Remittances and economic growth nexus: Do financial development and investment act as transmission channels? An ARDL bounds approach

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Abstract

The study seeks to investigate the causal links between economic growth and remittances through two specific transmission channels, namely financial development and investment. Using Bangladesh as a case study, the study employs autoregressive distributed lag (ARDL) approach to cointegration proposed by Pesaran et al. (2001). Based on a time series data over the period 1977–2013, the findings reveal no long term lead-lag relationship between economic growth and remittances. However, the short term relation exists between remittances and investment. Investment also stimulates economic growth. A unidirectional transmitting channel through investment can be identified in the short run. The financial development was found to be weak in the growth remittances nexus and this shows the presence of a missing link between investment and financial development. This might happen due to financial exclusion and inflow of remittances through informal unaccounted channel. Policy makers should focus on financial sector deepening to promote financial inclusion. Moreover, creating awareness to promote flow of remittances through formal channel should get priority. For the future researchers, the inclusion of microfinance sector as a transmission channel might provide significant findings as the remittances in fact represent the people at the bottom of the pyramid, where microfinance sector has a strong presence unlike the formal financial sector.

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1. Introduction

Workers' remittances, in developing countries, are considered to be one of the most important economic indicators that facilitate economic growth. This comprises a significant share in the export basket of these countries. The empirical studies in the literature reports an ambiguous relationship between remittances and economic growth through direct or indirect transmission channels like financial development, investment, trade, consumption, etc. Nevertheless, few empirical works stress that workers' remittances positively influence economic growth, while others reported of negative relation (Chami, Fullenkamp, & Jahjah, 2005; Kireyev, 2006; Jongwanich, 2007; Ratha, 2007; Bjuggren, Dzansi, & Shukur, 2010; Parinduri & Thangavelu, 2011). Few studies investigated such lead-lag relation through transmission channels e.g. Le (2009), Bettin, Lucchetti, and Zazzaro (2009), Ahmed and Salah Uddin (2009), Siddique, Selvanathan, and Selvanathan, (2010).

Mundaca (2007), using the sample of Central America, Mexico, and the Dominican Republic, reported that financial development facilitates the use of remittance to foster economic growth. The author also found significant influence of remittance in local consumption that also fuels economic growth. Giuliano and Ruiz-Arranz (2009) also reported similar findings on the role of financial development in the growth-remittance nexus. The authors further pointed out the role of remittance as an alternative tool to promote investment and reduce liquidity crisis in the presence of inefficient financial sector. However, financial development loses its relevance for more developed nations. Nevertheless, remittancesare found to be positive role in boosting up investment climate in those countries (Bjuggren et al., 2010). These findings support the fact that the financial development and investment represent important channels to explain better the causal relationship between remittances and economic growth. Jouini (2015) conducted a similar study in context of Tunisia where a bi-directional causal relationship found between GDP and remittances in the short-run. The study considered investment and financial development as a transmitting channel. However, no significant findings were reported in that context.

Therefore, the present study makes a humble attempt to unearth the causal nexus between economic growth and remittances through transmission channels namely financial development and investment in context of Bangladesh over the period 1977-2013. Notably, Bangladesh, one of the top ten remittance receiving countries in the world, has been maintaining a burgeoning GDP growth of above five percent over the last decade despite persistent political turmoil and natural disaster. This is certainly a remarkable achievement for a country like Bangladesh that got liberation in 1971. And Remittances, comprising seventy five percent of foreign reserve and two-third of total export, are assumed to be one of the contributing factors to such success.

In context of Bangladesh, Ahmed and Salah Uddin (2009) study the causal links between remittances, import, export and GDP over the period 1976–2005 using the VAR-VECM approach. Their findings support the evidence of unidirectional causal nexus running from remittances, export and import to GDP. Siddique et al. (2010) investigate the causality relationship between remittances and economic growth in Bangladesh, India and Sri Lanka based on the Granger causality approach. Their findings reported a unidirectional causality running from remittances to economic growth in Bangladesh. Mamun and Nath (2005) investigate the causal links between economic growth and exports in the context of Bangladesh over the period 1976–2003, and find unidirectional causality running from exports to economic growth over the long-term based on the VAR-VECM methodology. Shirazi and Abdul Manap (2005) employed Granger causality and cointegration tests to study the export-led growth hypothesis in the context of South Asia. Their findings show that for Bangladesh there is evidence of bidirectional causal links between exports and GDP, and imports and GDP.

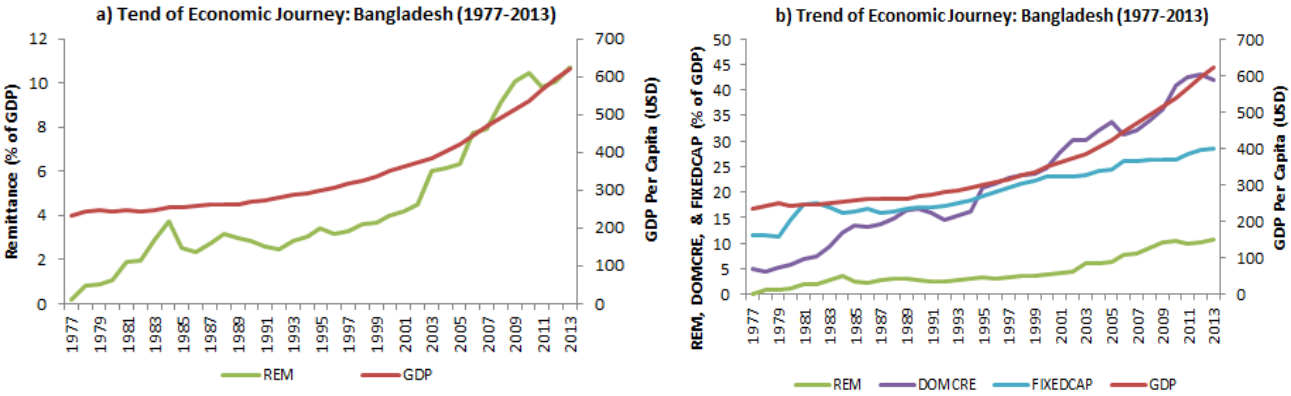


Figure 1: Trend of Economic Journey: Bangladesh (1977 -2013)

The investigation of such transmitting links for growth remittances nexus in Bangladesh is thus interesting because remittances constitute an important source of external finance. In this context, as can be seen from Figure 1, the growth of remittances was almost stable during the last two decades and it doubled its share in GDP during last twelve years. Moreover, the study employs advanced time series techniques like ARDL, which, according to the literature, corrects the endogeneity problem associated with remittances. Therefore, the obtained estimates possess desirable properties and allow making final conclusions. The remainder of the paper is organized as follows. Section 2 presents the literature review. Section 3 presents the methodology used to investigate the causality links between the variables. Then, the empirical findings have been presented and analyzed in section 4. Given the obtained results, policy implications are provided in Section 5. Section 5 concludes the paper.

2. Literature review

The relationship between remittances and economic growth has been the object of many

empirical works in the literature, which stresses that such a relationship is ambiguous. In this context and based on a panel of Andean countries, Solimano (2003) concludes in favor of a positive relationship between remittances and economic growth. Aggarwal, Demirguc-Kunt, and Martinez-Peria (2006) show that remittances have a positive impact on bank deposits and credit to GDP based on an empirical work of 99 countries. Ratha (2007) points to the fact that remittance flows improve the country access to international capital markets since they could ameliorate its creditworthiness, which is another way to increase economic development by stimulating physical and human capital investment. Pradhan, Upadhyay, and Upadhyaya (2008) estimate a linear regression model between five variables for a group of 36 countries, and find that remittances positively affect economic growth.

Other studies focus on the negative influence of remittances on economic growth. In this context, Amuedo and Pozo (2004) show that remittances could reduce the international competitiveness and impose economic costs on the export sectors of receiving countries. Chami et al. (2005) conclude in favor of a negative link between remittances and economic growth for a panel of 113 countries over almost thirty years. Parinduri and Thangavelu (2011) indicate that human capital accumulation of children can be negatively affected by the fact that one parent leaves hometo work abroad and sends money. It is also important to stress that there are other empirical works supporting the view that there is no influence of remittances on economic growth or investment, such as Spatafora (2005) who shows that remittances do not impact per capita output growth. Remittances have also been discussed in relation to poverty. In this context, Adams and Page (2003) conduct a study based on 74 developing countries, and conclude that remittances significantly reduce poverty. This finding is confirmed by the investigation reported in the International Monetary Fund (2005) World Economic Outlook for 101 countries over the period 1970–2003.

In the context of the causal relationship between remittances and economic growth, Bettin et al. (2009) consider a remittances equation using data of immigrants coming to Australia from 125 countries and reverse causality links between remittances, income, consumption and savings. The obtained findings point to the importance of accounting for reverse causality and simultaneity between consumption and remittances. Le (2009) investigates the determinants of economic growth in developing countries, and attempts to check whether institutions, trade openness and remittances are complements or competitors in economic growth. The empirical results stress that trade, institutions and remittances impact economic growth.

3. Methodology and results

The study applies ARDL approach proposed by Pesaran and Pesaran (1997), and Pesaran, Shin, and Smith (2001), which is commonly used to investigate the long-run links between variables. In comparison with other known cointegration methods, the ARDL approach allows different optimal lags for the variables, and is a very useful tool since it substantially improves the small-sample properties of the estimates regardless of the nature of the time

series, stationary or not. This contrasts with the conventional methods that require unit root pre-testing before carrying out the cointegration tests. Another feature of substantial importance of the ARDL approach is that it can be applied even for small sample size, and allows getting simultaneously the short-term and long-term estimates.

We first provide some descriptive statistics in order to understand the nature of the links between the variables we consider. Second, we conduct ADF, PP, KPSS tests to examine the stationarity properties of the series. Third, we perform diagnostic tests to ensure the validity of the regressions used for the implementation of the bounds test approach of cointegration among the variables. Fourth, given the supported cointegrating relationships, we compute the long- and short-run elasticity, assess the causality direction between variables, and check the return to the long-run equilibrium based on the estimated error correction model. Finally, given the obtained results of the ARDL approach, we also employ other suitable econometric methods, namely variance decomposition and impulse response to ensure that our findings are not contingent upon only one approach.

3.1 Data and preliminary analysis

The study attempts to investigate the dynamic relationship between economic growth (GDP per capita as a proxy), remittances (remittances as share of GDP), financial development (measured by the domestic credit to private sectors as share of GDP), and investment (defined as the ratio of gross fixed capital formation to GDP)for Bangladesh over the period 1977–2013 based on annual data obtained from the World Development Indicators database.

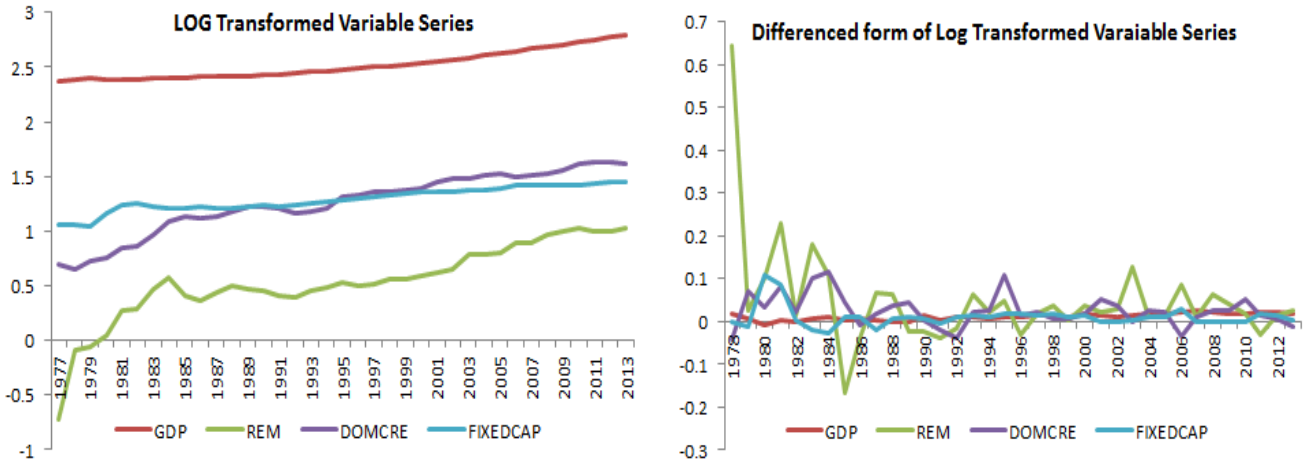


Figure 2: Movement of study variables

Figure 2 reports the graphs of the level series (taken in natural logarithms) in order to better apprehend the joint dynamics of the variables and it also shows the behavior of first difference of the log transformed series. A time trending behavior, which could be indicative of long-run links between the variables, can be identified. Initial assessment from the summary statistics presented in Table 1 documents that for level (first-difference) series, the variables vary in average from the minimum of -1.6817 (0.004) for remittances

(investment) and the maximum of 7.377 (0.034) for GDP per capita (GDP per capita). The investment (GDP per capita) has lower risk than the other variables for the level (first-difference) case. The empirical unconditional correlations between GDP per capita, remittances and financial development are quite high and positive. As a result, higher increases in each variable lead to higher values of the other variables. However, the correlations between these variables and the investment are low, even negative for GDP per capita. The GDP per capita is more correlated to remittances. Indeed, the correlation ranges from −0.070 (LGDP/LI) to 0.765 (LGDP/LREM). This correlation analysis just allows providing a preliminary idea about the nature of the relationship among the variables of interest, but cannot be determinative of the presence of causal links between series.

Table 1: Descriptive Statistics

Variable(s)	LGDP	LREM	LDOMCRE	LFIXEDCAP	DGDP	DREM	DDOMCRE	DFIXEDCAP
Mean	5.7989	1.2343	2.8955	2.9745	0.027114	0.11249	0.059039	0.025046
Std. Deviation	0.29487	0.82477	0.65055	0.25373	0.018416	0.28126	0.085729	0.056714
Minimum	5.4554	-1.6817	1.5116	2.4163	-0.019577	-0.38589	-0.09575	-0.06398
Maximum	6.4315	2.368	3.7612	3.346	0.057302	1.4818	0.26982	0.2537

Table 2: Correlation Matrix

	LGDP	LREM	LDOMCRE	LFIXEDCAP
LGDP	1			
LREM	0.83134	1		
LDOMCRE	0.87396	0.91149	1	
LFIXEDCAP	0.90117	0.91718	0.94035	1

	DGDP	DREM	DDOMCRE	DFIXEDCAP
DGDP	1			
DREM	0.066657	1		
DDOMCRE	-0.29548	-0.05272	1	
DFIXEDCAP	-0.29067	0.077965	-0.04045	1

Before conducting tests for cointegration among variables, we test for unit root using the ADF, PP and KPSS tests[3] in order to ensure that the considered series are not integrated of order two or more because in this case the Pesaran et al. (2001) cointegration test statistic used in this paper is not valid. As can be seen from Table 3 and 4, the unit root tests provide contradicting results. For an instance, DOMCRE and FIXEDCAP, in level form, have been

[3]ADF and PP tests are based on the unit root null hypothesis, while the KPSS test examines the stationarity under the null hypothesis.

reported to be stationary by ADF (both AIC & SBC), and KPSS, except PP. However, the first difference form came out as stationary. Difference form of GDP has been reported to be non-stationary in all tests.

Since the variables may be instable due to the long period covered by the study, and these traditional tests suffer from power loss in the presence of potential regime-shifts in the data. We also employ CUSUM and CUSUM SQUARE to see the presence of any structural breaks.

Table 3:Result of ADF Test of Stationarity

		AIC			SBC			
		Test Stat.	**Crit. Val.**	**Decision**		**Test Stat.**	**Crit. Val.**	**Decision**
Intercept and Trend; Log Transformed Variables; Null: Non-Stationary								
LGDP	ADF(4)	0.14736	-3.4199	Non-Stationary	ADF(1)	-0.28722	-3.5815	Non-Stationary
LREM	ADF(5)	-2.9013	-3.555	Non-Stationary	ADF(5)	-2.9013	-3.555	Non-Stationary
LDOMCRE	ADF(1)	-5.4583	-3.5815	Stationary	ADF(1)	-5.4583	-3.5815	Stationary
LFIXEDCAP	ADF(5)	-4.0104	-3.555	Stationary	ADF(1)	-4.3256	-3.5815	Stationary
Intercept and No Trend; First difference of Log Transformed Variables; Null: Non-Stationary								
DGDP	ADF(2)	-0.85254	-2.9146	Non-Stationary	ADF(2)	-0.85254	-2.9146	Non-Stationary
DREM	ADF(3)	-5.4931	-2.7966	Stationary	ADF(1)	-6.706	-2.8916	Stationary
DDOMCRE	ADF(1)	-4.133	-2.8916	Stationary	ADF(1)	-4.133	-2.8916	Stationary
DFIXEDCAP	ADF(5)	-3.3702	-2.8128	Stationary	ADF(1)	-4.0178	-2.8916	Stationary

Table 4: Results of PP and KPSS Tests

	PP			KPSS		
	Test Stat.	**Crit. Val.**	**Decision**	**Test Stat.**	**Crit. Val.**	**Decision**
LGDP	1.1225	-3.5292	Non-Stationary	0.14583	0.1993	Stationary
LREM	-6.3012	-3.5292	Stationary	0.12453	0.1993	Stationary
LDOMCRE	-1.0401	-3.5292	Non-Stationary	0.15774	0.1993	Stationary
LFIXEDCAP	-2.3519	-3.5292	Non-Stationary	0.16741	0.1993	Stationary
DGDP	-2.968	-3.0274	Non-Stationary	0.37755	0.37173	Non-Stationary
DREM	-11.4816	-3.0274	Stationary	0.29746	0.37173	Stationary
DDOMCRE	-4.7656	-3.0274	Stationary	0.34218	0.37173	Stationary
DFIXEDCAP	-3.9005	-3.0274	Stationary	0.25559	0.37173	Stationary

GDP seems to experience a structural break from 2008 due to sharp increase in the GDP per capita (Figure 3). During 2008-2013, GDP per capital increased by around 26%. After creating a dummy for the period 2008-2013, we again employed CUSUM and CUSUM SQUARE test to see if the inclusion of dummy creates any effect. Figure (4) shows that the dummy identifies the shift in trend for GDP.

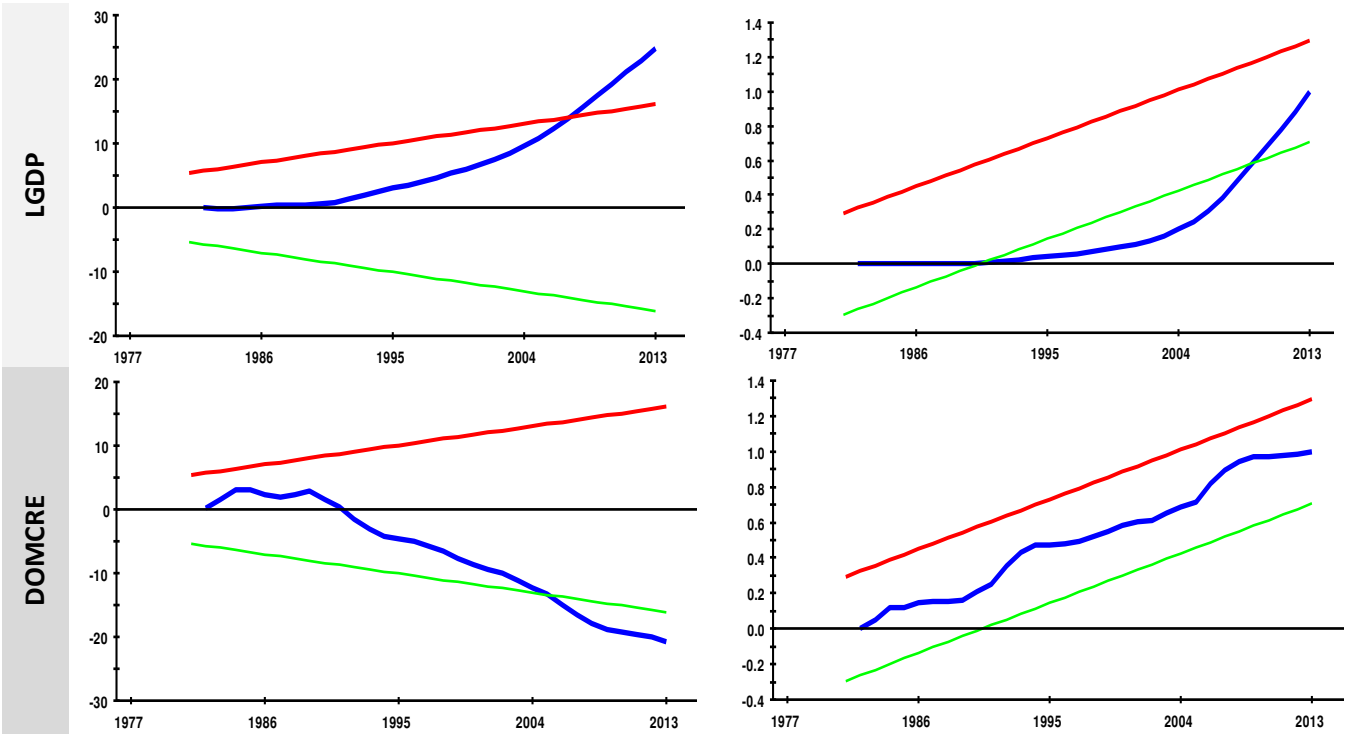
3.2 VAR Lag Order Selection

Before moving on to test the cointegration among the variables, we first have to determine

the optimal order of VAR. To choose the optimal order of VAR, we look at the highest AIC and SBC values. Then, we also look at the adjusted LR test. According to our findings, the highest AIC and SBC suggest five and zero lag order respectively, whereas adjusted LR test recommends four lag order. In this context, we have to proceed towards the next steps and thus we consider a lag order of four to test the contegration.

Plot of Cumulative Sum of Recursive Residuals

Plot of Cumulative Sum of Squares of Recursive Residuals



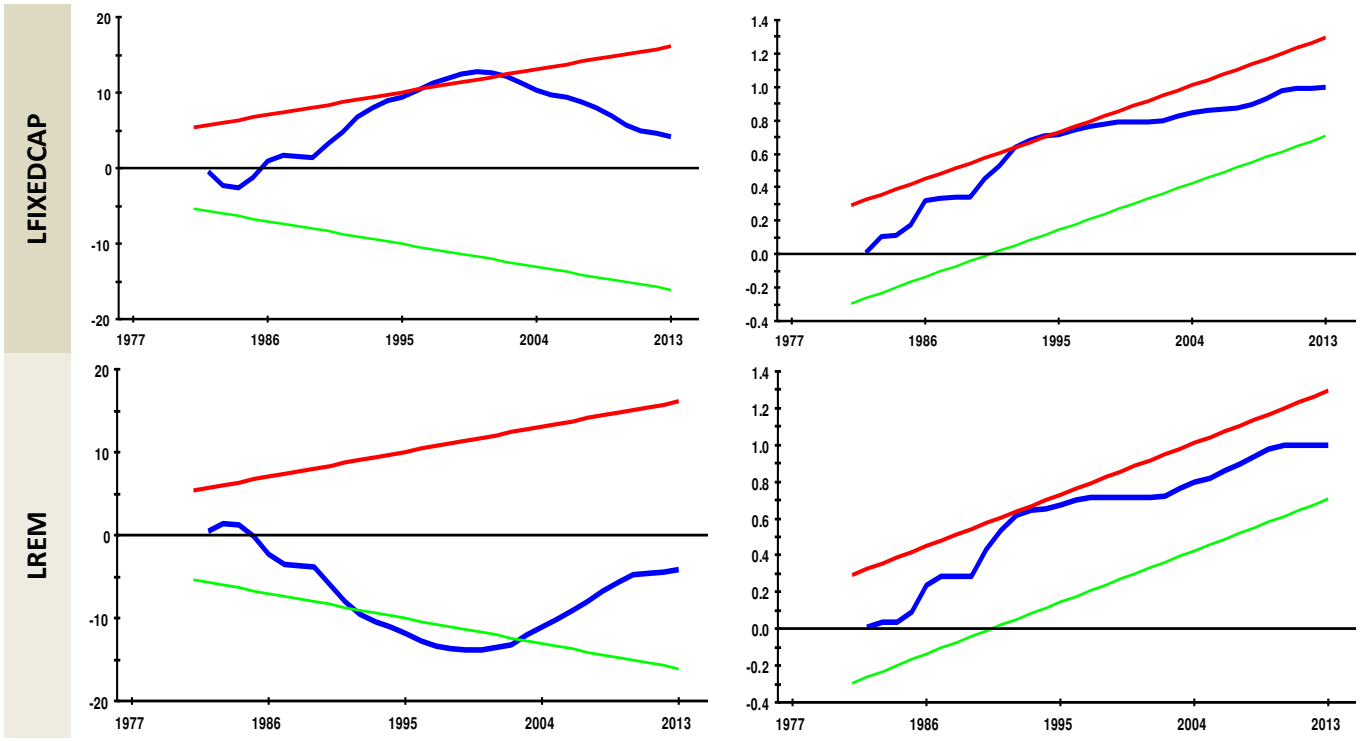
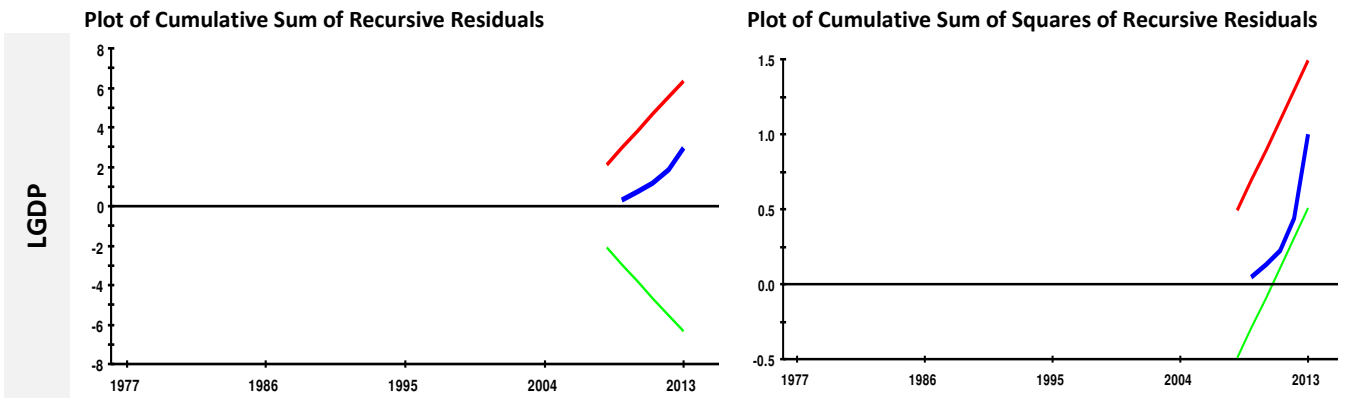


Figure 3: CUSUM and CUSUM SQUARE (The straight lines represent critical bounds at 5% significance level)

Dummy 2008-2013



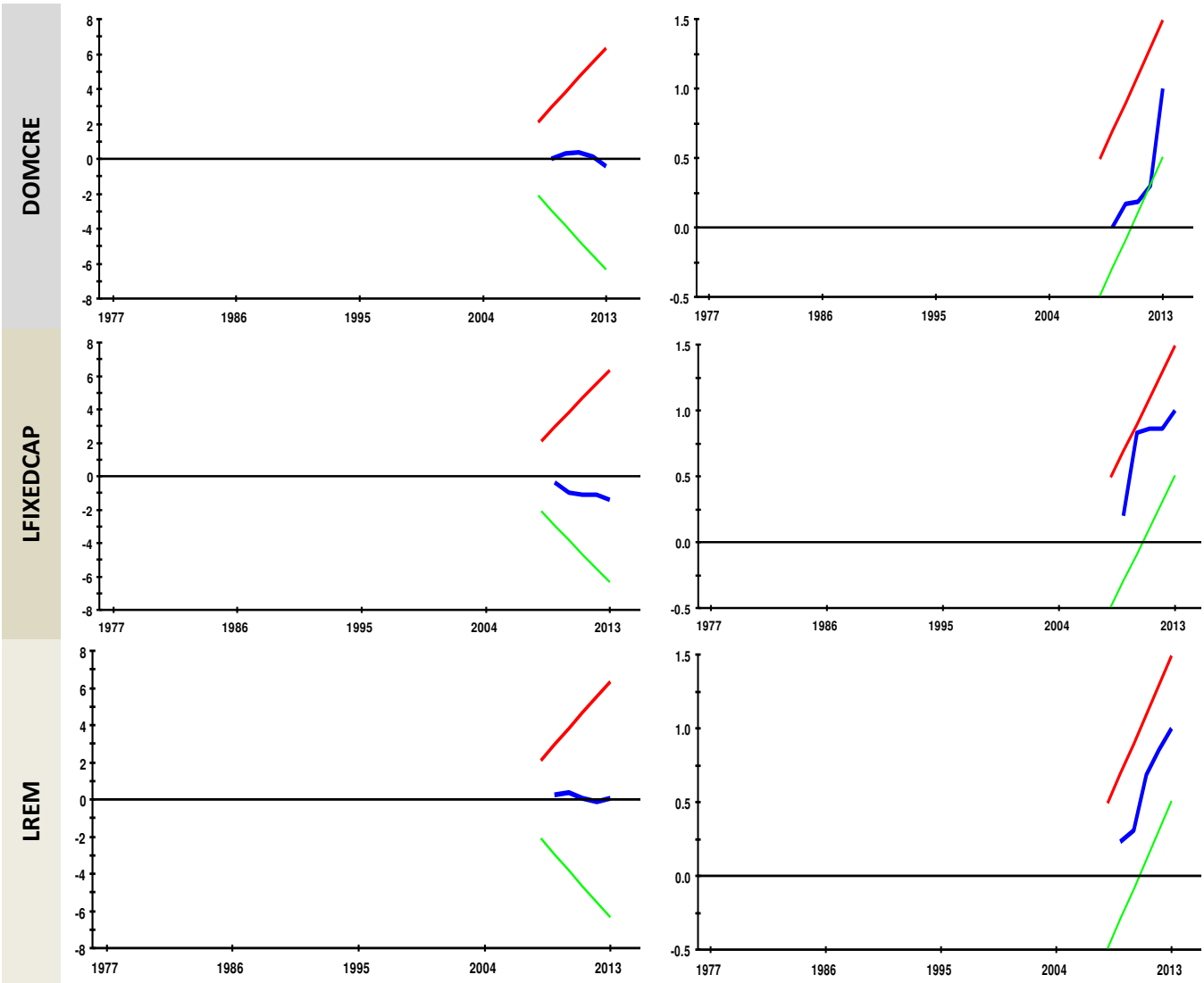


Figure 4: CUSUM and CUSUM SQUARE (The straight lines represent critical bounds at 5% significance level)

3.3 Test of Cointegration

3.3.1 Engle-Granger

Assuming that all the variables are I(1), we can now proceed to test the cointegration among the variables. Statistical meaning of the test is that some combination of the variables, we have chosen, may result in a stationary error term. Economic meaning of the result is that these variables are expected to be theoretically related and move together in the long run. This result is very important because it tells the researcher if the variables are theoretically related or the relationship among the variable is spurious.

Table 5: Result of Engle-Granger Cointegration

	Test Statistic	AIC	SBC
DF	0.78534	66.9686	66.2516

ADF(1)	0.054396	68.6118	67.1778
ADF(2)	0.60016	68.9938	66.8428
ADF(3)	0.46705	68.0557	65.1877
ADF(4)	0.28564	67.174	63.589
ADF(5)	-0.092885	67.2293	62.9274

95% critical value for the Dickey-Fuller statistic = -4.4691

As depicted in the above table the critical value is higher than the corresponding t-statistics. Therefore, we fail to reject the null that the residuals are non-stationary. The above results indicate that the variables we have chosen, in some combination, result in non-stationary error term and hence there is no cointegration. This might happen due to the structural break, identified earlier.

3.3.2 Johansen Cointegration Test

Using four VAR lag order as decided earlier, we employed Johansen cointegration test. As depicted in the Table-6 below, the maximal Eigenvalue, Trace statistic, AIC, SBC and HQC provide conflicting results regarding the presence of the cointegrating vectors. Maximal Eigenvalue, Trace statistic, and HQC recommended for one cointegration, whereas AIC and SBC recommend the presence of four cointegration. The presence of four cointegration is quite surprising, given the study considers four variables only.

Since we identified the presence of structural break during 2008 – 2013, we introduced a dummy variable for the period an employed Johansen Cointegration again to see if the structural break creates any difference. The result is shown in Table 6. Unlike the previous findings, Maximal Eigenvalue and Trace statistics suggest the presence of two cointegration, whereas AIC, SBC, and HQC suggest for four cointegration.

These results conflict with each other, and these also conflict with Engle – Granger test. As these approaches have many limitations that are taken care off by ARDL, we decided to go for ARDL approach for testing cointegration among variables.

Table 6: Result of Johansen Cointegration (Full Sample)

Maximal Eigenvalue

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	53.5461	31.79	29.13
r<= 1	r = 2	17.4215	25.42	23.1
r<= 2	r = 3	12.7639	19.22	17.18
r<= 3	r = 4	7.4262	12.39	10.55

Trace Statistics

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	91.1577	63	59.16
r<= 1	r>= 2	37.6116	42.34	39.34
r<= 2	r>= 3	20.1901	25.77	23.08
r<= 3	r = 4	7.4262	12.39	10.55

Model Selection Criteria			
Rank	**AIC**	**SBC**	**HQC**
r = 0	217.844	179.735	205.2115
r = 1	236.617	192.645	222.0412
r = 2	239.327	190.958	223.2944
r = 3	241.709	190.409	224.7046
r = 4	243.423	190.656	225.9319

Table 7: Result of Johansen Cointegration (with Dummy; 2008-2013)

Maximal Eigenvalue				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r = 1	51.4225	31.79	29.13
r<= 1	r = 2	25.4433	25.42	23.1
r<= 2	r = 3	16.2122	19.22	17.18
r<= 3	r = 4	7.5624	12.39	10.55
Trace Statistics				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r>= 1	100.64	63	59.16
r<= 1	r>= 2	49.2179	42.34	39.34
r<= 2	r>= 3	23.7746	25.77	23.08
r<= 3	r = 4	7.5624	12.39	10.55
Model Selection Criteria				
Rank	**AIC**	**SBC**	**HQC**	
r = 0	215.9323	174.892	202.3285	
r = 1	233.6435	186.74	218.0963	
r = 2	240.3651	189.064	223.3604	
r = 3	244.4712	190.239	226.4948	
r = 4	246.2524	190.555	227.7901	

3.4 Bounds test approach

At a first stage, we perform some diagnostic tests to check the validity of the following unrestricted error correction regressions[4] on which is based the analysis of cointegration among the variables:

$$\Delta LGDP_t = \alpha_g + \beta_g t + \sum_{i=1}^{p} a_{ig}\,\Delta LGDP_{t-i} + \sum_{i=0}^{p_1} b_{ig}\,\Delta LREM_{t-i} + \sum_{i=0}^{p_2} c_{ig}\,\Delta LDOMCRE_{t-i} + \sum_{i=0}^{p_3} d_{ig}\,\Delta LFIXEDCAP_{t-i}$$

$$+ \lambda_{1g} LGDP_{t-1} + \lambda_{2g} LREM_{t-1} + \lambda_{3g} LDOMCRE_{t-1} + \lambda_{4g} LFIXEDCAP_{t-1} + \mu_{1t}$$

$$\Delta LREM_t = \alpha_r + \beta_r t + \sum_{i=1}^{p} a_{ir}\,\Delta LREM_{t-i} + \sum_{i=0}^{p_1} b_{ir}\,\Delta LGDP_{t-i} + \sum_{i=0}^{p_2} c_{ir}\,\Delta LDOMCRE_{t-i} + \sum_{i=0}^{p_3} d_{ir}\,\Delta LFIXEDCAP_{t-i}$$

$$+ \lambda_{1r} LREM_{t-1} + \lambda_{2r} LGDP_{t-1} + \lambda_{3r} LDOMCRE_{t-1} + \lambda_{4r} LFIXEDCAP_{t-1} + \mu_{2t}$$

[4] In other words, we have to make sure that the classical regression assumptions are verified.

$$\Delta LDOMCRE_t = \alpha_f + \beta_f t + \sum_{i=1}^{p} a_{if}\,\Delta LREM_{t-i} + \sum_{i=0}^{p_1} b_{if}\,\Delta LGDP_{t-i} + \sum_{i=0}^{p_2} c_{if}\,\Delta LDOMCRE_{t-i} + \sum_{i=0}^{p_3} d_{if}\,\Delta LFIXEDCAP_{t-i}$$
$$+ \lambda_{1f} LREM_{t-1} + \lambda_{2f} LGDP_{t-1} + \lambda_{3f} LDOMCRE_{t-1} + \lambda_{4f} LFIXEDCAP_{t-1} + \mu_{3t}$$

$$\Delta LFIXEDCAP_t = \alpha_v + \beta_v t + \sum_{i=1}^{p} a_{iv}\,\Delta LREM_{t-i} + \sum_{i=0}^{p_1} b_{iv}\,\Delta LGDP_{t-i} + \sum_{i=0}^{p_2} c_{iv}\,\Delta LDOMCRE_{t-i} + \sum_{i=0}^{p_3} d_{iv}\,\Delta LFIXEDCAP_{t-i}$$
$$+ \lambda_{1v} LFIXEDCAP_{t-1} + \lambda_{2v} LGDP_{t-1} + \lambda_{3v} LREM_{t-1} + \lambda_{4v} LDOMCRE_{t-1} + \mu_{4t}$$

where *ΔLGDP* , *ΔLREM*, *ΔLDOMCRE* and *ΔLFIXEDCAP* are changes in the natural logarithm of the GDP per capita, the remittances, the financial development and the investment[5]. The coefficients a_{ij} , b_{ij}, $c_{ij}$and $d_{ij}$for *j = g, r, f, v* are the short-run coefficients, and λ_{1j} , λ_{2j}, $\lambda_{3j}$and $\lambda_{4j}$for *j = g, r, f, v* are the long-run parameters. It is important to stress that according toPesaran et al.(2001), the above unrestricted regressions may also be interpreted as an ARDL model of orders (p, p_1, p_2, p_3)[6]. Before computing the observed values of the diagnostic tests, we have to select the optimal lag lengths $\hat{p}$ and $\hat{p}_i$ (*i*= 1, 2, 3, 4) using the Schwarz Bayesian information criterion by estimating (m+ 1)[4] regressions, where *m* is the maximum lag length[7].

In Table 8, we report the empirical statistics of the Breusch–Godfrey LM test for autocorrelation, the Jarque–Bera normality test, and the Ramsey RESET test for the correct functional form of the above equations. The hypotheses of uncorrelated and normally residuals are well supported whatever the specification. There is evidence in favor of the homoskedasticity hypothesis of the residuals[8]. The RESET test shows that the correct functional form of the specifications is confirmed, except two models LREM and LDOMCRE. Notably, we are not using the dummy in the ARDL.

Table 8: Diagnostic tests

	LGDP	**LREM**	**LDOMCRE**	**LFIXEDCAP**
Serial Correlation	2.17E-06	0.004482	1.1371	0.003246
	0.999	0.947	0.286	0.955
Functional Form	0.80263	4.1828*	5.4903*	0.014851
	0.37	0.041	0.019	0.903
Normality	0.40085	1.7396	5.827	2.1588
	0.818	0.419	0.054	0.34
Heterscedasticity	3.4541	0.15551	0.03684	3.1228
	0.063	0.693	0.848	0.077

The null hypothesis of non-cointegrating relationship among the variables is formulated analytically as follows: $\lambda_{1j} = \lambda_{2j} = \lambda_{3j} = \lambda_{4j} = 0$ for j = g, r, f, v, and can bedenoted by F

[5] We consider these four regressions because there is no prior information about the directions of the long-run links between the variables under investigation.

[6] Note that we can allow for the same lag length on the lagged variables without affecting the asymptotic theory (see Pesaran et al. (2001) for more details).

[7] Note that here we choose *m* = 4.

[8]Not that for model 1 & 4, the null hypothesis of homoskedasticity is rejected at the 10% significance level.

(LGDP |LREM, LDOMCRE, LFIXEDCAP) (model 1), F (LREM |LGDP, LDOMCRE, LFIXEDCAP) (model 2),*F* (*LDOMCRE*|*LGDP, LREM, LFIXEDCAP*) (model 3) and *F* (*LFIXEDCAP*|*LGDP, LREM, LDOMCRE*) (model 4), respectively. This is simply the *F*-test of joint significance of the lagged variables. Pesaran et al. (2001) show that under the null hypothesis of no cointegration, the asymptotic distribution of the test statistic is non-standard, and thus tabulate two critical values sets for the cases when the variables are all stationary and all non-stationary. In this context, we conclude in favor of cointegration among the variables regardless of whether they are stationary or not if the observed test statistic exceeds the upper critical bound. On the other hand, we do not reject the null hypothesis of no cointegration regardless of whether the variables are stationary or not if the computed *F*-statistic is less than the lower critical bound. However, no conclusion is drawn if the test statistic is between the lower and upper critical bounds unless we know the nature of the variables, stationary or not.

The empirical *F*-statistics of the bounds test presented in Table 4 indicate that there is no evidence of long-run links among the variables under consideration at the 5% significance level since the observed values are below the corresponding lower bound critical value. This implies remittances and growth nexus does not exist in the long run.

Table 9: Testing Long run relationship

IV	F-STATISTIC	LOWER BOUND	HIGHER BOUND	DECISION
DGDP	1.7804	2.85	4.459	No long run relationship
DREM	1.0679	2.85	4.459	No long run relationship
DCOMCRE	2.5120	2.85	4.459	No long run relationship
DFIXEDCAP	2.3714	2.85	4.459	No long run relationship

3.5 Long-run elasticities

Given the emergent cointegrating relationships, we attempt to estimate the long-run elasticities based on the following ARDL (*p, p*1*, p*2*, p*3) model:

$$\Phi\,(L,p)y_t = \propto_0 + \sum_{i=1}^{4} \beta_i\,(L,p_i)x_{it} + \gamma' v_t + \varepsilon_t$$

Where $\Phi\,(L,p) = 1 - \Phi_1 L - \Phi_2 L^2 - \cdots - \Phi_p L^p$,

$\beta_i(L,p_i) = \beta_{i0} + \beta_{i1}L + \beta_{i2}L^2 + \cdots + \beta_{ipi}L^{pi}$ for *i* = 1,2,3, y_t is chosen dependent variable (LGDP, LREM, LDOMCRE, or LFIXEDCAP), x_{it} is the *i*th independent or forcing variable (LGDP, LREM, LDOMCRE, or LFIXEDCAP), v_t is a deterministic vector of variables, and ε_t is the error term. After selecting the appropriate model, the responses of a dependent variable to the movements of a long-run forcing variable are given by the following long-run elasticities:

$$\hat{\mu}_i = \frac{\hat{\beta}_{i0} + \hat{\beta}_{i1} + \hat{\beta}_{i2} + \cdots + \hat{\beta}_{i\hat{p}_i}}{1 - \hat{\Phi}_1 - \hat{\Phi}_2 - \cdots - \hat{\Phi}_{\hat{p}}}$$

where $(\hat{p}, \hat{p}_1, \hat{p}_2, \hat{p}_3)$ are the estimatesd values of the orders (p,p_1, p_2, p_3)

The results reported in Table 10 first show evidence of a significant transmission of information from the investment to the GDP per capita in the long-term during our sample. The financial development do not exert an impact on GDP per capita over the long-run, which may be explained by the fact that these financial flows promote and enhance consumption and not economic growth in Bangladesh. Second, there is significant long-run impact from the GDP per capita and remittances to the investment. Third, the remittances influence the financial development over the long-run. The findings show all the three variables significantly influence investment. There is also a missing link between financial sector and GDP. Overall, our findings also show evidence of GDP and investment nexus, which is also promising.

Table 10: Long-run elasticity

Regressor	**LGDP[a]**	**LREM[b]**	**LDOMCRE[c]**	**LFIXEDCAP[d]**
LGDP	-	1.2766	-2.7755	0.56583**
	-	0.96367	1.733	0.13827
LREM	0.38528***	-	1.5839*	-0.24767**
	0.065367	-	0.63638	0.071668
LDOMCRE	-0.0089982	0.021609		0.2076***
	0.14282	0.66932		0.03384
LFIXEDCAP	1.0825***	2.1278	1.751	
	0.24172	3.518	1.253	
INPT	2.289***	-11.8615*	11.9271	-0.68384
	0.5483	4.6519	6.8841	0.68855

Standard error in parenthesis

*p<.05, **p<.01, ***p<.001

[a]ARDL(1,4,2,0) ; [b]ARDL(4,2,3,3); [c]ARDL(1,0,0,0); [d]ARDL(2,4,3,1)

3.6 Error correction model representation

We now investigate the short-run and long-run dynamics in the error correction model (*ECM*) associated with the appropriate ARDL. This procedure allows drawing conclusions about the dynamic adjustments of short-run deviations of the variables from their long-term state. The ECM specification, against Δy_t is then expressed as follows:

$$-\left(1 - \widehat{\Phi}_1 - \widehat{\Phi}_2 - \cdots - \widehat{\Phi}_{\hat{p}}\right) ECM_{t-1} + \sum_{i=1}^{4} \beta_{i0}\, \Delta x_{it} + \gamma'\, \Delta v_t - \sum_{j=1}^{\hat{p}-1} \Phi_j^*\, \Delta y_{t-j}$$

$$- \sum_{i=1}^{4} \sum_{j=1}^{\hat{p}_i - 1} \beta_{ij}^*\, \Delta x_{it-j} + \varepsilon_t$$

where, $ECM_t = y_t - \sum_{i=1}^{4} \hat{\mu}_i\, x_{it} - \hat{\eta}' v_t, \hat{\eta}$ is the vector of the long-run parameters

associated with i = 1 the variables vector υ_t, and Φ_j^* and β_{ij}^* are the short-run dynamic coefficients.

The results reported in Table 11 show evidence of a certain return to the long-run equilibrium for all the specifications, except remittances. The corresponding error correction terms are significantly negative for all the variables except remittances. Remittances take long time to come back to the equilibrium. Another feature of substantial importance is that the adjustment speed from short-run disequilibrium towards the long-run state is faster when the investment is considered as dependent variable. In this situation, the error correction term coefficient is equal to (−0.64495), which implies that a deviation from the equilibrium level in the current year will be corrected by 64% in the next year. Consequently, it takes about two years to restore the long-run equilibrium state. For the other specifications, the adjustment speed is quite low especially for the case where the GDP per capita is the dependent variable in the error correction model. In this case, we need more than eight years to restore the long-run equilibrium state since the error correction term coefficient is equal to (−0.11176). The fact that all error correction term coefficients are between 0 and 1 signifies that the relationships are characterized by high predictability and that the spread movement is mean-reverting.

As can be seen from Table 11, we document that the adjustment of the investment to the long-run equilibrium is driven by short-run adjustments in the remittances, and the GDP. The impact of remittances is positive and highly significant. Finally, the adjustment of the remittances to the long-run state is driven by short-run adjustments in its own only.

Overall, the obtained results indicate that there is significant bidirectional causal link between economic growth and investment over the short-term. However, there is a positive and significant unidirectional causal link running from remittances to investment.

Table 11: Error correction representation

Regressor	**dLGDP[a]**	**dLREM[b]**	**dLDOMCRE[c]**	**dLFIXEDCAP[d]**
dLGDP		-1.4409	-0.49666	0.98882*
		2.788	0.24718	0.38231
dLGDP1		-4.5232		0.47805
		2.1864		0.42177
dLGDP2				0.87216*
				0.35119
dLGDP3				0.7244
				0.38731
dLREM	0.0093464		0.28344**	7.66E-04
	0.013997		0.084594	0.037744
dLREM1	-0.017604	0.10878		0.12706***
	0.016244	0.2233		0.028053

dLREM2	-0.0068819	-0.11282		0.139***
	0.015188	0.20978		0.029722
dLREM3	0.016042*	0.36523*		
	0.0069388	0.14605		
dLDOMCRE	0.0071154	0.44285		-0.049664
	0.022984	0.30283		0.057132
dLDOMCRE1	-0.040822	-0.65801		0.21957
	0.024118	0.32714		0.13538
dLDOMCRE2	-0.32229			
	0.26695			
dLFIXEDCAP	0.12098*	0.43797	0.31333	
	0.050694	1.0797	0.21909	
dLFIXEDCAP1		-1.6492*		
		0.6114		
dLFIXEDCAP2		0.84289		
		0.67374		
ecm(-1)	-0.11176*	-0.36241	-0.17894**	-0.64495***
	0.043109	0.28703	0.049385	0.084203

*p<.05, **p<.01, ***p<.001

[a]ARDL(1,4,2,0)

[b]ARDL(4,2,3,3)

[c]ARDL(1,0,0,0)

[d]ARDL(2,4,3,1)

To sum up, only the bidirectional causal link between GDP and investment is observed over the short-run and long-run, which supports the strong association between these variables. And a unidirectional causal link from remittance to both investment and financial development over the short-run and long-run. In this context, some empirical works in the literature indicate that there is no consensus on the causal direction between remittances and financial development. Indeed, Giuliano and Ruiz-Arranz (2009) stress that on the one hand a high level of financial development can help remittances to promote economic growth since it allows reducing costs and increasing transactions, and on the other hand remittances can alleviate the credit constraints to local investors to set out productive activities. We also stress that the positive unidirectional causality running from remittances to investment and from this latter to economic growth is observed over the short-run and long-run. This shows the importance of the investment as a transmission channel through which the impact of remittances on economic growth is observed.

3.7 Robustness of the results

To check the robustness of these conclusions, we extend the short-run analysis by relying on the VAR approach. This allows us to ensure that our findings are not contingent upon only one approach. Therefore, the government can make good economic policies and strategies based on the relationship between remittances and economic growth in presence of two transmission channels, namely financial development and investment.

3.7.1 Impulse response functions

We investigate the short-run dynamics of the variables we consider by using the generalized impulse response functions that assess the response of a variable to shock in another variable at some time horizons[9]. The impulse response functions shown in Figure 5 outline that both remittances and financial development take time to get stabilized after a shock is induced in rest of the variables. A shock to remittances don't affect GDP that much, however, it destabilizes the financial development and the investment climate. Nevertheless, investment adjusts quite quickly than the financial development which behaves erratically. A shock to financial development and investment affect GDP quite rapidly. A shock to the investment destabilizes all three variables, however, remittances handle the shock very quickly.

3.7.2 Variance decomposition

The analysis aims at calculating the contribution of innovations to the forecast-error variance. To that effect, we express the individual forecast-error variance to a given horizon in function of the error variance assigned to each variable in the system in order to obtain the relative importance in percentage. Over a 25-year horizon the results presented in Table 12 indicate that the individual forecast-error variance of any variable is explained largely by its own variations, as in the case of the impulse response function analysis, with mildly varying degrees between GDP per capita and remittances, and between financial development and investment. It is equally important to stress that these contributions are higher for the latter variables than the former variables over the 25-year horizon. Another feature of substantial importance is that all the variables almost contribute to the forecast-error variance of any variable, which implies that there are cross effects between the variables.

These obtained results are consistent with those of the impulse response function analysis and show the sensitivity of one particular variable to movements in the other variables over the short-run. We then outline that the conclusions drawn from the VAR approach are in line with the short-run analysis we obtained previously from the error correction model estimated based on the ARDL approach. The evidence is then robust and indicates that this approach is suitable and reliable for investigating the causal linkages between remittances and economic growth when controlling for financial development and investment in the model.

4. Policy implications

In the last decades, many empirical research studies attempt to investigate how external financial flows exert an impact on economic growth directly or indirectly through some channels. Our findings indicate that the application of the ARDL approach enhances the understanding of the causal links between remittances and economic growth for developing

[9] Note that the generalized impulse response functions do not depend on the ordering of the variables in the VAR system.

economy like Bangladesh when financial development and investment are controlled for in the model, and provide a mixed view that these links are of great interest for economic policy makers. Indeed, the significant relationship between the variables we consider can help the Bangladesh government to make deep economic policies over the short-run and long-run depending on the causality direction and its magnitude, and on whether the impact of each variable on the others is positive or negative. Government should take measures to promote the remittance flow through the formal channels. This will help strengthen the financial sector making the transmission channel stronger in the growth remittance nexus.

The government should also support projects to stimulate profitable investment opportunities by improving small investments, and creating new businesses in productive sectors of the economy for migrants and their families. To that effect, the government should have the policy scheme to reduce the informal remittances and increase the formal international transfers through ensuring reliable, rapid, safe and cost-effective official transfer mechanisms. The authorities should move to this approach even in rural areas to improve remittances, thus enhancing economic growth in these areas. These formal remittances offer opportunities for more important foreign currency since during crisis periods they can boost economic activities in order to maintain a certain macroeconomic stability and to reduce the impact of negative shocks. The authorities should also create favorable conditions to orientate remittances to productive investment through formal channel, thus creating employment and economic growth opportunities. In this context, the government should offer incentives such as developed public infrastructure in disadvantaged areas and tax exemption for new projects during the early years to enhance investment opportunities.

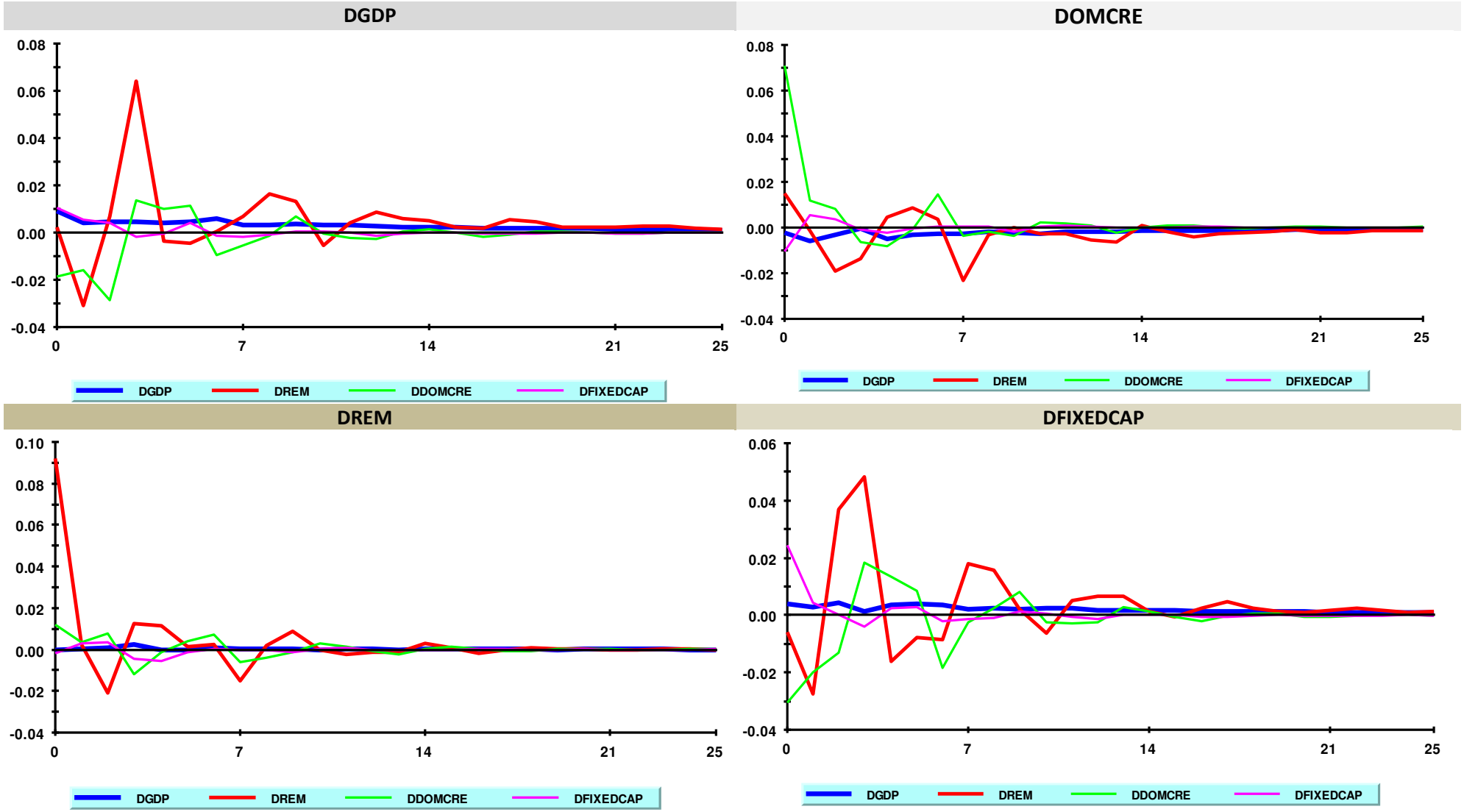


Figure 5: Impulse Response Function *(Generalized Impulse Response to one SE shock)*

Table 12: Variance Decomposition (Generalized)

	Five Years					Ten Years			
	DGDP	**DREM**	**DDOMCRE**	**DFIXEDCAP**		**DGDP**	**DREM**	**DDOMCRE**	**DFIXEDCAP**
DGDP	52%	2%	25%	21%	DGDP	53%	2%	24%	22%
DREM	26%	46%	4%	24%	DREM	25%	43%	7%	25%
DDOMCRE	19%	4%	56%	22%	DDOMCRE	19%	4%	53%	24%
DFIXEDCAP	17%	7%	15%	61%	DFIXEDCAP	17%	7%	15%	61%
Exogeneity	52%	46%	56%	61%	Exogeneity	53%	43%	53%	61%
Ranking	3	4	2	1	Ranking	3	4	2	1

	Fifteen Years					Twenty Years			
	DGDP	DREM	DDOMCRE	DFIXEDCAP		DGDP	DREM	DDOMCRE	DFIXEDCAP
DGDP	53%	2%	23%	22%	DGDP	53%	2%	23%	22%
DREM	26%	43%	7%	25%	DREM	26%	42%	7%	25%
DDOMCRE	19%	4%	53%	24%	DDOMCRE	19%	4%	53%	24%
DFIXEDCAP	17%	7%	15%	61%	DFIXEDCAP	17%	7%	15%	61%
Exogeneity	53%	43%	53%	61%	Exogeneity	53%	42%	53%	61%
Ranking	2	4	3	1	Ranking	2	4	3	1

	Twenty Five Years			
	DGDP	**DREM**	**DDOMCRE**	**DFIXEDCAP**
DGDP	53%	2%	23%	22%
DREM	26%	42%	7%	25%
DDOMCRE	19%	4%	53%	24%
DFIXEDCAP	17%	7%	15%	61%
Exogeneity	53%	42%	53%	61%
Ranking	3	4	2	1

5. Conclusion

In this study, the causal relationship between remittances and economic growth for Bangladesh over the period 1977–2013 has been meticulously investigated based on the ARDL bounds testing approach and by including financial development and investment as channels through which the impact is examined. Our analysis shows absence of growth remittances nexus and instead showed a unidirectional causality from remittance to investment. The contribution of financial sector is weak. The GDP is not the dependent on the remittances. The variables behave exogenous. We also find that the causality among the variables depends on whether we are in the short-term or long-term. As a check of the robustness of the results, alternative methods allow drawing the same conclusions as the ARLD bounds testing approach, implying that this latter seems to be appropriate for examining the causal link between the variables we consider.

While this work attempts to study the causal link between remittances and economic

growth by including the financial development and investment as two channels through which the relationship is investigated, future empirical research works could introduce microfinance (as it plays significant role in the rural areas unlike the formal financial channels), financial inclusion, governance, and skilled andunskilled human capital indicators to explain and to distinguish the causal impact. In this context, it is also important to understand how policy makers could address this issue.

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