability to accommodate both I(0) and I(1) series. Given that our series comprises a combination of I(0) and I(1) components, the ARDL limits test is deemed suitable for our analysis.

The ARDL (1, 1) model is presented in a simplified form as follows:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \beta_0 X_t + \beta_1 X_{t-1} + \varepsilon_t$$

3.2.1 Model Specification

To examine the dynamic relationship between exchange rate depreciation and foreign exchange reserves in Bangladesh, the following ARDL (p, q_1, q_2, q_3) model is specified:

$$\begin{aligned} \ln(EX_t) = & \alpha_0 + \sum_{i=1}^p \alpha_i \ln(EX_{t-i}) + \sum_{j=0}^{q_1} \beta_j \ln(IN_{t-j}) + \sum_{k=0}^{q_2} \gamma_k \ln(PGDP_{t-k}) \\ & + \sum_{l=0}^{q_3} \delta_l \ln(RE_{t-l}) + \varepsilon_t \end{aligned}$$

where EX_t denotes the nominal exchange rate, IN_t represents inflation, $PGDP_t$ denotes per capita GDP, RE_t represents foreign exchange reserves, and ε_t is a white-noise error term.

3.2.2 Error Correction Representation

Following confirmation of cointegration using the ARDL bounds test, the short-run dynamics are estimated using an error-correction model (ECM). The ECM captures both short-run adjustments and the speed at which deviations from the long-run equilibrium are corrected. The ECM is specified as:

$$\begin{aligned} \Delta \ln(EX_t) = & \phi_0 + \sum_{i=1}^{p-1} \phi_i \Delta \ln(EX_{t-i}) + \sum_{j=0}^{q_1-1} \theta_j \Delta \ln(IN_{t-j}) \\ & + \sum_{k=0}^{q_2-1} \psi_k \Delta \ln(PGDP_{t-k}) + \sum_{l=0}^{q_3-1} \omega_l \Delta \ln(RE_{t-l}) + \lambda ECM_{t-1} \\ & + u_t \end{aligned}$$

where ECM_{t-1} represents the lagged error correction term derived from the long-run relationship. A negative and statistically significant coefficient of ECM_{t-1} indicates convergence toward long-run equilibrium, with its magnitude reflecting the speed of adjustment.

Finally, the Unit root properties of the variables are examined using the

Augmented Dickey–Fuller (ADF) test with a constant term. The specification with a constant is selected as it is most appropriate for macroeconomic time series exhibiting non-zero means. To avoid ambiguity, the integration order is determined by this consistent specification.

4.0 Results and Discussion

This section presents and discusses the empirical results obtained from the Autoregressive Distributed Lag (ARDL) model, focusing on the dynamic relationship between exchange rate depreciation and foreign exchange reserves in Bangladesh. The analysis proceeds in four stages: unit root testing, lag length selection and ARDL estimation, cointegration analysis, and short- and long-run dynamics through the error-correction framework.

Table 1. Results of ADF Unit Root Test

Null Hypothesis: the variable has a unit root					
		<u>At Level</u>			
		EX	IN	PGDP	RE
With Constant	t-Statistic	-4.0660	-4.4393	5.1825	-0.3957
	Prob.	0.0025	0.0008	1.0000	0.9014
		***	***	n0	n0
With Constant & Trend	t-Statistic	-3.2095	-4.6102	-0.0869	-2.9252
	Prob.	0.0945	0.0029	0.9937	0.1639
		*	***	n0	n0
Without Constant & Trend	t-Statistic	3.9019	-1.7423	2.2515	3.3376
	Prob.	0.9999	0.0773	0.9934	0.9997
		n0	*	n0	n0
		<u>At First Difference</u>			
		d(EX)	d(IN)	d(PGDP)	d(RE)
With Constant	t-Statistic	-4.5126	-10.2525	-1.7596	-7.7130
	Prob.	0.0007	0.0000	0.3954	0.0000
		***	***	n0	***
With Constant & Trend	t-Statistic	-5.2091	-10.2067	-13.0724	-7.6122
	Prob.	0.0005	0.0000	0.0000	0.0000
		***	***	***	***
Without Constant & Trend	t-Statistic	-3.4836	-10.3181	0.1247	-5.8100
	Prob.	0.0008	0.0000	0.7171	0.0000
		***	***	n0	***

Note: a: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%, and (no) Not Significant

4.1 Unit Root Test Results

Before estimating the ARDL model, the stationarity of the variables is examined using the Augmented Dickey–Fuller (ADF) test. Table 1 presents the outcomes of the ADF unit root examination. Assuming “with constant & trend,” the t-statistics for EX, IN, PGDP, and RE are -3.2095, -4.6102, -0.0869, and -2.9252, respectively. The corresponding p-values are 0.0945, 0.0029, 0.9937, and 0.1639. With the exception of the p-value for IN, all other p-values exceed 0.05. This indicates that EX, PGDP, and RE are non-stationary in level form. After computing the first differences of EX, IN, PGDP, and RE, the corresponding t-statistics were -5.2091, -10.2067, -13.0724, and -7.6122, respectively. The resulting p-values were 0.0005, 0.0000, 0.0000, and 0.0000, respectively. Given that all p-values are below the 0.05 significance level, the null hypothesis can be rejected, indicating that all variables are stationary. Hence, the series EX, IN, PGDP, and RE are a combination of both $I(0)$ and $I(1)$ series. These findings justify the use of the ARDL methodology, which allows for the estimation of both short-run and long-run relationships without requiring all variables to be integrated of the same order.

4.2 Lag Selection and ARDL Model Estimation

Lag lengths for the ARDL model are selected using the Akaike Information Criterion (AIC), which is well-suited for small-sample time-series analysis. Based on this criterion, the selected specification is ARDL(3,0,1,2), with exchange rate depreciation as the dependent variable.

The estimated ARDL model reveals strong persistence in exchange rate movements. Lagged exchange rate values are highly significant, indicating that current depreciation is strongly influenced by its own past behavior. This result suggests the presence of inertia or adjustment frictions in the foreign exchange market, consistent with the observed gradual exchange rate adjustment over time.

Inflation does not exhibit a statistically significant contemporaneous effect on exchange rate depreciation. This suggests that inflationary pressures, at least within the annual data framework, do not directly drive exchange rate movements once other variables are accounted for. Per capita GDP shows marginal short-run significance, while foreign exchange reserves exhibit weak, unstable effects across lags. These findings indicate that reserve movements do not exert a strong or consistent short-run influence on exchange rate depreciation.

Table 2. ARDL Model

Dependent Variable: EX

Model selection method: AIC

Selected Model: ARDL (3, 0, 1, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
EX (-1)	1.370091	0.093705	14.62140	0.0000
EX (-2)	-0.721312	0.127093	-5.675461	0.0000
EX (-3)	0.336173	0.081918	4.103783	0.0002
IN	-0.005603	0.006787	-0.825566	0.4143
PGDP	0.710847	0.374947	1.895860	0.0658
PGDP (-1)	-0.613311	0.378819	-1.619010	0.1139
RE	-0.033347	0.017091	-1.951122	0.0586
RE (-1)	-0.038186	0.022501	-1.697104	0.0981
RE (-2)	0.033800	0.018611	1.816120	0.0775
C	0.270461	0.121214	2.231266	0.0318
R-squared	0.997353	Mean dependent var		3.800677
Adjusted R-squared	0.996709	S.D. dependent var		0.558069
S.E. of regression	0.032016	Akaike info criterion		-3.858829
Sum squared resid	0.037927	Schwarz criterion		-3.465181
Log likelihood	100.6825	Hannan-Quinn criterion.		-3.710697
F-statistic	1548.792	Durbin-Watson stat		2.217079
Prob (F-statistic)	0.000000			

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

4.3 ARDL Bounds Test for Cointegration

The ARDL bounds test is employed to examine the existence of a long-run equilibrium relationship among exchange rate depreciation, inflation, per capita GDP, and foreign exchange reserves. The computed F-statistic exceeds the upper critical value at conventional significance levels, indicating cointegration among the variables.

The bounds test F-statistic is 5.22254, surpassing the upper bound critical value of 4.66 at the 1% level as established by Pesaran et al. (2001). Therefore, it can be inferred that the variables EX, RE IN, and PGDP are highly cointegrated. Thus, the hypothesis of a degenerate lagged dependent variable is refuted. The present study's findings suggest that the variables in question exhibit cointegration and demonstrate long-term convergence.

Table 3. ARDL Bounds Test

Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	k
F-statistic	5.292254	3
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10 %	2.37	3.2
5 %	2.79	3.67
2.5 %	3.15	4.08
1 %	3.65	4.66

4.4 Short-Run Dynamics and Error Correction Mechanism

Following confirmation of cointegration, the short-run dynamics are analyzed using the error-correction model (ECM). The coefficient of the lagged error correction term is negative and statistically significant, confirming the presence of long-run equilibrium adjustment.

However, the magnitude of the ECM coefficient is relatively small (approximately -0.015), indicating that only about 1.5 percent of deviations from long-run equilibrium are corrected each year. This implies a very slow adjustment process, suggesting that shocks to the exchange rate–reserve system persist for extended periods before convergence occurs. Such slow adjustment is consistent with the use of annual data and the presence of structural rigidities in the economy.

In the short run, changes in the exchange rate continue to exhibit strong dependence on their own past values, reinforcing the finding of exchange rate persistence. Changes in inflation remain statistically insignificant, while per capita GDP shows a positive and significant short-run association with exchange rate depreciation. This may reflect demand-side pressures associated with income growth, such as increased import demand and higher foreign-currency requirements, rather than a causal mechanism linking growth to depreciation.

Changes in foreign exchange reserves display mixed signs across lags and are only weakly significant. This instability suggests that reserve fluctuations do not exert a systematic short-run influence on exchange rate depreciation, further weakening support for a reserve-driven adjustment mechanism.

Table 4. ARDL Cointegrating and Long Run Form

Short Run Result				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D (EX(-1))	0.398791	0.085538	4.662138	0.0000
D (EX(-2))	-0.345375	0.080119	-4.310771	0.0001
D (IN)	-0.002929	0.005268	-0.555914	0.5816
D (PGDP)	0.705695	0.134901	5.231223	0.0000
D (RE)	-0.034401	0.014684	-2.342708	0.0246
D(RE (-1))	-0.032334	0.015826	-2.043083	0.0482
ECM (-1)	-0.015155	0.002810	-5.393500	0.0000
ECM = EX - (-0.3723*IN + 6.4814*PGDP -2.5074*RE + 17.9725)				

4.5 Long-Run Coefficients and Interpretation

The estimated long-run coefficients for inflation, per capita GDP, and foreign exchange reserves are statistically insignificant in Table 5. This indicates that, over the long run, none of these variables individually exerts a robust influence on exchange rate depreciation within the model framework.

The insignificance of the reserve coefficient in the long run is particularly important for evaluating the “domino effect” hypothesis. While reserve depletion is often assumed to generate sustained exchange rate pressure, the empirical evidence does not provide strong support for this mechanism in the Bangladeshi context. Instead, exchange rate dynamics appear to be driven primarily by internal persistence rather than by reserve movements alone.

Table 5. Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IN	-0.372339	0.612865	-0.607538	0.5472
PGDP	6.481377	10.615745	0.610544	0.5452
RE	-2.507407	4.442822	-0.564372	0.5759
C	17.972545	32.339694	0.555743	0.5817

4.6 Diagnostic and Stability Tests

A series of diagnostic tests is conducted to assess the adequacy of the estimated ARDL model. The Breusch–Godfrey serial correlation test indicates no evidence of autocorrelation, while the Breusch–Pagan–Godfrey test suggests homoscedastic residuals. The Jarque–Bera test confirms that the residuals are normally distributed.

A key limitation of this study is that, although the CUSUM and CUSUMSQ tests indicate overall parameter stability, they also reveal signs of structural

breaks over the sample period. In particular, the analysis spans two distinct exchange rate regimes—a fixed exchange rate period (1973–1993) followed by a floating or managed (dirty floating) regime thereafter. The model does not explicitly account for these regime shifts, which may mask underlying parameter instability and lead to biased or averaged effects across fundamentally different policy environments. Therefore, we suggest interpreting the results with caution, as using annual data across heterogeneous economic regimes may obscure important structural changes.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.441157	Prob. F(2,35)	0.6468
Obs*R-squared	1.155687	Prob. Chi-Square(2)	0.5611

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.710024	Prob. F(9,37)	0.6960
Obs*R-squared	6.921842	Prob. Chi-Square(9)	0.6453
Scaled explained SS	4.003887	Prob. Chi-Square(9)	0.9112

Normality Test

In order to conduct a normality test, it is necessary to ensure that the residuals of the null hypothesis exhibit a normal distribution. The results indicate that the residuals are normally distributed, as evidenced by the JB statistic of 0.403 and the corresponding p-value of 0.817, both of which exceed the 5% significance level. The normality plot depicted in Figure 1 is presented below

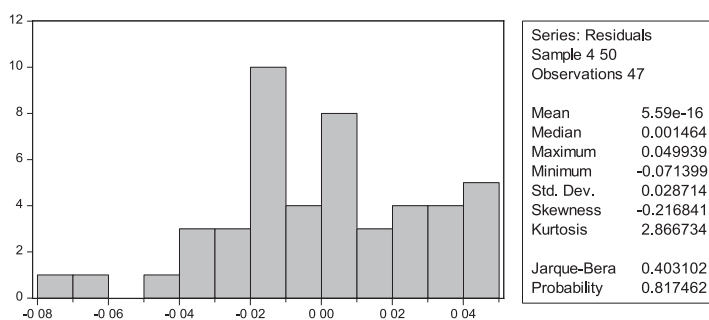
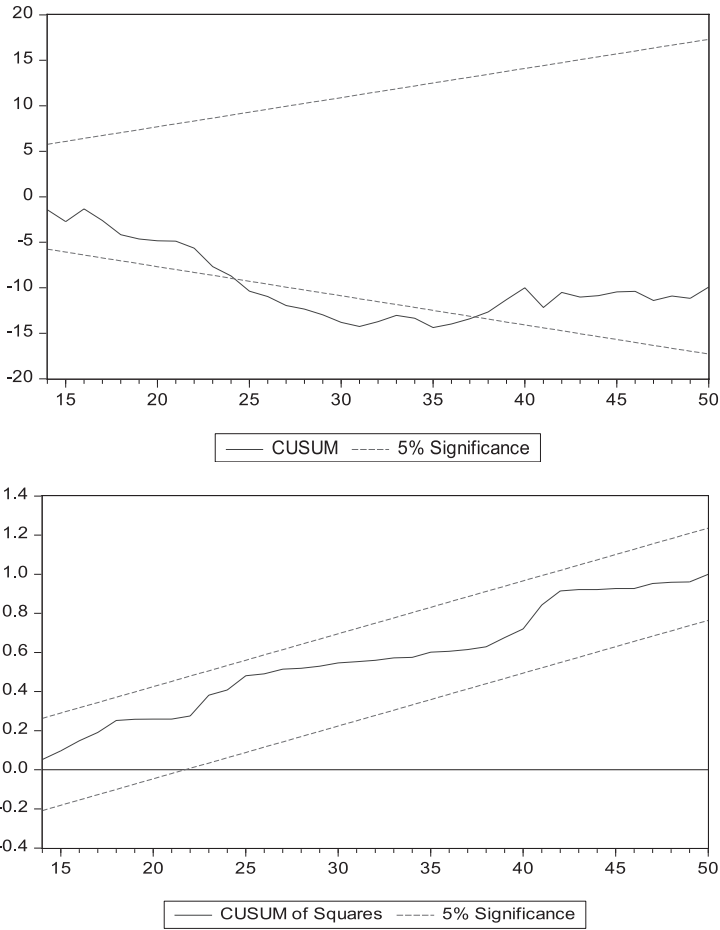


Figure 1. Normality Test

Both the CUSUM and CUSUM square demonstrate a consistent correlation over time, but only a slight break in the CUSUM test. This finding suggests the possibility of a structural change in the relationship between the variables under investigation



4.7 Discussion: Implications for the Domino Effect Hypothesis

Taken together, the empirical results provide limited support for a reserve-driven “domino effect” in Bangladesh. While exchange rate depreciation and foreign exchange reserves are cointegrated, reserve movements do not exert statistically significant or stable effects on exchange rate depreciation in either the short- or long-run. This suggests that reserve depletion, by itself, does not constitute a dominant transmission channel through which exchange rate pressures materialize in the Bangladeshi economy.

One possible explanation for this outcome is that exchange rate dynamics in Bangladesh are influenced by broader macroeconomic and institutional factors that are not fully captured by reserve levels alone. The presence of strong exchange rate persistence indicates that past exchange rate movements play a more important role in shaping current depreciation than contemporaneous reserve changes. This persistence may reflect gradual policy adjustments, market expectations, and administrative interventions that smooth exchange rate

movements over time rather than allowing abrupt adjustments driven solely by reserve fluctuations.

The slow speed of adjustment captured by the error correction mechanism further reinforces this interpretation. With only a small fraction of deviations from long-run equilibrium corrected each year, the adjustment process appears gradual rather than crisis-driven. Such slow convergence suggests that shocks to the exchange rate–reserve system tend to have prolonged effects, consistent with structural rigidities and policy constraints in the economy. As a result, even substantial reserve changes may not immediately translate into pronounced exchange rate responses.

These findings also imply that the commonly cited domino effect—whereby declining reserves rapidly erode confidence and trigger accelerated depreciation—may not operate strongly in the Bangladeshi context, at least when examined using long-horizon annual data. Instead, reserve movements and exchange rate depreciation may respond jointly to underlying macroeconomic conditions, such as external shocks, trade imbalances, or demand pressures, rather than one variable systematically driving the other.

Overall, the evidence suggests that exchange rate depreciation in Bangladesh is more closely associated with internal persistence and broader macroeconomic dynamics than with reserve depletion alone. This underscores the importance of cautious interpretation when attributing exchange rate movements to reserve changes and highlights the need to consider a wider set of structural and policy factors when evaluating exchange rate behavior in emerging economies.

5.0 Conclusions and Policy Implications

This study examined the relationship between exchange rate depreciation and foreign exchange reserves in Bangladesh using annual data from 1973 to 2022 and applying the Autoregressive Distributed Lag (ARDL) bounds testing framework. The analysis was motivated by the widely held assumption that declining reserves may exert systematic pressure on the exchange rate through a reserve-driven “domino effect.” By distinguishing between short-run dynamics and long-run equilibrium relationships, the study provides a focused empirical assessment of this hypothesis within the Bangladeshi context.

The empirical results reveal strong persistence in exchange rate movements, indicating that current depreciation is largely influenced by past exchange rate behavior. While the bounds test confirms the existence of a long-run relationship among exchange rate depreciation, inflation, per capita GDP, and foreign exchange reserves, the estimated long-run coefficients are statistically insignificant. In the short run, inflation does not exert a meaningful influence on

exchange rate depreciation, while per capita GDP shows a positive but context-dependent association. Importantly, foreign exchange reserves do not exhibit a stable or statistically robust effect on exchange rate depreciation in either the short- or long-run.

The error correction mechanism indicates a statistically significant but very slow speed of adjustment toward long-run equilibrium, with only a small fraction of deviations corrected each year. This slow convergence suggests that shocks to the exchange rate–reserve system tend to persist over extended periods, which may reflect structural rigidities, policy inertia, or the limitations inherent in annual data. Taken together, these findings suggest that exchange rate depreciation in Bangladesh is better characterized by internal persistence and broader macroeconomic conditions rather than by reserve depletion alone.

From a policy perspective, the results caution against viewing foreign exchange reserve depletion as a sole or dominant driver of exchange rate depreciation. While maintaining adequate reserves remains important for confidence, liquidity provision, and external payment obligations, the empirical evidence does not support strong claims that reserve losses mechanically trigger sustained exchange rate depreciation. Policymakers should therefore avoid overreliance on reserve drawdowns as a primary tool for exchange rate stabilization and instead consider a broader set of macroeconomic and structural factors influencing exchange rate dynamics.

Several limitations of the study should be acknowledged. The analysis is based on a relatively small set of macroeconomic variables and relies on annual data, which may not fully capture short-term crisis dynamics or high-frequency market adjustments. Additionally, potential structural breaks over the long sample period may affect the estimated relationships, despite evidence of overall parameter stability. Future research could extend this analysis by incorporating higher-frequency data, additional macroeconomic variables such as interest rate differentials or trade balances, and alternative econometric techniques to further explore exchange rate–reserve interactions.

Finally, this study contributes to the literature by providing long-horizon empirical evidence on the exchange rate–reserve relationship in Bangladesh and by offering a cautious evaluation of the reserve-driven domino effect hypothesis. The findings highlight the importance of disciplined interpretation when linking reserve movements to exchange rate outcomes and underscore the need for comprehensive policy frameworks that address exchange rate dynamics beyond reserve management alone.

References

- Ahamed, F. (2021). Macroeconomic impact of COVID-19: A case study on Bangladesh. *IOSR Journal of Economics and Finance*, 12(1), 24–29. <https://doi.org/10.9790/5933-1201042429>
- Ahmed, R., Aizenman, J., & Jinjara, Y. (2021). Inflation and exchange rate targeting challenges under fiscal dominance. *Journal of Macroeconomics*, 67, 103281. <https://doi.org/10.1016/j.jmacro.2020.103281>
- Ariyasinghe, A., & Cooray, N. S. (2021). The nexus of foreign reserves, exchange rate, and inflation: Recent empirical evidence from Sri Lanka. *South Asia Economic Journal*, 22(1), 29–72. <https://doi.org/10.1177/1391561420987106>
- Baço, P., Domingues, J., & Duarte, A. (2012). Financial crisis and domino effects. *Journal of Economic Studies*, 39(6), 672–688.
- Bangladesh Bank. (2023). *Monthly economic trends*. <https://www.bb.org.bd>
- Cheung, Y.-W., & Ito, H. (2009). A cross-country empirical analysis of international reserves. *International Economic Journal*, 23(4), 447–481.
- Chowdhury, M. N. M., Uddin, M. J., & Islam, M. S. (2014). Determinants of foreign exchange reserves in Bangladesh. *Journal of World Economic Research*, 3(6), 72–82.
- Heller, H. R. (1976). International reserves and world-wide inflation. *IMF Staff Papers*, 23 (1), 1–26.
- Khan, A., & Amin, S. (2021). Nexus among foreign exchange reserves, remittance and trade openness: Evidence from Bangladesh. *Journal of Empirical Studies*, 8(1), 1–12. <https://doi.org/10.18488/journal.66.2021.81.1.12>
- Lee, Y., & Yoon, S.-M. (2020). Relationship between international reserves and exchange rate movements. *Sustainability*, 12(17), 6961. <https://doi.org/10.3390/su12176961>
- Narayan, P. K., & Smyth, R. (2006). The dynamic relationship between exchange rates and foreign reserves. *Journal of Economic Studies*, 33(6), 480–493.
- Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289–326.

An Inquiry into the Influence of Key Macroeconomic Variables on the Dhaka Stock Exchange Equity Prices

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Abstract

This study examines the performance of the Dhaka Stock Exchange (DSE) from January 2015 to December 2024 and empirically analyzes the implications for key macroeconomic variables, including interest rates, inflation, and exchange rates. The analysis uses monthly data from Bangladesh Bank and employs time-series econometric methods, including unit root tests, Johansen cointegration tests, vector error correction models (VECMs), and Granger causality tests. The results show that all variables are integrated of order one and indicate a single long-run cointegrating relationship. Interest rates have a substantial negative long-term impact on the DSE index, consistent with theoretical predictions that higher borrowing and opportunity costs depress equity prices. Conversely, inflation and exchange rates do not exhibit statistically significant long-term effects; however, short-term dynamics indicate that inflation positively influences the index, perhaps due to speculative market behavior. Granger causality tests establish bidirectional causality between interest rates and the DSE index, while inflation is found to affect exchange rates. These results underscore the DSE's inefficiency, in which macroeconomic shocks may exert delayed or exacerbated impacts on pricing. The research offers practical insights for investors, policymakers, and regulators, including the importance of monetary policy coordination and enhanced market efficiency in Bangladesh.

Keywords: Dhaka Stock Exchange (DSE) · Macroeconomic Variables · Stock Market Volatility · Time-Series Models

JEL Codes: G12 · E00 · G28 · E44 · C32

1. Introduction

There has been considerable discussion about the effectiveness of stock exchanges, given their significant role in global economies and financial

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markets. Stock markets help the economy expand by influencing how people and businesses spend and save their money. They achieve these objectives by ensuring people spend their money wisely and encouraging them to invest in assets that will pay dividends. As a result, market performance has become a key measure of economic fundamentals that affects the investment decisions of both domestic and international investors (Islam et al., 2015). Macroeconomic variables are often considered crucial factors influencing stock market trends, as they may affect future corporate cash flows and the risk-adjusted discount rates used in valuation models (Islam et al., 2015; Eldomiaty et al., 2020). Stock exchanges are also beneficial for firms because they facilitate trading and generate substantial cash flow (Adjasi & Biekpe, 2006). For this beneficial role to work, the stock market and key macroeconomic data must be closely connected. Theorists agree that macroeconomic factors are important, but their nature, size, and direction are unclear. This position is especially true in Emerging Markets (EM), where institutional and structural factors are completely unique (Islam et al., 2014; Islam et al., 2015; Current Market Valuation, 2025). This variation shows how vital it is to look at each country separately. There have been several ups and downs at the Dhaka Stock Exchange (DSE) in Bangladesh over the years (Islam et al., 2023a). Therefore, investors, regulators, and politicians need to determine which macroeconomic conditions affect its performance. The research examines the impact of macroeconomic indicators on the DSE's stock prices. From an economic standpoint, Bangladesh's leading stock market, the DSE, is classified as an emerging market (EM); however, significant efforts are required to address capacity building relative to GDP, as well as structural constraints and volatility challenges. This study analyzes several key macroeconomic variables and their impact on the DSE index's stock prices. To understand equity prices, the study analyzes three key macroeconomic variables: interest rates, inflation, and currency rates. Interest rates, inflation, and exchange rates are crucial macroeconomic factors that significantly impact investment decisions in equity markets and encourage companies to list on the DSE to finance productive endeavors.

2. Background of the Study

Stock markets are pivotal for economic growth; they function as efficient mechanisms for mobilizing capital and channeling it toward productive investment. In emerging economies, their roles are even more evident, as they intensify domestic financial systems, enhance resource allocation, and support industrialization and economic development (Islam et al., 2014; Islam et al., 2015). The increasing interconnectedness of global financial markets further accentuates the importance of understanding their complex dynamics (Islam et al., 2015). This study focuses on the DSE, Bangladesh's primary stock

exchange, within the broader context of the country's strong economic growth recently (Islam et al., 2014). National economic conditions are closely tied to the DSE's performance, serving as a barometer of fundamental factors. However, the exchange is characterized by unique characteristics and risks, including frequent regulatory changes, a relatively small market size, low liquidity, and limited depth. Historically, the DSE has been prone to manipulation and sharp crashes, most notably in 1996 and 2011 (Gwala & Mashau, 2022; Islam et al., 2023a). These features distinguish the DSE from developed markets and impact the transmission of macroeconomic shocks. Evidence indicates that the DSE is not weak-form efficient because its index follows a predictable pattern (Islam et al., 2017). Structural weaknesses, such as low market capitalization and turnover, a narrow range of financial products, and a large proportion of inexperienced investors (Islam et al., 2023a), undermine price discovery and slow the incorporation of information into stock prices. Consequently, macroeconomic announcements may exert a stronger or delayed effect than efficient markets would predict. This inefficiency highlights the relevance of analyzing macroeconomic-stock market linkages in Bangladesh. For investors, understanding these relationships provides valuable guidance for portfolio management. For policymakers, it sheds light on the interplay between financial markets and broader economic stability (Islam et al., 2015).

3. Literature Review

Research indicates that macroeconomic factors account for approximately 30–35% of the variation in stock prices (Chandra, 2004). This study focuses on economic fundamentals, offering a thorough examination of fundamental analysis and illustrating the impact of root macroeconomic variables on stock price movements. Corporate earnings, a crucial determinant of stock prices, are affected by multiple factors, including economic growth, productivity, labor quality, and capital stock (Golob & Bishop, 1997). In addition, direct and indirect factors such as interest rates, industrial output, inflation, exchange rates, and the money supply significantly affect stock market performance (Goswami & Jung, 1997). Maysami et al. (2005), in their cointegration analysis of Singapore's stock market, confirmed the importance of these macroeconomic variables. Similar findings have been reported by Aga & Kocaman (2006), Abeyratna et al. (2004), and Bilson et al. (1999), among others.

3.1 Theoretical Foundations of Macroeconomic Influences on Stock Markets

The interaction between macroeconomic conditions and stock market performance is pivotal to financial economics and is grounded in several theoretical constructs. The Efficient Market Hypothesis (EMH), articulated by Fama (1970), posits that stock prices fully reflect market expectations of a company's future performance, which is inherently tied to broader macroeconomic conditions (Eldomiaty

et al., 2020). In a truly efficient market, all available information, including macroeconomic data, is quickly and completely absorbed into prices. However, evidence indicates that the DSE does not conform to the weak form of the EMH (Islam et al., 2017), suggesting that macroeconomic variables may exert stronger, more exploitable effects due to information asymmetries and delayed adjustments. Ross's (1976) Arbitrage Pricing Theory (APT) further extends this view, proposing that asset returns are influenced by multiple macroeconomic risk factors, with investors earning risk premia in response. APT does not identify specific factors; however, it provides a comprehensive framework for the simultaneous analysis of multiple variables, in contrast to single-factor models like the Capital Asset Pricing Model (CAPM) (Eldomiaty et al., 2020). Interest rates are widely regarded as a major determinant of stock prices. They fluctuate with time, default risk, inflation, and capital productivity (Chandra, 2004). Shifts in interest rates influence investor behavior, leading to reallocations between equity markets and fixed-income instruments, as well as to speculative activity. Central banks regulate interest rates through monetary policy (Kevin, 2000), while informal financial markets remain unregulated. Theory predicts an inverse relationship between interest rates and stock prices. Smith (1990) exhibited that U.S. stock prices often rose following interest rate cuts. In Korea, Goswami & Jung (1997) found an inverse relationship between stock prices and long-term rates, but a positive correlation with short-term rates due to liquidity effects.

The cash-flow discounting model posits that elevated interest rates augment discount rates, consequently diminishing the present value of anticipated cash flows and, by extension, stock prices (Islam et al., 2017; Eldomiaty et al., 2020; Rahman et al., 2012). At the same time, higher borrowing costs reduce corporate profitability, suppressing valuations. Conversely, lower rates stimulate investment and economic activity, boosting stock returns. The opportunity cost channel reinforces this relationship: when interest rates rise, fixed-income assets become more attractive relative to equities, prompting investors to shift capital out of the stock market (Islam et al., 2017; Rahman et al., 2012). Given the inefficiency of the DSE, this channel likely has an amplified effect, as investors may quickly reallocate funds into bank deposits promising higher guaranteed returns. Inflation also plays a pivotal role. While Chandra (2004) noticed its dual impact across industries, most studies indicate an inverse relationship between inflation and stock prices. Fama & Schwert (1977) demonstrated that both expected and unexpected inflation reduce stock returns. Feldstein (1979, 1997) and Summers (1981) highlighted the distorting impact of inflation on taxation and accounting rules, including understated depreciation and the taxation of nominal gains, which depress real returns. Amadi & Odubo (2002) argued that mispricing often results from investors relying on nominal instead of real

measures. Empirical evidence strongly supports the negative effect of inflation, which arises through purchasing power erosion, reduced profitability, tax distortions, and negative real returns (Eldomiaty et al., 2020; Gopinath, 2025). The exchange rate–stock price relationship is more intricate. Fluctuations directly affect import-dependent industries and corporate earnings. Maku & Atanda (2010) found a positive correlation between stock prices and a depreciating Naira in Nigeria. Exchange rates influence competitiveness, trade balances, and reserves, creating risks and opportunities (Osamwonyi, 2003). Channels include (i) international competitiveness and trade balance, where depreciation boosts exports (Eldomiaty et al., 2020; Phylaktis & Ravazzolo, 2005); (ii) transaction and translation exposure in trade and financial statements; and (iii) the economic activity channel, where depreciation can increase aggregate demand. Empirical findings are mixed—negative (Mfugale & Olomi, 2023), positive (Golder et al., 2020), or even reverse causality (Ullah et al., 2017). This variability underscores the need for country-specific analysis.

3.2 Empirical Evidence in Emerging Economies

A substantial body of literature highlights the impact of macroeconomic factors on emerging markets (EM) (Islam et al., 2014; 2015; Eldomiaty et al., 2020). Garza-Garcia & Yue (2010) demonstrated U.S. influence on Chinese markets, while Sharma & Mahendru (2010) found similar dynamics in India. Asmy et al. (2010) noted differences in the pre- and post-crisis relationships among inflation, the money supply, and exchange rates. Humpe & Macmillan (2009) found strong macro-market linkages in the U.S. and Japan. Qayyum & Anwar (2011) showed that monetary policy drives volatility in Pakistan. More recent studies confirm that GDP, interest rates, inflation, exchange rates, money supply, and capital flows are key factors, though results often conflict in direction and significance (Mfugale & Olomi, 2023). This inconsistency demonstrates the importance of localized analysis, as causality and magnitude vary across contexts (Adrian et al., 2024; Gopinath, 2025).

3.3 Literature on the Dhaka Stock Exchange

For the DSE, multiple studies confirm a long-run cointegrating relationship between stock prices and macroeconomic variables (Islam et al., 2018). Inflation consistently negatively affects DSE returns (Gwala & Mashau, 2022; Golder et al., 2020; Mfugale & Olomi, 2023). Similarly, interest rates negatively affect prices, aligning with opportunity cost and profitability theories (Islam et al., 2017; Mfugale & Olomi, 2023). Exchange rate effects, however, are mixed: some studies demonstrate a positive link, others a negative one, and some indicate reverse causality, where stock prices Granger-cause exchange rates (Ullah et al., 2018). These contradictions highlight the DSE's inefficiency, low liquidity, and heightened sensitivity to macro shocks.

3.4 Identification of the Research Gap

While theory and empirical evidence suggest that macroeconomic factors influence stock markets, findings for emerging markets (EM) are inconsistent and context-dependent. In Bangladesh, the DSE's inefficiency, volatility, and structural limitations suggest that macroeconomic shocks may have stronger, delayed effects than in developed markets. Empirical evidence on the impacts of inflation and exchange rates is particularly contradictory, underscoring the need for context-specific verification. This study addresses these gaps by examining the effects of *interest rates, inflation, and exchange rates* on the DSE using updated monthly data (2015–2024) and advanced econometric methods. It tests the applicability of established theories in Bangladesh's unique market environment, characterized by import dependency and the opportunity cost of bank deposits. The findings aim to provide nuanced insights for investors, policymakers, and regulators.

3.5 Research Questions

This study aims to address the following research questions:

3.5.1 Time-Series Properties

What are the stationarity characteristics and descriptive statistics of the DSE index, interest rate, inflation rate, and exchange rate of Bangladesh during 2015–2024?

3.5.2 Long-Run Relationships

Are the DSE index, interest rate, inflation rate, and exchange rate cointegrated in the long run over the study period?

3.5.3 Short-Run and Long-Run Effects

How do interest rates, inflation, and exchange rates influence the DSE index in both the short run and the long run?

3.5.4 Causality Dynamics

Does Granger causality exist between the DSE index and the selected macroeconomic variables? If so, what is the direction of causality?

3.6 Research Hypotheses

3.6.1 H1: Time-Series Properties

H1a: The DSE index, interest rate, inflation rate, and exchange rate are non-stationary at their levels.

H1b: These variables become stationary after first differencing, indicating integration of order one, $I(1)$.

3.6.2 H2: Long-Run Relationships

H2a: The DSE index, interest rate, inflation rate, and exchange rate share at least one cointegrating relationship in the long run.

H2b: Interest rates exert a significant negative long-run effect on the DSE index.

H2c: Inflation and exchange rates exert significant long-run effects on the DSE index.

3.6.3 H3: Short-Run Dynamics

H3a: Interest rates have a significant short-run effect on the DSE index.

H3b: Inflation has a significant short-run effect on the DSE index.

H3c: Exchange rate fluctuations have a significant short-run effect on the DSE index.

3.6.4 H4: Granger Causality

H4a: There exists bidirectional Granger causality between interest rates and the DSE index.

H4b: Inflation Granger-causes the DSE index and/or the exchange rate.

H4c: Exchange rate fluctuations Granger-cause the DSE index.

4. Data and Research Methods

4.1 Data Availability

This study uses monthly time-series data for the DSE Index (as the dependent variable) and three key macroeconomic variables: the interest rate, inflation rate, and exchange rate (as independent variables). The primary data source for all variables is the Bangladesh Bank website, ensuring consistency and direct applicability to the research query. The dataset covers a continuous 10-year period from January 2015 to December 2024, yielding a total of 120 monthly observations per variable. This length of data is generally considered sufficient for robust time-series econometric analysis.

Among the four variables, the first, i.e., the DSE Index datasets collected from the Dhaka Stock Exchange depository, refer to datasets that track the performance of the Dhaka Stock Exchange, Bangladesh's main stock exchange (<https://www.dsebd.org/>). The other three variables recognized were collected from the Bangladesh Bank's (BB) repository system (<https://www.bb.org.bd/en/index.php>). Both repositories are publicly available. The two data sources' names and repositories:

4.1.1 Name of Data Source: Dhaka Stock Exchange (DSE) and

Repository: <https://www.dsebd.org/>

4.1.2 Name of Data Source: Bangladesh Bank (BB) and

Repository: <https://www.bb.org.bd/en/index.php>

The variables are defined as follows:

4.1.1 DSE Index

Represents the overall performance of the Dhaka Stock Exchange, serving as a proxy for the aggregate stock market return.

4.1.2 Interest Rate

Reflects the general cost of borrowing in the economy and the opportunity cost of holding equity investments.

4.1.3 Inflation Rate

Measured by the Consumer Price Index (CPI), indicating the rate of change in the general price level of goods and services.

4.1.4 Exchange Rate

Represents the value of the Bangladeshi Taka against USD.

4.2 Model Specification (General)

$INDEX = A * INTEREST_RATE + B * INFLATION_RATE + C * EXCHANGE_RATE + D + E$

Where A, B, and C are coefficients, D and E consist of a parameter and a disturbance term, respectively, and INDEX means DSE Index.

4.2.1 The Static Model (Baseline Specification)

Based on the model specification you provided and the dataset details (monthly time-series data from 2015 to 2024), the study has reformulated the equation into a proper time-series econometric model. To do so, the given static model is redefined as:

If we write the equation exactly as given, but with a time subscript (t) to denote the monthly observations, it is:

$$(INDEX)_t = \beta_0 + \beta_1 \cdot (INTEREST_RATE)_t + \beta_2 \cdot (INFLATION_RATE)_t + \beta_3$$

Where:

$t = 1, 2, \dots, 120$ (representing January 2015 to December 2024).

β_0 = The constant term (D in your specification, containing the parameter).

$\beta_1, \beta_2, \beta_3$ = The coefficients (A, B, C).

ϵ_t = The disturbance term (E), assumed to be white noise.

4.2.2 The Dynamic Time Series Model

The use of monthly data over a decade requires accounting for dynamics (lags) and the error structure in a proper time-series equation. Because you are using the DSE Index (a financial variable) with monthly data, the static model above is likely to suffer from autocorrelation and non-stationarity. In time-series econometrics, it is standard to include a lagged dependent variable to capture market momentum (investors often look at last month's performance) and to ensure that the residuals are uncorrelated. A more appropriate time series equation for your specification is an Autoregressive Distributed Lag (ARDL) model:

$$\text{INDEX}_t = \alpha + \phi \cdot \text{INDEX}_{t-1} + \beta_1 \cdot \text{INTEREST_RATE}_t + \beta_2 \cdot \text{INFLATION_RATE}_t + \beta_3 \cdot \text{EXCHANGE_RATE}_t + \epsilon_t$$

Where:

INDEX_{t-1} : The DSE Index value from the previous month (lag 1). This accounts for the fact that stock indices are path-dependent.

ϕ : The coefficient of the lagged dependent variable. If ϕ is close to 1, the index follows a random walk. α : The constant parameter (D), ϵ_t : The disturbance term (E)

4.2.3 Considering Stationarity (Unit Root Context)

Since your data spans 10 years (120 months), the DSE Index, Interest Rate, and Exchange Rate are likely non-stationary (they contain unit roots). If that is the case, a simple regression may be “spurious” (showing relationships that are not real). To correct for this, the time series equation should be estimated in first differences (γ, δ , and λ) or using a cointegration framework¹.

4.3 General Tendency of Data

The study seeks to empirically investigate the short- and long-term effects of three principal macroeconomic variables—interest rate, inflation rate, and exchange rate—on the influence of the Dhaka Stock Exchange (DSE) through time-series analysis. To do so, the data of each variable are depicted individually in Fig. 1. In the figure, the study plotted each variable and obtained each frequency curve, which presents the general trend line of the study. Among the four quartiles in

¹ If the variables are cointegrated (they move together in the long run), the equation becomes an Error Correction Model (ECM): $\Delta \text{INDEX}_t = \gamma \cdot \text{ECT}_{t-1} + i=1 \sum p_i \Delta \text{INDEX}_{t-i} + j=0 \sum q_j \Delta X_{t-j} + \epsilon_t$

the figure, inflation and exchange rates showed an upward trend over time (the 3rd and 4th quartiles). With little fluctuation, the interest rate also showed an upward trend (2nd quartile), but the dependent variable of the research, the DSE index, did not show a trend line (1st quartile). In fact, the DSE index did not respond equally to the progress of the three independent variables.

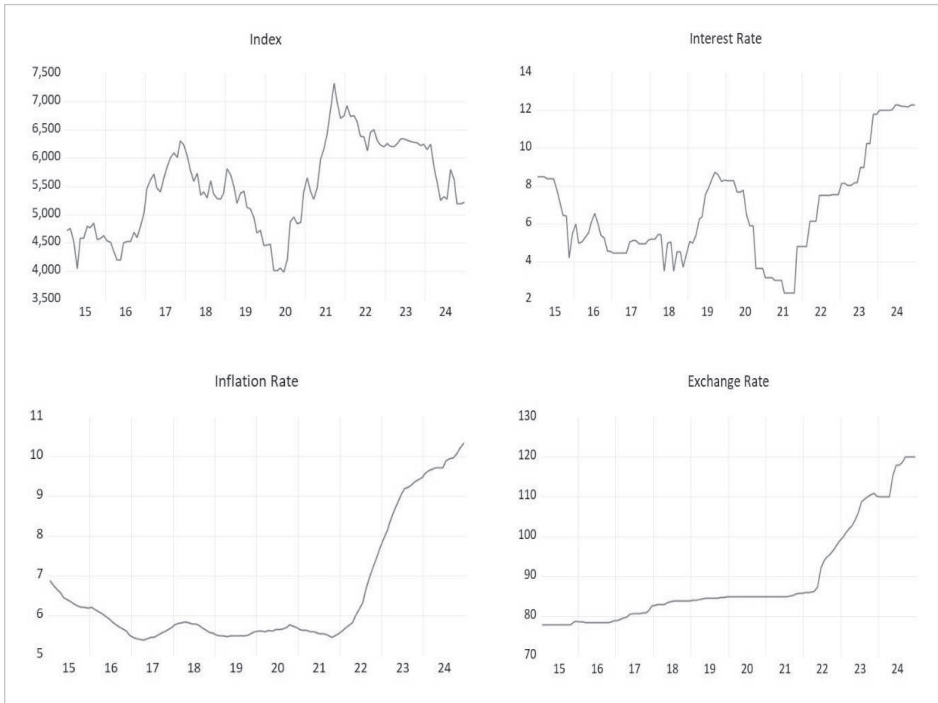


Fig. 1 Time series plots of the variables, Bangladesh Bank (January 2015 to December 2024).

4.4 Time Series Properties

a) Stationarity Tests: A fundamental prerequisite for many time-series econometric models, particularly regression analyses, is that the variables are stationary. Stationarity implies that the statistical properties of a time series (mean, variance, and autocorrelation) remain constant over time. To formally test for the presence of a unit root (indicating non-stationarity) in each variable, the Augmented Dickey-Fuller (ADF) Test and the Phillips-Perron (PP) Test are typically employed. The ADF test is a widely used and robust test that extends the basic Dickey-Fuller test by incorporating lagged differenced terms to account for potential serial correlation in the error terms. The null hypothesis (H_0) for the ADF test is the presence of a unit root (i.e., the series is non-stationary). The PP test is another powerful test for unit roots that addresses serial correlation and heteroskedasticity in the error terms by applying nonparametric corrections to the t-statistic. As with ADF, its null hypothesis (H_0) is that a unit root is present. Using both tests provides a more robust assessment of stationarity. Unit root

test results directly determine the appropriate econometric model for subsequent analysis. If all variables are stationary at levels, a standard Vector Autoregression (VAR) model can be employed. The test results reveal whether the series exhibits trends or random walks, providing insights into their underlying economic dynamics.

b) Cointegration Analysis: If the variables are found to be non-stationary but integrated of the same order (e.g., $I(1)$), cointegration analysis is performed to determine if there is a long-run equilibrium relationship among them (Corporate Finance Institute, 2025). The Johansen Cointegration Test is typically employed for this purpose. This method is generally preferred over the Engle-Granger two-step method when dealing with more than two variables, as it allows for the identification of multiple cointegrating relationships (Corporate Finance Institute, 2025). It is also considered more robust for larger sample sizes, which is relevant for the 10-year monthly data used in this study. Both the trace and maximum eigenvalue statistics are used to test the null hypothesis of no cointegration against the alternative of one or more cointegrating relationships (Corporate Finance Institute, 2025).

c) Vector Error Correction Model (VECM) Specification: The choice between a Vector Autoregression (VAR) model and a Vector Error Correction Model (VECM) is determined by the outcome of the cointegration tests. If no cointegration is found among the variables (or if variables are stationary at levels), a standard VAR model is applied to the appropriate (stationary) series (Buteikis, 2019). A VAR model captures the linear interdependencies among multiple time series, where each variable in the system is affected by its own past values (lags) and the past values of all other variables in the system. However, if cointegration is found, a VECM is used. A VECM is a restricted VAR model that explicitly incorporates the long-run cointegrating relationships through an error correction term while simultaneously modeling the short-run dynamics and adjustments towards the long-run equilibrium (Buteikis, 2019). The optimal lag length for the VAR/VECM is determined using various information criteria (e.g., Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Hannan-Quinn Information Criterion (HQIC)) to ensure model parsimony, avoid overfitting, and capture sufficient dynamics. The selected VAR/VECM is then estimated using appropriate econometric software to obtain the coefficients, standard errors, and significance levels of the relationships between the DSE Index and the macroeconomic variables.

d) Granger Causality Analysis: Granger causality analysis is conducted to investigate the predictive power between the DSE Index and the selected macroeconomic variables (interest rate, inflation rate, and exchange rate) (Buteikis,

2019). Granger causality tests determine whether past values of one variable can statistically help predict the current values of another variable, implying a causal relationship in a statistical, rather than philosophical, sense. Granger causality tests are conducted within the established VAR/VECM framework. The F-test is commonly employed to assess the joint significance of the lagged coefficients of the “causing” variable in the equation of the “affected” variable. A low p-value (typically below 0.05) indicates rejection of the null hypothesis that the variable does not Granger-cause the other variable, suggesting a statistically significant causal link. The analysis explores all pairwise relationships (e.g., interest rate Granger-causes DSE, DSE Granger-causes interest rate, etc.).

4.5 Data Availability

The study used two repository systems to collect the data and analyze the econometric model. Among the four variables: The datasets for all four variables—1. DSE Index, 2. Interest Rate, 3. Inflation Rate, and 4. Exchange Rate—covered a 10-year period from January 2015 to December 2024, consisting of 120 monthly point-to-point datasets for each variable. Among the four variables, the first, i.e., the DSE Index (independent variable), is a dataset collected from the Dhaka Stock Exchange (DSE) depository and tracks the performance of the DSE, Bangladesh’s main stock exchange (<https://www.dsebd.org/>). The other three variables, recognized as independent, were collected from the Bangladesh Bank’s (BB) repository system (<https://www.bb.org.bd/en/index.php>). The datasets used in this study are available in the following repositories:

a) Name: Dhaka Stock Exchange (DSE), Persistent Web Link to Datasets: <https://www.dsebd.org>

b) Name: Bangladesh Bank (BB), Persistent Web Link to Datasets: <https://www.bb.org.bd/en/index.php>

5. Empirical Results and Discussions

5.1 Descriptive Statistics of Variables

Initial statistical summaries of each variable are computed to understand their basic characteristics, central tendencies, and dispersion over the study period. This step is crucial for gaining preliminary insights into the data’s behavior. Measures calculated for each variable include the mean, median, standard deviation (as a proxy for volatility), minimum value, and maximum value (Table 1). The table below presents the calculated descriptive statistics for the DSE Index, interest rate, inflation rate, and exchange rate from January 2015 to December 2024.

Table 1. Descriptive Statistics of Variables (January 2015-December 2024)

Particulars	Index	Interest_Rate	Inflation_Rate	Exchange_Rate
Mean	5474.59	6.70	6.55	88.86
Median	5413.54	6.14	5.77	84.80
Maximum	7329.04	12.31	10.34	120.00
Minimum	3989.09	2.33	5.38	77.80
Std. Dev.	792.17	2.68	1.52	12.20
Skewness	0.02	0.61	1.38	1.34
Kurtosis	2.09	2.66	3.30	3.49
Observations	120	120	120	120

Source: Bangladesh Bank (Jan. 2015–Dec.2024), Study Approximations.

The DSE Index, for instance, shows a mean of approximately 5474.59, with a standard deviation of 792.17, indicating notable volatility throughout the decade. The minimum index value was 3989.09, while the maximum reached 7329.04, highlighting significant market swings (2nd column, Table 1). Interest rates in Bangladesh during this period averaged 6.70%, ranging from a low of 2.33% to a high of 12.31%. This wide range reflects dynamic monetary policy adjustments and economic conditions over the ten years (3rd column, Table 1). The inflation rate, measured by CPI, had a mean of 6.55% and a standard deviation of 1.52, indicating a relatively stable but upward-trending price level, especially towards the latter part of the study period (4th column, Table 1). The exchange rate showed a mean of 88.86, with a significant range from 77.80 to 120.00, underscoring a substantial depreciation of the Bangladeshi Taka, particularly evident from mid-2022 onwards (5th column). This depreciation is a key trend that warrants further in-depth analysis regarding its impact on the DSE. Observing the raw trends in the data provides preliminary visual clues about potential correlations before formal econometric testing. For instance, the DSE Index experienced a notable bull run from late 2020 to late 2021, a period during which interest rates were comparatively low (Data File, 2015-2024). Conversely, from mid-2022 to 2024, the DSE Index generally trended downwards, coinciding with rising interest rates and inflation and a sharp depreciation of the exchange rate (Data File, 2015-2024). These observed co-movements, even prior to formal statistical validation, establish an intuitive basis for the expected relationships and aid in contextualizing the subsequent econometric findings, thereby allowing for a richer interpretation of the results.

5.2 Results of Unit Root Tests

Based on the results from the table, both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests consistently indicate that all four variables –

the DSE Index, Interest Rate, Inflation Rate, and Exchange Rate – are non-stationary at their levels. The p-values for the level series are generally above the conventional 0.05 significance level, leading to a failure to reject the null hypothesis of a unit root. This suggests that these series exhibit trends or random walk characteristics, meaning that shocks to these variables have permanent effects.

Table 2. Unit Root Test Results

Variable	Test Type	ADF Statistic	P-value	PP Statistic	P-value	Conclusion	Order of Integration
DSE Index	Level	-1.887039	0.3374	-1.822736	0.3680	Non-stationary	I (1)
	1st Diff	-9.471213	0.0000	-9.419641	0.0000	Stationary	
Interest Rate	Level	-1.364658	0.5973	-0.992641	0.7543	Non-stationary	I (1)
	1st Diff	-4.116200	0.0014	-11.86208	0.0000	Stationary	
Inflation Rate	Level	-0.920426	0.9495	-0.759389	0.9656	Non-stationary	I (1)
	1st Diff	-3.394659	0.0570	-3.410458	0.0549	Stationary	
Exchange Rate	Level	-0.297940	0.9899	0.090248	0.9969	Non-stationary	I (1)
	1st Diff	-7.054045	0.000	-6.979780	0.0000	Stationary	

Source: Bangladesh Bank (Jan. 2015–Dec.2024), Study Approximations.

However, upon taking the first difference of each variable, both ADF and PP tests show highly significant p-values, leading to a strong rejection of the null hypothesis of a unit root (Table 2). This indicates that all variables become stationary after first differencing, classifying them as integrated of order one, or I (1) (8th column, Table 2). It suggests that market shocks have permanent effects, meaning the market does not automatically revert to its long-run mean after a disturbance. This is a critical characteristic for investors and risk managers, as it implies that market downturns or upturns might represent new, persistent levels rather than temporary deviations. Such a characteristic underscores the need to employ econometric models that can appropriately handle non-stationary data.

5.3 Results of Cointegration Tests

The study employs the Johansen-Juselius (1990) maximum likelihood method to analyze the long-term connection between the dependent and independent variables. The null hypothesis asserts the absence of cointegration, while the alternative hypothesis asserts its presence.

Table 3: Johansen Cointegration Test Results

Hypothesis, H_0	Hypothesis, H_1	Trace Statistic	Prob.	Max-Eigen Statistic	Prob.
$r = 0$	$r = 1$	62.72217***	0.0014	32.09441***	0.01225
$r \leq 1$	$r = 2$	29.62775*	0.0522	19.36733*	0.0866
$r \leq 2$	$r = 3$	10.26041	0.2612	10.00636	0.1312
$r \leq 3$	$r = 4$	0.25404	0.6142	0.25404	0.6142

Source & Note: Bangladesh Bank (Jan. 2015–Dec.2024), Study Approximations. Here r is the number of cointegration vectors, and lag intervals is 2. (***, **, and * show the level of rejection at 1%, 5%, and 10% respectively).

The J-J cointegration test statistics indicate that the null hypotheses (none to at most 2) are rejected, as the test statistics fall below the 10% threshold. The J-J cointegration test results indicate that the null hypothesis (at most 3 to 4) is accepted, as the test statistic exceeds the 10% significance level, whereas the alternative hypothesis is rejected. The J-J cointegration test statistics indicate that the null hypothesis (at most 1 to 2) is rejected, as all statistic values fall below the 10% significance level, thereby accepting the alternative hypothesis. Conversely, the null hypothesis (at most 3 to 4) is accepted, since the statistic values exceed the 10% significance level, leading to the rejection of the alternative hypothesis. The results indicate the existence of at least two cointegrating equation models, demonstrating long-run cointegration among all variables. Evidence indicates the existence of long-term links between the dependent (DSE) and independent variables. Therefore, the results indicate the existence of one cointegrating relationship among the variables. The finding that all variables are integrated of order none to at most 2 and exhibit a single cointegrating relationship strongly supports the theoretical notion that macroeconomic fundamentals drive long-run stock market performance, even in an emerging market like Bangladesh. This empirically validates the idea that the DSE is not merely subject to random fluctuations but is fundamentally tied to the broader economic environment, with an underlying equilibrium relationship that ensures long-term co-movement.

5.4 VAR/VECM Estimation Results

Given the confirmation of a single cointegrating relationship, a VECM is the appropriate choice for estimating the short-run and long-run impacts of the macroeconomic variables on the DSE Index. A summary of the results is shown in the following Table 4. The output from the EViews software is provided in *Appendix A*.

Table 4: Cointegrating Relationship (Long-run Equation)

Variable	Coefficient	t-statistic	Significance (at 5%)
Interest_Rate (-1)	+ 290.79	4.58	Yes
Inflation_Rate (-1)	- 271.78	-1.38	No
Exchange_Rate (-1)	- 11.49	-0.49	No
Constant (C)	- 4623.60	—	—

Source: Bangladesh Bank (Jan. 2015–Dec. 2024), Study Approximations

The cointegrating equation represents the long-run equilibrium relationship that the variables tend to revert to over time. The estimated long-run equation, normalized on INDEX (-1), is:

$\text{Index} (-1) + 290.7916 * \text{Interest_Rate} (-1) - 271.7757 * \text{Inflation_Rate} (-1) - 11.49420 * \text{Exchange_Rate} (-1) - 4623.596 = 0$ (from the 1st and 2nd column of Table 4)

5.4.1 Interest Rate

The coefficient for Interest_Rate (-1) (290.79) is statistically significant (t-statistic [4.58]) (2nd row, Table 4). This suggests a strong, long-run inverse relationship: a one-unit increase in the interest rate is associated with a substantial decrease in the Index, holding other factors constant. This highlights the central and robust role of interest rates as the primary macroeconomic determinant of the DSE's long-term equilibrium path among the variables studied.

5.4.2 Inflation Rate

The coefficient for Inflation_Rate (-1) (-271.78) is not statistically significant (t-statistic [-1.38]) (3rd row, Table 4). This indicates that, within this specific long-run equilibrium, the inflation rate does not have a statistically significant long-term impact on the Index.

5.4.3 Exchange Rate

The coefficient for EXCHANGE_RATE (-1) (-11.49) is also not statistically significant (t-statistic [-0.49]) (4th row, Table 4). Similar to the inflation rate, the exchange rate does not appear to have a statistically significant long-term relationship with the index in this cointegrating vector. This could indicate that the long-run effects of inflation and exchange rates are more complex, possibly non-linear, or subject to regime shifts not captured by a single linear co-integrating vector.

5.5 Error Correction Terms (ECT)

The error correction term (COINTEQ1) in each differenced equation indicates how quickly each variable adjusts to correct deviations from the long-run equilibrium. A negative and statistically significant coefficient suggests that the variable adjusts back towards equilibrium (Table 5).

Table 5: Error Correction Terms (Speed of Adjustment)

Dependent Variable	ECT Coefficient	t-statistic	Adjustment to Long-run Equilibrium
D (Index)	-0.1529	-3.99	Significant, negative (adjusts)
D (Interest_Rate)	+0.00029	2.58	Adjusts, but a positive sign — suggests divergence
D (Inflation_Rate)	+0.0000198	2.83	Positive, may not support equilibrium
D (Exchange_Rate)	+0.000159	1.30	Not significant

Source: Bangladesh Bank (Jan. 2015–Dec. 2024), Study Approximations

5. 5. 1 D (Index)

The coefficient of the Error Correction Term (ECT) is -0.15 and is highly statistically significant (t-statistic [-3.99]) (2nd row, Table 5). The negative sign and statistical significance of the ECT confirm that the DSE Index adjusts towards its long-run equilibrium in response to the macroeconomic variables. The negative ECT confirms convergence, but the speed (15%) is unusually low compared with mature markets (typically 20–30%). This aligns with DSE’s documented inefficiency (Uddin, M. H., 2009).

5.5.2 D (Interest_Rate)

The coefficient for COINTEQ1 is 0.00029 (t-statistic [2.58]). This coefficient is statistically significant and positive (3rd row, Table 5). Typically, a negative coefficient is expected in an error-correction mechanism, indicating an adjustment towards equilibrium. A positive sign here suggests that if the system deviates from the long-run equilibrium, the interest rate might move in a direction that *increases* the disequilibrium, or it could imply that the interest rate is a driving force of the disequilibrium rather than an adjusting variable.

5.5.3 D (Inflation_Rate)

The coefficient for COINTEQ1 is 1.98E-05 (t-statistic [2.83]). This coefficient is also statistically significant and positive, similar to the interest rate (4th row, Table 5). This suggests a similar anomaly in which the inflation rate fails to adjust toward equilibrium in the expected manner.

5.5.4 D (Exchange_Rate)

The coefficient for COINTEQ1 is 0.000159 (t-statistic [1.30371]). This coefficient is not statistically significant 5th row, Table 5).

5.5.5 Short-Run Effects

The short-run dynamics capture the immediate impact of past changes in one variable on the current changes in another, after accounting for the long-run equilibrium. These are represented by the coefficients of the lagged differenced terms in each equation.

Equation for D (Index) (Changes in Index)

This equation models how the current change in the Index is influenced by past changes in the other variables.

Table 6: Short-Run Effects (Selected Lagged Differences)

Predictor (Lag 1)	Δ (Index) Coef. (t-stat)	Δ (Interest_Rate) Coef. (t-stat)	Δ (Inflation_Rate) Coef. (t-stat)	Δ (Exchange_Rate) Coef. (t-stat)
Δ (Index)	0.1501 (1.69)	-0.00031 (-1.18)	-0.000017 (-1.05)	-0.00029 (-1.03)
Δ (Interest_Rate)	30.4485 (0.88)	-0.2286 (-2.26)	0.00049 (0.08)	-0.1660 (-1.50)
Δ (Inflation_Rate)	607.7578 (2.12)	-0.9871 (-1.18)	0.76199 (14.51)	2.0302 (2.22)
Δ (Exchange_Rate)	-5.9414 (-0.22)	0.0990 (1.25)	0.00880 (1.78)	0.3437 (3.98)
Constant	-12.8684 (-0.57)	0.0335 (0.51)	0.00562 (1.36)	0.1838 (2.55)

Source: Bangladesh Bank (Jan. 2015–Dec. 2024), Study Approximations

5.5.5.1 D (Inflation_Rate (-1))

The coefficient is 607.7578, with a t-statistic of 2.12. This is statistically significant, indicating that a one-unit increase in the previous period's change in the inflation rate is associated with a substantial positive change in the current period's index (4th row, Table 6). The result conflicts with Feldstein's (1979) tax-channel theory, which predicts negative effects.

5.5.5.2

No other lagged differenced variables (D (INDEX (-1)), D (INTEREST_RATE (-1)), D (EXCHANGE_RATE (-1))) or the constant term show a statistically significant impact on D(INDEX) in this equation (Table 6).

Overall, the VECM findings largely corroborate previous research on the DSE and other EM regarding the general influence of macroeconomic variables. The consistent negative impact of interest rates on the DSE Index is also consistent with established literature on Bangladesh (Gwala & Mashau, 2022; Islam et al., 2017; Mfugale & Olomi, 2023; Islam et al., 2023c) and another emerging

market (Eldomiaty et al., 2020). The lack of long-term significance for inflation and exchange rate despite short-term movements implies these are transient or driven by other forces (e.g., policy, foreign investment sentiment).

5.6 Granger Causality Test Results

The Granger Causality Test results, as presented in Table 7, reveal the direction of predictive power between the DSE Index and the selected macroeconomic variables.

Table 7: Granger Causality Test Results

Dependent Variable	Excluded Variable	Chi-Sq	p-value	Causality (at 5%)
Index	Interest_Rate	15.05	0.0005	Yes
	Inflation_Rate	2.71	0.2583	No
	Exchange_Rate	2.79	0.2476	No
	all	17.91	0.0065	Jointly Yes
Interest_Rate	Index	8.86	0.0119	Yes
	Inflation_rate	2.71	0.2574	No
	Exchange_Rate	1.76	0.4138	No
	all	20.44	0.0023	Jointly Yes
Inflation_Rate	Index	5.85	0.0538	Marginal (10%)
	Interest_Rate	5.15	0.0760	Marginal (10%)
	Exchange_Rate	5.47	0.0648	Marginal (10%)
	all	19.05	0.0041	Jointly Yes
Exchange_Rate	Index	3.36	0.1865	No
	Interest_Rate	1.70	0.4264	No
	Inflation_Rate	6.28	0.0434	Yes
	All	16.06	0.0135	Jointly Yes

Source: Bangladesh Bank (Jan. 2015–Dec. 2024), Study Approximations

Summary of Causal Relationships is-

- a) Interest Rate is a significant Granger causality of the Index.
- b) Index is a significant Granger causality of the Interest Rate.
- c) Inflation Rate is a significant predictive causality of the Exchange Rate.

- d) There is marginal evidence (at 10% significance) that the Index, Interest Rate, and Exchange Rate individually predict causality in the Inflation Rate.

In all cases, the joint test for Granger causality from all other variables is significant, indicating that collectively, the other variables provide predictive power for each dependent variable. These results highlight the complex short-run interdependencies among these macroeconomic variables, suggesting that changes in one variable can indeed help predict changes in others.

5.7 Stability Test

The stability of the short- and long-run parameters is evaluated using the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMsq). The CUSUM test calculates the cumulative sum of recursive residuals for both the lower and upper bounds within a 95% confidence interval at each point, as described by Pesaran et al. (2001). The null hypothesis (no cointegration) is rejected, and the alternative hypothesis (cointegration) is accepted if the statistics of both tests fall within the lower and upper critical bounds at a 5% significant level (assuming that the regression equation is accurately specified) (Wright, 1993).

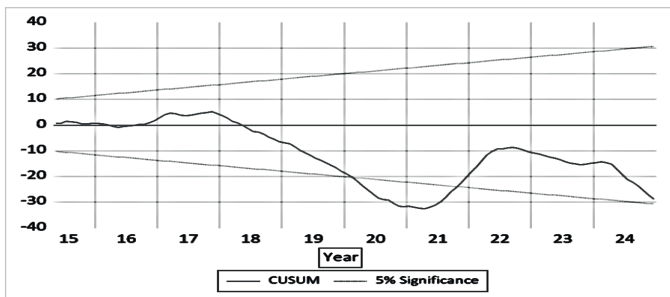


Figure 2. Cumulative Sum of Recursive Residuals at 5% Significant Level.

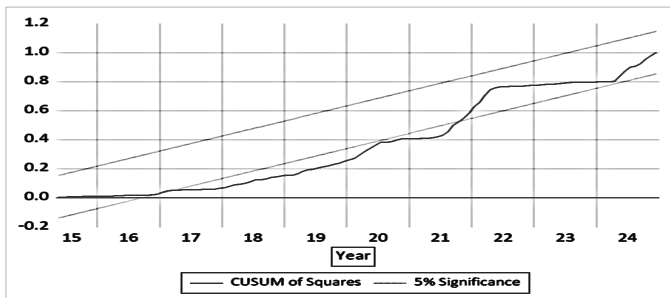


Figure 3. Cumulative Sum of Squares of Recursive Residuals at 5% Significant Level.

The CUSUM and CUSUMsq tests (Figures 2 and 3) demonstrate a steady correlation among the index, inflation rate, interest rate, and exchange rate, as the

CUSUM and CUSUMsq lines remain near the 5% critical thresholds. These tests examine the structural stability of constant coefficients over time, addressing the model's resilience, since the results indicate that the parameters related to the mean and variance structure remain stable. Robustness is essential for predicting and analyzing policies affecting DSE equity prices and macroeconomic indicators.

6. Summary of Principal Findings

This empirical research of the DSE from January 2015 to December 2024 demonstrates substantial macroeconomic impacts on its performance. All analyzed variables—the DSE Index, interest rate, inflation rate, and exchange rate—were found to be non-stationary at their levels but became stationary after initial differencing, indicating they are integrated of order one (I(1)). A single cointegrating relationship was identified among these variables, indicating a stable long-term equilibrium in which they tend to co-move over time. The Vector Error Correction Model (VECM) indicated that the interest rate has a statistically significant negative long-term effect on the DSE Index, consistent with recognized economic theories. In contrast, the inflation rate demonstrated a statistically significant positive short-term effect on the DSE Index, corroborating the idea of speculative rallies in emerging markets. The error correction term was substantial, validating the DSE Index's adjustment towards its long-term equilibrium. Granger causality experiments indicated bidirectional links between the interest rate and the DSE Index. The minimal influence of the exchange rate on the DSEX may result from the Bangladesh Bank's intervention in regulating the currency rate.

7. Limitations

This work offers significant insights; however, it is restricted by multiple constraints. *First*, the scope of macroeconomic variables was limited to three: the interest rate, the inflation rate, and the exchange rate. Other notable macroeconomic variables, including Gross Domestic Product (GDP) growth, industrial output, aggregate money supply, foreign direct investment (FDI), and global equity market indices, are considered to impact stock markets (Islam et al., 2014; Gwala & Mashau, 2022; Eldomiaty et al., 2020; Islam et al., 2023b) but were excluded due to limitations in data availability or scope delineation. *Second*, the use of monthly data, although suitable for my dataset, may conceal higher-frequency dynamics or prompt immediate daily market responses to macroeconomic news. *Third*, the VAR/VECM models employed assume linearity and stable parameters throughout the study period. In reality, structural fractures (e.g., resulting from significant policy changes or economic crises) or nonlinear interactions may be present, which these models may inadequately represent. Finally, the results are exclusive to the Dhaka Stock Exchange and the economic

setting of Bangladesh. They may not be directly applicable to other emerging or developed markets, which display unique characteristics and sensitivities. The DSE's recorded vulnerability to "unethical and poorly objective-oriented conduct among market participants, insufficient due diligence, and manipulation" (Gwala & Mashau, 2022; Islam et al., 2023a) suggests that just macroeconomic models may not comprehensively encompass all factors influencing market performance. This indicates that non-fundamental, market-specific factors may significantly influence DSE fluctuations, underscoring a limitation of the current study's scope.

8. Policy Recommendations

In light of the empirical findings, the following policy recommendations are proposed:

8.1 Recommendations for the Bangladesh Bank (Central Bank)

In light of the considerable adverse effects of interest rates and inflation on the DSE, the Bangladesh Bank must meticulously evaluate the potential ramifications of its monetary policy actions on the stock market. Policies designed to provide price stability and regulate interest rates must be developed with consideration of their direct impact on the capital market, with the objective of promoting market expansion while regulating inflation.

8.2. For the Bangladesh Securities & Exchange Commission (BSEC)

The BSEC must persist in its efforts to improve market efficiency, liquidity, and depth. It is essential to address concerns, including regulatory failures, market manipulation, and the influx of ignorant investors, as emphasized in the literature (Gwala & Mashau, 2022; Islam et al., 2023a). A more resilient and transparent market would facilitate the efficient pricing of macroeconomic information, potentially mitigating excessive volatility caused by non-fundamental issues.

8.3 Inter-Agency Coordination

The identified Granger causation from the DSE Index to the Exchange Rate indicates that the stock market is not solely a passive entity influenced by macroeconomic factors but can also serve as a precursor for currency fluctuations. This necessitates improved collaboration between the Bangladesh Bank and the BSEC. Policymakers ought to integrate DSE performance measurements into their comprehensive economic forecasts and policy development, especially with foreign currency management and capital movement oversight.

8.4 Investor Education

Considering the DSE's attributes and the observed "influx of numerous investors lacking pertinent knowledge and expertise" (Islam et al., 2023a), ongoing investor education initiatives are essential. These programs need to clarify the

links between macroeconomic factors and stock market performance, enabling investors to make more informed decisions and reducing their vulnerability to market manipulation.

References

- Abeyratna, G., Pisedtasalasai, A. and Brown, D. (2004), "Macroeconomic influence on the stock market: evidence from an emerging market in South Asia", *Journal of Emerging Market Finance*, Vol. 3 No. 3, pp. 285-304.
- Adjasi, C.K.D. and Biekpe, N.B. (2006), "Stock market development and economic growth: the case of selected African countries", *African Development Review*, Vol. 18 No. 1, pp. 144-161.
- Adrian, T., Erceg, C., Kolasa, M., Lindé, J., McLeod, R., Veyrune, R. and Zabczyk, P. (2024), "Monetary and capital markets: new perspectives on quantitative easing and central bank capital policies", IMF Working Paper, No. 2024/103, International Monetary Fund, Washington, DC, available at: <https://www.imf.org/en/Publications/WP/Issues/2024/06/07/Monetary-and-Capital-Markets-549814> (accessed 1 February 2025).
- Aga, M. and Kocaman, B. (2006), "An empirical investigation of the relationship between inflation, P/E ratios and stock price behaviour using a new series called Index-20 for Istanbul Stock Exchange", *International Research Journal of Finance and Economics*, No. 6, pp. 133-165.
- Amadi, S.N. and Odubo, T.D. (2002), "Macroeconomic variables and stock prices: causality analysis", *The Nigeria Journal of Economic and Management Studies*, Vol. 4 No. 1-2, pp. 29-41.
- Asmy, M.B.M.T., Rohilina, W., Hassama, A. and Amin, M.F.B. (2010), "Effects of macroeconomic variables on stock prices in Malaysia: an approach of error correction model", MPRA Paper, No. 20970, available at: <https://mpa.ub.uni-muenchen.de/20970/> (accessed 1 February 2025).
- Bilson, C., Brailsford, T.J. and Hooper, V. (1999), "Selecting macroeconomic variables as explanatory factors of emerging stock market returns", SSRN Working Paper, available at: <https://ssrn.com/abstract=201908> (accessed 1 February 2025).

- Buteikis, A. (2019), "VAR VECM Granger causality stock market analysis", lecture notes, Vilnius University, available at: https://web.vu.lt/amf/a.buteikis/wp-content/uploads/PE_07/Lecture_7.html (accessed 1 February 2025).
- Chandra, P. (2004), *Investment Analysis and Portfolio Management*, Tata McGraw-Hill, New Delhi. Corporate Finance Institute (2025), "Cointegration", available at: <https://corporatefinanceinstitute.com/resources/data-science/cointegration> (accessed 1 February 2025).
- Current Market Valuation (2025), "Understanding the theory: how interest rates impact stock prices", available at: <https://www.currentmarketvaluation.com/models/10y-interest-rates.php> (accessed 1 February 2025).
- Eldomiaty, T., Saeed, Y., Hammam, R. and Soud, A.S. (2020), "The associations between stock prices, inflation rates, interest rates are still persistent: empirical evidence from stock duration model", *Journal of Economics, Finance and Administrative Science*, Vol. 25 No. 49, pp. 149-161.
- Fama, E.F. (1970), "Efficient capital markets: a review of theory and empirical work", *The Journal of Finance*, Vol. 25 No. 2, pp. 383-417.
- Fama, E.F. and Schwert, G.W. (1977), "Asset returns and inflation", *Journal of Financial Economics*, Vol. 5 No. 2, pp. 115-146.
- Feldstein, M. (1979), "Inflation and the stock market", NBER Working Paper, No. 276, National Bureau of Economic Research, Cambridge, MA, available at: <https://www.nber.org/papers/w0276> (accessed 1 February 2025).
- Feldstein, M. (1997), "The effects of fiscal policy on stock prices", *National Tax Journal*, Vol. 50 No. 4, pp. 485-497.
- Garza-Garcia, J.G. and Yue, Y. (2010), "International determinants of stock market performance in China: a cointegration approach", *Centre for Global Finance Working Paper Series*, No. 03/10, University of Bristol.
- Golder, U., Islam, M.N. and Kayser, M.S. (2020), "Impact of foreign exchange reserve, exchange rate and crude oil price on Dhaka Stock Exchange Index: an empirical evidence from vector error correction model", *Indian Journal of Finance and Banking*, Vol. 4 No. 1, pp. 134-143.
- Golob, A. and Bishop, J. (1997), "What long-run returns can investors expect from the stock market?", *Economic Review – Federal Reserve Bank of Kansas City*, Vol. 82 No. 3, pp. 9-19.

- Gopinath, G. (2025), “Global reset is testing emerging markets: Gopinath”, US Central Banking, 1 February, available at: <https://www.centralbanking.com/central-banks/economics/7972856/global-reset-is-testing-emerging-markets-gopinath> (accessed 1 February 2025).
- Goswami, G. and Jung, S. (1997), “Stock market and economic forces: evidence from Korea”, paper presented at the Financial Management Association Annual Meeting, Honolulu, Hawaii, available at: https://www.researchgate.net/publication/229053375_Stock_Market_and_Economic_Forces_Evidence_From_Korea (accessed 1 February 2025).
- Gwala, R.S. and Mashau, P. (2022), “Corporate governance and its impact on organisational performance in the fourth industrial revolution: a systematic literature review”, *Corporate Governance and Organizational Behavior Review*, Vol. 6 No. 1, pp. 98-105.
- Humpe, A. and Macmillan, P. (2009), “Can macroeconomic variables explain long-term stock market movements? A comparison of the US and Japan”, *Applied Financial Economics*, Vol. 19 No. 2, pp. 111-119.
- Islam, F.T., Mostofa, M.S. and Tithi, A.A. (2017), “Macroeconomic and institutional determinants of capital market performance in Bangladesh: a case of Dhaka Stock Exchange”, *International Journal of Academic Research in Accounting, Finance and Management Sciences*, Vol. 7 No. 1, pp. 306-311.
- Islam, M.I., Jalil, M.A. and Mannan, M.A. (2014), “Determinants of stock market performance in Bangladesh”, *Indonesian Management and Accounting Research*, Vol. 13 No. 1, pp. 16-28.
- Islam, M.I., Jalil, M.A. and Mannan, M.A. (2015), “Impact of macroeconomic variables on stock markets: evidence from emerging markets”, *International Journal of Economics and Finance*, Vol. 8 No. 1, pp. 195-208.
- Islam, M.S., Parvin, R., Milon, M. and Das, M.K. (2023a), “The impact of gross domestic product on the Bangladesh stock market: an empirical analysis”, *International Journal of Finance and Accounting*, Vol. 12 No. 1, pp. 1-12.
- Islam, M., Chowdhury, M.M.H. and Sarker, M.M. (2023c), “The impact of big data analytics on stock price prediction in the Bangladesh stock market: a machine learning approach”, *International Journal of Science and Business*, Vol. 28 No. 1, pp. 219-228.
- Kevin, S. (2000), *Portfolio Management*, Prentice-Hall of India, New Delhi.

- Maku, O.E. and Atanda, A.A. (2010), "Determinants of stock market performance in Nigeria: long-run analysis", *Journal of Management and Organizational Behaviour*, Vol. 1 No. 3, pp. 1-16.
- Mfugale, N. and Olomi, W. (2023), "The impact of inflation and exchange rate on stock market returns in Tanzania", *European Journal of Theoretical and Applied Sciences*, Vol. 1 No. 6, pp. 1019-1026.
- Osamwonyi, I.O. (2003), "Forecasting as a tool for securities analysis", paper presented at the Workshop on Introduction to Securities Analysis, Securities and Exchange Commission, Lagos, Nigeria, 17 August.
- Pesaran, M.H., Shin, Y. and Smith, R.J. (2001), Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, Vol.16 No. 3, pp. 289-326.
- Phylaktis, K. and Ravazzolo, F. (2005), "Stock prices and exchange rate dynamics", *Journal of International Money and Finance*, Vol. 24 No. 7, pp. 1031-1053.
- Qayyum, A. and Anwar, S. (2011), "Impact of monetary policy on the volatility of stock market in Pakistan", *International Journal of Business and Social Science*, Vol. 2 No. 11, pp. 18-24.
- Rahman, S.M.F., Hossain, M.A. and Islam, M.A. (2012), "The relationship between interest rate, exchange rate and stock price: a wavelet analysis", *International Journal of Economics and Financial Issues*, Vol. 4 No. 7, pp. 220-229.
- Ross, S.A. (1976), "The arbitrage theory of capital asset pricing", *Journal of Economic Theory*, Vol. 13 No. 3, pp. 341-360.
- Smith, G. (1990), *Investments*, Scott, Foresman/Little, Brown, Glenview, IL.
- Summers, L.H. (1981), "Taxation and corporate investment: a q-theory approach", *Brookings Papers on Economic Activity*, Vol. 1981 No. 1, pp. 67-127.
- Ullah, G.M.W., Islam, A., Alam, M.S. and Khan, M.K. (2017), "Effect of macroeconomic variables on stock market performance of SAARC countries", *Asian Economic and Financial Review*, Vol. 7 No. 8, pp. 770-779.
- Wright J. H. (1993), "The CUSUM test based on least squares residuals in regressions with integrated variables", *Economics Letters*, Vol. 41 No 4, pp. 353-358 [https://doi.org/10.1016/0165-1765\(93\)90204-P](https://doi.org/10.1016/0165-1765(93)90204-P)

Appendix A

Date: 04/13/26 Time: 22:09
Sample: 2015M01 2024M12
Included observations: 120
Lags interval (in first differences): 1 to 2
Endogenous variables: INDEX INFLATION_RATE INTEREST_RATE EXCHA...
Deterministic assumptions: Case 3: Short-run dynamics include a constant.

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.** Critical Value
None *	0.239904533...	61.72217216...	47.85612715...	0.001495596...
At most 1	0.152557948...	29.62775709...	29.79707334...	0.052277535...
At most 2	0.081969369...	10.26041737...	15.49471287...	0.261220154...
At most 3	0.002168996...	0.254048219...	3.841465498...	0.614236488...

Trace test indicates 1 cointegrating equation(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Max-eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.** Critical Value
None *	0.239904533...	32.09441507...	27.58433778...	0.012251901...
At most 1	0.152557948...	19.36733972...	21.13161629...	0.086696019...
At most 2	0.081969369...	10.00636915...	14.26460015...	0.211503933...
At most 3	0.002168996...	0.254048219...	3.841465498...	0.614236488...

Max-eigenvalue test indicates 1 cointegrating equation(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b*S11*b=I):

INDEX	INFLATION_...	INTEREST_...	EXCHANGE_RATE
-0.00222063...	0.760536562...	-0.58049144...	0.009805107586668498
0.000126988...	-0.60667502...	0.750489864...	-0.06884479829197551
0.000457982...	1.864282428...	-0.01035864...	-0.1865322306304906
0.000528240...	0.827086404...	0.026533326...	-0.2095635516846227

Unrestricted Adjustment Coefficients (alpha):

D(INDEX)	63.72076588...	-47.3444757...	-24.5774767...	4.159173...
D(INFLATIO...	-0.00998581...	0.004306144...	-0.00600001...	0.000727...
D(INTERES...	-0.19649356...	-0.17251455...	-0.00517526...	-0.00811...
D(EXCHAN...	-0.09479345...	-0.03903283...	0.124659473...	0.020847...

10. Declarations

10.1 Ethical Approval and a Consent to Participate

This study did not involve human participants, human data, or human tissue. All the data used in this research was obtained from publicly available and anonymised secondary sources, including the official publications of the Bangladesh Bank (BB), the Dhaka Stock Exchange (DSE), the Bangladesh Security and Exchange Commission (BSEC), and the Bangladesh Bureau of Statistics (BBS). Formal ethical approval and individual consent to participate were unnecessary because this research did not involve primary data collection from individuals.

10.2 Consent for Publication

Not applicable. This manuscript does not contain any individual person's data in any form (including any individual details, images, or videos).

10.3 Funding

No funding or financial assistance was received for conducting this study at any stage of the research. The research was carried out independently without any financial support from public, commercial, or not-for-profit funding agencies.

11. Author's Contribution

The manuscript is titled, "Assessing the Influence of Key Macroeconomic Variables on Equity Returns: Evidence from the Dhaka Stock Exchange." This study seeks to empirically investigate the long-term and short-term effects of three principal macroeconomic variables—interest rate, inflation rate, and exchange rate—on the performance of the Dhaka Stock Exchange (DSE). The results highlight the ineffectiveness of the DSE, indicating that macroeconomic shocks can have delayed or intensified effects on pricing. This research offers useful perspectives for investors, policymakers, and regulators by emphasising the significance of monetary policy coordination and increased market efficiency in Bangladesh. Both authors are responsible for preparing this research work. The individual contributions are given below:

A) Mallik Rowshan Alam is responsible for preparing the concept note and literature review, identifying research gaps, collecting data, organising the manuscript, and conducting the primary methodology and data analysis, as well as writing some parts of the conclusion.

B) Dr Aoulad Hosen has contributed to the research objective determination, model setting, part of data analyses, Concise the review of literatures, research outcomes, conclusion, and policy recommendation. In addition to that, the final review, revision of reviewer comments, re-estimation of the model and corresponding work was done by Dr Hosen.

Footnoting and Writing Style Guidelines

Bangladesh Journal of Political Economy

I. General Submission Information

1. **Publication Schedule:** The *Bangladesh Journal of Political Economy* (BJPE) is published biannually in June and December.
2. **Submission Address:** Manuscripts (research articles, notes, reviews) in English or Bangla should be submitted electronically (preferred) or in triplicate to:

The Editor, BJPE, Bangladesh Economic Association, 4/C Eskaton Garden Road, Dhaka-1000, Bangladesh.

3. **Abstract:** Include an abstract not exceeding 150 words.
4. **Formatting Basics:**
 - Double-spaced throughout (including references)
 - 12-point Times New Roman font
 - 1-inch margins on all sides
 - Page numbers in bottom right corner
 - Line numbers included for peer review
5. **Blind Review:** Author identification must not appear on the manuscript. Submit a separate title page containing full name(s), mailing address, telephone number, and paper title.
6. **Title:** Article titles should be concise. Brief, descriptive subheadings may be used. The Editorial Board reserves the right to modify titles for clarity or consistency.
7. **Duplicate Submission:** If a submitted manuscript is accepted elsewhere, the author must notify the Editor immediately. The author bears full responsibility for any resulting conflicts.
8. **Visual Elements:** Tables, graphs, and maps may be included. Each must have a clear title and source attribution.

II. Manuscript Structure and Section Numbering

9. **Standard Article Sequence:**
 - Introduction (background and problem statement)
 - Objectives and hypotheses
 - Methodological framework

- Findings/Results
- Policy implications
- Limitations (if applicable)
- Conclusion(s)

Empirical papers may adapt the IMRaD structure (Introduction, Methods, Results, Discussion, Conclusion) where appropriate.

10. Hierarchical Section Numbering:

- **Main sections: 1, 2, 3...** (bold)
- *Subsections: 1.1, 1.2, 1.3...* (italics)
- Sub-subsections: 1.1.1, 1.1.2... (underlined)
- Avoid numbering beyond three levels to preserve readability. A fourth level is discouraged.

III. Tables and Figures

11. Tables:

- Number consecutively (Table 1, Table 2...).
- Place titles *above* the table, centred.
- Use minimal horizontal lines (above/below column headers and at table bottom); avoid vertical lines.
- Ensure legibility in black-and-white printing; use patterns, textures, or line styles instead of color.
- Submit as editable text (not images) with minimum 9-point font.

12. Figures:

- Number consecutively (Figure 1, Figure 2...).
- Place captions *under* the figure, centred.
- Design for grayscale: use distinct symbols (circles, squares, triangles), hatching, or line styles rather than color.
- Ensure high resolution (300+ DPI) and legible fonts when scaled to column width.

IV. Citations and References (APA Style with BJPE Conventions)

13. In-text citations follow the author–date format: (*Author, Year*) or *Author (Year)*.

- Example: (*Wilmore, 2000*) or *Wilmore (2000)* argues that...
- For two authors: (*Bosworth & Yang, 2000*)
- For three or more authors: (*Hoque et al., 2023*)

14. Reference list requirements:

- Appear at the end of the article, arranged alphabetically by first author's surname.
- Use hanging indents for all entries.
- Follow APA 7th edition conventions, adapted to BJPE's traditional formatting:

a) Book (single or multiple authors)

Format: SURNAME, Initial(s). (Year). *Title of book*. Place of publication: Publisher. *Example:* WILMORE, G.T.D. (2000). *Alien plants of Yorkshire*. Kendall: Yorkshire Naturalists' Union.

b) Chapter in an edited book

Format: SURNAME, Initial(s). (Year). Title of chapter. In Initial(s). SURNAME (Ed./Eds.), *Title of book* (chap. X, pp. xx–xx). Place: Publisher.

Example: NICHOLLS, G. (2002). Mentoring: the art of teaching and learning. In P. JARVIS (Ed.), *The theory and practice of teaching* (chap. 12, pp. 245–260). London: Kogan Page.

c) Journal article

Format: SURNAME, Initial(s). and Initial(s). SURNAME (Year). Title of article. *Title of Journal*, vol. X, no. Y, pp. XX–YY.

Example: BOSWORTH, D. and D. YANG (2000). Intellectual property law, technology flow and licensing opportunities in China. *International Business Review*, vol. 9, no. 4, pp. 453–477.

Note: Abbreviations *vol.*, *no.*, and *pp.* may be omitted if consistency is maintained throughout. When multiple journals share the same title, include the place of publication in parentheses (e.g., *International Affairs* (London)).

d) Electronic source

Format: ORGANIZATION/AUTHOR. (Year). *Title of document*. [Accessed online from Database/URL, Access Date].

Example: DIXONS GROUP PLC (2004). *Company report: profile*. [Accessed online from Financial Analysis Made Easy (FAME) database at <http://www.bvdep.com/en/FAME.html>, 13 Dec. 2005].

15. Footnotes and Endnotes:

- Footnotes are discouraged; integrate explanatory or supplementary content directly into the main text.
- If essential endnotes are required (e.g., for methodological clarifications or ancillary data), number them consecutively

throughout the manuscript and place them *after* the main text but *before* the Reference list.

- Endnote citations in text should appear as superscript numerals: ... *as demonstrated previously*.¹

V. Additional Guidelines

16. Language and Style:

- Define all abbreviations at first use.
- Use italics for emphasis only; avoid bold or underlining in body text.
- Maintain formal, precise academic English (or Bangla, where applicable).

17. File Submission:

- Submit manuscripts in editable Word format (.doc or .docx).
- Provide separate, clearly labeled files for tables, figures, and supplementary materials.
- Ensure all embedded objects are editable and not flattened images.

18. Editorial Process:

- The Editorial Board may request revisions, condensation, or rephrasing prior to publication. All proposed changes will be shared with the author for approval.
- Authors are responsible for securing permissions for any reproduced tables, figures, or lengthy quotations.

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- The Bangladesh Economic Association disclaims responsibility for views expressed in published contributions. Authors bear full responsibility for the accuracy of data, originality of content, and ethical compliance of their work.

20. Post-Acceptance:

- Unaccepted manuscripts are not returned.
- Upon publication, each author receives one complimentary journal copy and five off-prints.

Consistency in punctuation, capitalization, and italicization across all reference entries is mandatory. Authors are advised to verify all URLs and access dates for electronic sources prior to submission.

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