

The Remittance-GDP Relationship in the Liberalized Regime of Bangladesh: Cointegration and Innovation Accounting*

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Abstract. *Bangladesh, being one of the top remittance-recipient countries in the world, has drawn attention to the remittance-output relationship in recent years. The results on this aspect are nevertheless inconclusive. Working on a relatively liberalized regime from 1979 to 2009, this study finds a long run positive relationship between remittances and GDP in Bangladesh. The adjustment of this relation, however, goes against traditional belief in that GDP does not respond to the movements in remittances while correcting disequilibrium after a shock in the system, but the reverse is true. There is no evidence on remittance-led growth in the short run. Innovation accounting shows that the impact of output on remittances is remarkably stronger than that of remittances on output. These findings have policy implications for other emerging nations in that GDP growth is capable of attracting further remittances arguably through increasing investment demand and initiating institutional reforms in the economy.*

Keywords: remittances; GDP; Bangladesh economy; cointegration; impulse responses; variance decompositions.

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1. Introduction

Globalization has augmented the flows of remittances to the emerging nations in the recent decades. The pace of remittance growth appears to have exceeded that of globalization. For example, while remittances worldwide were less than 2 billion US dollars in 1970, they reached over 70 billion dollars in 1995 (Taylor, 1999). 150 million migrants worldwide sent more than 300 billion dollars to their families in developing countries in 2006 (IFAD, 2010). Bangladesh, being an emerging economy in South Asia, has become one of the top 10 remittance-recipient countries in the world. Bangladesh's position in 2008 was ninth in that 'top 10' list after India, China, Mexico, Philippines, Poland, Nigeria, Egypt, and Romania (Ratha et al., 2008).

Between 1976 and 2010, a total of 6.8 million people emigrated temporarily from Bangladesh (BMET, 2010). Given restricted labor mobility across countries, Bangladesh's emigration figure is quite significant. Revenues from remittances in the country exceed various types of foreign exchange inflow, particularly official development assistance and net earnings from exports. Remittance inflows to Bangladesh are increasing at an average annual rate of 19 percent in the last 30 years from 1979 to 2008 (Hussain, Naem, 2009). Income from remittances has recently exceeded the 10-billion dollar mark, which has been 11.8 percent of the country's Gross Domestic Product (GDP) in 2009 (BBS 2010).

Although remittances to Bangladesh remarkably began in the mid 1970s, the country achieved a stable trend of remittances in the late 1970s, when the regime embarked on trade liberalization by abandoning the fixed exchange rate and switching to a managed exchange rate. The country's growth performance has remarkably improved during its last decades of liberalization. For instance, Bangladesh achieved 4.54 percent of average annual growth since the 1980s (WB, 2010). The figure rose to 5.21 percent since the 1990s with the increased momentum of liberalization. This scenario raises a number of questions such as: 1) What is the remittance-output relationship in the liberalized regime of Bangladesh? 2) Is this relationship, if present, a long-run or short-run phenomenon? 3) What is the direction of causality? 4) What are the policy implications of the findings? Despite numerous studies on this aspect, no paper in the past examined the relationship between remittances and GDP in Bangladesh in the liberalized regime. Hence, a gap has been evident. This study fills that gap by addressing the above questions with the background of liberalization in Bangladesh.

The existing literature on the remittance-GDP relationship, which we discuss in the next section, does not point out any conclusive result. Most papers are cross-country studies that suggest no direction of causality. Some studies on

panel data derive confounding results, and finally recommend examining the relationship on country-specific time series. We also agree that given the differences of growth performances and remittance flows across countries, the income-remittance interaction should be tested on a case-by-case basis, and this work reflects that imperative.

A visual inspection of GDP and remittances of Bangladesh, as presented in Figure 1, suggests a possibility of a long-run relationship between the variables. We find unit roots in these variables. Both the series, being integrated of order one, i.e. $I(1)$, are tested in the widely used Johansen method, which shows that the variables are cointegrated. Hence, the vector error correction (VEC) model is estimated to get the estimates on the cointegrating vector and short-run dynamics. We extend the VEC model to derive innovation accounting that includes generalized impulse responses and forecast error variance decompositions of the variables. Thus, we examine the remittance-GDP interaction in both the long run and short run in a comprehensive approach, which is still absent in the existing literature on Bangladesh.

We argue that examining the remittance-GDP relationship in a relatively liberalized regime is likely to give better results. Doing so in a sample that includes restricted regime may produce distorted estimations. Remittances are likely to be linked with the exchange rate regime (Maimbo et al., 2005, p. 12, Lueth, Ruiz-Arranz, 2007). Based on that criterion, we point out that Bangladesh began its liberalization since 1979, when the country moved to a managed and flexible exchange rate regime (Aziz, 2008, Choudhury, 2008). Working on a relatively liberalized regime from 1979 to 2009, this study finds long run cointegration between GDP and remittances in Bangladesh.

Although the long-run relationship is positive, the nature of adjustment is contrary to traditional belief. Remittances respond to the movements in GDP to correct any disequilibria in the long-run steady-state relationship following a shock, but GDP does not do the same in response to the movements in remittances. GDP turns out to be weakly exogenous in the system. Evidence on remittance-led growth in the short run is also absent. Generalized impulse responses and variance decompositions show that the impact of output on remittances is remarkably stronger than that of remittances on output. These findings have policy implications for other emerging economies where income growth can foster further remittance inflows arguably through augmenting investment demand and expediting institutional reforms.

This paper comprises five sections, the first being the introduction. The next section is devoted to literature review with a focus on Bangladesh. Section 3 describes data and methodology. Cointegration, VEC estimations, generalized impulse responses, and variance decompositions are illustrated in Section 4. And Section 5 concludes.

2. Literature on the remittance-GDP relationship

Despite conventional belief that remittances are highly beneficial to output, the existing literature does not produce any conclusive result in this respect. This review includes two steps: presenting the cross-country and panel studies, and finally focusing on South Asia along with Bangladesh in particular.

In a study for 113 countries, Chami et al. (2003) find that remittances have a negative effect on growth. The study concludes that income from remittances allows receiving families to decrease their own work and productivity, which then translates into a reduction in the labor supply for the developing country. The authors attribute this negative effect on the moral hazard problem that remittances create.

Using data from Egypt, Greece, Jordan, Morocco, and Portugal, Glytsos (2005) shows that the impact of remittances on output varies over time and across countries over the 1969-1998 period. The growth-generating capacity of rising remittances characteristic is smaller than the growth-destroying capacity of falling remittances for Egypt, Jordan, and Morocco. Moreover, the large fluctuations in the real value of remittances contribute to large fluctuations of output growth and cause instability in the economies concerned. Hence, due to differences in characteristics across countries, country-specific studies are warranted. An IMF (2005) study with 101 developing countries finds no statistical link between remittances and per capita output growth.

A study by Adams and Page (2005) using 71 developing countries finds that remittances significantly reduce the level, depth, and severity of poverty in the developing world. Jongwanich (2007) examines the impact of workers' remittances on growth and poverty reduction in developing Asia-Pacific countries using panel data over the period 1993-2003. He finds that remittances seem to have a positive but marginal impact on economic growth in Asia and the Pacific countries through the improvement of domestic investment and human capital. Remittances have a significant direct impact on poverty reduction through increasing income, smoothing consumption and easing capital constraints of the poor.

In a work with 39 developing countries over the 1980-2004 period, Pradhan et al. (2008) find that remittances have a positive impact on growth. Using data for about 100 developing countries over the 1975-2002 period, Giuliano and Ruiz-Arranz (2009) find that remittances boost growth in countries with less developed financial systems by providing an alternative way to finance investment and helping overcome liquidity constraints. There could be an investment channel, as they argue, through which remittances can promote growth especially when the financial sector does not meet the credit needs of the

population. While it is undeniable that remittances have poverty-alleviating and consumption-smoothing effects on recipient households, a key empirical question is whether they also serve to promote long-run economic growth. Barajas et al. (2009) tackle this question and find that workers' remittances have no impact on economic growth.

Working with 114 countries, Catrinescu et al. (2009) assert that officially recorded remittances to developing countries have increased over the last decade, but research has not come to a consensus over whether remittances have a positive or negative impact on long-run growth. Catrinescu et al. argue that remittances will be more likely to contribute to longer-term growth in countries with higher quality political and economic policies and institutions. Thus, big panel or cross-country studies often contradict to each other in their findings due to institutional differences.

Using data for more than 20 Asian countries for the 1988-2007 sample, Vargas-Silva et al. (2009) find that a 10 percent increase in remittances as a share of GDP leads to a 0.9-1.2 percent increase in GDP growth. They also show that remittances only have a negligible effect on the overall poverty rate, but they tend to decrease the poverty gap and thereby ameliorate the depth of poverty. The estimates reveal that a 10 percent increase in remittances decreases the poverty gap by about 0.7-1.4 percent.

Using panel data for 33 African countries over the 1990-2005 period, Anyanwu and Erhijakpor (2010) find that international remittances reduce the level, depth, and severity of poverty in Africa. But the size of the poverty reduction depends on how poverty is being measured. As they show, a 10 percent increase in official international remittances as a share of GDP leads to a 2.9 percent decline in the poverty headcount or the share of people living in poverty. Over the period 1970-2005 for 95 countries, Craigwell et al. (2010) assert that remittances can play a key role in mitigating the effect of adverse output shocks but exert no significant influence on consumption and investment volatility. Moreover, important differential impacts exist across the various country groupings. Hence, country-specific studies become necessary.

The use of remittances in investment purposes is supported in various studies (see Brown 1994; Ratha 2003; Zarate-Hoyos 2004). Stark and Lucas (1988), Taylor (1992), and Faini (2002) find a positive impact of remittances on consumption and income. Faini argues that remittances overcome capital market imperfections and allow migrant households to accumulate positive assets. By showing that Mexican migrant families invest a significant part of their remittance income in productive activities, Zarate-Hoyos (2004) claims that expenditures originating from remittances benefit the national economy as the multiplier effect works through labor and goods markets across Mexico.

The studies on South Asia and Bangladesh in particular are few in number. In a study with India over the 1975-2003 period, Gupta (2005) shows that remittances are affected by the economic environment in source countries, and appear to be countercyclical — higher during periods of low economic growth in India. Lueth and Ruiz-Arranz (2007) find that remittance receipts are procyclical in Sri Lanka. A study by Frankel (2009) confirms the smoothing hypothesis in that remittances are countercyclical with respect to income in the worker's country of origin, while procyclical with respect to income in the migrant's host country. Qayyum et al. (2008) analyze the positive impact of remittances inflow on economic growth in Pakistan for the period 1973-2007. The authors claim that the importance of remittance inflows cannot be denied in terms of growth enhancement and poverty reduction that consequently improves the social and economic conditions of the recipient country. Ahmed and Walmsley (2009) find a net increase in welfare and real income due to increasing inflows of remittances to India.

Some of the early studies focused on the macroeconomic impact of overseas remittances in Bangladesh (Ali, 1981, Salim, 1992, Matin, 1994). Ali identifies that remittances help Bangladesh achieve a favorable balance of payments, as well as create a new resource base for the country. Salim discusses how remittances are used to make import payments and for other productive investments by the Bangladesh government. Stahl and Habib (1989) find that remittances in Bangladesh tend to be spent within those sectors which have relatively strong linkages with the rest of the economy. They assert that although a small fraction of remittances is directly spent on investment goods, it cannot be concluded that their potential contribution toward economic development is minimal. Even when utilized for seemingly 'non-productive' uses, remittances may expand the domestic production of consumption goods as well as the intermediate products necessary to support that increased consumption.

Mahmud (2003) claims that remittances contribute to faster growth in Bangladesh. As Mahmud argues, remittances are one of the three major sources of demand stimulus in investment and consumption. Other two sources of demand stimulus are the increase in income from crop production and readymade garment export. Siddiqui (2003) emphasizes that through timely and appropriate intervention, migration can be turned into a major development enhancing process. It can reduce poverty and be an important sustainable livelihood strategy of the poor in Bangladesh. Beaudouin (2006) shows that a loss of rural income due to emigration is compensated by remittances sent home by migrants.

Bruyn (2006) finds that remittances allow families to meet their basic needs, open up opportunities for investing in education and health care, loosen

up constraints in the family budget to invest in business, save as emergency resources, provide a social security for the elderly, and can boost the local economy. Bruyn asserts that the negative impacts of remittances are a possible dependency on this money flow and inflation. However, there is no conclusive evidence of the impact on income distribution. The study of Rahman et al. (2006) concludes that exports, foreign direct investment (FDI) and external remittances enhance both economic growth and employment in Bangladesh in the short run. Working over the 1976-2005 period, Ahmed and Uddin (2009) find that remittances cause GDP growth only in the short run, and this causal effect is unidirectional.

Raihan et al. (2009) show that remittances have positive effects on the economy and they reduce poverty. They reveal the positive impacts of remittances on the household's food and housing-related expenditures. Their results suggest that the probability of the household becoming poor decreases by 5.9 percent if it receives remittances. In a study over the 1979-2008 period, Hussain and Naeem (2009) find that every dollar increase in oil price increases annual remittances by nearly 15 million dollars. They also find that each additional migrant worker brings 816 dollars of remittances in Bangladesh annually, and remittances are higher during periods of low economic growth in Bangladesh.

Rahman (2009) works with the variables of remittances, exports, and FDI for Bangladesh, India, Pakistan, and Sri Lanka over the 1976-2006 period in an autoregressive distributed lag (ARDL) method. The long-term relationship between remittances and output for Bangladesh, however, is still unclear in that study due to two reasons: 1) No joint significance of the F -statistic with exclusively remittances and output was tested, and 2) output was always placed in the LHS ruling out the possibility of the reverse causation from output to remittances. Rahman concludes that remittances seem to have some insignificant and ambiguous effects on Bangladesh's GDP.

Using the data from 1976 to 2010, Paul et al. (2011) use the ARDL method, and find a long-run relationship between remittances and GDP in Bangladesh. Any short-run interaction between remittances and GDP is absent in their study. Now the questions as to how our work is different from theirs may arise. While they use the ARDL approach, we use the Johansen method, which is the most widely used approach to cointegration (Maddala, Kim, 1998, p. 191). Moreover, our data choose a relatively liberalized regime to examine the relationship, an aspect that was ignored in all previous studies.

3. Data and methodology

The variables of GDP and remittances have been collected from the World Development Indicators of the World Bank (WB, 2010). GDP is expressed at the 2000 constant US7 dollar prices. The remittance series, originally presented in current US dollars, has also been expressed at the 2000 constant US dollar prices by using the US GDP deflator (BEA, 2011). Both the series commence in 1979, the beginning of a relatively liberalized regime in Bangladesh, as discussed in the introduction, and end in 2009 in our study.

Before testing the long-run or short-run relations of these variables, we need to check them for unit roots. These macroeconomic variables, as we see in Figure 1, are most likely to have unit roots and thereby are nonstationary. The variables must be integrated of order one, i.e. $I(1)$, before they can be tested for cointegration. The Augmented Dickey-Fuller (ADF) test is widely used in this regard (Dickey, Fuller, 1979, 1981). Phillips and Perron (1988) proposed a modification of the Dickey-Fuller (DF) test and have developed a comprehensive theory of unit roots. The Phillips-Perron (PP) test has introduced a t -statistic on the unit-root coefficient in a DF regression, corrected for autocorrelation and heteroskedasticity. Formally, the power of a test is equal to the probability of rejecting a false null hypothesis. Monte Carlo simulations show that the power of the various DF tests can be very low (Enders, 2010, p. 234). Maddala and Kim (1998, p. 107) comment that the DF test does not have serious size distortions, but it is less powerful than the PP test. Choi and Chung (1995) assert that for low frequency data like mine the PP test appears to be more powerful than the ADF test. Accordingly, we adopt the PP methodology to test unit roots in the variables.

If the variables are found to be $I(1)$, testing them for cointegration will be followed as per the Johansen approach, due to Johansen (1988), and Johansen and Juselius (1990). In this two-variable case, the number of the cointegrating relation must be less than two if the series are really cointegrated. Then estimating them in a VEC model will be required. There are five options to make an assumption before carrying out the Johansen test. Option 1 assumes no deterministic trend in data, and no intercept or trend in the cointegrating equation or the test vector autoregression (VAR). Option 2 is the same as Option 1 except for intercept in the cointegrating equation. Options 3 and 4 allow for linear deterministic trend in data, and assume intercept in both the cointegrating equation and the test VAR. Option 4 just adds trend in the cointegrating equation. Option 5, being implausible in the present case for allowing quadratic deterministic trend in data, is not considered.

Based on the data, as shown in Figure 1, it appears that either of options 3 or 4 will be appropriate in this study. If both the trace and maximum eigenvalue tests recommend the presence of one cointegrating relationship, the long-term relationship exists in the system. Next, the VEC estimation will embody both the cointegrating equation and the short-run dynamics of the variables in first differences. For the sustainability of the equilibrium system, at least one of the error correction terms must be significant, because they represent the coefficients for the speed of adjustment once the system is shocked.

After the VEC estimation, we will proceed to unveil innovation accounting that includes impulse responses and variance decompositions. Impulse response functions and variance decompositions are used to summarize the dynamic relations between variables in the system (Hamilton, 1994, p. 291). The generalized forecast error variance decomposition shows to what variability in one element can be explained by the innovations from the other element in the VAR system. As Enders (2010, p. 380) asserts, innovation accounting could help determine whether the model is adequate.

The results of the VEC estimation are sensitive to the lag length and the ordering of the variables. For determining the lag length, the most common procedure is to estimate an unrestricted VAR with the variables, and to use the Akaike information criterion (AIC) or Schwartz Bayesian criterion (SBC) to decide on the lag length (Enders, 2010, p. 402). Given our sample size, we decide to use the SBC that chooses the most parsimonious model (Enders, 2010, p. 120). The issue with the ordering of the variables will be inapplicable since both impulse responses and variance decompositions will be generalized. Pesaran and Shin (1998) first proposed the generalized impulse response analysis for unrestricted VAR models. Unlike the traditional impulse response analysis, their approach does not require orthogonalization of shocks and is invariant to the ordering of variables in the VAR. This approach is also used in the construction of order-invariant forecast error variance decompositions.

4. Estimations on cointegration and innovation accounting

As per the methodology, Table 1 presents the results on the PP unit root tests with remittances and GDP. The outcomes are consistent in that both series are $I(1)$ in levels, and $I(0)$ in first differences. We add intercept in the unit root test, and define this specification as Model A, as shown in Table 1. Next, we include trend in addition to intercept and define it as Model B. The variables give robust and consistent results irrespective of models selected. These properties qualify the variables to be examined in the Johansen test whose results are

presented in Table 2. The decision on the lag length is made by running the variables in an unrestricted VAR. The SBC chooses the lag length to be one.

The next decision involves selecting the right option for the Johansen test. As discussed before, only options 3 and 4 are plausible in our case. While both options include unrestricted intercepts, option 4 also includes restricted trend in cointegrating relation. We will choose Option 4 only if the trend term is significant. Table 2 shows the estimations under options 3 and 4. The results are consistent irrespective of the option chosen. Both the trace and maximum eigenvalue tests find one cointegrating vector between these variables. Thus, GDP and remittances are cointegrated in the liberalized regime of Bangladesh.

The trend term in the cointegrating equation is highly significant, confirming the acceptance of option 4 for the subsequent VEC model whose results are presented under VECM(1) in Table 3. The cointegrating equation for VECM(1) has been normalized on GDP, and shows a significant and positive long-run relationship between remittances and GDP. Remittances can explain 14 percent of long-run movement in GDP in Bangladesh. Despite having some convincing results, some problems with the VECM(1) estimation are encountered.

The error correction terms on both output and remittance growth are significant, but the term on output growth has improper sign, i.e. positive. The sign on the error correction term of a variable must be opposite to that on its level variable in the cointegrating equation to ascertain the long-run equilibrium of the system (Pesaran, Pesaran 2009, p. 307). Moreover, the Portmanteau tests shown under VECM(1) exhibit the presence of serial correlation at various lags at the 5 percent level. Any evidence that the errors are not white noise usually means that lag lengths are too short (Enders, 2010, p. 402). Since the SBC selects a parsimonious model, the presence of serial correlation is likely. The way out is sequentially increasing the lag length until serial correlation is corrected (Mills, 1999, p. 249, Pesaran et al., 2001). Hence, we increase the lag length from 1 to 2. The estimation results, as presented under VECM(2) in the same table, do not exhibit any signs of serial correlation, heteroskedasticity, or non-normality at the 5 percent level.

The VECM(2), being more acceptable than before, possesses a significant error correction term on remittance growth with appropriate sign. The same term on GDP growth has proper sign, but is insignificant, suggesting that output is weakly exogenous in the system. Although there is a long-term relationship between these variables, it is only the remittance variable that adjusts any disequilibrium once the system is ever shocked. While remittances maintain a long-run positive relationship with GDP in Bangladesh, the hypothesis of GDP-led remittances should be interpreted with caution. Remittances received through

unofficial channels are likely to be of substantial amount, but they are not captured in the estimations. The estimation results could have been different if we had devised ways to bring unofficial flows into account.

The estimates of unofficial remittances are still judgmental and ad hoc. For instance, a World Bank study estimates that unofficial remittances were even more in amount than their official counterpart over the 1986-1996 period in Bangladesh (Maimbo et al., 2005). One aspect of that study, which we find convincing, is the declining ratio of unofficial remittances over official flows. The ratio has dropped from 1.62 in 1986 to 0.92 in 1996, suggesting that an increasing share of remittances is coming through official channels than before. We argue that the growing economy of Bangladesh is simultaneously engaged in gradual liberalization and institutional reforms, which have been attracting more remittances through normal institutional channels than before. Moreover, GDP growth can augment import and investment demand that may have drawn greater inflows of remittances than before. Hence, the finding that Bangladesh's GDP determines remittances in the long run has become evident, while the reverse causality is still insignificant. Again, this remains an area of further investigation, which goes beyond the scope of this paper.

Remittances appear to be countercyclical in the short run, because, in the equation of remittance growth, the coefficient on GDP growth is -5.78, and it is highly significant. This countercyclicity, however, may be neutralized by the coefficient on the error-correction term, which is 6.58. The net effect of output on remittances may eventually become positive or something near zero in the short run if these two coefficients work simultaneously. The output growth equation under VECM(2) reveal no short-run effect of remittances on GDP, nullifying traditional belief that remittances contribute to GDP growth in Bangladesh every year. These findings are consistent with that in Paul et al. (2011), which adopted different sample and methodology. Thus, the results on the long-run relationship between GDP and remittances along with the weak exogeneity of output, and the short-run non-causality from remittances to GDP appear to be robust in Bangladesh.

Based on the VECM(2), generalized impulse responses and forecast error variance decompositions with remittances and GDP in Bangladesh are presented in Figures 2 and 3, respectively. The 95 percent confidence bands consisting of the ceiling and floor for each response path have been calculated using the bootstrap method (Pesaran, Pesaran, 2009, p. 135). The response of GDP due to one standard deviation innovation in remittances appears to be very weak and insignificant, since the ceiling of the confidence band merges with the zero line. In contrast, the response of remittances due to a similar shock in GDP becomes positive and significant in four years. The response of remittances to GDP keeps

on rising over time. These results are consistent with those in the VECM(2) in that remittances respond to output, but the reverse is not true.

The variance decomposition of remittances due to GDP is shown in Panel A of Figure 3. The share of the forecast error variance of remittances due to GDP is roughly 80 percent, whereas that of GDP due to remittances is 40 percent in 10 years, as shown in Panel B of the same figure. Moreover, the floor of the confidence band for the variance decomposition of GDP is lying close to the zero line, suggesting that the estimates of variance decomposition are almost insignificant. Elyasiani et al. (2007) argue that the variance decomposition analysis provides an important insight into the relative importance of each variable in the system. Panel C of Figure 3 shows a comparative picture between these two variance decompositions, further vindicating the robust role of GDP in the explanation of remittance flows in Bangladesh. Thus, output greatly determines remittances in Bangladesh, while the reverse is not true.

5. Conclusion

With the advent of liberalization programs in developing countries, worldwide remittance growth has been more pronounced than ever before. Bangladesh began liberalizing its economy, although slowly, since the late 1970s. The country has achieved spectacular annual growth of more than 5 percent in the last two decades (WB, 2010). Remittances have also been high and growing in Bangladesh particularly over its liberalization era that began in 1979. In 2008, Bangladesh was the ninth highest remittance-recipient country in the world after India, China, Mexico, Philippines, Poland, Nigeria, Egypt, and Romania. This scenario has raised a number of questions such as: 1) What is the remittance-GDP relationship over the liberalization regime of Bangladesh? 2) Is the relationship, if present, a long-run or short-run phenomenon? 3) What lessons do other developing countries learn from the remittance-output dynamics of Bangladesh? There lies a gap in the existing literature in this respect. Our study fills that gap by addressing the above questions.

We adopt the widely used Johansen approach to cointegration along with VEC models to unveil both long run and short-run relation between the variables. Generalized impulse responses and forecast error variance decomposition, jointly called innovation accounting, are also used to explore the dynamics between them. Working on a liberalized regime from 1979 to 2009, this study finds long-run cointegration between remittances and GDP in Bangladesh. Contrary to traditional belief, GDP is weakly exogenous in the VEC model, suggesting that it is only the remittance variable that responds to correct long-run disequilibrium if the system is ever shocked, but the reverse is not true.

Simply, remittances follow the movements in output in a positive fashion in the long run, and correct short-run disequilibria.

Although this is another area of research that goes beyond the scope of this paper, we hypothesize that an increase in GDP may have caused institutional improvement to bring more remittances through formal channels than before. Moreover, GDP growth that augments import and investment demand necessitates greater inflows of remittances over time. Remittance growth appears to be countercyclical, and it has no significant effect on output growth in the short run. That countercyclicality may often be offset by the procyclical adjustment of remittances towards the correction of disequilibria in the cointegrating relation. These findings have policy implications for other developing nations in that output growth can be addressed first to attract more remittances. Undertaking institutional reforms and exploring investment opportunities can further boost remittance growth in developing nations.

This work raises some additional questions such as: 1) What are the underlying channels that dictate the long-run causality from output to remittances? 2) Why is the short-run effect of remittances on GDP still insignificant? 3) What is the remittance-GDP relationship in other top remittance-recipient economies? These issues are, of course, intriguing, and thus left for future research.

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Table 1

Phillips-Peron unit root tests with Bangladesh's GDP and remittances: 1979-2009

Variables:	In levels		In first difference		Integration
	Model A	Model B	Model A	Model B	
GDP	7.16 (1.00)	-1.12 (0.91)	-3.97 (0.01)	-7.13 (0.00)	I(1)
Remittances	-0.13 (0.96)	-1.47 (0.82)	-6.26 (0.00)	-10.63 (0.00)	I(1)

Note: Model A includes intercept, and Model B includes both intercept and trend. The null hypothesis states that the variable has a unit root. p -values are shown in the parentheses under each adjusted t -statistic. The critical values and details of the test are presented in Phillips and Perron (1988).

Source: World Bank (WB 2011).

Table 2

Johansen co integration Tests with Bangladesh's GDP and remittances: 1979-2009

		Option 3			Option 4		
		λ Stat	CV	CE	λ Stat	CV	CE
λ_{trace} tests:							
H ₀ : $r = 0$	H _A : $r > 0$	20.76	15.49	1	35.43	25.87	1
H ₀ : $r \leq 1$	H _A : $r > 1$	1.10	3.84	0	12.20	12.52	0
λ_{max} tests:							
H ₀ : $r = 0$	H _A : $r = 1$	19.66	14.26	1	23.23	19.39	1
H ₀ : $r = 1$	H _A : $r = 2$	1.10	3.84	0	12.20	12.52	0

Note: The λ_{trace} and λ_{max} are calculated as per Johansen (1990). p -values are calculated as per MacKinnon et al. (1999). CV signifies critical values calculated for the 5 percent significance level. CE stands for co integrating equation. H₀ and H_A denote the null and alternative hypotheses, respectively. Option 3 includes an intercept in the CE and the test VAR, whereas Option 4 includes an intercept and a trend in the CE without any trend in the VAR. The λ_{Trace} and λ_{Max} test statistics under both models are computed by allowing for liner deterministic trends in data. The lag length is determined by the SBC (see Enders 2010:402). r stands for the rank of the matrix, which denotes the number of the CE between the variables.

Source: WB (2010).

Table 3

Vector error correction estimates with Bangladesh's GDP and remittances> 1979-201

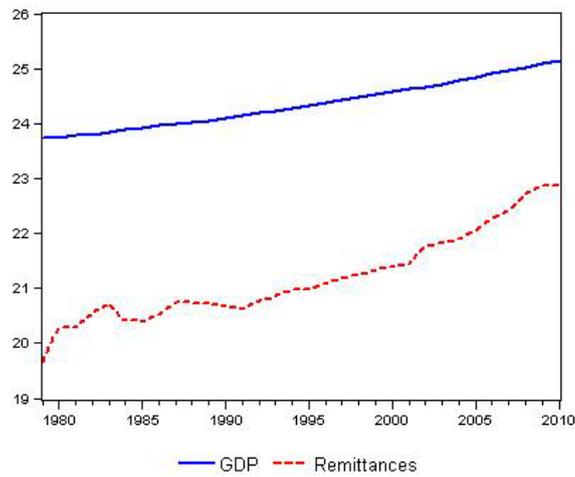
CE for VECM(1): $ECT(t) = GDP(t-1) -0.14 \times Rem(t-1) -0.03 \times Trend -20.86$

CE for VECM(2): $ECT(t) = GDP(t-1) -0.16 \times Rem(t-1) -0.03 \times Trend -20.41$

LHS variables →	VECM(1)		VECM(2)	
	$\Delta GDP(t)$	$\Delta Rem(t)$	$\Delta GDP(t)$	$\Delta Rem(t)$
<u>Regressors:</u>				
Constant	0.044 (0.011)	0.300 (0.113)	0.011 (0.012)	0.317 (0.082)
$\Delta GDP(t-1)$	0.030 (0.229)	-4.444 (2.333)	0.438 (0.24)	-5.777 (1.535)
$\Delta GDP(t-2)$			0.346 (0.200)	0.010 (1.300)
$\Delta Rem(t-1)$	0.006 (0.013)	-0.111 (0.136)	0.010 (0.018)	0.399 (0.120)
$\Delta Rem(t-2)$			-0.010 (0.014)	0.051 (0.093)
ECT(t-1)	0.148 (0.061)	2.352 (0.626)	-0.118 (0.141)	6.580 (0.923)
Adjusted R ²	0.37	0.35	0.28	0.70
<u>Diagnostic tests:</u>				
Portmanteau Serial correlation test:				
Adjusted Q-stat at lag 2	9.95 [0.04]		n/a	
Adjusted Q-stat at lag 4	16.74 [0.16]		8.12 [0.42]	
Adjusted Q-stat at lag 6	36.24 [0.01]		17.43 [0.36]	
Adjusted Q-stat at lag 8	40.82 [0.06]		25.66 [0.37]	
Heteroskedasticity test: χ^2 stat:	27.10 [0.08]		28.91 [0.52]	
Normality test:				
χ^2 stat for skewness	1.20 [0.55]		0.77 [0.68]	
χ^2 stat for kurtosis	0.95 [0.62]		2.17 [0.34]	
Jarque-Bera stat	2.14 [0.71]		2.94 [0.57]	

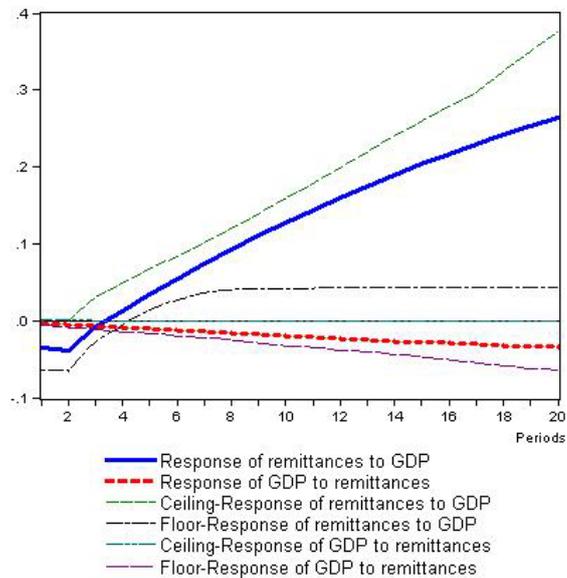
Note: The error correction estimation follows Model B as explained in Table 2. “Rem” denotes remittances. “ECT” is the error correction term. “CE” stands for co integrating equation. “ Δ ” indicates the first-order difference operator, and “stat” signifies statistic. Coefficients are bold when significant at the 5 percent level. All values in parentheses against each coefficient are standard errors. The values in brackets are *p*-values of the respective statistic. Null hypotheses are “no serial correlation”, “no heteroskedasticity”, and “no non-normality” in VEC errors in the respective tests. The serial correlation test for VECM(2) at lag 2 is not available (n/a) by design.

Source: WB (2010).



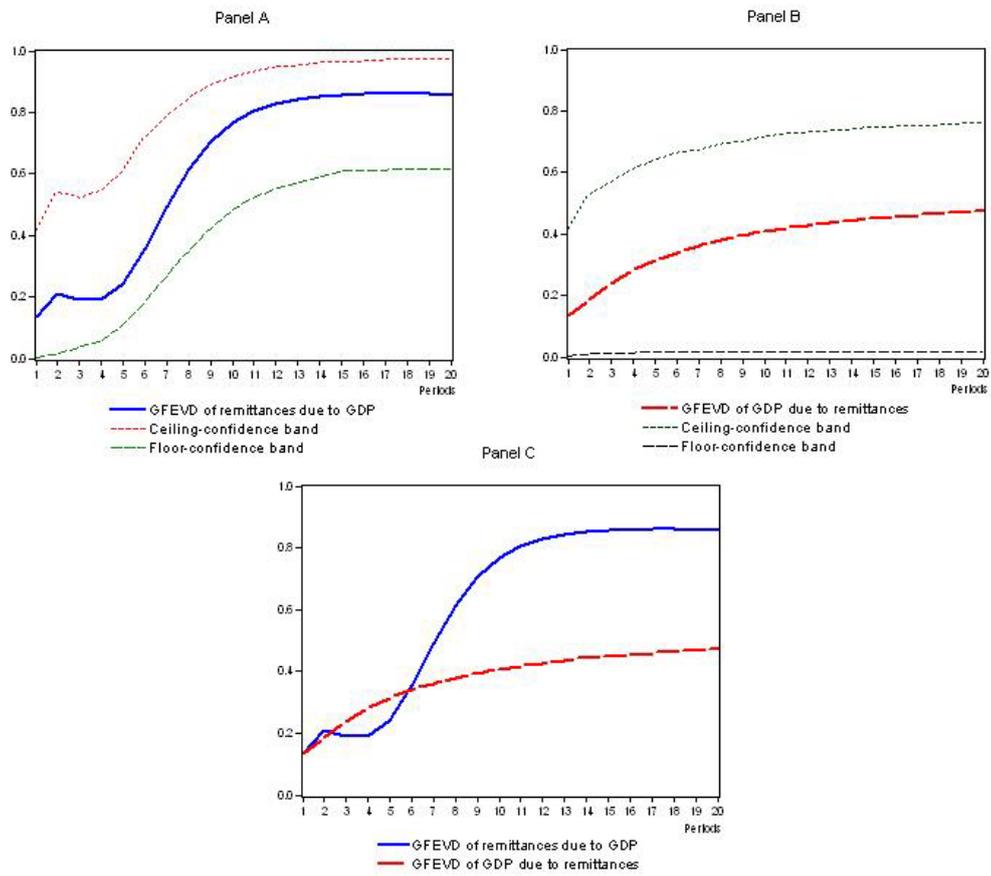
Source: WB (2010).

Figure 1. GDP and remittances (in logs) in Bangladesh: 1979-2009



Source: WB (2010).

Figure 2. Generalized impulse responses with Bangladesh's remittances and GDP: 1979-2009



Source: WB (2010).

Figure 3. Generalized forecast error variance decomposition (GFEVD) of remittances and GDP in Bangladesh: 1979-2009