Remittances Review
May 2022
Volume: 7, No: 1, pp. 91 - 116
ISSN: 2059-6588 (Print) | ISSN: 2059-6596 (Online)
journals.tplondon.com/rem
TRANSNATIONAL PRESS® LONDON

Received: 12 April 2021 Accepted: 11 May 2021
DOI: https://doi.org/10.33182/rr.v7i1.1480

Impact of Covid-19 Pandemic on Remittance Inflow-Economic Growth-Nexus in India: Lessons from an Asymmetric Analysis

T. K. Jayaraman[1] and Keshmeer Makun[2]

Abstract

The relentless spread of the Covid-19 pandemic from the first quarter of 2020 and the emergence of new variants since early 2021 have caused a steep decline in economic activities in all countries. The forecast by international agencies including World Bank is that remittances (REM) on a global scale would decline by 20 percent in 2021; and to South Asia in particular would decrease by 25 percent. India, a low-middle-income country, which has been among the top ten REM recipient countries, is expected to be adversely affected much more. This study examines the asymmetric effects of REM on India's per capita GDP by using a nonlinear methodology. Additionally, factors like ICT and the financial sector are considered in an extended version of the remittance-growth relationship. The study findings reveal that the impact of the negative partial sum of decomposition of REM is higher than the impact of positive partial sum decomposition of REM, implying a greater adverse effect of declining remittances on per capita GDP growth. The findings are expected to be of substantial importance in designing appropriate policies that affect economic growth through the interaction of remittances with ICT, and financial markets.

JEL codes: *E44; O33*

Keywords: *Remittances; ICT; FSD; Economic Growth; Asymmetries; NARDL approach; India*

Introduction

Annual inflows of overseas development assistance (ODA) have been declining along with fluctuations in foreign direct investment (FDI) inflows to lower-middle-income countries[3] (LMICs). However, global inward remittances (REM) are on the rise, which reached a new high at $529 billion in 2018 (World Bank, 2018), an increase of 9.6 percent from $483 billion in 2017. Aside from adding to foreign exchange reserves, REM's biggest

[1] International Collaborative Partner in Research, Universiti Tunku Abdul Rahman, Kampar Campus, Perak, Malaysia.
E-mail: tkjayaraman@yahoo.com.
[2] School of Accoutning, Finance and Economics, University of the South Pacfic, Laucala Campus, Suva, Fiji Islands.
E-mail: keshmeer.e.makun@usp.ac.fj.
[3] According to World Bank have categorised countries as follows: (i) low income countries are those with has gross national income (GNI) per capita being less than US$1,025 per capita; (ii) lower middle income countries are with GNI per capita between US$1,026 and US$3,995; (iii) upper middle income with GNI percapita ranging between US$3,996 and US$12,375; and (iv) high-income countries with per capita GNI being $12,.476 and above.

contribution lies in the alleviation of poverty in LMICs, as they supplement the income of the families left behind (Kumar and Hossain, 2018; Rahman and Moni, 2019; Kumar, 2019; Chaudhury, 2020).

Remittance inflows, now increasingly passing through banking formal channels rather than informal channels, have had wider positive spillover effects in the recipient countries. In the second half of 2020 and early 2021, when borders were closed due to Covid-19 pandemic, electronic transfers to banks and other financial institution became more convenient and reliable (Dinarte et al., 2021). There have been considerable progress in promoting financial inclusion of the hitherto bypassed sections of the economy and in strengthening financial sector development (Jayaraman et al., 2018). These are non-reversible improvements, which are due to the rapid spread of information and communication technology (ICT) and the growing use of mobile phones and online banking, especially in rural parts of the recipient countries, which were ignored by urban banks in the past (Jayaraman et al., 2021). Savings from REM are presently more in the form of bank deposits of households, which add to bank reserves, and households turn to banks that are ready to lend from their rising reserves for loans for investing in education, health, housing, and mini and micro-enterprises. The rise in investments, short term as well long term, has been stimulating growth (Makun and Jayaraman, 2020).

In the absence of growth in ICT and greater financial inclusion, annual regular REM inflows are likely to be wasted away on wasteful and needless consumption. For India, REM in recent years has become a much more reliable source of foreign exchange earnings for the economy. Unlike foreign aid, which has been on a declining trend during the last two decades, and foreign direct investment (FDI) which is often subject to fluctuations, REM receipts by India are seen steadily rising since 2009. For instance, REM rose from US$49.2 billion in 2009 to an estimated figure of US$83.1 billion in 2019, the highest amongst all LMICs.

Most of the literature, empirical studies, in particular, have dealt with REM and growth nexus with linear models and their conclusions are in line with the general hypothesis that REM promotes growth, although there are studies to show the relationship between remittances and economic growth is not yet fully established and the debate may continue (Cazachevici et al., 2020). However, there has been no notable study on the asymmetric effect of remittances on economic growth, although there are some emerging studies in describing the link between remittances and economic growth, especially the non-linear effects of remittances which are partly discussed in the literature (Makhlouf, 2019). The extant literature on remittances-growth relationship has mostly focused on linear models. Kocaarslan and Soytas (2019) argue that ignoring the existence of asymmetric relations leads to misleading findings[4]. The findings of such a study would enable policymakers to design suitable measures to deal with the adverse negative effects of declining REM inflows.

Our objective is to investigate the asymmetric effects of remittances on growth, in particular, in India. In the context of the prevailing worldwide recessionary conditions consequent to the unabated spread of the Covid-19 and continuing uncertainties, the World Bank (2020) has warned that global remittances to developing countries would decline by 20% in 2020 and much more in 2021. This paper is organized along the following lines. The following section gives a brief literature review, discussing the effects of REM on growth. Section three provides a review of trends in REM, ICT, and FSD. The fourth section outlines the theoretical framework, data, and model including estimation procedures. Section five presents the empirical results and finally, the last section presents the conclusions with policy implications.

A brief literature review

Studies on growth and REM nexus were of very recent origin. REM are largely believed to have a beneficial effect on output growth through an increase in savings and investment. Studies such as Buch and Kuckulenz (2010) and Ratha (2007) show that REM improves welfare by supporting consumption, education, and investment including entrepreneurship. In a panel analysis, Pradhan et al. (2002) explore that the effect of workers' remittances on growth in 39 developing countries in a conventional growth model and find a positive impact of remittances on economic growth. Country-specific studies, which include Jayaraman et al. (2012) and Masuduzzaman (2014) show REM is positively related to economic growth in India and Bangladesh. Focusing on poverty alleviation, besides economic growth studies by Jawaid and Raza (2016), Kumar (2012), Taylor (1999), and Brown et al. (2013), shows that remittances inflow contributes to poverty alleviation, and wealth creation in countries such as India, Nepal, Sri Lanka, Philippines, Mexico, Fiji, and Tonga.

However, the literature on the effect of remittances on output growth remains disputed. For example, Chami et al. (2003) show a negative association between remittances and economic growth. More recently, studies such as Rao and Takirua (2010), Siddique et al. (2012), Pradhan (2016), and Kumar (2014) demonstrate that REM had a negative effect on output in Kiribati, India, Brazil, Russia, and Kenya, respectively.

Although the extant literature on REM and growth is growing, the REM-growth nexus through the support of financial sector development (FSD) began to attract attention once

[4] See also Filis et al. (2011).

the liberalization of banking and financial institutions began. The advent of the Fourth Industrial Revolution (Schwab, 2015) since the start of the New Millennium with the wider use of innovations and products including the internet and mobile phones have been facilitating online banking, remitting and promoting financial inclusion of those who had no banking facilities earlier. These revolutionary innovations have been responsible for a speedy FSD.

There are notable studies that have examined the REM-growth nexus with respect to FSD. Giuliano and Ruiz-Arranz (2009) in a sample of hundred countries including India demonstrate that local financial markets provide an important link to take advantage of remittances. Similarly, covering over 100 developing countries in a panel study, Aggarwal et al. (2006, 2011) investigated the link between REM and credit flows and found a positive and robust association between REM and FSD. Bettin and Zazzaro (2012), however, found that the impact of REM is less, where FSD was weak, but higher where FSD is more efficient. Sobiech (2019) in a recent work, using a newly developed FSD index and a different methodology arrived at a similar finding to the finding by Bettin and Zazzaro (2012). Most of these are cross-sectional and their focus has been on groups of countries, where it is hard to gauge the outcome at a specific point in the individual economy over time.

Earlier studies were mostly focused on productivity and economic growth (Solow, 1956; Romer, 1990, Buhalis and Law 2008, Minghetti and Buhalis, 2010) by minimizing production cost, greater access to information, and quality goods and services at an economical price. Focusing on the Pacific region, Horscroft (2010) emphasized the positive role of the ICT industry in assimilating business markets by conquering three tyrannies of: (i)geography of a dispersed group of islands, especially of the archipelago of atolls; (ii) distance of individual settlements from each other within a country; and (iii) distance from the markets in advanced countries. Table 1 presents details of leading contributions on REM, ICT, and economic growth.

Trends in REM, FSD, and ICT in India

Remittances Inflow

Figures 1 and 2 present inflows of capital transfers in terms of percentages of GDP and in absolute amounts of US Dollars in billions. Both Figures 1 and 2 show a rising trend in REM inflows to receiving countries as well as a reversal for a while, due to fall in employment, following decline in the world price of petroleum crude, in oil-producing countries. However, with the rise in the price of crude oil, which lasted nearly ten months of 2018, there was a notable rebound in REM outflows from the Gulf Cooperation Council (GCC) countries and the Russian Federation with the migrant labour, resuming their remittances. According to *Brief 30* (World Bank Group and KNOMAD, 2018), REM inflows to LMICs are estimated to have grown by 10.8 percent in 2018 to reach US$ 528 billion, a new record. In keeping with the general rising trend, REM flows to South Asia, belonging to the category of LMICs, are reported to have grown by 12 percent in 2018 to $131 billion. The increase was supported by the global economic recovery from the Great Recession and the resultant rising oil prices. Similarly, REM inflows grew by over 14 percent in India, especially underpinned by the generous response to the 2018 flood disaster relief funds appeal by the Indian State of Kerala to its citizens, working as migrant labour in Middle Eastern countries.

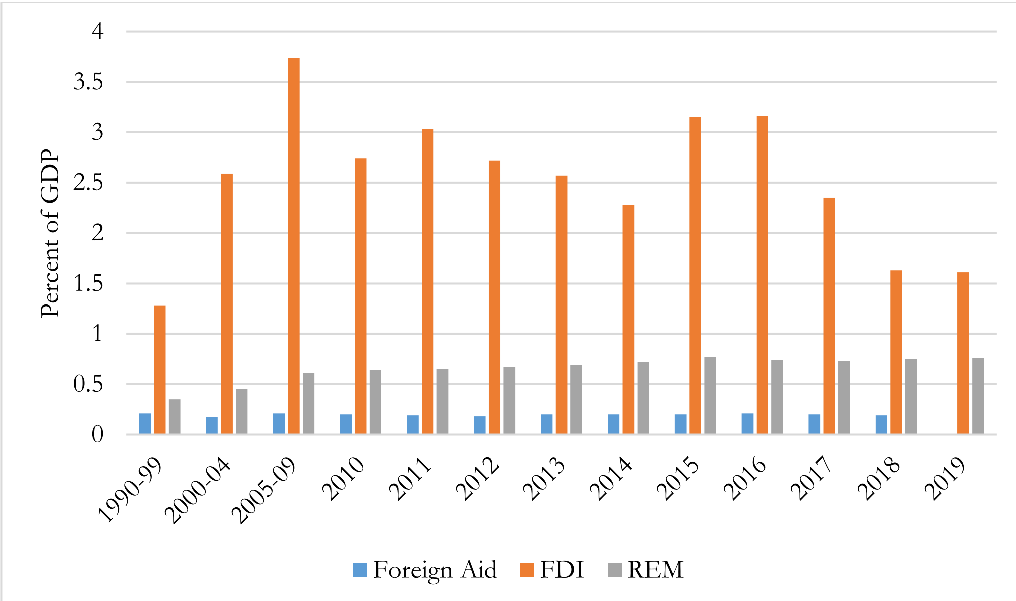
Table 1. Remittances, ICT, and growth literature review summary

Author	Period	Country	Frequency	Variables	Methodology	Effect/causality
Adams and Page (2005)	Specific country sample	71 countries	Annual	Remittances as a share of GDP	Panel estimates	+
Pradhan et al. (2008)	1980-2004	31 countries	Annual	Workers remittances	Panel estimates	+
Kumar (2014)	1978-2010	Kenya	Annual	Remittances as a share of GDP	ARDL	+/REM→GDP
Kumar and Vu (2014)	1980-2012	Vietnam	Annual	Remittances, ICT, capital	ARDL	+ (but not significant)/ REM→GDP and ICT→GDP
Jongwanich (2007)	1993-2003	Asia-Pacific countries	Annual	Remittances, investment, human capital	Panel estimates	+ (Marginal impact)
Pradhan (2016)	1994-2013	BRICS countries	Annual	Remittances and export	FMOLS	+/-/ REM→GDP
Jackman et al. (2009)	1986-2005	20 Small island states	Annual	Remittances, investment, and consumption	Panel estimates	+ (effect on investment and consumption)
Jayaraman et al. (2019)	2000-2017	CLV Country	Annual	Mobile use	Panel estimate	+/REM→GDP ICT→GDP
Roller and Waverman (2001)	1970-1990	OECD 21	Annual	Investment in telecom, telephone lines, penetration rate	GMM – nonlinear	+
Datta and Agarwal (2004)	1980-1992	OECD 22	Annual	Telephone lines per 100 inhabitants	OLS, FE	+
Dimelis and Papaioannou (2010)	1993-2001	42 countries	Annual	ICT, FDI	Growth accounting	+
Gruber et al. (2014)	2005-2011	EU-27	Annual	Broadband access	3SLS/CBA	ICT→GDP
Ishida (2015)	1980-2010	Japan	Annual	ICT technologies	ARDL	ICT→GDP
Ward and Zheng (2016)	1991-2019	China	Annual	Mobile use, fixed tele-line	Growth accounting	+/ICT→GDP
Hong (2017)	1988-2013	South Korea	Annual	ICT investment	VECM	ICT→GDP

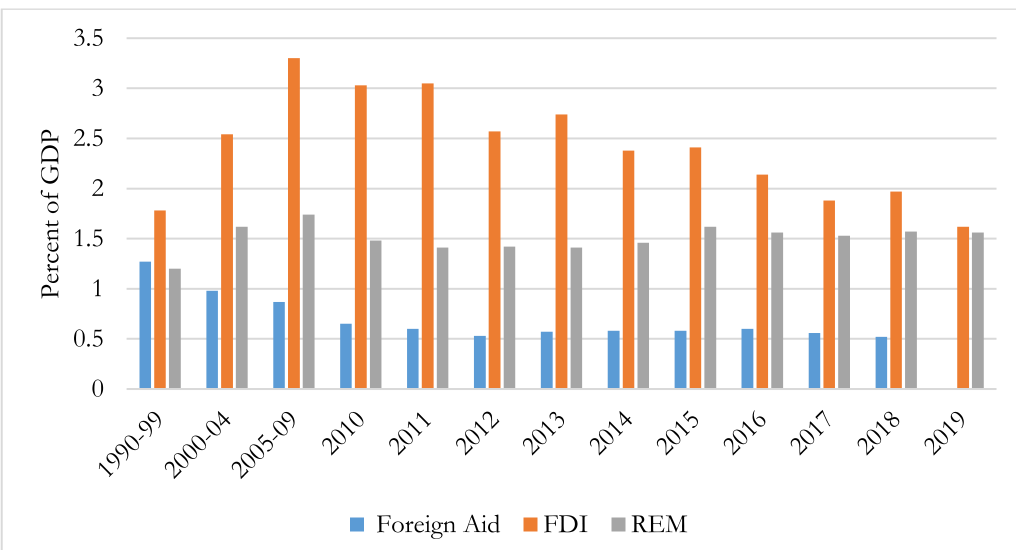
Notes: GDP –Gross domestic product. ARDL – autoregressive distributed lag approach. ICT→GDP –causality relationship from information and communications technology to GDP. REM→GDP causality from remittances to GDP. + is a positive effect of ICT/REM on GDP.

Figure 1. Capital Transfers: World, LMICs, South Asia and India: 1990-2019 (% of GDP)

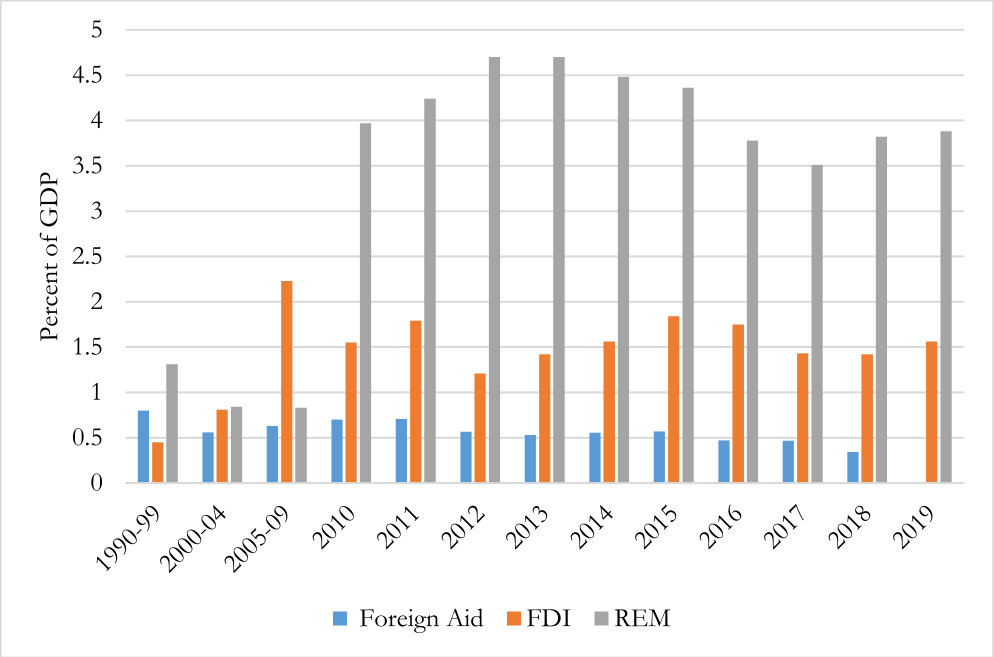
(i) World



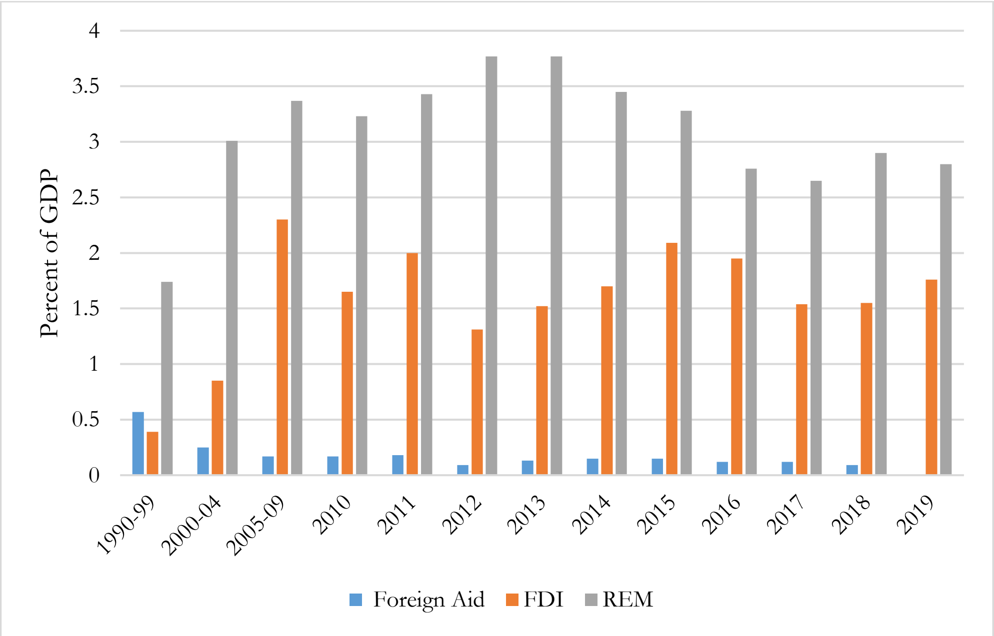
(ii) LMICs



(iii) South Asia



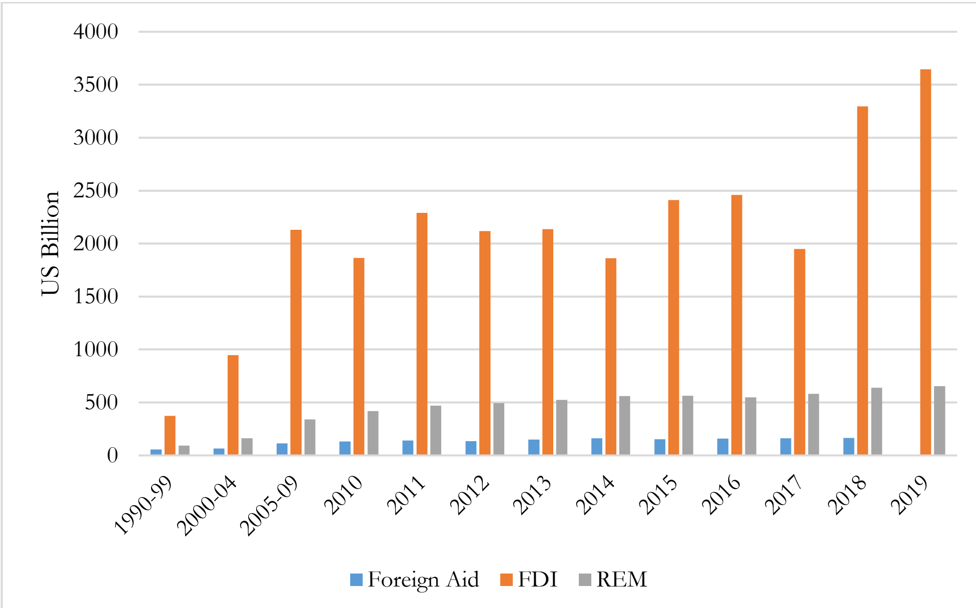
(iv) India



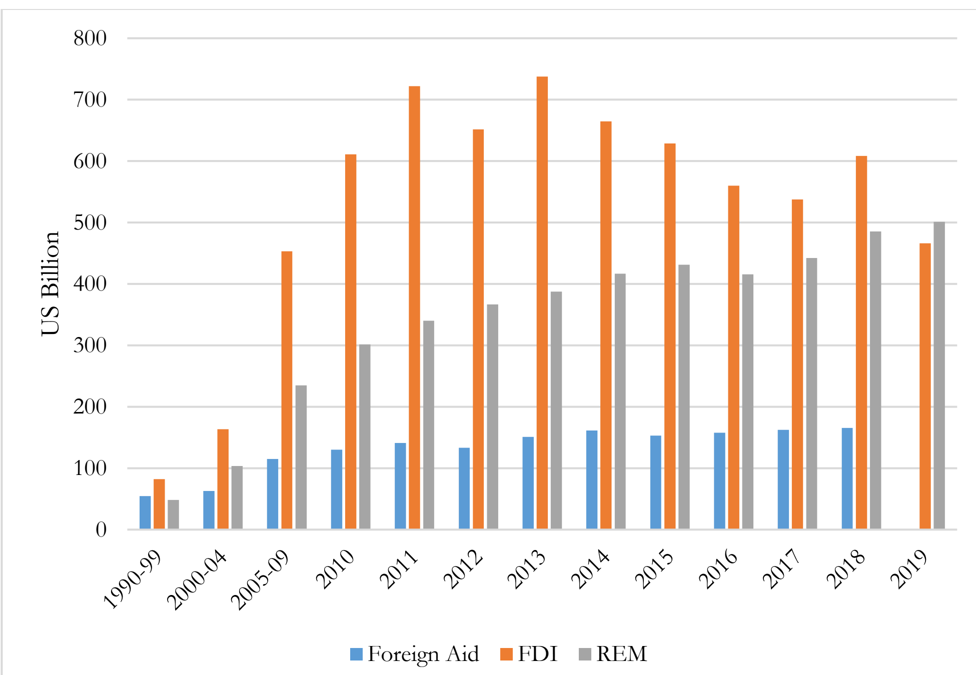
Source: World Bank (2019) and Authors' Calculation.

Figure 2. Capital Transfers: World, LMICs, South Asia and India: 1990-2019 (US billion)

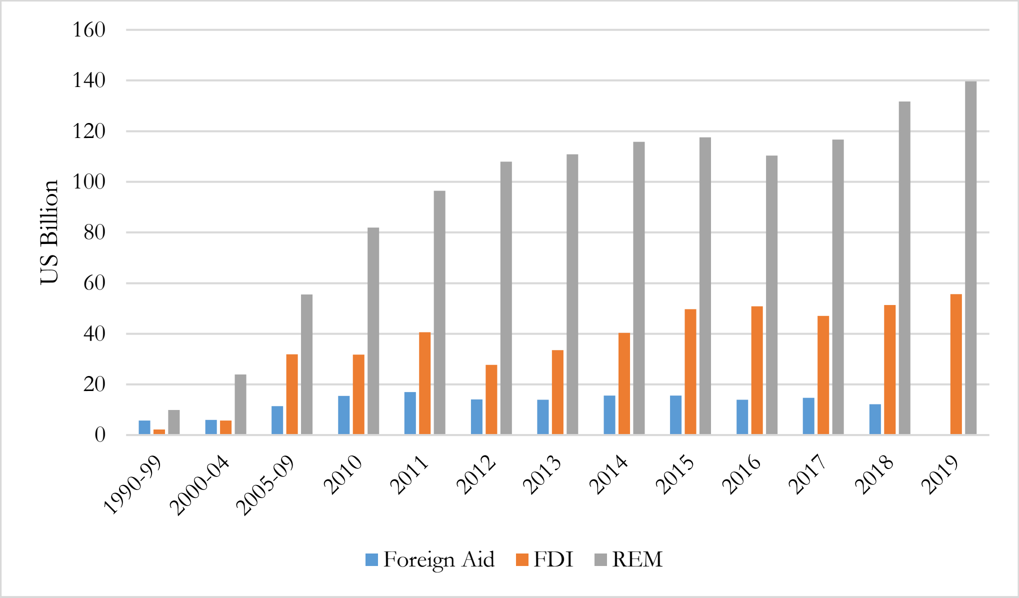
(i) World



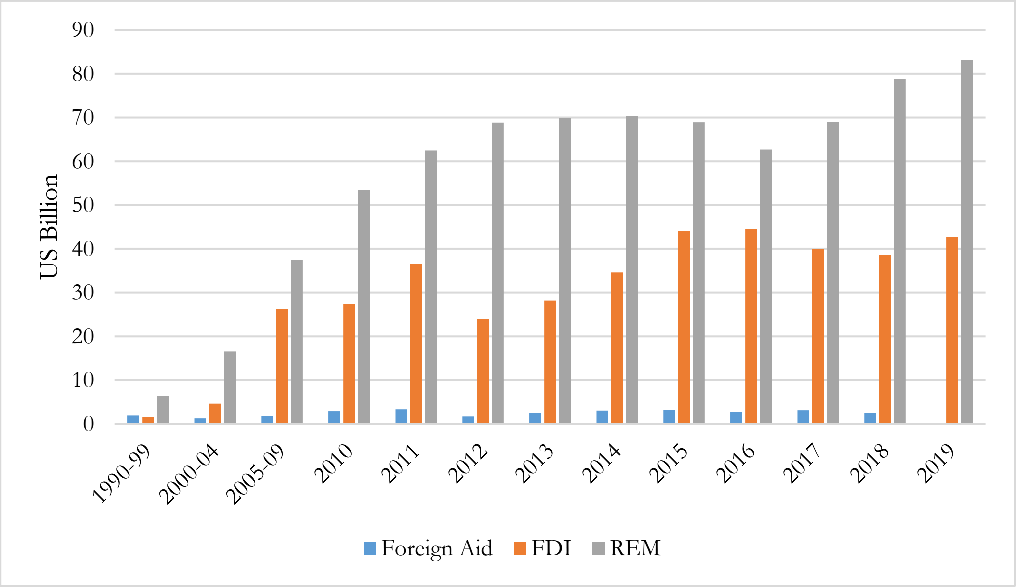
(ii) LMICs



(iii) South Asia



(iv) India



Source: World Bank (2019) and Authors' Calculation.

In recent years, India has made it to be the world's top receiver among the of REM recipient countries, claiming more than 12% of the world's remittances in 2015. The growth in REM inflows from 63 billion in 2016 to US$83.1 in 2019 (a 32 percent increase) shows India continued to retain the first rank before the pandemic hit all countries in 2019.

Table 2. Top ten remittances recipient countries, 2016-2019

2016		2017		2018		2019	
Country	US$ billion	Country	US$ billion	Country	US$ billion	Country	US$ billion
India	63	India	69	India	79.5	India	83.1
China	61	China	64	China	67.4	China	68.4
Philippines	30	Philippines	33	Mexico	33.7	Mexico	38.5
Mexico	28	Mexico	31	Philippines	33.7	Philippines	35.2
Pakistan	20	Nigeria	22	Egypt	25.7	Egypt	26.8
Nigeria	19	Egypt	20	Nigeria	25.1	Nigeria	25.4
Egypt	17	Pakistan	20	Pakistan	20.9	Pakistan	21.9
Bangladesh	14	Vietnam	14	Ukraine	16.5	Bangladesh	17.3
Vietnam	13	Bangladesh	13	Bangladesh	15.9	Vietnam	16.7
Indonesia	9	Indonesia	9	Vietnam	15.9	Ukraine	15.9

Source: World Bank (2020)

FSD and ICT

India's financial sector[5] began to play a major role in economic growth in the 1990s soon after the introduction of economic reforms (Mohan and Ray, 2017). The spread of ICT in India towards speeding up the progress of FSD was another factor in the second decade of the New Millennium (Table 3). Although India currently accounts for more than 10% of the global smartphone market, the findings of a *Mobile Technology and its Social Impact Survey* by Pew Research Center (2019) reveal India's smartphone ownership rate is the lowest among the 11 developing countries. Though a close 79 per 100 of the population in 2015-16 had mobile phones, the number of internet users per 100 persons was only about 26 in 2015-16. According to a private marketing agency survey released in late March 2019 (*Economic Times,* 2019), the number of internet users was around 566 million in December 2018 and 493 million were reported to be regular users (defined as those who accessed the internet last 30 days)[6]. The usage of the internet is limited as 47 percent of mobile phone users had only basic phones that cannot connect to the internet.

The present urban-rural divide was attributed to the following reasons: (i) internet use has been more of an urban activity as urban population was fortunate to have the assured availability of electricity when compared with rural parts where too many power outages per day were usual; (ii) urban towns have a higher proportion of the formal sector institutions with private commercial establishments and public sector institutions; and (iii)

[5] The financial sector institutions comprise 93 scheduled banks of which 27 and 21 are in the public and private sectors; and the rest owned by foreign interests. The other institutions include 95,000 cooperative banks, 56 regional rural banks, post office banks, 53 insurance companies.

[6] About 293 million were active users in urban areas and 200 million in rural areas. About 97 percent of the users use the mobile phone to access the internet (Economic Times, 2019)

urban towns have a large number of white-collar working community with higher educational background[7] as well as high school and tertiary level students, who tend to be quick to adopt modern technology innovations. With greater availability of broadband width, less expensive data plans, and increased awareness of government programs linking to various services, the rural internet users (251 million in 2018) have reached 290 million in 2019, an increase of 15 percent. Similarly, the urban internet users of around 336 million in 2019 are up by 7 percent from 315 million in 2018 (*Economic Times,* 2019).

Table 3. FSD and ICT indicators

	World	LMICs	EAP	South Asia	India
Population Age (+ 15)	5.5 billion	2.1billion	1.6 billion	1.2 billion	950.8 million
GNI per capita (USD)	10,308	2,078	6,667	1,611	1,671
Account with Banks of all adults (% , Age +15)					
2017	68.5	57.8	70.6	69.6	79.9
2014	62.0	41.9	69.1	46.5	53.1
2011	50.6	28.9	55.1	32.4	35.2
Financial Market Account (% , Age +15)					
2017	67.1	56.1	70.3	68.4	79.8
2014	61.2	40.6	68.9	45.6	53.1
2011	50.6	28.9	55.1	32.4	35.2
Mobile Phone Money Account (% , Age +15)					
2017	4.4	5.3	1.3	4.2	2.0
2014	2.1	3.2	0.4	2.6	2.4
Account by different Characteristics (2017)					
Women	64.8	53	67.9	64.1	76.6
Adults in poorest 40%	60.5	50.7	59.3	65.6	77.1
Adults in rural area	66	57.6	68.8	69.2	79.3
Digital payments, made or received payments (%, age+15), 2016.					
To make bill payments	22.3	7.5	28.8	7.1	6.5
To receive wages	15.9	5.5	15.9	4.8	5.4
To accept payments from government	16.3	8.3	12.2	7.1	8.1
To do online payment	29	6.8	38.6	4.5	4.3
Via mobile subs and internet to operate an account	24.9	8.3	31	7.1	5.3
debit or credit card	32.6	6.8	33.1	10	12.3
Savings (%, age +15)					
2016	26.7	15.9	30.6	17.2	19.6
2014	27.3	14.4	*36.7*	8.6	14.4
Credit (from financial Institution/used credit card)					
2016	22.5	9.8	21.5	7.8	8.1
2014	22.3	10	19.5	8.6	9.1

Note: LMICs denote low and middle-income countries and EAP is East Asia and the Pacific.
Source: World Bank (2018).

[7] The Pew Research Center Study (2019) reports that in the 11 countries surveyed, adults with a secondary education or higher are more likely to own their own smart mobile phone than are those with less than a secondary education. The education gap is most pronounced in India, where more educated people are 41 points more likely to use a smartphone.

Theoretical framework and data

Theoretical framework

We employ the neoclassical production function approach of Solow (1956), one of the most prominent ones among the theoretical models, which is increasingly used to study the effect of macroeconomic variables on economic growth. The role of technological factor, known as the 'Solow residual' is a central feature in the model and it is exogenously explained, besides labor and capital, which are known as fundamental factors as the model is designed as a production function. Therefore, we augment this model to accommodate the growth effects of additional variables, as shift factors which include ICT and FSD.

We present the Solow (1956) framework, where the output per capita is expressed as:

$$y_t = A_t k_t^{\alpha}, \qquad 0 < \alpha < 1 \tag{1}$$

Where y_t is real GDP per capita; A_t is technology stock; k_t is capita stock per capita; α is the capital share.

According to the Solow framework, technological progress is represented by:

$$A_t = A_o e^{gt} \tag{2}$$

Where A_t is the cumulative technology in period *t*, A_o is the initial stock of technology, *t* is time and *g* is the exogenous progress of technology. The pace of technical progress determines the output growth, which is exogenous in the model. Thus, it is possible to include other growth-enhancing variables. With the introduction of REM, ICT, and FSD into the aggregate technology function, we adopt the following:

$$A_t = f(REM_t, ICT_t, BM_t), \tag{3}$$

where *REM* is remittance as a share of GDP, *ICT* is represented by mobile subscriptions per 100 inhabitants and *BM* is the ratio of broad money to GDP representing financial market development. Hence, the function is amended as:

$$y_t = (A_o e^{gt} REM_t^{\beta_1}, ICT_t^{\beta_2}, BM_t^{\beta_3}) k_t^{\alpha_1} \tag{4}$$

We transform Equation (4) into logs (*l*) and re-arrange as in Equation (5). We further transform Equation (5) into linear and nonlinear ARDL regression equations in the modeling and estimation section.

$$ly_t = \alpha_0 + \alpha_1 lk_t + \beta_1 lREM_t + \beta_2 lICT_t + \beta_3 lBM_t + \varepsilon_t \tag{5}$$

Data and primary analysis

The data used in the model are the time series of annual observations for the period 1980 to 2017 in India. Data series on real GDP per capita, expressed in constant US dollars (*y*), *REM* as a percent of GDP, *ICT* which is represented by mobile subscriptions per 100 inhabitants and broad money (*BM*), the ratio of broad money to GDP, an indicator for FSD are obtained from the World Development Indicators (WDI). The data series on per capita capital stock (*k*) in constant US$ is obtained from Penn World Tables (2019). Table 4 reports the descriptive statistics and correlation analysis in Panel A and B, respectively. The average REM inflows to India are about 2.3 percent of GDP over the study period with a maximum being 4 percent. The coefficient of REM and per capita GDP association is 0.77 while the respective coefficients of the relationship of capital stock, ICT, and broad money with per capita GDP per capita are 0.99, 0.95, and 0.92, respectively.

Table 4. Descriptive statistics and correlation matrix: 1980-2017

Panel A: Descriptive Statistics					
	Y	*k*	*REM*	*ICT*	*BM*
Mean	875.816	8760.033	2.278	19.033	56.582
Median	723.160	6759.652	2.488	0.798	50.659
Maximum	1964.595	20093.850	4.211	87.285	80.147
Minimum	389.926	4535.937	0.753	0.008	34.923
Std. Dev.	458.788	4604.519	1.049	30.335	15.975
Skewness	0.919	1.120	0.006	1.255	0.242
Kurtosis	2.653	2.959	1.617	2.839	1.456
JB (Prob)	5.535(0.063)	7.945(0.019)	3.031(0.220)	10.016(0.007)	4.144(0.126)
Observations	38	38	38	38	38
Panel B: Correlation Matrix					
	Y	*k*	*REM*	*ICT*	*BM*
Y	1.000	0.995	0.768	0.948	0.917
K	0.995	1.000	0.725	0.970	0.886
REM	0.768	0.725	1.000	0.624	0.903
ICT	0.948	0.970	0.624	1.000	0.811
BM	0.917	0.886	0.903	0.811	1.000

Modeling and Estimation

First, we employ the ARDL linear model as a benchmark model ((Pesaran et al., 2001). In time series analysis, an important issue is to account for the unit root process of the variables towards checking presence of cointegration relationship. Variables in the model can be characterized by different unit root processes and still be cointegrated. Any failure to address this can generate a spurious long-run outcome (Granger and Newbold, 1986). The ARDL methodology provides flexibility in this regard by allowing a blend of I(1) and I(0) variables in the analysis and firmly determining long-run (linear and nonlinear) cointegration. The methodology is suitable as it performs better in small sample studies

(Narayan and Narayan, 2005). We then follow it up by resorting to the well-tested NARDL model developed by Shin et al. (2014) to explore the asymmetric effects of remittances.

The common linear ARDL model based on Pesaran et al. (2001) is defined as:

$$\Delta ly_t = \alpha_0 + \alpha_1 ly_{t-1} + \alpha_{2i} lk_{t-1} + \alpha_{3i} lREM_{t-1} + \alpha_{4i} lICT_{t-1} + \alpha_{5i} lBM_{t-1} + \sum_{i=1}^{n} \beta_{1i} \Delta ly_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta lk_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lREM_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lICT_{t-i} + \sum_{i=0}^{n} \beta_{5i} \Delta lBM_{t-i} + \varepsilon_t \quad (6)$$

Where all the variables are defined as above. α_0 is the constant, $\alpha_{1,2..5}$ represents long-run parameters, and $\beta_{1...5}$ is short-run parameters; and n indicates optimal lags of variables in difference form, which is selected by Schwarz information criterion. The presence of cointegration in Equation (6) requires an error correction model, which can be written as follows:

$$\Delta ly_{it} = \delta\tau_{t-1} + \sum_{i=1}^{n} \beta_{1i} \Delta ly_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta lk_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lREM_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta lICT_{t-i} + \sum_{i=0}^{n} \beta_{5i} \Delta lBM_{t-i} + \varepsilon_t \quad (7)$$

Where $\delta\tau_{t-1}$ is the error correction term (ECT) and δ is the adjustment parameter. Δ is the difference factor and gives short-run effects. The primary stage in the ARDL approach entails confirming the cointegrating relationship amid the variables.

The null hypothesis is zero cointegration ($\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$) while the alternative suggests a cointegration relationship ($\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq 0$). To test this hypothesis, Pesaran et al. (2001) recommend an F-test. There are two critical bounds values: (i) a lower bounds value that takes all variables are I(0), and (ii) an upper bounds value that takes all variables are I(1).[8] In doing so they cover all classifications of the series including those that are marginally integrated. The null proposition is discarded (not discarded) once the F-statistic is more (less) than the upper (lower) critical bound value. The test is inconclusive if the F-statistics falls between the critical bound values. In the next step, the long-run and short-run outcomes of remittances are estimated.

[8] Narayan and Narayan (2005) argue that the critical values of Pesaran et al. (2001) is based on large sample study (500 and 1000 observations) and cannot be used for small sample study. They compute critical values based on small sample study. Hence, we use critical bounds value based on Narayan and Narayan (2005).

To apply the nonlinear ARDL, which allows for the asymmetric effect of remittances to real per capita GDP, we consider Equation (6) following Shin et al. (2014). The NARDL is the asymmetric addition of the linear ARDL model. Under this scenario, positive and negative shocks of remittances are examined and their impacts on per capita GDP are not expected to be the same. The asymmetric regression is defined as below:

$$\Delta ly_t = \alpha_{0i} + \alpha_{1i} ly_{t-1} + \alpha_2 lk_{t-1} + \alpha_{3i} lICT_{t-1} + \alpha_{4i}^{+} lREM_t^{+} + \alpha_{4i}^{-} lREM_t^{-} + \alpha_{5i} lBM_{t-1} + \sum_{i=1}^{n} \beta_{1i} \Delta ly_{t-i}$$
$$+ \sum_{i=0}^{n} \beta_{2i} \Delta lk_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lICT_{t-i} + \sum_{i=0}^{n} \beta_{4i}{}^{+} \Delta lREM_{t-i}^{+} + \sum_{i=0}^{n} \beta_{4i}{}^{-} \Delta lREM_{t-i}^{-} + \sum_{i=0}^{n} \beta_{5i} \Delta lBM_{t-i} + \varepsilon_t \quad (8)$$

Where $lREM_t^{+}$ and $lREM_t^{-}$ are the REM's partial sum decomposition in a positive and negative effect, respectively, and computed as

$lREM_t^{+} = \sum_{t=1}^{n} \Delta lREM_t^{+} = \sum_{t=1}^{n} \max(\Delta lREM_{t,} 0)$ and

$lREM_t^{-} = \sum_{t=1}^{n} \Delta lREM_t^{-} = \sum_{t=1}^{n} \min(\Delta lREM_{t,} 0)$ where

$lREM_t = lREM_0 + lREM_t^{+} + lREM_t^{-}$. The elasticity coefficient of $lREM_t^{+}$ and $lREM_t^{-}$ is computed as: $\eta^{+} = -\frac{\alpha_{4i}^{+}}{\alpha_{1i}}$ and $\eta^{-} = -\frac{\alpha_{4i}^{-}}{\alpha_{1i}}$.

The error correction representation of Equation (8) yields the following:

$$\Delta ly_t = \rho\varsigma_{t-1} + \sum_{i=1}^{n} \beta_{1i} \Delta ly_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta lk_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lICT_{t-i} + \sum_{i=0}^{n} \beta_{4i}{}^{+} \Delta lREM_{t-i}^{+}$$
$$+ \sum_{i=0}^{n} \beta_{4i}{}^{-} \Delta lREM_{t-i}^{-} + \sum_{i=0}^{n} \beta_{5i} \Delta lBM_{t-i} + \varepsilon_t \quad (9)$$

The error correction term ($\rho\varsigma_{t-1}$) estimates the equilibrium asymmetric relationship in the specified model and the associated parameter (ρ) captures the adjustment speed aftershock. The short-run positive and negative changes in remittances are captured by β_{4i}^{+} and β_{4i}^{-} respectively.

The estimation procedure of the nonlinear model involves the same steps as in the normal ARDL technique. Specifically, the first thing is to investigate the nonlinear long-run cointegrating relationship. This can be achieved by using the F-test. Hence, the nonlinear

ARDL is analogous to the linear approach and considers stationary properties of the series and, thus does not necessitate unit root pre-testing. To test for the long run and short run symmetry, the standard Wald test is applied. The null hypothesis ($H_{null} : \eta^{+} = \eta^{-}$) for long-run symmetry is tested against the alternative hypothesis ($H_{alt} : \eta^{+} \neq \eta^{-}$). Similarly, the short-run symmetry of remittance is tested by evaluating the null hypothesis

($\sum_{i=0}^{n} \beta_{4i}^{+} = \sum_{i=0}^{n} \beta_{4i}^{-}$).

Results and Discussion

Unit Root tests

For examining the stationary properties of the variables, we use the Augmented Dickey-Fuller (ADF) and Philipps Perron (PP) unit root tests. These two tests are applied both in levels and in the first difference and with and without a trend. The results which are reported in Table 5 show that in level form, variables are non-stationary in all cases. However, in the first difference form they are found to be stationary. The variables are with maximum integration order of I(1), making the ARDL procedure a valid procedure.

Table 5. Unit root test results

	ADF				PP			
	No trend		Trend		No trend		Trend	
Variables	Level	1st diff	Level	1st diff	Level	1st diff	Level	1st diff
Ly	-1.611	-4.330*	-0.879	-5.850*	-1.950	-4.293*	-0.669	-6.687*
lk	-0.171	-4.232*	-2.366	-4.188**	-0.663	-4.169*	-0.663	-4.116**
lREM	-0.881	-7.769*	-1.088	-7.671*	-0.946	-7.536*	-2.120	-7.451*
lICT	-0.378	-2.857***	-2.035	-6.774*	-0.094	-2.863***	-1.979	-9.011*
lBM	-1.336	-4.256*	-1.241	-4.389*	-1.093	-4.234*	-1.224	-4.373*

Notes: Numbers reported are the test statistics. The null indicates that series contain unit root for which Mackinnon P-values are used. *, ** and *** imply significance at 1, 5 and 10 %, correspondingly.

Linear and nonlinear results

Detailed results of linear ARDL estimation are reported in Appendix, which serves as the basic benchmark analysis. All the variables are positively associated with the dependent variable, per capita GDP. Specifically, the coefficient of REM, being in a double log model, denotes the magnitude of elasticity of per capita income with respect to REM. Accordingly, the long run elasticity is 0.039 (*lREM* = 0.039). The indicators of FSD and ICT, namely *lBM* and *lICT* are positively linked with GDP per capita-real (ly_t). Notably, the contribution of broad money (*lBM* = 0.271) is relatively higher. The ICT effect is about 0.02 percent in the long run and is significant at the five percent level.

The NARDL model, which focuses on asymmetric relationships, is based on the notion that falling remittances inflow may not have the same influence on economic growth as rising remittances inflows. The first step is to check the existence of a nonlinear cointegration relationship. This is obtained through Pesaran's F-test for cointegration. The results are reported in Table 6, with panel (C) illustrating the cointegration test. The estimated F-test statistic (F-stats=5.13) is higher than the critical bound value at one percent, providing evidence of nonlinear cointegration between REM and per capita GDP visa-v other conditioning variables in the model. We then proceed to examine the long run and short run symmetries to confirm the presence of any asymmetric effects of REM. Table 6 panel (D) reports the results of the Wald test for long-and short-run symmetry. The null hypothesis of symmetry is rejected given the estimated probability values of associated F-statistics are significant at a five percent level, providing evidence in support of asymmetric behavior of REM.

Table 6. Nonlinear ARDL estimation

Panel A: (a) Long run: Dependent variable ly_t				(b) Short run: Dependent variable Δly_t			
Variable	Coefficient	SE	P-value	Variable	Coefficient	SE	P-value
lk	0.560	0.068	0.000	Δlk	0.472	0.141	0.003
$lREM_t^+$	0.088	0.024	0.003	$\Delta lREM_t^+$	0.071	0.016	0.000
$lREM_t^-$	0.409	0.063	0.000	$\Delta lREM_t^-$	0.095	0.025	0.002
lBM	0.316	0.162	0.072	ΔlBM	0.278	0.069	0.001
$lICT$	0.044	0.016	0.011	$\Delta lICT$	0.022	0.006	0.005
Constant	1.076	0.447	0.031	*Constant*	1.033	0.071	0.000
Trend	0.053	0.27	0.845	*Trend*	0.106	0.078	0.183
				ECT_{t-1}	-0.682	0.100	0.000
Panel B: Model diagnostic test							
Serial correlation		X^2 (1) = 0.317 (0.732)		R- squared		0.806	
Functional form		X^2 (1) = 1.252 (0.277)		R-bar-squared		0.754	
Normality		X^2 (2) = 1.467 (0.480)		DW- statistic		2.282	
Heteroscedasticity		X^2 (1) = 0.621 (0.817)		SE of regression		0.003	
Panel C: F-test							
F-statistics		5.13*					
Critical Bounds values		1%	5%	10%			
Lower bound		3.89	3.47	3.03			
Upper bound		5.07	4.57	4.06			
Panel D: Asymmetric test							
Null hypothesis: Remittances have symmetric effect on real per capita GDP							
Long run		X^2 (1) = 2.615(0.021)**					
Short run		X^2 (1) = 5.045(0.024)**					

Notes: *, ** and *** indicate significance level at 1%, 5% and 10%, respectively. SE is the standard error and DW is Durbin Watson statistics for autocorrelation. The probability value for the model diagnostic test is in (). Critical bounds values are obtained from Narayan and Narayan (2005).

Given the evidence of the presence of nonlinear cointegration and asymmetric relationship, , we estimate the nonlinear ARDL model (8) to obtain the long-run elasticity and short-run dynamics of the asymmetric remittances effect. Table 6 panel (A) reports results of the long and short-run nonlinear effects of REM. The long-run asymmetric parameters ($lREM_t^+$ and $lREM_t^-$) capture the asymmetric effect of REM on per capita GDP. The estimated coefficients of 0.088 and 0.409 are associated with positive ($lREM_t^+$) and negative ($lREM_t^-$) partial sum decomposition, respectively. The positive coefficient of REM explains that a 1 percent increase in the variable leads to an increase in real per capita GDP by 0.088 percent. The negative decomposition implies that a 1 percent decrease in REM inflows causes per capita real GDP to decrease by 0.409 percent. Thus, the magnitude of negative impact of ($lREM_t^-$) partial sum decomposition is much greater than positive ($lREM_t^+$) partial sum decomposition. This implies that a decline in REM inflows is not only adverse but also the magnitude of the negative effect is much larger than that of a similar size increase in REM inflows. The fundamental variable in the production function namely capital stock and the shift variables namely FSD and ICT have expected positive signs and are statistically significant in the long run.

The error correction coefficient, which is negative, is statistically significant (ECT_{t-1} =-0.682) in the nonlinear model. It measures the rate of adjustment to equilibrium from prior deviation, which is about 68 percent, and the model converges to the long-run path in about 1.5 years. Relatively, the error-correcting speed is slower in the nonlinear setting. This is possible since the negative effect of declining REM inflows has a far greater adverse impact on per capita GDP. Besides this, we also examine several model diagnostic tests in panel (B). The results show that errors are serially uncorrelated and normally distributed with residuals homoscedastic. Ramsey's RESET test results confirm that the model is correctly specified. Moreover, the CUSUM and CUSUMQ of squares graphs indicate that estimated coefficients are stable over time (Figure 3a and b).

Figure 3a. CUSUM

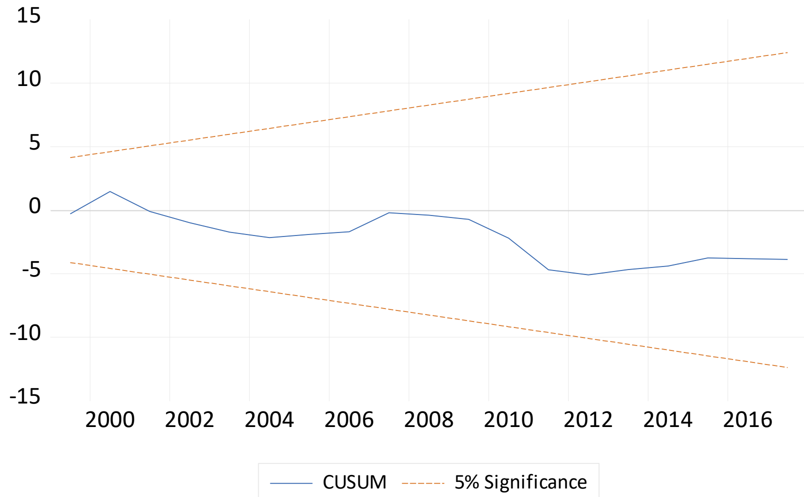
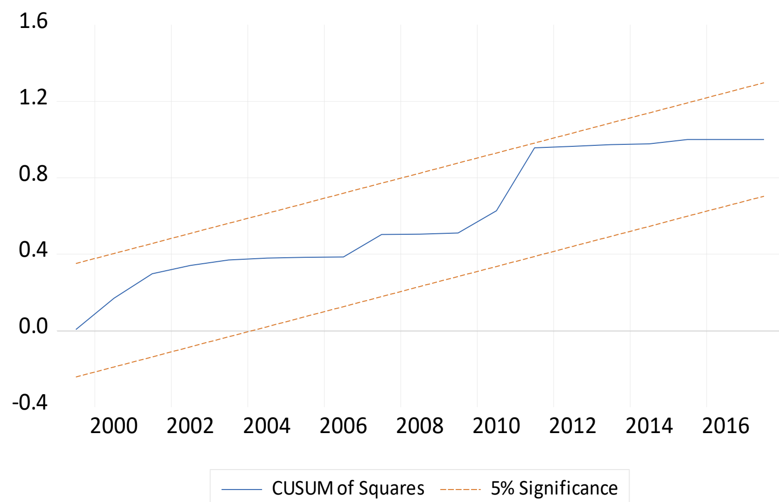


Figure 3b. CUSUMQ



Conclusion and implications

We focused on investigating the existence of any asymmetry in the REM and economic growth nexus in India, which has been the largest REM recipient country. Using annual data from 1980-2017, we employed the Solow neoclassical production function approach (Solow, 1956) with economic growth represented by per capita real income as the dependent variable, and per capita capital stock in constant prices as a fundamental variable and REM, ICT and FSD as conditioning variables. By formulating a nonlinear (NARDL) model, along the lines of Shin et al. (2014), we conducted the econometric analysis. With a linear model, our findings reveal that REM inflows have a statistically significant and positive effect on real per capita GDP - a measure of economic growth. The growth effects of ICT and FSD are positive and statistically significant, confirming their roles as supporting factors facilitating growth.

The results of the nonlinear analysis, which confirm the long-run nonlinear cointegration, reveal that there is an asymmetric relationship between REM and growth. The Wald test for symmetry further authenticates the asymmetric nature of remittances. This relationship is observed in the long run as well as in the short run. While an increase in REM has a positive impact on economic growth, a decrease in REM has a far greater negative effect on economic growth.

From a policy perspective, the implications flowing out of the analysis are the following. If India were to capitalize on the beneficial impact of remittances in the context of globalization, it is crucial to put in policies that would provide incentives to migrant workers to remit funds and deposit in financial institutions. Further, efforts should not be only stepped up on reducing the cost of money transfer but also ensure improving the efficiency as well as reliability of remittances transfer. Financial liberalization policies, promoting competitive interest rates, could be an important conduit to attract remittances from working Indian migrants and the Indian diaspora.

Similarly, the remittance recipient families depositing their remittances in banks and wishing to borrow for legitimate purposes such as improvements to current dwellings and or undertaking additional investments including new housing and other productive investments including education of their children and undertaking mini and micro-enterprises can be offered concessional rates of interest. Further, encouraging financial markets to expand their networks via information technology and offer products and services such as launching long-term special bonds with attractive interest rates as well as foreign currency bank accounts would be helpful for potential remitters.

References

Adams Jr, R. H., & Page, J. (2005). Do international migration and remittances reduce poverty in developing countries?. *World development*, *33*(10), 1645-1669.

Aggarwal, R., Demirgüç-Kunt, A., & Pería, M. S. M. (2011). Do remittances promote financial development?. *Journal of development economics*, *96*(2), 255-264.

Aggarwal, R., & Peria, M. S. M. (2006). Do workers' remittances promote financial development?, *Policy Research Working Paper Series 3957,* Washington, DC: The World Bank.

Barajas, A., Chami, R., Fullenkamp, C., Gapen, M., & Montiel, P. J. (2009). Do workers' remittances promote economic growth?, IMF WP/09/153, Washington, DC: IMF

Bettin, G., & Zazzaro, A. (2012). Remittances and financial development: substitutes or complements in economic growth?. *Bulletin of Economic Research*, *64*(4), 509-536.

Brown, R. P., Carmignani, F., & Fayad, G. (2013). Migrants' remittances and financial development: Macro and microlevel evidence of a perverse relationship. *The World Economy*, *36*(5), 636-660.

Buch, C. M., & Kuckulenz, A. (2010). Worker remittances and capital flows to developing countries. *International Migration*, *48*(5), 89-117.

Buhalis, D., & Law, R. (2008). Progress in information technology and tourism management: 20 years on and 10 years after the Internet—The state of eTourism research. *Tourism management*, *29*(4), 609-623.

Catrinescu, N., Leon-Ledesma, M., Piracha, M., & Quillin, B. (2009). Remittances, institutions, and economic growth. *World Development*, *37*(1), 81-92.

Chaudhary, D. (2020). Influence of Remittances on Socio-Economic Development in Rural Nepal. *Remittances Review*, *5*(1), 83-96.

Chami, R., Fullenkamp, C., & Jahjah, S. (2005). Are immigrant remittance flows a source of capital for development?. *IMF Staff papers*, *52*(1), 55-81.

Cazachevici, A., Havranek, T., & Horvath, R. (2020). Remittances and economic growth: A meta-analysis. *World Development*, *134*, 105021.

Datta, A., & Agarwal, S. (2004). Telecommunications and economic growth: a panel data approach. *Applied Economics*, *36*(15), 1649-1654.

Dewan, S., & Kraemer, K. L. (2000). Information technology and productivity: evidence from country-level data. *Management science*, *46*(4), 548-562.

Dimelis, S. P., & Papaioannou, S. K. (2010). FDI and ICT effects on productivity growth: A comparative analysis of developing and developed countries. *The European Journal of Development Research*, *22*(1), 79-96.

Dinarte, L., Jaume, D., Medina-Cortina, E., & Winkler, H. (2021). Neither by Land nor by Sea: The Rise of Electronic Remittances during COVID-19.

Giuliano, P., & Ruiz-Arranz, M. (2009). Remittances, financial development, and growth. *Journal of development economics*, *90*(1), 144-152.

Gruber, H., Hätönen, J., & Koutroumpis, P. (2014). Broadband access in the EU: An assessment of future economic benefits. *Telecommunications Policy*, *38*(11), 1046-1058.

Hong, J. P. (2017). Causal relationship between ICT R&D investment and economic growth in Korea. *Technological Forecasting and Social Change*, *116*, 70-75.

Horscroft, V. (2010). An Eye on East Asia and Pacific-The Role of Information and Communications Technology in Mitigating the Challenges on Economic Geography in the Pacific Islands. *World Bank. Retrieved from http://siteresources. worldbank. org/INTEASTASIAPACIFIC/Resources/226262-1291126731435/EOEA_Virginia_Horscroft_Nov2010. pdf [29 December 2010]*.

Inklaar, R., O'Mahony, M., & Timmer, M. (2005). ICT and Europe's productivity performance: Industrylevel growth account comparisons with the United States. *Review of Income and Wealth*, *51*(4), 505-536.

Ishida, H. (2015). The effect of ICT development on economic growth and energy consumption in Japan. *Telematics and Informatics*, *32*(1), 79-88.

Flanagan, L., & Jacobsen, M. (2003). Technology leadership for the twenty-first century principal. *Journal of educational administration*.

Jayaraman, T. K., Nathan, T. & Ng, C.F. (2021). Remittances and growth nexus in three transitional countries in the ASEAN region: A panel study with Static Random Effect Model. *Remittances Review*, *6*(1), 3-20.

Jayaraman, T. K., Nathan, T. M., & Ng, C. F. (2019). ICT, AS A CONTINGENT FACTOR IN REMITTANCES AND GROWTH NEXUS IN CAMBODIA, LAOS AND VIETNAM A PANEL STUDY: 2000-17, Asian Scholars Network International Conference, Kuala Lumpur, Malaysia, July October, 2019.

Jayaraman, T. K., Lau, L. S., & Ng, C. F. (2018). Role of financial sector development as a contingent factor in the remittances and growth nexus: A panel study of pacific Island countries. *Remittances Review*, *3*(1), 51-74.

Jayaraman, T. K., Choong, C. K., & Kumar, R. R. (2012). Role of remittances in India's economic growth. *Global Business and Economics Review*, *14*(3), 159-177.

Jawaid, S. T., & Raza, S. A. (2016). Effects of workers' remittances and its volatility on economic growth in South Asia. *International Migration*, *54*(2), 50-68.

Jackman, M., Craigwell, R., & Moore, W. (2009). Economic volatility and remittances: evidence from SIDS. *Journal of Economic Studies*.

Jorgenson, D. W., Stiroh, K. J., Gordon, R. J., & Sichel, D. E. (2000). Raising the speed limit: US economic growth in the information age. *Brookings papers on economic activity*, *2000*(1), 125-235.

Jongwanich, J. (2007), "*Workers' remittances, economic growth and poverty in developing Asia and the Pacific countries",* (No. WP/07/01). United Nations Economic and Social Commission for Asia and the Pacific (ESCAP).

Kocaarslan, B., & Soytas, U. (2019). Asymmetric pass-through between oil prices and the stock prices of clean energy firms: New evidence from a nonlinear analysis. *Energy Reports*, *5*, 117-125.

Kumar, B. (2019). The impact of international remittances on poverty alleviation in Bangladesh. *Remittances Review*, *4*(1), 67-86.

Kumar, B., Hossain, M. E., & Osmani, M. A. G. (2018). Utilization of international remittances in Bangladesh. *Remittances Review*, *3*(1), 5-18.

Kumar, R. R., Kumar, R. D., & Patel, A. (2015). Accounting for telecommunications contribution to economic growth: A study of Small Pacific Island States. *Telecommunications Policy*, *39*(3-4), 284-295.

Kumar, R. R., & Vu, H. T. T. (2014). Exploring the nexus between ICT, remittances and economic growth: A study of Vietnam. *Journal of Southeast Asian Economies*, 104-120.

Kumar, R. R. (2014). Exploring the nexus between tourism, remittances and growth in Kenya. *Quality & Quantity*, *48*(3), 1573-1588.

Kumar, R. R. (2012). Exploring the interactive effects of remittances, financial development and ICT in Sub-Saharan Africa: an ARDL bounds approach. *African Journal of Economic and Sustainable Development*, *1*(3), 214-242.

Levine, R. (1997). Financial development and economic growth: views and agenda. *Journal of Economic Literature*, *35*(2), 688-726.

Masuduzzaman, M. (2014). Workers' remittance inflow, financial development and economic growth: A study on Bangladesh. *International Journal of Economics and Finance*, *6*(8), 247-267.

Makhlouf, F. (2019). Is productivity affected by remittances? The evidence from Morocco. *Journal of International Development*, *31*(2), 211-222.

Minghetti, V., & Buhalis, D. (2010). Digital divide in tourism. *Journal of Travel Research*, *49*(3), 267-281.

Narayan, S., & Narayan, P. K. (2005). An empirical analysis of Fiji's import demand function. *Journal of Economic Studies*, *32*(2), 158-168.

Nyamongo, E. M., Misati, R. N., Kipyegon, L., & Ndirangu, L. (2012). Remittances, financial development and economic growth in Africa. *Journal of economics and business*, *64*(3), 240-260.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289-326.

Pradhan, G., Upadhyay, M., & Upadhyaya, K. (2008). Remittances and economic growth in developing countries. *The European journal of development research*, *20*(3), 497-506.

Pradhan, K. C. (2016). Does remittance drive economic growth in emerging economies: Evidence from FMOLS and Panel VECM. *Theoretical & Applied Economics*, *23*(4).

Rahman, R., & Moni, N. N. (2019). Impact of International Remittances on Poverty in Bangladesh: Evidence from the Household Data. *Remittances Review*, *4*(1), 41-66.

Rao, B. B., & Hassan, G. M. (2011). A panel data analysis of the growth effects of remittances. *Economic modelling*, *28*(1-2), 701-709.

Bhaskara Rao, B., & Takirua, T. B. (2010). The effects of exports, aid and remittances on output: the case of Kiribati. *Applied Economics*, *42*(11), 1387-1396.

Ratha, D. (2007). Leveraging remittances for development. *Policy Brief*, *3*(11).

Roller, L. H., & Waverman, L. (2001). Telecommunications infrastructure and economic development: A simultaneous approach. *American economic review*, *91*(4), 909-923.

Romer, P. M. (1990). Endogenous technological change. *Journal of political Economy*, *98*(5, Part 2), S71-S102.

Saidi, K., & Mongi, C. (2018). The effect of education, R&D and ICT on economic growth in high income countries. *Economics Bulletin*, *38*(2), 810-825.

Schwab, K. (2015). The fourth Industrial Revolution: What it means and How to respond. Foreign Affairs. World Economic Forum. Accessed on February 26 *https: //www.foreignaffairs.com/articles/2015-12-12/fourth-industrial-revolution--*)

Senbeta, A. (2013). Remittances and the sources of growth. *Applied Economics Letters*, *20*(6), 572-580.

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In *Festschrift in honor of Peter Schmidt* (pp. 281-314). Springer, New York, NY.

Siddique, A., Selvanathan, E. A., & Selvanathan, S. (2012). Remittances and economic growth: empirical evidence from Bangladesh, India and Sri Lanka. *Journal of development studies*, *48*(8), 1045-1062.

Sobiech, I. (2019). Remittances, finance and growth: Does financial development foster the impact of remittances on economic growth?. *World Development*, *113*, 44-59.

Solow, R. M. (1956). A contribution to the theory of economic growth. *The quarterly journal of economics*, *70*(1), 65-94.

Taylor, E. J. (1999). The new economics of labour migration and the role of remittances in the migration process. *International migration*, *37*(1), 63-88.

Ward, M. R., & Zheng, S. (2016). Mobile telecommunications service and economic growth: Evidence from China. *Telecommunications Policy*, *40*(2-3), 89-101.

World Bank. (2020), "Migration and remittances: Recent developments and outlook", *Migration and Development Brief Outlook*.

World Bank (2020a), Migration and Development Brief 32, April, 2020l.Washington, D.C.: World Bank

World Bank (2019). World Development Indicators, Washington, D.C.: World Bank, Retrieved on May 27 2019, *https://databank.worldbank.org/data/reports.aspx?source=world-development-indicators#*.

Appendix

The Linear ARDL Model

The linear ARDL model (Equation 6) is estimated as a benchmark model first and then, the long-run and short-run dynamics are examined. The Schwarz criterion is used to select the ARDL lag order. The initial step in the ARDL procedure is examining the presence of a cointegrating relationship among the variables. This is obtained by testing the null hypothesis of no-cointegration versus the alternative hypothesis of cointegration. For this, the F-test of Pesaran et al. (2001) is used. The result is presented in Table 1A, with panel (C) illustrating long-run cointegration. The estimated F-test statistics (F-stats = 6.03) is greater than the value of the critical bound at a 1 percent significance level, duly validating the existence of a single long run cointegration, when per capita GDP is the dependent variable.

Table 1A, Panel A shows that in the long run, the capital stock and real GDP per capita are positively related. The capital stock (*lk*) share is 0.49. The log-linear model implies that a one percent increase in capital stock per capita causes a 0.49 percent increase in real per capita GDP. The estimated capital stock elasticity is relatively more than the conventional stylized values of Rao (2010). However, it is believed that over the years, the Indian economy has grown and has experienced an increase in physical capital stock. The remittances inflow, which is of particular interest, is estimated to be positive. Specifically, remittances contribute about 0.04 percent (*lREM* = 0.039), to real per capita GDP in the long run. The finding is statistically significant at a one percent level. The effect of remittances is also positive and significant in the short run at 0.03 percent.

The indicators of FSD and ICT, namely *lBM* and *lICT* are positively linked with GDP per capita-real (ly_t). Notably, the contribution of broad money (*lBM* = 0.271) is relatively higher, contributing about 0.3 percent to per capita GDP in the long run. The ICT effect is about 0.02 percent in the long run and is significant at the five percent level. In the short run, the estimated effect of FSD and ICT is about 0.2 and 0.01 percent, respectively. The relatively smaller effect of REM, FSD, and ICT in the short-run may suggest that the growth effects of these inputs may take some time, given that it comprises investments and infrastructure development. Hence, the beneficial effect may not be immediate. Nonetheless, the positive effect confirms the theoretical underpinnings and indicates the crucial function that ICT, particularly mobile subscriptions, has in remittances inflow and therefore, economic growth. The use of information technology has enhanced access to various information and services like mobile payment systems. As a result, technology is believed to have substantially improved the resource transfer and financial sector by reducing cost and increase in competitiveness.

Table 1A. Linear ARDL estimation

Panel A: (a) Long run: Dependent variable ly_t				(b) Short run: Dependent variable Δly_t			
Variable	Coefficient	SE	P-value	Variable	Coefficient	SE	P-value
Lk	0.493*	0.051	0.000	Δlk	0.377*	0.081	0.000
lREM	0.039*	0.012	0.006	$\Delta lREM$	0.028**	0.010	0.011
lBM	0.271*	0.085	0.004	ΔlBM	0.212*	0.053	0.000
lICT	0.016**	0.005	0.012	$\Delta lICT$	0.014*	0.004	0.002
Constant	1.026**	0.393	0.014	*Constant*	1.074*	0.014	0.000
Trend	1.07***	0.929	0.079	*Trend*	0.009*	0.001	0.000
				ECT_{t-1}	-0.809*	0.113	0.000
Panel B: Model diagnostic test							
Serial correlation	X^2 (1) = 1.137 (0.336)			R- squared		0.771	
Functional form	X^2 (1) = 0.978 (0.247)			R-bar-squared		0.751	
Normality	X^2 (2) = 2.937 (0.230)			DW- statistic		2.021	
Heteroscedasticity	X^2 (1) = 0.377 (0.935)			SE of regression		0.004	
Panel C: F-test							
F-statistics	6.03*						
Critical Bounds values	1%	5%		10%			
Lower bound	3.89	3.47		3.03			
Upper bound	5.07	4.57		4.06			

Notes: *, ** and *** indicate significance at 1%, 5% and 10% level, respectively. SE is the standard error and DW is Durbin Watson statistics for autocorrelation. The probability value for the model diagnostic test is in (). Critical bounds values are obtained from Narayan and Narayan (2005).

The estimated error-correction-model coefficient (ECM_{t-1}= -0.809), which indicates the speediness of improvement towards steady-state has the right sign (negative) and is statistically significant at one percent. Any distortion from the equilibrium due to any positive/negative shocks will adjust by about 80 percent in the next period – demonstrating a rather fast recovery. Thus, for India, it is vital to circumvent any negative shocks with respect to remittances inflow, which would be detrimental to the economic growth process. Furthermore, the model diagnostic test (panel (B)) suggests that the model has the correct and appropriate functional form. The residuals are uncorrelated, normally distributed, and are homoscedastic. The coefficient stability test with CUSUM and CUSUMQ of squares (Figure 1A and 2A) shows that estimated parameters are relatively stable.

Figure 1A. CUSUM

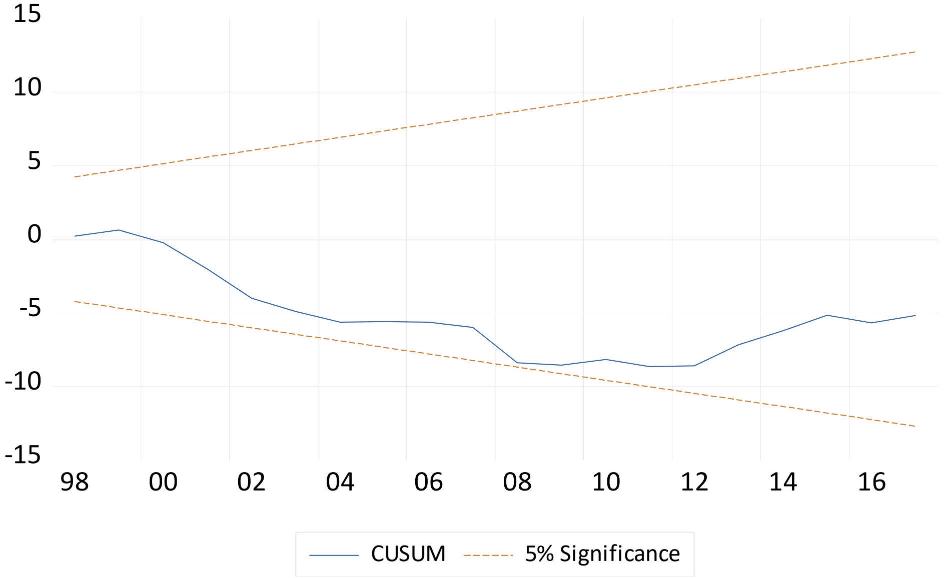


Figure 2A. CUSUMQ