Role of Financial Inclusion for Economic Development: Evidence from Bangladesh

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ABSTRACT: *Financial Inclusion has been considered as an important driver for economic growth and development of a nation. In recent years, Bangladesh is also doing well in this field. This paper had tried to study the relationship between financial inclusions with few factors on the Gross Domestic Product (GDP) of Bangladesh. Secondary data of 10 years from the banking industry of Bangladesh had been collected and analyzed using factor analysis and a multiple regression model. The positive and statistically significant relationship with GDP has been found. It would be a supportive document for the online/mobile banking service providers, commercial banks, central bank, policymakers, government, and non-government related parties for necessary steps for the sustainable development of financial inclusion and economy at large.*
KEY WORDS: *Financial inclusion, GDP, mobile money account, mobile money agent, economic development.*

I. INTRODUCTION AND LITERATURE REVIEW

Financial Inclusion (FI) has been recently acknowledged as a key enabler for reducing poverty and improving prosperity. In reality, more than 50 percent of adults of the poorest households are still unbanked globally (Uddin et al., 2017). Government of Bangladesh has made effort for progressing financial inclusion sectors to reach all including the rural poor.

Financially included adults were 47% of the population in 2018, and that 10 percentage-point increased from 2017. Moreover, 45% of people in Bangladesh are not covered in formal financial services (IMF, 2021). In Bangladesh, high-interest rates and low literacy rates are among the prominent factors that restrained the government and the World Bank's joint initiatives to reach universal financial access.

Immediately after independence, Bangladesh focused on financial inclusions through expansion of public sector banks and undertaking agriculture as well as micro and small enterprise credit programs, and at the same time, microfinance institutions pioneered by the Grameen Bank have made considerable efforts to reach poor with finance using peer monitoring group-biased approaches. Bangladesh government had formulated via National Financial Inclusion Strategies (NFIS) to develop a common vision and range of financial products (GoB, 2020).

The Covid-19 pandemic has been the cause of increasing the socioeconomic downturn. Nonetheless, the financial system has already felt a dramatic impact, and further intensification of the crisis could affect global financial stability (IMF, 2021).

However, during the last two decades, there have been tremendous improvements and introductions in the field of financial inclusion, but still, a large number of people in Bangladesh are far from being granted access to basic financial services. That means FI development would be considered as an essential part of this country by targeting rural women, marginal farmers, informal sector enterprises, etc. This study had tried to find the relationship and importance of financial inclusion with gross domestic products in the development of Bangladesh.

Banerjee (2000) links Financial Inclusion with solvencies and Paul Samuelson's (1954) Public Goods theory pointing that Public Goods theory suggests that everyone benefits from financial inclusions regardless of status, income level, or demographic differences which means both rich and poor, financially included and financially excluded citizens enjoy the benefits of financial inclusions. Besides, as public goods, allows the government to take responsibility for promoting financial inclusion.

On the contrary, Allen et al., (2016) provided evidence of country characteristics affecting financial inclusions. Quality institutions, strong contract enforcement, efficient legal rules, and political stability improve and maximized financial inclusions. Moreover, Characteristics of the banking sector play a key role as the high

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cost of maintaining of bank accounts. New more incentive schemes had been added to financial inclusions in new banking system too.

Nizam et al., (2020) had investigated the effect of financial inclusiveness on economic growth in a few selected 63 countries for the years from 2014 to 2017 based on the financial inclusion index. The role of financial inclusiveness on economic growth is found positive and the effect is more visible at a high level than in the low level among financial inclusion index.

Aduda and Kalunda (2012) conducted a study on financial inclusion and financial sector stability of Kenya and recognized that the significance of creating inclusive development, social inclusion is necessary as financial inclusion had its roots in social inclusion. It concluded that access and usage, as well as informal financial services, should be applied in measuring enhanced financial inclusion in developing countries.

Dixit and Ghosh (2013) investigated inclusive growth attainment greatly depends upon an equitable distribution of growth opportunities and benefits to attain comprehensive growth in the context of greater India.

Eastwood and Kohli (1999) explored the enhancement of small-scale industrial output depending on branch expansion with the linkage of direct lending programs of the financial institutions. They also argued that exploitative informal sources of credit can be reduced by an inclusive financial system.

Sahu (2013) examined a study to understand the contemporary scenario of India's financial inclusion with an objective to make the relationship between the financial inclusion index and socio-economic variables and estimate the financial inclusion index for various states in India.

Decker (2012) found the usefulness of Microcredit institutions in the field of financial inclusion in Nairobi, Kenya. Targeting the traders and farmers by MFIs who are often excluded financially by the formal sector, it is found that the use of savings and credits are the key financial weapons that are critical for the empowerment as the first step regarding financial inclusion.

George (2012) discovered the factors determining the exercise of mobile financial services by applying a multinomial logit model in Kenya that used three types of financial services i.e. mobile payments, mobile money transfers, and mobile banking beside various explanatory resources, such as, age, gender, education level, the tariff of service and volume of transactions. The study observed that the use of mobile banking depends and mobile payments on education, gender, and wealth of individuals as well as the tariffs of service and volume of transactions.

Andrianaivo and Kpodar (2011) accomplished a study on information and communication technology (ICT), growth and financial inclusion with evidence from African countries. They used a sample of African countries from the year 1988 to 2007 and showed the mobile phone rollout as the result of information and communication technologies (ICT) on the economic growth.

Paramasivan and Ganeshkumar (2013) carried out a study on the field of financial inclusion in India and discovered a significant impact of having branch density on financial inclusion. Julie (2013) found that economic growth results a strong positive relationship with the branch networks and a minimum positive relationship with number of mobile money accounts/users in Kenya. The study also found a minimal negative relationship with the number of ATM in the country and a high negative relationship with the lending interest rates of banks in Kenya.

Kamboj (2014) found a positive relationship between the number of bank branch networks and the number of ATMs in the country with the GDP growth rate of India. Akileng et al., (2018) conducted a study and found that financial innovation and financial literacy are superior factors of financial inclusion among households comprised of the adult population in both rural and urban areas in the context of African Nation, Uganda.

Demirguc-Kunt and Klapper (2013) aimed at an attempt to investigate financial inclusion in 148 countries using the 2011 data from the World Bank's Global Findex database. Moreover, they found that ownership of a bank account, use of bank credit, and savings on a bank account as indicators of financial inclusion to reveal the individual as well as the country characteristics. They also summarized that individuals with higher education levels and high income tend to get benefit more from the greater financial inclusion.

Again, in a study Allen, et al., (2016) emphasized on factors that affect the choice to own a bank account, country characteristics and savings account of individual across 123 countries. They also realized that higher education and higher income level is positively associated with more financial inclusion.

Uma, Rupa, and Madhu (2013) tried to evaluate the general and economic impact of financial inclusion in the Hunsur taluk, Mysore district in India, and show the positive impact of financial inclusion on the several saving account holders. Sarma and Pais (2011) empirically attempted to evaluate the relationship between economic development and financial inclusion by identifying country-specific denominators that are linked with the level of the financial inclusion. They found that financial inclusion and human development levels shift closely related with each other.

Saluja (2012) focused on the altering definition and role of the Micro, Small, and Medium Enterprises (MSME) towards the growth story of India's economy. Anzoategui, et al., (2014) examined the

impact of having remittances on financial inclusion by deploying household-level survey data from the El Salvador and revealed that although remittances have a positive impact on financial inclusion by promoting the use of deposit accounts, they do not possess a significant and robust effect on the use of and demand for credit from formal institutions.

Choudhury (2010) strived to observe the issues related to FI, international experience, and the status of Bangladesh. Islam and Mamun (2011) examined the role of BB in achieving an inclusive financial sector. Ali and Islam (2013) attempted to discover the status of innovative steps of BB, especially farmers' accounts and sharecroppers financing. Hossain et al., (2015) attempted to evaluate the effectiveness of various initiatives taken by the central bank of Bangladesh (Bangladesh Bank) and also to ascertain challenges onward.

This paper had tried to focus more on the economic development of Bangladesh and had examined the relationship with different factors under the financial inclusion index i.e. number of active mobile money agent outlets, number of active mobile money agent outlets, number of active mobile money accounts, and outstanding balances on active mobile money accounts.

The null and alternative hypotheses of three variables (Number of active mobile money agent outlets, number of active mobile money accounts, and outstanding balances on active mobile money accounts) with GDP have been assumed as follows:

H_{10} = There is no significant relationship between GDP and Number of active mobile money agent outlets

H_{11} = There is significant relationship between GDP and Number of active mobile money agent outlets

H_{20} = There is no significant relationship between GDP and Number of active mobile money accounts

H_{21} = There is significant relationship between GDP and Number of active mobile money accounts

H_{30} = There is no significant relationship between GDP and outstanding balances on active mobile money accounts

H_{31} = There is significant relationship between GDP and outstanding balances on active mobile money accounts

II. RESEARCH METHODOLOGY

2.1 Data Source

The secondary data have been used in this study and data was collected from World Bank for the year 2011 to 2020.

2.2 Data Analysis Techniques

The secondary data has been analyzed in SPSS 16.00 version, descriptive statistics and multiple linear regression and factor analysis were used to analyze the macroeconomic factors.

2.3 Dependent Variable

Gross Domestic Product (GDP) Per Capita was used as dependent variable for this study.

2.4 Independent Variables

Number of active mobile money agent outlets, number of active mobile money accounts, and outstanding balances on active mobile money accounts were used as independent variables.

2.5 Factor Analysis

Factor analysis is an approach that is utilized to minimize a large number of variables into lower numbers of factors. This process extracts highest common variance from all relevant variables and puts them into a common score. Different techniques are available, but principal component analysis (PCA) is utilized most commonly. Researchers used principal component analysis (PCA) here. Scree plot is also employed to establish the statistically significant factors through principal component analysis (PCA).

2.6 Multiple Linear Regression

The multiple linear regression models have been applied to find out the relationship between a dependent variable and one or more independent variables. The general form of the regression model is:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \dots + \beta_k x_k + \varepsilon \qquad (1)$$

Where y the dependent is variable, β_0 is the intercept, x_1 to x_k are the independent variables, β_1 to β_k is the change in y for each one increment change in the independent variables, and ε is the disturbances. Therefore, the ordinary least square fitted model from (1) is given by,

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \hat{\beta}_3 x_3 + \dots + \hat{\beta}_k x_k$$

$\hat{y}$ is the predicted value of the dependent variable, $\hat{\beta}_0$ is the intercept, x_1 to x_k are the independent variables, $\hat{\beta}_1 \ to \ \hat{\beta}_k$ is the estimated value of β_1 to β_k.

III.   DATA ANALYSIS, FINDINGS AND INTERPRETATION

There are numerous macroeconomic variables that affect gross domestic product (GDP). Here, we used some selected variables (GDP Per Capita, Number of active mobile money agent outlets, number of active mobile money accounts, and outstanding balances on active mobile money accounts) from the year 2011 to 2020, which are given in the following table.

Table 1: Some macroeconomic factors of Bangladesh economy

Year	GDP Per Capita (in dollar)	Number of active mobile money agent outlets (in thousand dollar)	Number of active mobile money accounts (in lac dollar)	Outstanding balances on active mobile money accounts (in dollar)
2011	861.76	2.6	0.1	44.0
2012	883.12	20.8	5.2	747.0
2013	981.86	131.8	48.9	5850.6
2014	1118.87	240.2	95.0	6073.0
2015	1248.45	243.0	128.0	10695.2
2016	1401.56	352.4	158.0	17861.5
2017	1563.77	482.1	211.0	27285.2
2018	1698.13	443.7	375.0	27534.4
2019	1855.74	436.2	349.0	31146.0
2020	1961.61	403.0	325.0	40737.8

Data source: World Bank

3.1 Graphical Analysis

Figure 1: Scatter plot of number of active mobile money agent outlets, number of active mobile money accounts, and outstanding balances on active mobile money accounts with GDP
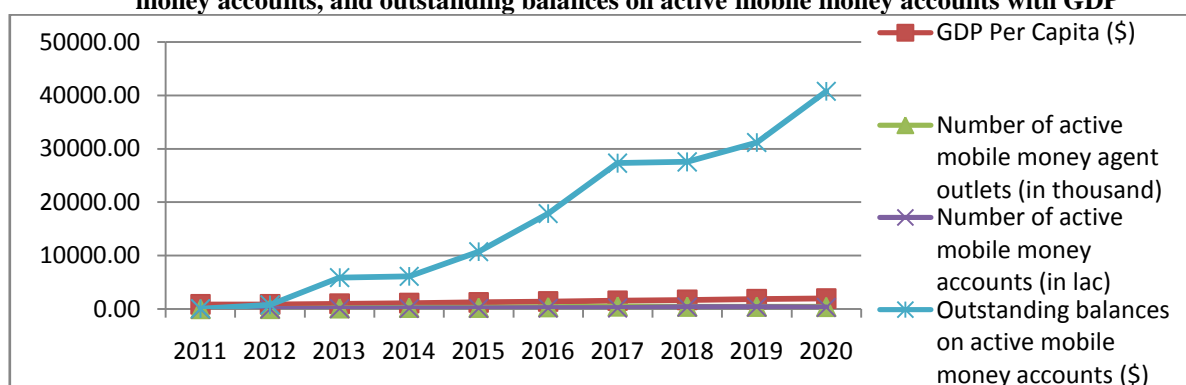
From the figure 1, it is seen that number of active mobile money agent outlets, number of active mobile money accounts and outstanding balances on active mobile money accounts gradually increased with GDP.

3.2 Determination of Factors Influencing Financial Inclusion

Table 02: Kaiser-Meyer-Olkin and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.775
Bartlett's Test of Sphericity	Approx. Chi-Square	27.310
	df	3
	Sig.	.000

It is observed from the table 2 that Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.775 so we should be confident that factor analysis is appropriate for these data. Again, for these data, Bartlett's test is highly significant ($p < 0.001$), and therefore factor analysis is appropriate.

Figure 02: Determination of the optimal number of components by graph

It is seen from the above graph (figure 2) that an elbow occurs in the plot in the figure at about i = 2. That is, the eigenvalues after $\hat{\alpha}_1$ are all relatively small and about the same size. In this case, one sample principal components effectively summarize the total sample variance.

Table 03: Total Variance Explained by Different Variables

Variables	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
V_1	2.018E8	99.996	99.996	2.018E8	99.996	99.996
V_2	6.760E3	.003	99.999	Extraction Method: Principal Component Analysis		
V_3	2.023E3	.001	100.000			

V_1= Number of active mobile money agent outlets
V_2= Number of active mobile money accounts
V_3= Outstanding balances on active mobile money accounts

It is observed from the table 3 that about 99.996 % of the total variance explained by the first factor and therefore we extract only one variables. That is, they explain nearly 99.996% of the variability in the original three variables, so we can considerably reduce the complexity of the data set by using these components, with only a 0.004% loss of information.

3.3 Correlation Analysis
Table 4: Correlation among different macroeconomic factors with GDP

Factors	Pearson r	P value
Number of active mobile money agent outlets	0.911	.000
Number of active mobile money accounts	0.965	.000
Outstanding balances on active mobile money accounts	0.987	.000

Source: Authors calculation from collected data

The above table (4) shows the correlation among different macroeconomic factors (Number of active mobile money agent outlets, number of active mobile money accounts, and outstanding balances on active mobile money accounts with GDP). Where, it is also found that each of the factors has highly positive linear relationship with GDP. Their relationship is statistically significant at 5% level of significance.

3.4 Multiple Linear Regression Model for GDP
Table 5: Testing overall significance of the regression model

Sources of Variation	DF	SS	MS	F value	P value
Regression	3	1439465.406	479821.802	192.184	0.000
Residual	6	14980.097	2496.683		
Total	9	1454445.502			

Source: Authors calculation from collected data

From the table 5, it is observed that number of active mobile money agent outlets, number of active mobile money accounts, and outstanding balances on active mobile money accounts are jointly significant with GDP at 5% level of significance.

Table 6: Testing individual significance of the regression model

Sources of Variation	Coefficients	Std. Error	t value	P value	95% CI		VIF
					Lower	Upper	
Intercept	867.014	31.50	27.51	0.00	789.920	944.109	
Number of active mobile money agent outlets	0.091	0.228	0.399	0.70	-.466	0.648	5.842
Number of active mobile money accounts	0.913	0.355	2.569	0.04	0.043	1.782	9.003
Outstanding balances on active mobile money accounts	0.018	0.004	5.266	0.00	0.010	0.027	8.970

$$R = 0.995, R^2 = 0.990 \text{ and } R^2_{adj} = 0.985$$

Source: Authors calculation from collected data

From the table 6, the estimated model for GDP is,

$$\widehat{GDP} = 867.014 + 0.091 Number of active mobile money agent outlets$$
$$+ 0.913 Number of active mobile money accounts$$
$$+ 0.018 Outstanding balances on active mobile money accounts$$

3.5 Model reliability status

According to the Variance Inflation Factor (VIF) value form the table it is observed that the values of three independent variables are 5.842, 9.003 and 8.970 respectively. That means there is no multicollinearity problem in the proposed model as it is less than accepted level 10 (Vittinghoff et al., 2012).

3.6 Nature of the relationship with degree among dependant and independent variables

Number of active mobile money agent outlets is positively associated with GDP and the coefficient 0.091 indicates that one unit increase in number of active mobile money agent outlets would lead to 0.091 unit increase in GDP.

Number of active mobile money accounts is positively associated with GDP and the coefficient 0.913 indicates that one unit change inNumber of active mobile money accounts would lead to 0.913 unit increase in GDP.

Outstanding balances on active mobile money accounts is positively associated with GDP and the coefficient 0.018 indicates that one unit change in Outstanding balances on active mobile money accounts would lead to 0.018 unit increase in GDP.

3.7 Result of hypotheses test

Number of active mobile money agent outlets is statistically insignificant at 5% level of significance. That means, number of active mobile money agent outlet has no influence individually on GDP. Number of active mobile money accounts is statistically moderately significant at 5% level of significance. That means, number of active mobile money accounts has moderate influence on GDP. Outstanding balance on active mobile money accounts statistically highly significant at 1% level of significance. That means, outstanding balance on active mobile money accounts has high impact on GDP.

Adjusted R-square value 0.985 indicates that 98.5% of the total variation of GDP is explained by number of active mobile money agent outlets, number of active mobile money accounts, and outstanding balances on active mobile money accounts, i.e., this model is extremely good in predicting the dependent variable GDP.

IV.   CONCLUSION

Financial intermediaries, especially banking industry, play an important role in the economic development of a country. In the form of intermediation new and new form are being added in this competitive arena. Under these circumstances an attempt had been undertaken to find out whether the considered form of intermediation i.e., financial inclusion has any effect on the economic development. The study has found the significant relationship among the GDP growth with number of active mobile money accounts and outstanding balance on active mobile money accounts. And found no significant effect between GDP and number of active mobile money agent outlets. Therefore, the stakeholders should be more careful on those two more relevant factors for the economic development of the country. More relevant variables and more data period may be added in the further study to have the in depth understanding on the very issues.

References

[1].   Aduda, Josiah and Kalunda, E. (2012) "Financial Inclusion and Financial Sector Stability With Reference To Kenya: A Review of Literature," Journal of Applied Finance and Banking, vol. 2, no. 6, pp. 95-120
[2].   Akileng, G.; Lawino, G.; Mercy, and Eric,N. (2018). "Evaluation of determinants of financial inclusion in Uganda," Journal of Applied Finance and Banking, vol. 8, no. 4, pp. 47-66.

[3]. Ali, A. and Islam, N.S. (2013). "Innovations in Rural Banking: Farmers Accounts and Sharecropper Financing," Bangladesh Institute of Bank Management (BIBM), Dhaka, Research Monograph, Research monograph no. 005

[4]. Allen, F.; Demirguc-Kunt, A.; Klapper, L. and Peria, M. S. M. (2016). "The foundations of financial inclusion: Understanding ownership and use of formal accounts," Journal of Financial Intermediation, no. 27, pp. 1-30

[5]. Andrianaivo, Mihasonirina and Kpodar, K. (2011) "ICT, Financial Inclusion, and Growth: Evidence from African Countries," International Monetary Fund-2011

[6]. Anzoategui, D.; Demirgüç-Kunt, A. and Pería, M.S.M. (2014). 'Remittances and Financial Inclusion: Evidence from El Salvador," World Development. vol.54, pp. 338-349. Available: https://www.sciencedirect.com/science/article/abs/pii/S0305750X13002180?via%3Dihub

[7]. Banerjee, A.V. (2001). Contracting Constraints, Credit Markets and Economic Development. Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=306990

[8]. Choudhury, T.A. (2010). "Inclusive Banking/Financial Inclusion: Issues, International Experiences and Bangladesh Status," A Paper Presented in a Workshop arranged by Bangladesh Economic Association

[9]. Decker, Pa Ye (2012) . "The Effectiveness of Microfinance Institutions in Financial Inclusion: The Case of MFIs in Nairobi" A research project submitted in partial fulfillment of the requirements for the degree of Master of Business Administration (MBA), School of Business, University of Nairobi.

[10]. Demirguc-Kunt, A. and Klapper, L. (2013). "Measuring financial inclusion: Explaining variation in use of financial services across and within countries," Brookings Papers on Economic Activity, no. 1, pp. 279-340

[11]. Dixit, Radhika and Ghosh, M. (2013) "Financial Inclusion for Inclusive Growth of India -A Study of Indian States," International Journal of Business Management & Research (IJBMR), no. 3, pp. 147-156

[12]. Eastwood, R. and Kohli, R. (1999). "Directed credit and investment in small-scale industry in India: Evidence from firm-level data, 1965-1978," Journal of Development Studies, vol. 35, no. 4

[13]. George, P. K. (2012). "Factors determining financial inclusion: the case of mobile money transfer services in Nairobi," A research project submitted to the School of Economics, University of Nairobi in partial fulfillment of the requirement for the award of Master of Arts degree in Economics.

[14]. Government of Bangladesh (GoB), (2020), Office Order, Notice Board, Finance Department, https://fid.gov.bd/sites/default/files/files/fid.portal.gov.bd/notices/98ddd286_f45f_4895_9a98_10c34c9ade0c/Draft%20National %20Financial%20Inclusion%20Strategy%20Bangladesh%20(NFIS-B).doc

[15]. Hossain, S.M.; Islam, S.N.; Hossain, M.N.; Hossain, M.M.; Yesmin, R. and Mohiuddin, G. (2015). "Financial Inclusion Initiatives of Bangladesh Bank: Evaluation and Challenges," Banking Research Series, BIBM, Dhaka, paper no. 5, pp. 199-268

[16]. International Monetary Fund (IMF). 2021. Global Financial Stability Report. Available at: https://www.imf.org/-/media/Files/Publications/GFSR/2021/October/English/text.ashx

[17]. Islam, Ezazul and Mamun, S.A. (2011). "Financial Inclusion: The Role of Bangladesh Bank," Research Department Bangladesh Bank, Head Office Dhaka, working paper series: WP1101. Available: http://www.bb.org.bd/openpdf.php

[18]. Julie, O. (2013).'"The relationship between financial inclusion and GDP growth in Kenya," Doctoral dissertation, University of Nairobi. Available: http://erepository.uonbi.ac.ke/bitstream/handle/11295/58543/OruoFinancial%20Inclusion %20and%20GDP%20Growth%20.pdf?sequence=3.

[19]. Kamboj, S. (2014). "Financial inclusion and growth of Indian economy: An empirical analysis," The International Journal of Business & Management, vol. 2, no. 9, pp. 175–179

[20]. Nizam, R.; Karim, Z.A.; Rahman, A.A.: and Sarmidi, T. (2020) Financial inclusiveness and economic growth: new evidence using a threshold regression analysis, Economic Research-Ekonomska Istraživanja, 33:1, 1465-1484, DOI: 10.1080/1331677X.2020.1748508

[21]. Paramasivan,C. and Ganeshkumar,V. (2013) "Overview of Financial Inclusion in India," International Journal of Management and Development Studies, vol. 2, no. 3, pp. 45–49

[22]. Sahu, (2013) "Commercial Banks, Financial Inclusion and Economic Growth in India," International Journal of Business and Management Invention, no. 2, pp. 1-6

[23]. Saluja, D. (2012.) "Role of MSME's in Economic Development of India," International Journal of Economics, Commerce and Research (IJECR), vol. 2, no. 1, pp. 35-43

[24]. Samuelson, P. (1954). The Pure Theory of Public Expenditure. The Review of Economics and Statistics. Vol. 36, No. 4 (Nov., 1954), pp. 387-389 (3 pages). The MIT Press

[25]. Sarma, M. and Pais, J. (2011). "Financial Inclusion and Development," Journal of International Development, no. 23, pp. 613-628

[26]. Uddin, A.; Chowdhury, MM.; Chowdhury, A.F. and Islam, M., N. (2017) Determinants of Financial Inclusion In Bangladesh: Dynamic Gmm & Quantile Regression Approach. The Journal of Developing Areas 51(2):221-237, DOI: 10.1353/jda.2017.0041

[27]. Uma, H.R.; Rupa, K.N. and Madhu, G.R.(2013). "Impact of Bank Led Financial Inclusion Model on the Socioeconomic Status of Saral Saving Account Holders," Paripex - Indian Journal of Research, vol. 2, no. 9, pp. 50-52

[28]. Vittinghoff E, Glidden DV, Shiboski SC, McCulloch CE. (2012) "Regression Methods in Biostatistics: Linear, Logistic, Survival, and Repeated Measures Models". Statistics for Biology and Health. 2nd ed. 2012 edition. Springer; 2011.