Information and Communication Technology as a Contingent Factor in India's Economic Growth-Remittances nexus

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Chapter 5

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1. Introduction

The stock of international migrants residing and working in countries away from their home countries is estimated at 258 million in 2017, having risen from 173 million in 2000 [United Nations Department of Economic and Social Affairs (UNDESA), 2017]. In 2017, the Indian-born migrants working overseas were 17 million in 2017, exceeding the corresponding number of the Mexican-born persons (13 million). They are followed by migrants from Russian, China, Bangladesh, Syrian Arab Republic, Pakistan and Ukraine, ranging from 6 to 11 million each (UNDESA, 2017). Although their remittances (REM) to the countries of origin fell from US$444.3 billion in 2014 to US$429.3 billion in 2016 due to slow recovery from the Great Recession of 2008-2012 in advanced countries, India continued to remain the largest REM recipient country: US$70.4 billion in 2014, US$72.2 billion in 2015 and US$62.7 billion in 2016 followed by the second largest recipient, China with US$62.3 billion, US$63.9 billion and US$61.0 billion during the corresponding years.

The REM inflows from the blue collar Indian immigrants working in the Gulf Cooperation Council (GCC) nations and in other countries in the Middle East have been dominating the annual REM inflows into India. Though in smaller amounts, unlike those from the white-collar Indian migrants in North America, they were sent on a regular basis, monthly or quarterly, to their families left behind. Aside from supplementing and enhancing household incomes, REM being in foreign currencies adds to India's real resources. In the absence of REM inflows, these annual additions to foreign exchange reserves would have to be earned through export of goods and services. In the context of India's weak export performance, REM provide a substantial support to India in building up its foreign exchange reserves.

The connection between REM and growth is through rising aggregate demand by stepping up consumption by beneficiary families in the rural India, which is dependent on monsoon-fed

agriculture. Increments in expenditure on food, clothing and medicines and education for children have been made easier by regular inflows of REM for reducing poverty to a great extent. However, any savings from steady annual inflows of REM without any opportunity for depositing in banks tend to get frittered away on wasteful consumption. Depositing them in financial institutions, a process known as financialisation of savings, increases the reserves in banks. Growth in credit is a logical consequence to financial deepening and financial sector development (FSD). It is well known that well-functioning financial markets lower the transaction expenditures and would enable the savings from REM into productive investments.

Further, economic progress in recent years has also been benefitted from the emergence of information and communication technology (ICT). Rapid spread of ICT since the late 1990s, with mobile voice and data networks has brought in notable gains in several spheres including, labour productivity, entrepreneurship, and innovations in business processes and service delivery. One of the most visible areas of improvement is the enhanced access to financial services with and savings in transaction costs through new modes of online as well as mobile banking.

Despite the fact that India has been lagging behind (Kumar and Radcliffe, 2015) relative to similarly placed countries in the low and middle income group (LMIC)[1] as classified by World Bank (2017b), the impact of initiatives in recent years has been noticeable in Asia and Africa[2]. Although there were negative effects of the India's 2016 demonetization and the resultant cash crunch which were felt in some states in India, those states which have made notable progress in digitalization since the mid-2000s, the adverse effects were reported to be minimal[3]

Earlier empirical studies (Jayaraman *et al.* 2012 and Siddique *et al*. 2010) on the relationship between growth and REM in India did not pay attention on the influence of FSD and ICT. The present paper attempts to fill the gap by focusing on these missing factors. The paper is structured on the following lines: the next section provides a brief literature review of theoretical and empirical studies on REM and growth nexus in the context of ongoing pro-active measures in favour of FSD and ICT. Section 3 discusses growth trends in REM and FSD, and ICT spread. Section 4 deals with data, modeling and econometric estimation methodology. Section 5 reports the results while the final Section 6 provides conclusions and policy implications.

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[1] The criteria observed by World Bank (2017b) for classifying the countries on the basis of gross national income per capita were the following:

Low income Countries: GNI less than $1,025 per capita,
Lower middle income countries : between GNI $1,026 per capita and $4,035 per capita
Upper middle income countries : between GNI $4,.036 per capita and $12,475 per capita
High-income countries are with more than GNI $12,475 per capita.

[2] The 2014 Intermedia Financial Inclusion Insight Survey (IFIIS) of 45000 Indian adults which was conducted by Consultative Group to Assist the Poor (CGAP), found that 0.3% of adults use mobile money, compared to 76% in Kenya, 48% in Tanzania, 43% in Uganda, and 22% in Bangladesh.

[3] Successful stories have been reported in Indian newspapers and in social media. These include: Ghosh (2017) and *Hindustan Times* (2017).

2. A brief literature review

Among the three categories of capital transfers to the capital-starved LIMCs (Tables 1 and 2) REM has emerged to be the most reliable one (Mashayekhi, 2014). Further, REM in absolute amounts and in percentages of GDP of the region or countries are higher than respective figures of FDI and ODA inflows[4]. According to the latest estimates of the World Bank (2019) is that except for China, REM flows to LMICs ($462 billion) were bigger than FDI streams in 2018 ($344 billion). Quantitative studies either for a single country and panels of countries (Stahl and Habib, 1989; Leon-Ledesma and Piracha, 2001; Edwards and Ureta, 2003; Page and Adams, 2003; Hildebrandt and McKenzie, 2005; Yang, 2008; Giuliano and Ruiz-Arrranz, 2009) have shown that inflows of REM have (i) helped the wellbeing of families, which are left behind; (ii) assisted the beneficiary families in upgrading their homes and to improve their farming activities; (iii) enabled households to pay children's education fees and bear the costs of old-age medical care; and (iv) added to the recipient nation's foreign reserves. Increase in reserves also raises the credit worthiness of recipient countries, enabling them to borrow from international funding agencies for financing further growth enhancing investments.

Role of Financial Sector Development (FSD)

It is estimated that only 50 percent of grown-ups (+15 years and above) in LMICs have access to financial institutions. Further, only 47 percent of women and 37 percent of the youth have access to banking services; and furthermore, only 34 percent of firms use bank loans, compared to 51 percent in developed nations. Almost 80 percent of micro, small to medium sized businesses in rural areas does not have access to bank credit, compelling them to look for funds at much higher rates of interest from money lenders (Mashayekhi, 2014). Giuliano and Ruiz-Arranz (2009) observe that REM becomes a substitute in countries with weak financial sectors. In countries, with well developed credit markets, REM might also be utilized for consumption spending. In the previous case of substitutability, in econometric analysis the sign of the coefficient of REM would be positive and significant and the interaction term's coefficient would be negative and significant. In the second and complementary case of the relationship, the coefficients of REM and interaction term would be both positive and statistically significant.

Financial inclusion

The term financial inclusion became popular in the mid-2000s, following the big boost given by United Nation (UN). It also became a major component of poverty alleviation efforts. Recognizing the requirement for enlarging the availability of contacts to financial products and services, the UN included financial inclusion, by characterizing the term as ""successful access to reasonable and sustainable financial services from formal suppliers", as one of its major goals in its post-2015 Development Programme (UN, 2015).

India has been in the forefront, well before the beginning of the New Millennium (Chakrabarty,

[4]The World Bank Group and KNOMAD (2018) have estimated that in 2018 remittances were US$ 528 billion, FDI US$ 473, and foreign aid US$ 150 billion while the portfolio private investment in short term debt and equity instruments were US$ 156 billion.

2011) by adopting a pro-active set of initiatives[5]. The purpose behind these initiatives was to cover the hitherto neglected segments of population by mainstream commercial banks, such as peripheral farmers, landless laborers, oral lessees, the self-employed, urban slum residents, migrants, ethnic minority farmers, socially omitted groups, senior residents, women and unorganized sector enterprises (Reserve Bank of India, 2008). Once a bank account is opened, it paves the way for access to all financial products. Further, having a bank account enables usual payments and acceptance of deposits as well as automatic receipt of REM transfers from overseas remittances at a small charge, besides making purchases on credit much easier and faster (Mohan and Ray, 2017).

Emergence of ICT

Developed countries which made notable investments in the ICT sector by the 1980s, began to derive benefits by mid 1990s through inventing cheaper devices for spreading ICT over different segments of economic activities. Understanding its significance in economic progress, the developing nations by late 1990s, took serious interest to speed up development of ICT sector, along with implementation of general economic reforms. The major focus was on moving away from government monopolies by inviting new competitors and promoting investment in ICT with joint ventures with private sector. One immediate impact of growth in ICT investments in LMICs was seen in the spurt in foreign direct investment (FDI) inflows, which led to rise in local employment and use of local resources, aside from transfer of technology and upgrading of skills. The ICT is now perceived as a basic infrastructural sector for advancing growth in different areas, including financial sector.

Studies, which include Wilson (1993), Radeck, Wenninger and Orlow (1997) and Freund, Konig and Roth (1997), have highlighted benefits flowing out of ICT in banks and financial markets. Kumar et al. (2015) studied the role of ICT on economic development in small South Pacific island countries and found that ICT contributed to long term economic growth in these countries. Aghaei and Rezagholizadeh (2017) and Niebel (2018) also show that ICT enhances economic growth in Organisation of Islamic Cooperation countries and other emerging, developing as well as developed countries. Majeed and Ayub (2018) examined the similar relationship in a sample of 149 economies from 1980-2015 came to similar conclusion.

3. Trends in India's Remittance Inflows, Financial Inclusion and Spread of ICT

Remittance Inflows

There has been a revival of upward trend in REM inflows to developing countries both in terms of absolute amounts of US dollars and as percentages of gross domestic products (GDP) after end of the Great Recession (2008-2012). In particular, with the rise in the price of crude oil in the first ten months of 2018, there was a notable rebound in remittances outflows from the Gulf

[5] These include setting up a postal savings bank, rural and urban cooperative banks and these efforts culminated in the nationalization of private banks in two tranches, one in 1969 and another in 1989, as part of "quit poverty strategy goals".

Cooperation Council (GCC) countries and the Russian Federation. The *Development Brief 30 (*World Bank Group and KNOMAD, 2018) has estimated REM flows to LMICs at US$ 528 billion in 2018. In keeping with the general rising trend, REM flows to South Asia[6], (which belongs to the category of LMICs) are reported to have grown to a new high as well. Inflows of REM to South Asia grew 12 percent to $131 billion in 2018, exceeding the 6 percent growth rate in 2017. The upsurge was influenced by stronger growth in 2018 in the United States and a pick-up in oil prices in 2018, benefitting oil producing countries.

Table 1 Capital Transfers: **World, Low and Middle income countries, South Asia: 1990-2017 (US$ billion)**

	1980-89 (Ave)	1990-99 (Ave)	2000-04 (Ave)	2005-09 (Ave)	2010	2011	2012	2013	2014	2015	2016	2017
World												
Foreign Aid	36.02	57.6	64.83	115.29	130.94	141.9	133.77	151.14	161.52	153.21	158.22	162.78
FDI	88.8	373.6	946.6	2130.2	1863.6	2290.3	2118.7	2136.9	1860.6	2411.4	2458.3	1949.6
Remittances	42.64	92.37	162.36	338.81	418.67	470.27	495.47	525.18	559.36	564.51	549.69	580.49
Low & Middle Income Countries												
Foreign Aid	33.39	54.42	63.04	115.04	130.27	141.31	133.28	150.87	161.5	153.12	157.97	162.6
FDI	11.1	82.2	163.5	453.3	610.9	722	651.6	737.6	664.9	628.5	560	537.3
Remittances	20.87	48.26	103.51	234.96	301.54	339.9	366.91	387.48	416.5	431.32	415.75	442.08
South Asia												
Foreign Aid	0.26	5.72	5.99	11.43	15.46	16.93	14.13	13.94	15.58	15.65	13.94	14.71
FDI	4.99	2.23	5.76	31.9	31.7	40.65	27.78	33.53	40.31	49.67	50.84	47.06
Remittances	5.69	9.9	23.9	55.47	81.98	96.4	107.97	110.82	115.81	117.61	110.41	116.70
India												
Foreign Aid	1.83	1.88	1.28	1.82	2.83	3.27	1.68	2.46	2.99	3.17	2.68	3.09
FDI	0.1	1.51	4.61	26.3	27.4	36.5	24	28.15	34.58	44.01	44.5	39.97
Remittances	2.49	6.39	16.53	37.37	53.48	62.5	68.82	69.97	70.39	68.91	62.7	68.97

Source: World Bank 2019: WDI and Authors' Calculation.

Table 2 Capital Transfers: World, Low and Middle income countries, South Asia: 1990-2017 (% of GDP)

	1980-89 (Ave)	1990-99 (Ave)	2000-04 (Ave)	2005-09 (Ave)	2010	2011	2012	2013	2014	2015	2016	2017

[6] In South Asia, Nepal is a low income country with Bangladesh, Bhutan, India, Pakistan and Sri Lanka assigned the group of low middle income countries.

World												
Foreign Aid	0.26	0.21	0.17	0.21	0.20	0.19	0.18	0.20	0.20	0.20	0.21	0.20
FDI	0.63	1.28	2.59	3.74	2.74	3.03	2.72	2.57	2.28	3.15	3.16	2.35
Remittances	0.40	0.35	0.45	0.61	0.65	0.65	0.67	0.69	0.72	0.77	0.74	0.73
Low & Middle Income												
Foreign Aid	1.26	1.27	0.98	0.87	0.65	0.60	0.53	0.57	0.58	0.58	0.60	0.56
FDI	0.54	1.78	2.54	3.30	3.03	3.05	2.57	2.74	2.38	2.41	2.14	1.88
Remittances	NA	1.20	1.62	1.74	0.65	0.60	0.53	0.57	0.58	0.58	0.60	0.56
South Asia												
Foreign Aid	1.69	5.72	5.99	11.43	15.46	16.93	14.13	13.94	15.58	15.65	13.94	14.71
FDI	0.08	0.45	0.81	2.23	1.55	1.79	1.21	1.42	1.56	1.84	1.75	1.43
Remittances	1.99	1.31	0.84	0.83	0.76	0.74	0.62	0.59	0.60	0.58	0.48	0.45
India												
Foreign Aid	0.81	0.57	0.25	0.17	0.17	0.18	0.09	0.13	0.15	0.15	0.12	0.12
FDI	0.04	0.39	0.85	2.30	1.65	2.00	1.31	1.52	1.70	2.09	1.95	1.54
Remittances	1.10	1.74	3.01	3.37	3.23	3.43	3.77	3.77	3.45	3.28	2.76	2.65

Source: World Bank 2019: WDI and Authors' Calculation.

A unique characteristic of REM

Ready response to call for aid in times of natural disasters caused by cyclones and earthquakes is one of the unique characteristics of REM, which distinguish them from other types of capital transfers. The FDI is generally in long term projects such as construction of factories with production processes of considerable gestation period. Hence, FDI funds are not pulled out in a short span of time. On the other hand, portfolio investments which are in short term debt and equity instruments tend to get pulled out at short notice, as they are mainly for speculative reasons; and they move in and out at the click of the mouse in search of higher return. On the other hand, REM belongs to a different category[7], as they are sent by migrants to their families, without expecting anything in return.

Remittances as a stabilizing factor

In the context of high degree of volatility in oil prices and stagnant exports, India's trade and current account deficits have started to widen in recent years. Steadily increasing inflows of remittances have however, been seen reducing the current account deficits to manageable levels[8].

[7] Remittances were once called unrequited transfers, as they do not have any *quid pro quo* element. They are not in expectations of financial return in terms of interest or dividend unlike the long term FDI or portfolio investments of short term nature.

[8] India's foreign reserves touched the ever highest level at $426 billion in April 2018 due to inflows of hot moneys,

In the absence of REM, the current account deficits would have been much higher and pressure on Indian rupee would have also been larger. Although, short term portfolio investment flowed in and strengthened the Indian rupee in 2016 and 2017[9], their well- known fickle mindedness betrayed their nature.

Rukhaiyar (2018) noted that the year 2018 was the worst one for the equity market of India as it witnessed a heavy outflow of foreign portfolio funds**.** From January 2018 onwards, oil price began to rise after a gap of three years. Fears of widening current account deficit rose dented the confidence in Indian economy. Outflows of foreign portfolio funds began to exceed inflows and consequently, the rupee depreciation was rapid. It depreciated from Rs 63.64 per US dollar in January 2018 to Rs 74.45 in October, 2018. The fall in rupee was by 14 percent. Towards the end of 2018, as oil price fell the rupee gained to finish on the last market day of 2018 at Rs 69.77 per dollar. The depreciation of the rupee in 2018 was 9.23 percent and the Indian currency was declared the worst performer amongst all the Asian currencies. The fall in the rupee value would have been worse but for REM inflows. While foreign aid inflows were on the decline and FDI was averaging at US$32 billion in 2014-15 to 2016-17, annual REM inflows during these years averaged US$65 billion.

Financial inclusion

India's financial sector[10] began to play a major role in economic growth in the 1990s only after the introduction of economic reforms (Mohan and Ray, 2017). However**,** the spread of ICT in India towards speeding up the progress of FSD was slow and sluggish until 2010. Although India accounted for more than 10% of the global smart phone market, the findings of a *Mobile Technology and its Social Impact Survey* study by Pew Research Center (2019) reveal India's smart phone ownership rate is the lowest among the 11 developing countries covered by survey. A close 79 per 100 of the population in 2015-16 have mobile phones and the number of internet users for every 100 persons is only around 26 in 2015-16. According to a private marketing agency's survey findings (Economic Times, 2019), the number of internet users was around 566 million in December 2018, out of which 493 million were reported to be regular users (defined as those accessed internet in last 30 days); 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 internet. The usage of internet is limited as 47 percent of the mobile phone users had only basic phone that cannot connect to the internet (Economic times, 2019).

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as the expectations of speculators were then high. However, export earnings from goods and services have been falling ($317.7 billion in 2014, $266.2 billion in 2015; and $261.9 billion in 2016). With higher imports, annual current account deficits began to widen. Steadily rising remittances however reduced the current account deficits: $26.8 billion in 2014, $22.1billion in 2015 and $15.2billion in 2016 or in percentages of GDP: -1.3%, 1% and -0.7% respectively. Remittances have been a major support, rendering the current account deficits smaller and manageable.

[9] The net inflows into investment and debt instruments were $42.2 billion in 2014-15. They dived to a negative figure, when outflows surpassed inflows: - 4.1billion in 2015-16. They climbed again to $7.6 billion of every 2016-17 (Jayaraman, 2018).

[10] 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.

The present urban-rural divide is generally attributed to the following reasons: (i) internet use has been more of an urban activity, as urban areas happen to have assured availability of electricity for longer hours; (ii) urban areas have higher proportion of formal sector institutions, with commercial establishments and offices of private and public sector institutions; and (iii) urban towns have a large number of white collar working community with a tertiary educational background and high school and tertiary level students, who tend to be quick to adopt modern technology. The indications are with assured supply of electricity and greater availability of broadband width and cheap data plans, and increased awareness of government programmes linking to various services, the rural internet users (251 million in 2018) would reach 290 million in 2019 up by 35 percent and the urban internet users would be 336 million in 2019, up by 7 percent from 315 million in 2018 (Economic Times, 2019).

Government initiatives

Introduction of government sponsored schemes to promote financial inclusion, increasingly supported by spread of mobile technology**,** have given a big boost to inculcation of banking habits. Financial inclusion is expected to enable financial sector provide universal access to a far wider range of financial services beyond banking, such as insurance and equity products by utilizing technological innovations such as ATMs, credit and debit cards, internet banking, electronic transfer, and usage of mobile phones. It has enabled the financial institutions reduce costs involved in maintaining records and in the mobilization of deposits. Indeed, the use of and rapid spread of mobile phones were seen as a welcome development to banking institutions themselves to prosper with "no more brick or mortar branches".

India's financial inclusion programme is said to have been triggered in last three years (2014-2016) by a trio: JAM (Char, 2016). The abbreviations indicate it is a combination of three measures: one is *Jan Dhan* (J for Jan), a universal biometric identification system, known as *Aaddhaar* card (A for Aadhaar) and rising penetration of smart phone (M for mobile). These initiatives have been supplemented in July 2017 by a fully online goods and services tax (GST) system changes, enabling formalization process, which would facilitate fast tracking India's digitization and bring about a higher degree of formalization of the India economy (Desai, Agarwal and Arya, 2017). The major advantage is seen in better credit delivery than ever before, as data particulars on the would-be-borrowers are now available to the lending institutions.

Earlier, lack of such information about the would-be-borrowers was preventing sanction of loans to non-corporate or small enterprises or individual members of the rural community. Digital transactions leave a data footprint that lenders can use easily and assess the credit worthiness of the prospective borrowers and process loans faster (Desai, Agarwal and Arya, 2017).

4. Data, methodology and estimation

Data

Our empirical study on growth and remittance nexus in India covers a period of 28 years (1990 - 2017). The key variables include: (i) GDP per capita in US$ constant price, represented by *y*; (ii)

capital stock per capita in US$ constant price, represented by *k*; and (iii) nominal REM in US$ as percent of nominal GDP in US$, represented by *REM*. For FSD, we considered nominal broad money (BM) in rupees as percent of GDP and nominal bank credit (BC) as percent of GDP in rupees. Out of these two FSD indicators, we choose bank credit to private sector (*BC*) for the following reason: Financial inclusion efforts are aimed at the bringing in the hither-to bypassed households in rural and inaccessible areas, who had no opportunities to access banking services, not only for putting their savings and but also borrowing from banks for productive investments. Therefore, a better indicator is BC

For ICT, we chose mobile subscriptions per 100 persons (MOB). Relative to internet use, whose data series are inadequate and patchy, time series on ownership of mobile phones is complete. All the data series are obtained from *World Development Indicators* (2019) except for capital, which is from Penn Tables available on the website of US Federal Reserve St. Louis (2019). Since the capital stock data series are available only up to 2014, we extrapolated for the missing years: 2015 to 2017. Table 3 presents the descriptive measures of the variables employed and Table 4 shows correlation matrix of the variables.

The model

The model employed in the study is along the lines of the Cobb-Douglas production function, adopted in Luintel et al. (2008), Kumar et al. (2015) and Rao *et al.* (2008). Taking into account the constant returns to scale and Hicks-neutral technological development, the real per-capita output (y_t) equation is written as:

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

Where:

y_t = real GDP per capita;

A_t = stock of technology;

k_t = stock of capital per capita;

α = share of capital.

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

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

Where:

A_t = represents the aggregate technology.

A_o = the opening stock of technology.

t = time.

g = the exogenous growth rate of technical progress.

In addition to the variables indicated above, we also employ an interaction term, which is the product of bank credit (BC) and mobile subscription (MOB). Consequently, it is decided to adopt the following:

$$A_t = f(k_t, REM_t, BC_t, MOB_t, BC * MOB_t) \tag{3}$$

Here:
REM = inflow of remittances as share of GDP;
BC = bank credit as percentage of GDP;
MOB = mobile subscription per 100 inhabitant;
*BC*MOB* = interaction of bank credit and MOB

Hence, the initial Cobb-Douglas function is amended as:

$$y_t = A_0 e^{\alpha_1 REM_t + \alpha_2 BC_t + \alpha_3 MOB_t + \alpha_4 BC*MOB_t} k_t^{\alpha_5} \quad (4)$$

The stochastic model in its single logarithmic form for analysis and estimation reason is expressed as:

$$ly_t = \alpha_0 + \alpha_5 lk_t + \alpha_1 lREM_t + \alpha_2 lBC_t + \alpha_3 lMOB_t + \alpha_4 lBC*lMOB + \varepsilon_t \quad (5)$$

The hypotheses to be confirmed are:

I. the explanatory variable, capital per capita stock (*ly*) is associated with real output per capita (*lk*) and hence, the sign of *lk* is positive;
II. the explanatory variable, REM (*lREM*) is expected to positively influence real output per capita (*ly*). Therefore, the sign of *lREM* is positive;
III. the FSD indicator (*lBC*) has a direct association with real output per capita (*ly*); hence, the sign of bank credit (*lBC*) is positive;
IV. the ICT indicator (*lMOB)* is anticipated to positively facilitate growth in real output per capita hence, the sign of (lMOB) is positive;

On the other hand, since there cannot be any *a priori* conclusion about the behaviour of the interaction term, $lBC*lMOB_t$ it is considered appropriate not to formulate a hypothesis but to leave it for the investigation to reach a robust conclusion.

If the interaction term emerges with a positive sign and is found significant as well, it would mean that the combined growth effects of interaction term are enhanced in a deeper financial system with FSD and ICT**,** displaying a complementary relationship to each other. However, if the interaction variable turns out to have a negative coefficient and is also significant, ICT and FSD are substitutes for each other. If the interaction variable has a negative sign and is found non-significant, the two variables are independent of each other.

Table 3 Descriptive Measures of Key Variables

	Y	*K*	*REM*	*BM*	*MOB*	*BC*MOB*
Mean	1029.524	10148.27	2.699362	62.72477	25.61113	3.667961
Median	876.5995	8126.407	2.773336	64.7715	3.838817	5.52063
Maximum	1964.595	20093.85	4.210553	80.14708	87.28492	19.33605
Minimum	530.8947	5413.852	0.752687	42.75409	0.007983	-18.2938
Std. Dev.	441.3213	4630.397	0.890965	14.0361	33.02138	13.35156
Skewness	0.670965	0.797313	-0.58927	-0.16492	0.788473	-0.14645
Kurtosis	2.200457	2.26713	2.601972	1.38442	1.872208	1.412158

Jarque-Bera	2.846721	3.593253	1.805272	3.172033	4.385118	3.041538
Probability	0.240903	0.165857	0.405499	0.20474	0.111631	0.218544

Source: Authors' calculations

Table 4 Correlation matrix of the variables

	Y	*K*	*REM*	*BM*	*MOB*	*BC*MOB*
Y	1					
K	0.996798	1.00E+00				
REM	0.646768	0.609535	1			
BC	0.879632	0.853657	0.861705	1		
MOB	0.964323	0.977502	0.548394	0.813399	1	
*BC*MOB*	0.911956	0.889775	0.797702	0.984787	0.851052	1

Source: Author's calculations.

To examine the existence of a long-run equilibrium relationship among the variables in the specified model, we employed the bounds testing procedure advanced by Pesaran et al., (2001). The bounds testing procedure within Autoregressive Distributed Lag (ARDL) context has some technical advantages. It enables tests for the existence of a cointegrating relationship between variables even if the underlying regressors are I(0) or I(1) (Pesaran and Shin, 1999;). It is also considered more suitable than the Johansen-Juselius multivariate approach when the sample size is small (Mah, 2000; Tang and Nair, 2002). The estimators of the long run and short-run factors are consistent (Pesaran and Shin, 1999).

Given that we do not have prior evidence on the course of long-run cointegration among the variables, we formulate the following unrestricted error correction model equations in the ARDL framework:

$$\Delta ly_t = \alpha_0 + \alpha_1 ly_{t-1} + \alpha_2 lk_{t-1} + \alpha_3 lREM_{t-1} + \alpha_4 lBC_{t-1} + \alpha_5 lMOB_{t-1} + \alpha_6 lBC*MOB_{t-1} + \sum_{i=1}^{n} \beta_1 \Delta ly_{t-i}$$
$$+ \sum_{i=0}^{n} \beta_2 \Delta lk_{t-i} + \sum_{i=0}^{n} \beta_3 \Delta lREM_{t-i} + \sum_{i=0}^{n} \beta_4 \Delta lBC_{t-i} + \sum_{i=0}^{n} \beta_5 \Delta lMOB_{t-i} + \sum_{i=0}^{n} \beta_6 \Delta lBC*MOB_{t-i} + \varepsilon_t \quad (6)$$

Here: Δ is the first difference operative and signifies short term dynamics. The coefficients devoted with a period lagged variable indicate long term relationships. Specifically, two steps are required in this method. First, we estimate equations (6) using least squares method. Secondly, the confirmation of a long-run relationship is traced by imposing restriction on the coefficients of the lagged level variables by equating to zero. Henceforth, the bounds test is based on the F-statistics (or Wald statistics) with the null hypothesis of no cointegration ($H_0 : \beta_{i1} = \beta_{i2} = \beta_{i3} = \beta_{i4} = \beta_{i5} = 0$) and the alternative hypothesis of a long-run cointegration relationship ($H_1 : \beta_{i1} \neq \beta_{i2} \neq \beta_{i3} \neq \beta_{i4} \neq \beta_{i5} \neq 0$).

The F-statistic of bounds test is checked with the lower and upper band critical values calculated

by Pesaran et al. (2001). However, Narayan (2005) contends, because Pesaran's critical values are on the basis of large observation sizes, they could not be used in a small sample study. Narayan (2005) calculated another set of values for small samples. Accordingly, we employ critical values of Narayan (2005). When the estimated F-statistic is higher than upper bound critical value, then the null hypothesis is rejected. If the F-statistic is lower than the lower bound critical value, then the null hypothesis cannot be discarded. When the F-statistic falls between the lower and upper bound critical values, then the result is not conclusive.

We then proceed to estimate the long run elasticity measures and short run error correction model (ECM). The short-run error-correction-model is useful to study short-run dynamics and to ratify the robustness of the estimated parameters of long-run in regards to equation (6). The ECM is specified as shown in equation (7):

$$\Delta ly_t = \alpha_0 + \sum_{i=1}^{n} \beta_1 \Delta ly_{t-i} + \sum_{i=0}^{n} \beta_2 \Delta lk_{t-i} + \sum_{i=0}^{n} \beta_3 \Delta lREM_{t-i} + \sum_{i=0}^{n} \beta_4 \Delta lBC_{t-i} + \sum_{i=0}^{n} \beta_5 \Delta lMOB_{t-i} + \sum_{i=0}^{n} \beta_6 \Delta lBC * MOB_{t-i} + \lambda ECM_{t-1} + \varepsilon_t \quad (7)$$

The ECM represents the error-correction. It is subtracted from the long term estimated parameters in equation (6). The error correction term is expected to be significant and negatively associated with the dependent variable.

5. Results and discussion

The results of analysis at various steps are presented in this section. These include the stationary properties of the series, cointegration analysis and short run and long run analyses.

Results for unit root tests

The unit root test results by means of a conventional method are provided in Table 5. The Augmented Dickey-Fuller (ADF) unit root test show that the null hypothesis that the variables are non-stationary could not be rejected in levels. However, in the first difference form, the null hypothesis that the variables are non-stationery is rejected. Consequently, we arrive at the decision that the variables in the model are integrated of order I (1). The results confirm that the maximum order of integration is one.

Table 5 Unit root test results

Variables	ADF T_{stat}	
	In Level	In first Diff.
Ly	0.677	8.072*
Lk	1.140	4.629**
lREM	2.371	5.529*
lBC	1.133	3.218**
lMOB	0.259	4.155*
*lBC*IMOB*	0.101	3.520**

Notes: Critical values for ADF test are based on Mackinnon (1996).

The length lag is based on Akaike Information Criterion (AIC).
The null hypothesis is that a series has a unit root (non-stationary).
* and ** indicates 1 percent and 5 percent level of significance. They denote rejection of null hypothesis.

Cointegration result

The bounds F-test outcomes are stated in Table 6. The estimated F-statistics is 8.731 for equation (6), which is more than upper band critical values- implying that null proposition of no-cointegration is rejected. In addition, the estimated result is significant at one percent level, confirming the presence of long run relation amongst the variables when real per-capita output (ly) is taken as the dependent variable.[11]

Table 6 Results of Bound F-test

Dependent Variable/ Independent Variable.	Calculated F-statistics
Ly	8.731
Lk	2.938
lREM	2.964
lBC	1.393
lMOB	2.198
*lBC*lMOB*	2.191
Critical Values from Narayan (2004)[a]	
Significance level	Lower bound / Upper bound
1 percent	4.4 / 5.664
5 percent	3.152 / 4.156
10 percent	2.622 / 3.506

Note: [a] Critical values for Bounds test are from Narayan (2004), Case D: restricted intercept and no trend.

Discussion of long-run and short-run findings

In the long run, the logs of capital stock and output per capita are positively related (Table 7). The estimated share of capital stock is 0.376 which is in line with stylized values for developing

[11] Similar specification is tested using other variables where; lk_t, $lREM_t$, lBC_t $lMOB_t$, and $lBC*lMOB_t$ were treated as dependent variables to estimate the F- statistics.

countries. It is also consistent with empirical results for developing economies (Rao, 2010). As expected, the coefficient of log REM, which is the measure of elasticity of output with respect to REM, emerged with a positive sign and is found significant at five percent level both in the long and short-run. It suggests that one percent increase in REM inflow run would induce 0.034 percent rise in per capita income; in the short-run a one percent increase would result in 0.027 percent rise in per capita income. The finding that REM has been supporting economic growth in India is consistent with findings of similar studies in other LMICs (Guha, 2013; Giuliano and Ruiz-Arranz, 2009).

The results also confirm the hypothesis that an increase in bank credit leads to an increase in the real output per capita. The estimated elasticity of output with respect to bank credit is 0.231, which implies that a one percent increase in bank credit raises per capita income by 0.231 percent in the long run. The effect of MOB representing ICT on per capita output is positive and significant in long run. Our finding is in line with that of Kumar et al. (2015) and Niebel (2018) who have shown that there is a positive relationship between ICT and economic growth. In the short run, the sign of *lMOB* is positive and statistically significant. The relatively large magnitude of the coefficient of *lMOB* in the long run indicates its predominant role in economic growth.

The interactive term of *lBC* (representing FSD) and *lMOB* (representing ICT)) has a positive sign and is statistically significant, showing that they complement each other. By mutually supporting each other, they boost the per capita income in the long run.

The error correction term (ECM_{t-1}), which reflects the speed of adjustment towards original equilibrium has the correct, negative sign and is statistically significant at one percent level. The estimated coefficient (-0.63) in Table 8 indicates that deviation from the long run original equilibrium as result of any shocks in the current period will be adjusted by around 63 percent in the next time period. Thus, the model implies a relatively rapid adjustment to the long run equilibrium relationship.

Table 7 Estimated long-run coefficients

Dependent variable *(ly)*

Independent variable	Coefficient	Standard-error	T-Ratio
Lk	0.369	0.153	2.407**
lREM	0.034	0.014	2.383**
lBC	0.231	0.058	3.969*
lMOB	0.321	0.062	5.132*
*lBC*ILMOB*	0.087	0.015	5.532*
Constant	-2.373	0.605	-3.918**
X^2sc: $X^2(1) = 0.811$, X^2ff: $X^2(1) = 0.087$, X^2n: $X^2(1) = 0.173$, X^2hc: $X^2(1) = 0.995$;			
R-square= 0.91, DW - stats. = 2.27, SER =0.009, AIC = 54.35.			

Note: *, and ** designates 1%, 5% and 10% level of statistical significances.

Table 8 Estimated short run coefficients
Dependent variable (Δly)

Independent variable	Coefficient	Standard- error	T-Ratio
Δly_{t-1}	0.535	0.158	3.380*
Δlk_t	0.305	0.153	1.983***
$\Delta lREM_t$	0.027	0.012	2.237**
ΔlBC_t	0.012	0.005	2.394**
$\Delta lMOB_{t-1}$	0.013	0.006	1.986***
$\Delta lBC*IMOB_t$	0.050	0.015	3.260*
ECM_{t-1}	-0.630	0.153	-4.112*
Constant	-2.373	0.605	-3.198*
R-square = 0.801 , $\bar{X}\Delta ly = 0.044$, $\hat{\sigma}\Delta ly = 0.021$, F-stat. (8, 26) = 12.607 (0.001)			

Note: *, **, and *** designates 1, 5 and 10 percent level of statistical significances.

Diagnostic test results

We examine the diagnostic test results for the stability of the specified model. Here we take into consideration the following: (i) Lagrange multiplier test of serial correlation (X^2sc), (ii) Ramsey's RESET test for correct functional form (X^2ff) using square of the fitted values, (iii) Jarque-Bera's normality (X^2n) test and (iv) Test for heteroscedasticity (X^2hc) using the regression of squared residuals on squared fitted values. The findings of aforementioned tests are reported in Table 7. It indicates that the specified model does not experience any classical econometric problem. There is no serial correlation. The test results also confirm that the sample is normally distributed. The functional form is correct and the presence of homoscedasticity cannot be rejected.

6. Conclusions with policy implications

This paper undertook an empirical investigation of India's economic growth and remittances nexus with specific focus on ICT as a contingency factor during a 28- year period of 1990 to 2017. The study adopted the Solow framework with a Cobb-Douglas production function with per capita real GDP (*y*) as a dependent variable and per capita capital stock (*k)* as fundamental, independent variable along with the chosen variables for the study, acting as shift variables. They are: remittances as percent of GDP (*REM)*, bank credit as percent of GDP (*BC*), representing financial sector development, and mobile phone subscription per 100 inhabitants (*MOB*) as a proxy for ICT. We also added an interaction variable, that is, the product of *BC* and *MOB* to check whether financial sector development and ICT were acting as complements to or substitutes for each other.

The bounds test methodology within the ARDL framework (Pearson et al., 2001) which is found to be consistent and suitable for relatively small sample size was employed. Following the unit

root tests, which showed all variables were of integrated order of one, long run and short run models were estimated. The tests showed all the variables were found cointegrated and the causality linkage ran only from logs of *k, REM, BC, MOBS* and the interaction variable to log of y. All the coefficients, which are elasticity estimates of respective variables, emerged with positive signs which were also found statistically significant. One percent rise in *REM* was found to result in 0.034 percent increase in per capita real GDP; one percent rise in *BC* led to 0.231 percent increase in per capita real GDP; and one percent rise in *MOB* gave rise to 0.321 percent increase in per capita real GDP. The interaction variable was found to have a positive sign which confirmed the existence of a complementary relationship between FSD and ICT.

From the policy perspective, it is clear REM and ICT are essential drivers of output growth. It is obvious that the advent of ICT has broken a new ground. Mobile and internet banking have contributed to making banking operations less expensive, without any additions to brick and mortar branches, and requiring less number of visits by customers to banks. The costs of banking operations have come down as the maintenance costs of records are drastically reduced. Payments procedures through use of mobile devices have also lessened the need for holding cash by consumers and entrepreneurs. Above all, savings from REM by the recipient families are now more swiftly deposited in banks as deposits, which were once frittered away on needless consumption. Young and ambitious entrepreneurs in the rural areas, who were hitherto denied of banking facilities and hence had no opportunity to put their savings and borrow from them, are now able to have access to bank credit.

The ICT revolution, which is still unfinished in India as the digital divide between urban and rural areas is still wide, should be carried on with greater vigour. First and foremost is the need for improving telecommunication and electricity infrastructure. Inadequacies in these two fundamentals hamper a widespread use of ICT in all economic activities. Improving the accessibility and affordability of ICT services in Indian economy would not only reduce the present digital divide but also enhance the scale-up effect of ICT use. The efficient use of present generation phone technologies like 3G and 4G is necessary.

In catching-up with the rest of the world, ICT should be promoted more effectively in the key areas of the economy with main focus in banking and finance, which will increase efficiency and productivity, and enhance long term economic growth. The urban areas are with better off and educated groups absorb ICT culture, while the rural folks tend to get less involved as their capacity to fully benefit from ICTs is limited.

The impact of ICT is dependent on a host of factors relating to user characteristics and environment. The spread of ICT is primarily influenced by an enabling policy and regulatory environment and through investment in infrastructure and improved digital literacy. The digital literacy in turn depends on quality of education now offered in primary and secondary schools in rural areas. Again, the general urban-rural divide continues to dominate the economic scene in terms of investment in infrastructure and equipment in educational institutions in rural areas, just as there are inequities in the provision of health and sanitation services between cities and villages. The whole picture then changes into one of balanced development, bridging the geographical inequalities aside from economic inequities.

Furthermore, improvement in ICT would not only promote economic growth, but if properly accomplished, it could become a crucial enabler of business innovation, job creation and new services and industries. To this end, decision makers may consider policy incentives such as tax exemption for ICT industries and duty free importation of technological devices.

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