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The Role of Mobile Financial Services (MFSs) on Financial Inclusions and Economic Growth of Bangladesh

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Abstract: *Brining the nonbanking people into the banking platform is termed as financial inclusion which could be a key driver to accelerate the economic growth of an economy. This study aims to establish whether MFS contribute in financial inclusion which further contribute in the economic growth of Bangladesh. After establishing significant contributions of MFSs to financial inclusion using t-tests' results, the short and long run contribution of financial inclusion on economic growth of Bangladesh has been assessed. Secondary monthly data ranging from December 2019 to January 2024 (50 observations) has been utilized using ARDL model. Foreign direct investment (FDI) has been used as proxy measures of economic growth. Eleven (11) independent variables representing financial inclusion include number of total registered clients (NORC), number of total transactions (NOTT), total transactions (TT), inward remittance (INREM), cash in transactions (CIT), cash out transactions (COT), personal to personal (P2P), business to personal (B2P), personal to business (P2B), merchant payment (MP), and government payment (GP). Results from ARDL short-run association, and long-run association state that financial inclusion is crucial to Bangladesh's economic growth.*

Keywords: *Financial Inclusion, Mobile Financial Services (MFS), Mobile Banking*

1. Introduction

1.1 Background of the study

Mobile Financial Services (MFS) have become a revolutionary financial development in the world, providing people with a convenient digital access to transactions, saving, remittances, and payments. MFS platforms in most developing nations in Africa and South Asia have minimized access barriers to financial services by cutting down documentation, costs, and accessing remote populations (GSMA, 2023; Andrianaivo and Kpodar, 2011). In Bangladesh,

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where conventional banking infrastructures are still low in rural regions, MFS has developed swiftly with bKash, Nagad, and Rocket providers as one of the primary sources of financial inclusion.

According to the different studies, financial inclusion (FI) depends on such factors as account ownership, the diversity of transactions, remittance channels, merchant payments, and mobile-based transfers (Kim et al., 2018; Aitaa et al., 2023). According to the financial intermediation theory, efficiently structured financial systems encourage savings, investment, and allocation of resources thus contributing to the growth of the economy (Levine, 2005). Digital financial services go further, allowing low-income households and small businesses to conduct transactions in a safe way, lessen cash dependency, and enhancing their involvement in economic activities (Chatterjee, 2020). By adopting mobile at scale, Bangladesh provides an interesting setting to explore how MFS-based inclusion can be converted into overall economic effects, especially via foreign direct investment (FDI), which is indicative of investor confidence and economic dynamism.

Although more and more literature is available on the topics of financial inclusion and digital finance, there are still a number of gaps. The existing literature on Bangladesh has largely evaluated the FI based on cross-section surveys or demographics or general measures of access, but has not investigated how the particular elements of MFS lead to inclusion and economic growth. More so, the number of studies that employ high-frequency monthly data to determine the dynamic short-run and long-run impacts of MFS on economic performance is very low.

That is why the main contributions of the study are threefold. First, it offers an in-depth evaluation of financial inclusion through the analysis of an extensive variety of MFS variables that include both access and utilization aspects. Second, it introduces a two-step connection MFS expansion → financial inclusion → economic growth and thus contributes to the theoretical and empirical knowledge on the digital finance in emerging economies. Third, it uses strict time-series methods to identify both short-run and long-run impacts, which would provide insights to policy-makers who aim to implement digital financial strategies in national economic objectives.

As financial services in Bangladesh are becoming digitalized very rapidly, it is high time to know how MFS affects financial inclusion and economic growth. This paper thus discusses the contribution of MFS towards increasing financial inclusion and explores how inclusion promotes Economic development of Bangladesh especially through inflow of foreign investment.

1.2 Objective of the study

The basic goal of this study includes the role of mobile financial services (MFSs) on the growth and expansion of financial inclusion in Bangladesh, and how financial inclusion is contributing to the economic growth of Bangladesh. More specific objectives of this study are given below:

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i. To identify and examine the factors related to mobile financial services (MFSs) that influences the financial inclusions in Bangladesh.
ii. To assess whether MFSs contributes to the economic growth of Bangladesh in the short-run.
iii. To identify whether MFSs influences the economic growth of Bangladesh in the long-run.

2. Literature Review

Financial inclusion is often used in the literature as described in terms of the availability, penetration and utilization of financial services, whereas economic growth is usually indicated in terms of improvement in GDP, per capita income, development of the financial sector, and the total economic activity.

Some studies in Africa have found that there is a positive association between financial inclusion and economic development. Aitaa and Amadi (2023) demonstrate that the relationship between availability, penetration, and usage on one hand and growth on the other is positive, and that financial inclusion can contribute to the economic development. In a similar vein, Oyadeyi (2024) points at the relevance of financial innovation through the application of MIDAS (Mixed-Dimensional Autoregressive Distributed Lag) and ARDL (Autoregressive Distributed Lag) methods and concludes that cheque, banking innovation like point of sales (POS) and internet transaction do not contribute to the economic growth of Nigeria significantly. These conclusions show that the use of contemporary digital tools, such as MFS-related services, facilitates financial inclusion and economic activity.

A review of five years of agent banking developments in Bangladesh by Chakrobortty and Sultana (2023) indicates that the groups with limited access to formal financial services such as rural, poor and unbanked people have gained more access to formal financial services. Based on Bangladesh Bank data, they report a gradual increase in the indicators of agent banking, the role of innovative delivery systems to bridge the access divide. Akhter and Khalily (2020) also indicate that MFSs in Bangladesh have grown at an alarming rate since 2011 and have resulted in a higher level of inclusivity and efficiency in the services they offer. Their research indicates that demographic variables, including poverty, city dwellers, gender, professions, education, migration, and others, have a bearing on mobile financial services usage and that specific policies should be designed to address the most underserved users.

Based on data on 22 SSA countries, Ifediora et al. (2022) demonstrate the positive impact of mobile financial inclusion, in particular, availability and penetration on growth, yet they also mention that mobile money agents may also act as obstacles to such outcomes, which is why such a financial education should be paid special attention. Here, Ndiaye et. al., (2022) utilize the Granger and dynamic panel causality tests on 20 SSA countries and establish that financial inclusion has a positive influence on economic growth where

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unidirectional causality is observed to flow in the direction of inclusion to the growth, which prompts them to propose the expansion of inclusion policies.

When applied to 24 developing countries, Wasim et al. (2022) discover that trade and financial inclusion have a substantial and positive influence on the economic growth. According to their findings, financial inclusion enhances the gains of trade, and such strategies as multilateral agreements and market diversification are supported. A study by Ahassan et al. (2021) on the subject of mobile money in SSA between 2011 and 2018 reveals that the growth in the number of mobile money agents and mobile money volume is positively associated with GDP per capita and growth in the financial sector. Their results point to the fact that mobile money helps to give the unbanked populations an extra financial channel, which assists household expenditures, remittances, and business.

In the Middle East and North Africa (MENA), Emara and El Said (2021) establish a positive relationship between financial inclusion indicators, including bank account ownership, the presence of ATMs, and access to business loans and GDP per capita in the Middle East and North Africa (MENA) during the period between 1990 and 2018. Their results highlight the essence of good governance, such as political stability and judicial independence, to enhance the full advantage of inclusion and increase access to finance.

The other research also points out the association of FI and economic performance. In their study, Thaddeus et al. (2020) provide 22 SSA countries with results based on a vector error correction and Granger causality tests that prove that economic growth causally influences digital inclusion, and consumer education. Chinoda and Kwenda (2019) discuss the relationship between FI, competition, bank stability, mobile phone usage and development in Africa and conclude that these variables have a positive and significant impact on inclusion, and economic efficiency. Kim et al. (2018) concentrate on OIC countries, which proves a two-way causal relationship between FI and economic growth.

Lenka and Sharma (2017) conclude that in India, financial inclusion has been strengthened by financial liberalization between 1980 and 2014, and inclusion has a positive relationship with growth based on indices and models derived through PCA such as ECM and ARDL. Investigating the situation in Nigeria between 1986 and 2015, Okoye et al. (2017) have discovered that rural credit alleviates poverty, whereas credit to the private sector has no significant effects on economic growth and should suggest reforms in monetary policy to enhance financial resources distribution. In a study based on GMM analysis of 44 countries, Lundqvist et al. (2014) indicate that mobile phones usage has a positive impact on financial inclusion and growth by increasing bank savings and loans per capita.

The technological advancement is also mentioned as the factor in the past. Andrianaivo and Kpodar (2011) discover that the growth in Africa is being propelled by ICT development, especially mobile phones and that financial inclusion enhances this growth. Based on Honohan (2008) financial inclusion

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indicator, Rojas-Suarez (2010) indicates national level obstacles as social underdevelopment, economic instability, ineffective legal systems, income inequality, and regulatory restraint, showing national-level obstacles determine access.

On the whole, the studies examined that mobile financial services and other online platforms are always helpful in increasing FI through access, barriers, and efficiency. The increased FI in its turn promotes economic growth by providing better participation in financial activities, improved savings and credit flows, and improved economic participation among the previously marginalized groups. These facts underscore the importance of investigation about the role of MFSs in improving FI and supporting economic growth in Bangladesh.

3. Conceptual Framework

3.1 Conceptual Linkage of Mobile Financial Services (MFS) on the Financial Inclusion

To develop the conceptual linkage of mobile financial services (mfs) on the FI, an analysis has been done in the first phase to identify the contribution of MFS on the FI in Bangladesh. A variety of selected variables were incorporated into the study, including MFS Agent, MFS Male Account, MFS Female Account, MFS Other Account & MFS Total Account. This analysis uses monthly data for all the variables from December-2018 to March-2024 (64 observations per variable) obtained from the Bangladesh Bank. Then for assessing growth of all the listed MFS growth indicators, this study split the entire sample period into three terms (i.e. December 2018 to September 2020 (1st Term); October 2020 to July 2022 (2nd Term); and August 2022 to March 2024 (3rd Term)). For a variety of data collection need, the official websites Bangladesh Bank (BB) have been utilized frequently.

3.2 Variables Specification

MFS Agent - An MFS agent in Bangladesh is authorized to perform transactions like transfers, payments (business, government, merchant), and handle microfinance or insurance-related services.

MFS Male Account - In Bangladesh, 82.58% of males use MFS accounts, often for advanced services like bill payments and business, while women primarily use them for sending and receiving money (*Star Business Report, Mar 9, 2024*).

MFS Female Account - In Bangladesh, only 47.16% of women have MFS accounts, highlighting a concerning gender gap in usage compared to men (Star Business Report, Mar 9, 2024).

MFS Other Account - These accounts—held by minors, students, and third-gender individuals—boost FI and contribute to Bangladesh's economy by involving diverse, often underserved population groups in financial activities.

MFS Total Account - It is a combination of all accounts: MFS Agent, MFS Male Account, MFS Female Account and MFS Other Account.

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3.3 Model Specification

t-test - A t-test examines hypotheses and determines whether a difference between two group means is, or is not, statistically significant. It is based on the use of t-distribution, distribution with the similar probability to distribution normal, which is widely used on numerical data. The p – value tells of probability that the differences observed occurred by chance. If samples distributions are normal, the difference of them will be also normal.

The unit root test is expressed as follows:

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

Here,

$$\bar{x}_1 = observed\ mean\ of\ 1^{st}\ sample$$
$$\bar{x}_2 = observed\ mean\ of\ 2^{nd}\ sample$$
$$\bar{s}_1 = standard\ deviaiton\ of\ 1^{st}\ sample$$
$$\bar{s}_1 = standard\ deviaiton\ of\ 2^{nd}\ sample$$
$$n_1 = sample\ size\ of\ 1^{st}\ sample$$
$$n_2 = sample\ size\ of\ 2^{nd}\ sample$$

3.4 Conceptual Linkage of Financial Inclusion on the Economic Growth of Bangladesh

The second phase different FI related variables have been used to measure their short and long run influence on the three dependent variables measuring economic growth. The conceptual framework is depicted below:

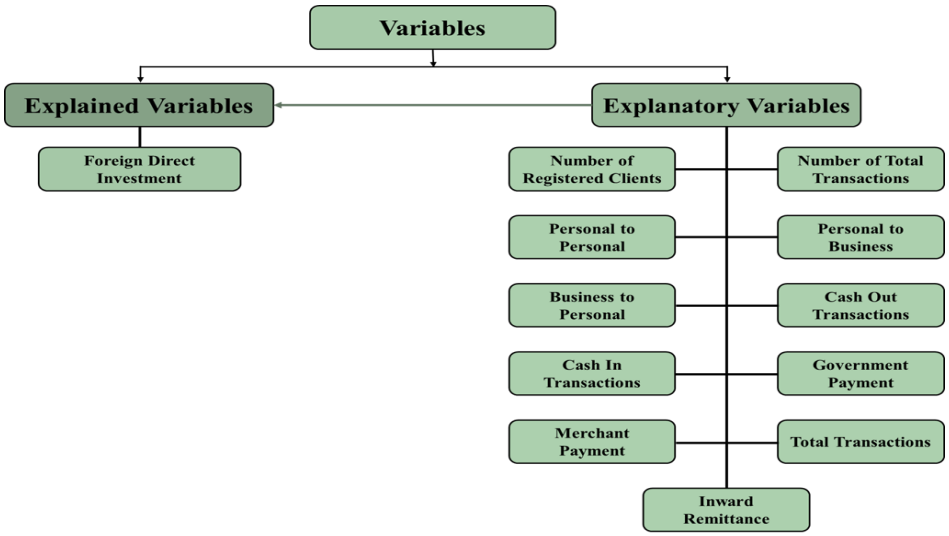

Figure 1: Dependent Variables, and Independent Variables

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3.5 Variable Specifications

Dependent Variables

Foreign Direct Investment (FDI)

Proxy: Growth of Foreign Direct Investment

Direct investments in companies or projects made by foreign investment in local markets is referred to as FDI. FDI has been critical in correcting aspects of resource deficiencies, which were already marked among the significant concerns from 1971 and had such policy measures such as the 1999 industrial policy to promote its increase (Rahman, 2015).

Independent Variables

Number of Registered Clients (NORC)- NORC in MFS refers to the total number of individuals registered to access mobile financial services including cash-in, cash-out, peer-to-peer transfers and bill payment.

Number of Total Transactions (NOTT) - NOTT in MFS is an indicator of the total number of transactions within MFS, which monitor all transactions made through mobile channels e.g. P2P transfers, cash-in, and cash-out, as well as bill payments.

Personal to Personal (P2P) - With MFS, users can also carry out P2P transactions; securely sending money to another individual's mobile wallet eliminating the need to use cash or cheques.

Personal to Business (P2B) - In MFS, P2B allows users to send secure, cashless payments of money to businesses from their mobile devices, giving them a quick and simple way to pay.

Business to Personal (B2P) - B2P transactions in mobile financial services (MFS) enable businesses to directly send funds to individuals for such reasons as salary disbursement, vendor payments and refunds.

Merchant Payment (MP) - Mobile Financial Services' (MFS) Merchant Payments (MP) allows individuals and businesses to transmit mobile money to merchants to facilitate safe, convenient and cashless transactions for purchases and services.

Total Transactions (TT) - The total transaction volume under MFS aggregates the total value of all cash-in, cash-out, peer to peer, bill payments and merchant payments made through the system.

Cash In Transactions (CIT) - In the MFS, this is a "cash-in transaction" when customer deposits cash through the designated agents/rail stores which are then transacted and turned into virtual funds within your mobile wallet.

Cash Out Transactions (COT) - The means of having funds withdrawn from MFS mobile wallet to cash in MFS are through authorized agents, stores and ATMs that can do mobile money transactions.

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Inward Remittance (INREM) **-** Inward remittance under MFS system refers to making foreign money going into a mobile wallet sided for helping relatives abroad; executing international trade or cross-border financial activities.

$$FDI = \alpha + \beta_1 \mathrm{NORC} + \beta_2 \mathrm{NOTT} + \beta_3 \mathrm{TT} + \beta_4 \mathrm{MP} + \beta_5 \mathrm{GP} + \beta_6 \mathrm{P2P} + \beta_7 \mathrm{P2B} + \beta_8 \mathrm{CIT} + \beta_9 \mathrm{COT} + \beta_{10} \mathrm{B2P} + \beta_{11} \mathrm{INREM} + \varepsilon$$

4. Methodology

4.1 Research Methods

This research discusses the impact of Mobile Financial Services (MFSs) on achieving financial inclusion and the economy of Bangladesh accordingly. The first part looks at several indicators for MFSs – number of agents, male, female and total accounts – through mean growth and standard deviation, to examine their part in promoting financial inclusion. The second part assesses the effects of financial inclusion on economic growth where Foreign Direct Investment (FDI) is used instead. Eleven MFS-specific variables are analyzed: number of registered clients (NORC), number of transactions (NOTT), total transactions (TT), inward remittance (INREM), cash in/out transactions (CIT, COT), P2P, B2P, P2B, merchant payments (MP), and government payments (GP). Before considering the Augmented Dickey-Fuller (ADF) test for order of integration, descriptive statistics and Pearson's correlation matrix are presented. Further tests of the variables incorporated at I(0) or I(1) are made using Autoregressive Distributed Lag (ARDL) model for short run relations. Long-run relationships are analyzed through the Bound Cointegration test (Pesaran et al., 2001), followed by Error Correction Model (ECM) to generate the estimates for the short-run dynamics.

The selection process of approaches for the time-series analysis is mainly based on the outcomes of the unit root test that specify the stationarity of the variables (Shrestha & Bhatta, 2018). The variables selected are tested for stationarity in this research using the Augmented Dickey Fuller (ADF) unit root test.

4.2 ARDL Model Specification

The ARDL model, using ordinary least squares (OLS), handles time series data with various integration orders, efficiently. The model depends on correct lag selection and uses a general-to-specific method of modeling (Shrestha & Bhatta, 2018). ARDL model can well deal with serial correlation when appropriate lags are used (Ghatak & Siddiki, 2001). Using ARDL, cointegration is calculated over both short and long periods, and unbiased estimates are offered (Pesaran et al., 2001). This model is usually noted as ARDL $(p, q_1, \ldots\ldots, q_k)$, where p denotes the dependent variable's number of lags, and q_k denotes k^{th} regressors.

The following is an expression of the ARDL model-

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$$y_t = \alpha + \sum_{i=1}^{p} y_i y_{t-1} + \sum_{j=1}^{k} \sum_{i=0}^{q_j} X_{j,t-1}\beta_{i,j} + \in_t$$

Regressor which contain lags are made dynamic while those which do not contain lags as fixed. Selection of appropriate lags for each variable (i.e., specifying $p, q_1, \ldots\ldots, q_k$) in the ARDL model is done with the assistance of criteria for model selection such as Hannan-Quinn, Akaike and Schwarz (Ali, 2020).

4.3 Bounds Cointegration Test

There may or may not be a causal link between the dependent and independent variables in the ARDL model over the long term, and Pesaran et al. (2001) have described a way, bounds test, for checking so. The Bounds test procedure can be expressed using the following equation-

-

$$\Delta y_t = -\sum_{i=1}^{p-1} y_i^* \Delta y_{t-1} + \sum_{j=1}^{k} \sum_{i=0}^{q_{j-1}} \Delta X_{j,t-1}\beta_{i,j,i^*} - \rho y_{t-1} - \alpha - \sum_{j=1}^{k} X_{j,t-1}\delta_j + \in_t$$

Thus, the following simple test can be used to determine if long-run relationships exist.

$$\rho = 0$$

$$\delta_1 = \delta_2 = \cdots = \delta_k = 0$$

Bounds, such as critical values, have been provided by Pesaran et al. (2001) for the most common cases in which the explanatory variables are a mix of I(0) and I(1). They have also provided bounds for the cases in which all of the regressors are I(0) or I(1).

4.4 Data and Data Sources

The secondary data sourced in this research was from relevant sources. The financial inclusion indicator was measured using Bangladeshi Mobile Financial Services (MFS) data from Bangladesh Bank. In order to analyze the relationship between financial inclusion and economic growth, in which case, FDI was used as dependent variable, data was also extracted from Bangladesh Bank. The explanative variables retained are NORC, NOTT, P2P, P2B, B2P, CIT, COT, GP, MP, TT and INREM. The analysis of financial inclusion was performed using monthly observations from December 2018 to March 2024 (64 observations), while economic growth was analyzed with data from December 2019 to January 2024 (50 observations).

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5. Analysis & Findings

5.1 Financial Inclusion through Mobile Financial Services (MFSs)

This paper examines the development story of Mobile Financial Services (MFS) and evaluates their role in limited inclusion and economic development in Bangladesh. Mobile Financial Services has its growth assessed through such factors as agents, gaps between male and female accounts, types of accounts and overall accounts count. The data is grouped into three periods: ① December 2018–September 2020; ② October 2020–July 2022; and ③ August 2022–March 2024. Through the analysis of the average growths of these indicators and the use of a t-test, we verify MFS growth.

The growth of MFS agent has been presented in table 1. It is observed that the mean MFS agent is increasing and the mean growth rate is found positive. The standard deviation of MFS agent is also found increasing in three sequential terms. The gradual growth of MFS agent in different specified term is also observed in figure 2.

Table 1: Growth of MFS Agent

Periods	No. of Obs.	Urban MFS Agent			Rural MFS Agent			Total MFS Agent		
		Mean '000	Mean Growth	δ '000	Mean '000	Mean Growth	δ '000	Mean '000	Mean Growth	δ '000
1st term	17	556.37	0.95%	42.12	522.23	1.32%	35.16	1,078.60	1.11%	75.46
2nd term	22	720.69	1.03%	50.81	666.72	1.29%	49.05	1,387.41	1.15%	96.25
3rd term	20	811.99	0.90%	59.65	808.65	0.60%	26.52	1,620.64	0.75%	85.52

Note: Authors' own calculation

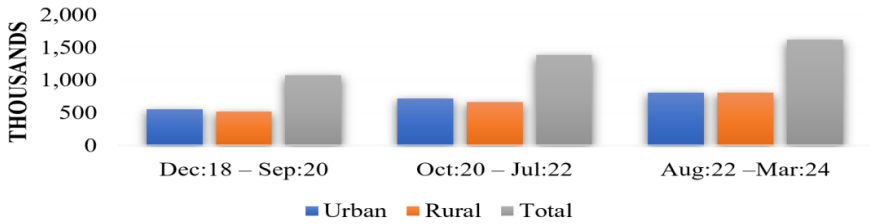

Figure 2: Growth of MFS Agent

Table 2 includes the t-test results and p-values, under the assumption that there is no mean variation in the MFS agents' numbers as time frames. In pairwise comparisons, we find that the null hypothesis of zero mean difference is rejected at the 5% level between the 1st and 2nd terms for urban, rural, and total MFS agents. Similar findings can be gone for when the 2nd and 3rd terms are being compared for each segment. In combination, these findings show a dramatic increase in the average number of agents for both urban, rural and total MFS across terms, with growth present in each segment.

The growth of MFS male account has been presented in table 3. The mean values MFS male account is increasing in urban, rural and total segments. The standard

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deviation in the 3rd term in all the three segments is also found to decrease as compared to the 1st and 2nd terms. The gradual growth rate of MFS male account is found highest in the 2nd term but 1st and 2nd term growth rate are also positive which is presented in figure 3.

Table 2: t-test for MFS Agent

H_0: Mean difference is zero.									
Periods	**Urban MFS Agent**			**Rural MFS Agent**			**Total MFS Agent**		
	d.f.	***t*- stat**	***p*- value**	**d.f.**	***t*- stat**	***p*- value**	**d.f.**	***t*- stat**	***p*- value**
Between 1st Term and 2nd Term	40	-11.99	4.04E-15	37	-11.39	5.83E-14	39	-12.14	4.06E-15
Between 2nd Term and 3rd Term	35	-5.39	2.45E-06	31	-12.1	1.42E-13	38	-8.52	1.21E-10

Note: Authors' own calculation

Table 3: Growth of MFS Male Account

Periods	**No. of Obs.**	**Urban MFS Male Account**			**Rural MFS Male Account**			**Total MFS Male Account**		
		Mean '000	**Mean Growth**	**δ '000**	**Mean '000**	**Mean Growth**	**δ '000**	**Mean '000**	**Mean Growth**	**δ '000**
1st term	17	20,000.40	-	727.53	25,193.07	-	1,187.24	45,193.47	-	1,907.29
2nd term	22	38,992.90	0.95%	1,592.23	49,354.10	0.96%	1,403.69	88,347.01	0.95%	2,972.54
3rd term	20	53,236.89	0.37%	675.57	65,973.68	0.34%	1,086.73	119,210.56	0.35%	1,750.33

Note: Authors' own calculation

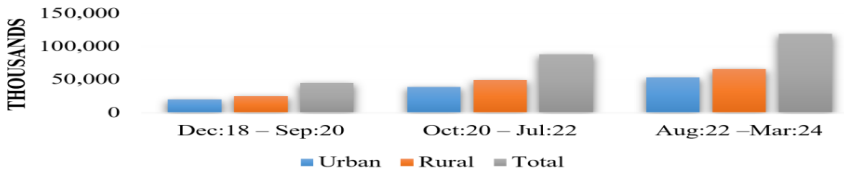

Figure 3: Growth of MFS Male Account

The findings (Table 4) of pairwise comparisons mean that null hypothesis of zero mean difference is rejected at 5% level for urban male accounts between 1st and 2nd terms, which shows significant difference. Analyses of the rural and total segments give similar results. The null hypothesis is retained for all segments if judged by 2nd and 3rd terms. Generally, it is clear that MFS male accounts have increased positively over terms in both urban, rural and total areas.

Table 4: t-test for MFS Male Account

H_0: Mean difference is zero.									
Periods	**Urban MFS Male Account**			**Rural MFS Male Account**			**Total MFS Male Account**		
	d.f.	***t*- stat**	***p*- value**	**d.f.**	***t*- stat**	***p*- value**	**d.f.**	***t*- stat**	***p*- value**
Between 1st Term and 2nd Term	28	-10.85	7.72E-12	40	-13.14	2.11E-16	34	-12.22	2.73E-14
Between 2nd Term and 3rd Term	27	-8.24	3.83E-09	37	-9.36	1.34E-11	32	-8.95	1.60E-10

Note: Authors' own calculation

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The growth of MFS female account has been presented in table 5. The period wise MFS female account shows that the average MFS female account is rising in all the three terms, and the average growth rate is positive. The standard deviation of MFS female account is lowest in the 3rd terms as compared to the 1st and 2nd term. The gradual growth of MFS female account in different specified term is also presented in figure 4.

Table 5: Growth of MFS Female Account

Periods	No. of Obs.	Urban MFS Female Account			Rural MFS Female Account			Total MFS Female Account		
		Mean '000	Mean Growth	δ '000	Mean '000	Mean Growth	δ '000	Mean '000	Mean Growth	δ '000
1st term	17	12,593.54	-	618.04	28,935.38	-	1,040.20	41,528.91	-	1,654.82
2nd term	22	26,061.43	1.07%	1,021.70	41,620.01	0.44%	445.30	67,681.44	0.63%	1,344.74
3rd term	20	49,155.59	0.89%	509.61	49,444.19	0.19%	718.13	86,244.20	0.27%	1,224.00

Note: Authors' own calculation

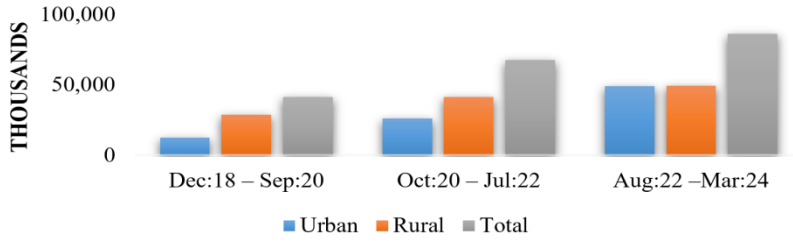

Figure 4: Growth of MFS Female Account

In Table 6, the t-test statistics with its respective p-values are presented to decide if there is a mean difference in MFS female accounts for two periods. For urban accounts by females pairwise comparisons reject the null hypothesis assuming zero difference in mean at the 5% level between the 1st and 2nd terms indicating a difference. For rural segment and also for total segment, null hypothesis of no difference between first and second term is not rejected. Similar results are attained when 2nd and 3rd terms are paired for all segments. The general findings indicate rising MFS female account activity over each term for all segments.

Table 6: t-test for MFS Female Account

H_0: Mean difference is zero.									
Periods	Urban MFS Female Account			Rural MFS Female Account			Total MFS Female Account		
	d.f.	*t*- stat	*p*- value	d.f.	*t*- stat	*p*- value	d.f.	*t*- stat	*p*- value
Between 1st Term and 2nd Term	33	-11.28	3.66E-13	28	-11.2104	3.65E-12	40	-12.26	1.96E-15
Between 2nd Term and 3rd Term	35	-18.49	6.05E-20	29	-9.45	1.16E-10	38	-10.21	9.59E-13

Note: Authors' own calculation

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The growth of MFS other account has been presented in table 7. It is observed that the mean MFS other account is increasing and the mean growth rate is found positive. It is surprising to found the mean MFS other account growth rate is highest is the 2nd term in our analysis. The standard deviation of MFS other account is higher in the 1st and 3rd term but found lowest in the 2nd tern in all the urban, rural, and total segment. The gradual growth of MFS other account in different specified term is also observed in figure 5.

Table 7: Growth of MFS Other Account

Periods	No. of Obs.	Urban MFS Other Account			Rural MFS Other Account			Total MFS Other Account		
		Mean '000	Mean Growth	δ '000	Mean '000	Mean Growth	δ '000	Mean '000	Mean Growth	δ '000
1st term	17	60.96	-	13.08	36.29	-	7.48	95.67	-	21.05
2nd term	22	200.50	2.29%	6.45	120.20	2.31%	3.85	320.70	2.35%	10.28
3rd term	20	333.34	0.66%	12.93	169.51	0.41%	7.42	502.85	0.57%	19.39

Note: Authors' own calculation

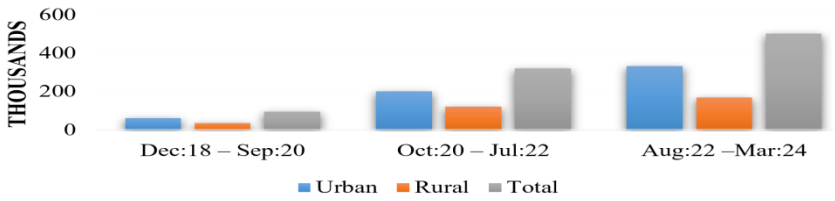

Figure 5: Growth of MFS Other Account

We provide the t-Test statistics and p-values that we calculated under the null hypothesis that the mean difference in MFS other accounts is 0 for the two terms in Table 8. The pair-wise comparison leads to rejection of the null hypothesis of the zero-mean difference at the 5% level for urban MFS other accounts between 1st and 2nd terms which can be are said to be significant. The same results are also observed for the 2nd and 3rd terms in the urban, rural, and total segments. The null hypothesis is rejected for each of the three segments showing a positive trend in MFS other accounts through terms, all segments having positive mean differences.

Table 8: t-test for MFS Other Account

H_0: Mean difference is zero.									
Periods	Urban MFS Other Account			Rural MFS Other Account			Total MFS Other Account		
	d.f.	*t*- stat	*p*- value	d.f.	*t*- stat	*p*- value	d.f.	*t*- stat	*p*- value
Between 1st Term and 2nd Term	31	-9.57	4.57E-11	29	-9.78	5.49E-11	31	-9.79	2.65E-11
Between 2nd Term and 3rd Term	27	-9.20	4.15E-10	27	-5.90	1.38E-06	28	-8.30	2.47E-09

Note: Authors' own calculation

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The growth of MFS total account has been presented in table 9. It is observed that the mean MFS total account is increasing and the mean growth rate is found positive except 3rd term of rural MFS total account. The standard deviation of MFS total account isn't found increasing in three sequential terms, sometimes it increases and sometimes it decreases. The gradual growth of MFS total account in different specified term is also observed in figure 6.

Table 9: Growth of MFS Total Account

Periods	No. of Obs.	Urban MFS Total Account			Rural MFS Total Account			Total MFS Total Account		
		Mean '000	Mean Growth	δ '000	Mean '000	Mean Growth	δ '000	Mean '000	Mean Growth	δ '000
1st term	17	32,666.15	-	1,345.70	54,641.15	-	2,222.39	86,818.05	-	3,572.38
2nd term	22	65,254.84	1.00%	2,613.54	91,094.31	0.67%	1,743.27	156,349.14	0.80%	4,296.95
3rd term	20	90,658.83	0.39%	1,192.11	11,529.87	-0.87%	1,802.54	205,957.61	0.32%	2,980.33

Note: Authors' own calculation

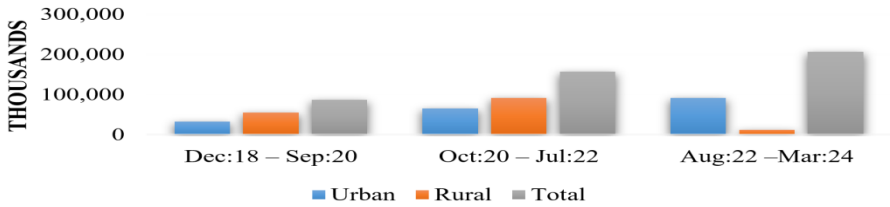

Figure 6: Growth of MFS Total Account

Table 10 presents t-test statistics and p-values with assumption of no mean difference between two periods on MFS total accounts. By analysis through pair-wise comparisons, null hypothesis of zero mean difference for urban MFS total accounts between the 1st and 2nd terms is rejected at the 5% level, indicating a significant difference. Similar results are presented for rural and total segments when comparing 1st and 2nd terms. As to the 2nd and 3rd terms, the null hypothesis of no-mean difference is rejected for all segments except rural in the 3rd term. In general, the data shows that MFS total accounts have experienced an increase in all examined segments.

Table 10: t-test for MFS Total Account

H_0: Mean difference is zero.									
Periods	Urban MFS Total Account			Rural MFS Total Account			Total MFS Total Account		
	d.f.	*t*- stat	*p*- value	d.f.	*t*- stat	*p*- value	d.f.	*t*- stat	*p*- value
Between 1st Term and 2nd Term	30	-11.07	2.03E-12	37	-12.71	2.26E-15	39	-12.44	1.86E-15
Between 2nd Term and 3rd Term	28	-8.84	6.74E-10	38	-9.65	4.52E-12	35	-9.49	1.65E-11

Note: Authors' own calculation

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5.2 Role of Financial Inclusion on Economic Growth

Table 11 summarizes the major variables studied in this research using the results of their descriptive statistics. Foreign direct investment (FDI) demonstrates average monthly growth rate of 0.48% and relatively stable standard deviations thus indicating controlled fluctuations. The average registered client count (NORC) is 1,395.44 while total monthly transactions (NOTT) is 374 million, with a fairly stable pattern. P2P transfers show the highest average monthly value (BDT 21,950.43) and the highest variation. On average the B2P transfers account to BDT 2554.15 while average P2B transfer stands at BDT 1574.22. With the help of the MFS, government payments amounting to on average BDT 626.97 per month are possible, but the high standard deviation of 866.03 indicates that there is considerable variation of these transactions. MFS inward remittances have a mean value (MEA) of BDT 291.63 with limited variance. Merchant payments (MP) account significantly for BDT 3,001.97 per month. The average CIT and COT transactions are BDT 23,721.39 and BDT 21,710.08 respectively, thereby the maximum standard deviation among all types of transactions. In general, the data highlight this increased ubiquity and spread of MFS in Bangladesh, specific emphasis is placed onto P2P transfers and cash-based activities, with notable disparities in stabilities in various transaction categories.

Table 11: Descriptive Statistics

Variables	Obs	Mean	Std. Dev.	Maximum	Minimum
FDI	50	0.0048	0.0348	0.093	-0.067
B2P	50	2,554.15	947.67	5,187.91	1,004.68
CIT	50	23,721.39	8,724.60	40,228.33	8,709.88
COT	50	21,710.08	7,746.63	37,707.68	8,227.60
GP	50	626.97	866.03	4,066.98	13.76
INREM	50	291.63	172.51	645.1	29.68
MP	50	3,001.97	1,614.98	6,494.55	233.7
NORC	50	1,395.44	516.74	2,204.57	795.08
NOTT (Million)	50	374	104	573	218
P2B	50	1,574.22	880.21	3,330.59	271.32
P2P	50	21,950.43	7,330.92	35,276.21	9,242.88

ADF test outcome in Table 12 is used to determine the stationarity of the variables. Stationarity could not be overemphasized because it has direct effects on model selection. In the case of time series data that have varying degrees of integration, ARDL model is preferred. For uniform integration levels of variables, Johansen's co-integration treatment is adopted. For non-stationary data, OLS must be adjusted indicating the role of unit root testing prior to time series models application (Shrestha & Bhatta, 2018).

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Table 12: ADF Unit Root Test

Variable	ADF Test's Prob.		Order of Integration
	I(0)	I(1)	
NoRC	0.8673	0.0000	I(1)
NoTT	0.8397	0.0000	I(1)
TT	0.8339	0.0000	I(1)
INREM	0.0293		I(0)
CIT	0.9351	0.0000	I(1)
COT	0.9127	0.0000	I(1)
P2P	0.3687	0.0000	I(1)
B2P	0.0276		I(0)
P2B	0.2569	0.0000	I(1)
MP	0.5093	0.0000	I(1)
GP	0.0002		I(0)
FDI	0.1038	0.0001	I(1)

Note: Authors' own calculation

As parameterized by the unit root test, INREM, B2P, and GP are all stationary at level; FDI and others are stationary only after having been differenced once– making them suitable candidates for ARDL estimation. Having determined the optimal lag order as 2 (appendix table 1), the ARDL model is used in this case, with FDI as the dependent variable. According to Table 13, at the level, INREM and P2B are correlated with significant negative impacts upon FDI whereas NORC is correlated with significant positive impact. For a lag, the COT, MP, NORC, and P2P have a negative impact on FDI, whereas the NOTT, P2B and TT have positive and significant effects. In the two-lag case, MP and P2P are positively and statistically correlated with FDI. However, CIT, B2P, and GP are not statistically significant in predicting FDI.

Table 13: ADF Unit Root Test

Dependent Variable: FDI
Dynamic regressors (2 lags, automatic): NORC NOTT TT MP GP P2P P2B CIT COT B2P INREM
Model selection method: Akaike info criterion (AIC)
Fixed regressors: C
Selected Model: ARDL(2, 1, 2, 1, 2, 0, 2, 1, 0, 2, 1, 0)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
FDI(-1)	0.6919	0.144	4.8057	**0.0001*** **
FDI(-2)	-0.561	0.1359	-4.1273	**0.0004*** **
COT	-0.0655	0.1526	-0.4292	0.672
COT(-1)	-0.5249	0.1434	-3.6611	**0.0014*** **
COT(-2)	-0.132	0.086	-1.5352	0.139
INREM	-0.0882	0.0303	-2.9133	**0.0081*** **
MP	0.0452	0.0331	1.3677	0.1852
MP(-1)	-0.1637	0.0404	-4.0494	**0.0005*** **
MP(-2)	0.0465	0.0226	2.0624	**0.0512***
NORC	0.1337	0.0646	2.0708	**0.0503***
NORC(-1)	-0.1683	0.0678	-2.4817	**0.0212*** *
NOTT	0.1786	0.1187	1.5043	0.1467
NOTT(-1)	0.2754	0.0965	2.8551	**0.0092*** **
NOTT(-2)	0.1294	0.0891	1.4514	0.1608
P2B	-0.0866	0.0446	-1.94	**0.0653***
P2B(-1)	0.0839	0.0296	2.8373	**0.0096*** **
P2P	0.2045	0.1959	1.044	0.3078
P2P(-1)	-0.3627	0.1542	-2.3525	**0.0280*** *
P2P(-2)	0.1817	0.0877	2.071	**0.0503***
TT	-0.3774	0.5975	-0.6315	0.5342
TT(-1)	0.7595	0.2502	3.0361	**0.0061*** **
CIT	0.0908	0.231	0.3933	0.6979
B2P	0.0777	0.0461	1.6859	0.1059
B2P(-1)	0.0453	0.0305	1.4858	0.1515
GP	-0.0033	0.0044	-0.7646	0.4526
C	-8.4345	2.6419	-3.1926	**0.0042*** **

FDI = 0.6919 × FDI(-1) - 0.561 × FDI(-2) - 0.0655 × COT - 0.5249 × COT(-1) - 0.132 × COT(-2) - 0.0882 × INREM + 0.0452 × MP - 0.1637 × MP(-1) + 0.0465 × MP(-2) + 0.1337 × NORC - 0.1683 × NORC(-1) + 0.1786 × NOTT + 0.2754 × NOTT(-1) + 0.1294 × NOTT(-2) - 0.0866 × P2B + 0.0839 × P2B(-1) + 0.2045 × P2P - 0.3627 × P2P(-1) + 0.1817 × P2P(-2) - 0.3774 × TT + 0.7595 × TT(-1) + 0.0908 × CIT + 0.0777 × B2P + 0.0453 × B2P(-1) - 0.0033 × GP - 8.4345 × C

*Note: Authors' own calculation; ***, **, * represent significant levels are 1%, 5%, and 10% respectively.*

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Based on table 14, joint significance of model coefficients from ARDL model is found, as F-statistic and Chi Square p-value of 0.0000 are both under 0.05, rejecting the null hypothesis of no joint significance.

Table 13: Wald Test for ARDL Model

Null Hypothesis: C(1)=0, C(2)=0, C(3)=0, C(4)=0, C(5)=0, C(6)=0, C(7)=0, C(8)=0, C(9)=0, C(10)=0, C(11)=0, C(12)=0, C(13)=0, C(14)=0, C(15)=0, C(16)=0, C(17)=0, C(18)=0, C(19)=0, C(20)=0, C(21)=0, C(22)=0, C(23)=0, C(24)=0, C(25)=0, C(26)=0

Test Statistic	*Value*	*df*	*Probability*
F-statistic	8486.331	(26,22)	**0.0000***
Chi-square	220644.6	26	**0.0000***

*Note: Authors' own calculation; ***, **, * represent significant levels are 1%, 5%, and 10% respectively.*

A variety of checks on the model's adequacy were performed. No evidence of heteroscedasticity was indicated (p-values: According to the Breusch-Pagan-Godfrey test in appendix table 2, 0.8803, 0.7610); in addition, the result of the Breusch-Godfrey LM test (Appendix table 3) reflected no serial correlation (p-values: 0.4836, 0.1861). The Ramsey RESET test (Appendix table 4) excluded specification error (p-value > 0.01), and the Jarque-Bera test (Appendix figure 1) verified normality of the residuals (p-value: 0.6336). Stability was validated through the CUSUM and CUSUMSQ tests as depicted in the appendix figures 2 and 3 none of the results falling outside a 5% significance level. The null hypothesis was rejected (at the 1% significance level), as an ARDL bounds test confirmed in Table 15, according to an F-statistic: 5.3766 showed that there is a long-term relationship between FDI and explanatory variables. The results support this model's ability to stay consistent and valid over long durations.

Table 14: Bounds Test Estimates

Null Hypothesis: No level (long-run) relationship exists		
Test Statistic	***Value***	***K***
F-statistic	**5.3766*** **	11
Critical Value Bounds		
Significance	***I(0) Bound***	***I(1) Bound***
1%	2.41	**3.61**
5%	1.98	**3.04**
10%	1.76	**2.77**

*Note: Authors' own calculation; ***, **, * represent significant levels are 1%, 5%, and 10% respectively.*

As table 16 explains, the long-run cointegrating (Pesaran et al., 2001) relationships show that B2P and NOTT promote FDI while COT, INREM, and MP have adverse effects. No strong long-run relationship was determined between FDI and factors such as CIT, GP, NORC, P2B, P2P, and TT.

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Table 15: Long-run Cointegrating Test Estimates

Dependent Variable: FDI				
Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
B2P	0.1415	0.0717	1.9728	**0.0612***
CIT	0.1045	0.2589	0.4037	0.6904
COT	-0.8311	0.221	-3.76	**0.0011*****
GP	-0.0039	0.0051	-0.756	0.4577
INREM	-0.1014	0.0355	-2.8587	**0.0091*****
MP	-0.0828	0.036	-2.2977	**0.0315****
NORC	-0.0398	0.0471	-0.8456	0.4069
NOTT	0.6712	0.1708	3.9304	**0.0007*****
P2B	-0.0031	0.0556	-0.0555	0.9562
P2P	0.0269	0.1707	0.1576	0.8762
TT	0.4397	0.622	0.7069	0.487
C	-9.7043	3.1328	-3.0976	**0.0053*****

EC = FDI - (0.1415 × B2P + 0.1045 × CIT -0.8311 × COT -0.0039 × GP - 0.1014 × INREM - 0.0828 × MP - 0.0398 × NORC + 0.6712 × NOTT -0.0031 × P2B + 0.0269 × P2P + 0.4397 × TT - 9.7043)

*Note: Authors' own calculation; ***, **, * represent significant levels are 1%, 5%, and 10% respectively.*

FDI's Error Correction Model (ECM) with the regressors is shown in table 17. The error correction coefficient, CointEq(-1), is -0.8692, and the p-value is 0.0000. This error correction coefficient means that each month, the prior dynamic disequilibrium, if any, is rectified by 86.92 percent to converge towards equilibrium.

Table 16: ECM Regression

Variable	***Coefficient***	***Standard Error***	***t-Statistic***	***Prob.***
D(FDI(-1))	0.561	0.0871	6.4426	0.0000
D(B2P)	0.0777	0.0129	6.0408	0.0000
D(COT)	-0.0655	0.0739	-0.8856	0.3854
D(COT(-1))	0.132	0.0381	3.4653	0.0022
D(MP)	0.0452	0.0187	2.4197	0.0242
D(MP(-1))	-0.0465	0.0139	-3.3462	0.0029
D(NORC)	0.1337	0.0374	3.5755	0.0017
D(NOTT)	0.1786	0.063	2.834	0.0097
D(NOTT(-1))	-0.1294	0.0528	-2.4495	0.0227
D(P2B)	-0.0866	0.02	-4.3212	0.0003
D(P2P)	0.2045	0.0722	2.8311	0.0097
D(P2P(-1))	-0.1817	0.0474	-3.831	0.0009
D(TT)	-0.3774	0.1348	-2.7992	0.0105
CointEq(-1)*	**-0.8692**	**0.0836**	**-10.3933**	**0.0000*****

*Note: Authors' own calculation; ***, **, * represent significant levels are 1%, 5%, and 10% respectively.*

6. Discussion and Conclusion

6.1 Discussion

The research explores the contributions and benefits of mobile financial services (MFS) for improving financial access in Bangladesh and evaluates how this helps

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economy grow. The investigation uses secondary data for the period December 2018–March 2024 (64 months) to conduct two important investigations. First, the research assesses the impact of MFS on financial inclusion across three distinct time intervals. The mean growth rates of MFS indicators for Bangladesh, analyzed using paired sample t-tests, demonstrate that MFS significantly contributes to the financial inclusion of the country. Second, the impact of MFS related financial inclusion variables on the growth of the economy was taken into consideration by applying ARDL model. The analysis shows that inward remittance (INREM), the number of registered clients (NORC), and P2B transactions have significant influence on FDI in the short run. Over the short horizon, the influence of such MFS variables as cash-out (COT) and merchant payments (MP) is statistically significant with regards to FDI, but business to personal (B2P) and government payments (GP) do not exhibit any such significance.

Table 17: Summary: Short-run ARDL Test Estimates

Dependent Variable: FDI											
Data Level	Independent Variable										
	B2P	CIT	COT	GP	INREM	MP	NORC	NOTT	P2B	P2P	TT
0					***		*		*		
(-1)			***			***	**	***	***	**	***
(-2)						*				*	

*Note: ***, **, * represent significant levels are 1%, 5%, and 10% respectively; (0), (-1), (-2) represent level data, one-period lag data, two-period lag data respectively.*

However, in the long-run, only B2P, COT, INREM, MP, and NOTT hits the proxy measurement of the economic growth of Bangladesh namely, FDI. Both in the short-run, and in the long-run, the role of MFSs in the economic growth of Bangladesh is statistically evidenced by this study.

Table 18: Summary: Long-run Co-integrating Test Estimates

Dependent Variable: FDI											
Data Level	Independent Variable										
	B2P	CIT	COT	GP	INREM	MP	NORC	NOTT	P2B	P2P	TT
0	*		***		***	**		***			

*Note: ***, **, * represent significant levels are 1%, 5%, and 10% respectively; (0) represents level data.*

Therefore, the findings of this study justify the impact and contribution of MFS in financial inclusion and demonstrate how financial inclusion influences economic growth of Bangladesh. Based on these findings, regulators and policymaker can strengthen MFS accessibility in rural areas, boost usages of MFS for remittance, link MFS with economic growth schemes, and help people in rural areas develop digital skills so that they can contribute to the economy and promote economic growth.

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6.1.1 Theoretical Contribution

The research is beneficial to theory because it reveals that financial inclusion is a complex concept whose particular MFS activities affect differently. Contrary to previous studies based on the generic access pointers, our discussion indicates that transactional elements of P2B, NOTT, MP, COT, and INREM have different short and long-term impacts on economic growth. This contributes to the theoretical knowledge by proving that digital financial services are executed by differentiated mechanisms, as opposed to a uniform course.

Second, the research empirically confirms a two-stage connection between linking to MFS expansion to financial inclusion, which in turn facilitates economic growth, expanding previous conceptual frameworks in financial intermediation and digital finance (Chatterjee, 2020). Through application of ARDL, the study also explains how these relationships evolve over time with some MFS aspects having direct, short-term effects on growth and some having indirect, long-term effects. Collectively, these findings narrow the previous theory of the role of digital financial ecosystems in macroeconomic development.

6.1.2 Managerial and Policy Implications

The results have a number of implications in the form of practical implications of MFS providers, financial institutions and policymakers. To begin with, NORC, NOTT, P2P, and P2B have very strong implications on FDI, which implies that the process of registering more accounts and diversifying the types of transactions can promote economic growth. MFS providers are thus encouraged to expand service accessibility, in particular, in rural and underserved areas, and incorporate additional business-orientated digital payment products.

Second, as the impact of merchant payments (MP), and inward remittances (INREM) have substantial long-run growth effects, regulators ought to increase the strength of digital merchant ecosystems and encourage the use of cheap, secure MFS-script remittance systems. Digital financial participation can also be further enhanced through partnerships between MFS operators and SMEs as well as payroll systems.

Lastly, cash-out transactions (COT) correlate negatively with other variables (long-run), which highlights the necessity of cash-light behavior policies, including digital incentives and financial literacy programs. Niche training, particularly among women and rural users, can also be used to address lack of use and make the digital financial system more inclusive and open to more users in a more equitable way.

6.2 Conclusion

Mobile Financial Services (MFS) have transformed the landscape of financial access in Bangladesh by offering convenient, technology-driven alternatives to traditional banking channels. Using data from December 2018 to March 2024, this study empirically demonstrates that MFS plays a substantial role in expanding FI across different user groups—men, women, and underserved populations—through the steady growth of agents, accounts, and transaction

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volumes. Paired t-test results across three time periods further confirm that these improvements are both statistically significant and structurally consistent.

Beyond inclusion outcomes, the study investigates how MFS-driven financial inclusion translates into economic growth, using Foreign Direct Investment (FDI) as a proxy. Employing ARDL, Bounds testing, and ECM techniques, the study shows robust short-run and long-run associations between key MFS variables and FDI. While indicators such as registered clients (NORC), total transactions (NOTT), P2P and P2B transactions, inward remittances (INREM), and merchant payments (MP) exhibit strong growth effects, the results also reveal heterogeneous impacts across transaction types. These nuances highlight that FI is not a uniform construct; rather, it operates through different channels and mechanisms, each with varying temporal influence on economic outcomes.

By identifying these multidimensional pathways, the study contributes to existing theoretical frameworks on financial intermediation and digital finance. It demonstrates a two-stage process—MFS expansion → financial inclusion → economic growth—that both supports and extends previous conceptual literature. The findings also generate actionable insights for policymakers and industry stakeholders. Strengthening rural MFS penetration, incentivizing digital merchant ecosystems, facilitating MFS-based remittance channels, and promoting digital literacy can amplify the economic benefits of mobile finance while fostering a more inclusive financial system.

In conclusion, this research provides strong empirical evidence that MFS is an essential driver of both financial inclusion and economic development in Bangladesh. As the adoption of digital financial services continues to rise, sustained policy support and targeted managerial actions will be critical to unlocking their full potential. Future research may further explore user behavioral patterns, sector-specific digital finance impacts, and regulatory innovations to deepen the understanding of how MFS can catalyze Bangladesh's broader economic transformation.

Future studies could explore sector-specific effects of MFS (e.g., agriculture, healthcare), user behavior and trust factors influencing digital adoption, and the role of regulatory frameworks in shaping transaction patterns. Incorporating micro-level household/firm-level data could also reveal deeper insights into how FI benefits different demographic groups. Finally, comparative studies across South Asian economies would help determine whether Bangladesh's experience aligns with or diverges from broader regional digital finance dynamics.

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Appendix

Appendix Table 19: Optimum Lag Selection for ARDL Model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	493.3374	NA	3.16e-24	-20.05573	-19.58792	-19.87894
1	872.5167	552.9699	2.07e-28	-29.85486	-23.77346*	-27.55669
2	1095.867	214.0440*	2.51e-29*	-33.16112*	-21.46612	-28.74156*

Appendix Table 20: Test of Heteroskedasticity

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	0.614050	Prob. F(25,22)	0.8803
Obs*R-squared	19.72785	Prob. Chi-Square(25)	0.7610
Scaled explained SS	2.774892	Prob. Chi-Square(25)	1.0000

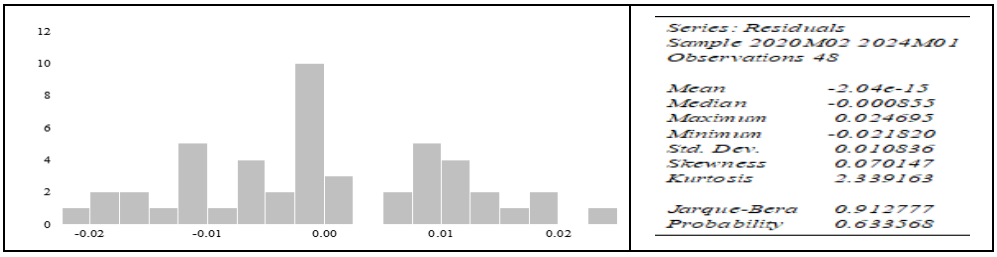
Appendix Table 21: Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.753431	Prob. F(2,20)	0.4836
Obs*R-squared	3.363083	Prob. Chi-Square(2)	0.1861

Appendix Table 22: Ramsey RESET Test

	Value	df	Probability
t-statistic	2.474667	21	0.0219
F-statistic	6.123978	(1, 21)	0.0219
Likelihood ratio	12.28299	1	0.0005



Appendix Figure 7: Residuals' Normality Test of ARDL Model

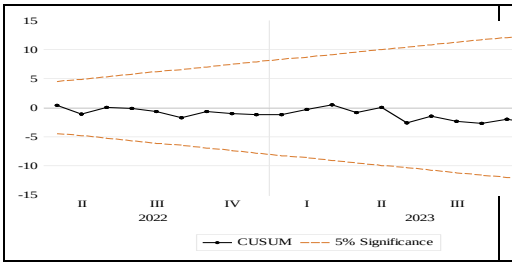


Figure 8: CUSUM Test

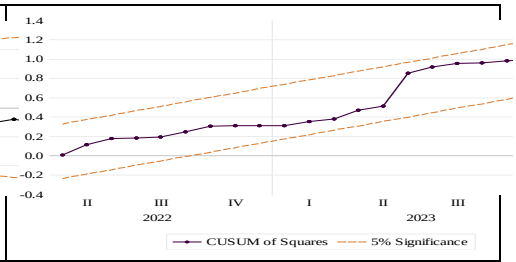


Figure 9: CUSUM of Square (CUSUMSQ) Test

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