



Digital revolution, financial infrastructure and entrepreneurship: The case of India[☆]

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ABSTRACT

This paper examines two aspects of the digitalization of finance in India, which has been surprisingly robust and fast growing. Much of this success is due to the government's introduction of a biometric identity known as Aadhaar. Because financial transactions require definitive proof of identity of the transacting parties, Aadhaar provides this proof without any document via biometric verification, thus greatly facilitating electronic transactions. The paper also documents the impact of digital financialization by showing examples of entrepreneurship, both directly in the fintech space through the creation of new web-based services as well as the rise of new businesses that make use of the fintech infrastructure that has been created.

Introduction

The Digital Revolution has been sweeping across the world over the last three decades. This revolution has spread far more rapidly, especially in developing countries, than was the case with either the Industrial or Agricultural Revolution. Indeed, the spread has been so rapid that China has become its major driver with India emerging as one as well.

This paper is devoted to two aspects of the Digital Revolution as it impacts India: financial technology or fintech, and innovation and entrepreneurship. As in other countries, the spread of digital technologies has led to a dramatic transformation of financial infrastructure in India. On the one hand, this has improved efficiency and on the other it has led to increased financial inclusion. The government's payments system has evolved to a point that it can make payments directly to individuals and firms through bank accounts. Individuals are seamlessly able to transfer funds from their bank accounts to those of others. Businesses and customers can transact digitally in real time.

Digital technologies have also helped democratize innovation and entrepreneurship. Unlike conventional technologies, digital innovations are less costly to commercialize on average. Scaling up of conventional innovations requires a large volume of investment. In contrast, many digital innovations lend themselves to scaling up at low costs. As a result, in the digital space, innovators themselves are often seen as

turning into entrepreneurs. The sharp division between innovators and entrepreneurs that existed in the past has greatly diminished.

I divide the paper into three parts. Part 1 focuses on the spread of financial technologies in India. Part 2 considers how the digital revolution has helped spawn and transform the nature of entrepreneurship in the country. Part 3 offers some concluding remarks

Financial technologies

While there is no consensus definition of fintech, the term is most commonly used to refer to technologically enabled financial innovations with applications in such areas as transfer of funds and payments, borrowing and lending, asset management and insurance. The activities that define fintech include: payments and transfers using mobile apps, investments in and payments via crypto-currencies, peer-to-peer lending and insurance, crowd sourcing via platforms such as Kickstarter, loan and insurance comparison websites, and robo-advice on both investment and asset management.

In developed countries, we think of fintech as largely a private-sector phenomenon consisting of transactions between and among businesses and households. If I were to follow the same approach in describing the role of financial technology in India, I would miss a large part of the role that technology is playing there in revolutionizing the payments system. This is especially true when we are considering the area of the economy

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in which financial technology intersects with inclusion and development. For this reason, in discussing the role of financial technology in India, I will take a broader view of it along two dimensions. First, I will include in financial technology the role that technology plays in transactions in which the government is one of the parties. Second, in defining financial technology, I will include all cashless transactions, whether or not they involve the use of the latest innovations or mobile-based applications. As I will discuss later, equipping individuals and households to transact digitally through such instrumentalities as the Business Correspondent model and payment banks represents a major step towards financial inclusion in a poor country like India.

Actors in the economy and transactions among them

For a poor country with per-capita income at approximately \$ 1928 per annum in current dollars in 2020, India has deployed financial technologies on a surprisingly large scale. In the following, I will outline the components of the infrastructure that India has built to bring digital modes of transaction to individuals and households. I will also explain how the government has been using this infrastructure to disburse the benefits under its various social schemes among the poor and what role businesses are playing in the spread of fintech in India.

But as an introduction to this discussion, it is useful to first consider a schematic chart providing the transactions that take place in an economy among various groups of actors. It is the efficiency of these transactions that fintech can greatly improve. In [Table 1](#), I identify three broad groups of actors in the economy: Government (G), Households (H) and Businesses (B) where I include all entities other than the government and households such as non-profit institutions in businesses. The table illustrates types of transactions that take place among these three entities in India.

As [Table 1](#) illustrates, myriad transactions take place within and among government, households and businesses. Technology offers opportunities to reduce friction and raise productivity in the conduct of these transactions. But this requires the building of platforms that can intermediate the transactions. During the past decade, India has been engaged in building many of these platforms. The process is far from complete but considerable progress has been made.

Bringing digital technologies to all

One of the most important developments in building financial-technology infrastructure in India is related to individuals and households. The ability to complete transactions through non-cash, digital means requires verification of identity, having a bank account and access to instruments of digital communication such as mobile phones. Access to investment and savings instruments also requires access to financial services conventionally provided through brick and mortar bank branches but now feasible via digital platforms. In recent years, India has made considerable progress along each of these dimensions.

Table 1

Illustrative list of transactions among major actors in the economy.

Transacting Parties	Transaction
Government ↔ Government	Employee payroll, pensions, insurance; Devolution of revenues to states; Centrally Sponsored Schemes
Government ↔ Households	Direct Benefit Transfers (DBT); NREGA wages; Income tax by individuals to government
Government ↔ Businesses	Procurement of goods and services; Subsidies; Central Sector Schemes; GST; Tolls; Custom Duties; Corporate tax
Households ↔ Households	Loans; Transfers; Rents
Households ↔ Businesses	Sales of goods and services; Salaries; Pensions; Health benefits; Loans; Investments
Businesses ↔ Businesses	Input purchases; Wholesale transactions; Loans; Transport services

Aadhaar: a biometric identity for all

If an individual is to engage in a financial transaction without using cash, the first thing she needs is a proof of identity. In a vast country such as India, where two-thirds of the population still lives in rural areas with many of these areas in remote locations, giving individuals proof of identity is a huge challenge. Indeed, until less than a decade ago, India had no systematic program of providing a proof of identity to its residents. In principle, anyone could apply for a passport or driver's license, but with the relevant offices located in far off places and many individuals lacking the basic documents required to complete the applications for them, it was not a practical option for most, especially women living in rural areas.

Surprisingly, today, nearly all residents of India have an identity card called the Aadhaar identity card. The process of issuing the card was kicked off in September 2010, and today there are over 1.2 billion of such cards in existence. Each of these cards gives a definitive proof of identity to an individual backed by biometric data. The Aadhaar card carries the name, gender, address, a 12-digit unique number and a photo of the individual. A simple instrument connected by Wi-Fi to a central database can scan the fingerprints and iris of the individual and match them against those stored in the database to verify whether she is who she claims to be.

How such a massive task of collecting biometric data and issuing the Aadhaar cards could be accomplished in such a short period of time in the contentious democracy that is India is itself a fascinating tale. Its details can be found in a recent book entitled "Rebooting India" by Nandan Nilekani and Viral Shah. In this book, the authors also provide a roadmap of how the Aadhaar identity can be leveraged to take advantage of many other technologies. Thanks to the Aadhaar project, Indian residents today have technologically the most advanced and reliable proof of identity. The beauty of this identity is that the individual need not carry a card with her to prove who she is. The proof is always there in her palms and eyes.

The Jan-Dhan Scheme: bank accounts for all

Proof of identity is just the starting point for promoting financial inclusion. By itself, it does not go very far. Its power is realized only when combined with other financial instruments. The most basic of such instruments is a bank account. Whatever other instruments private actors in the fintech industry make available must build on the bank account. Checks, credit cards, and wallets can be operated efficiently only if the individual using them has a bank account.

Creating banking infrastructure over its vast expanse has also been a challenge for India. Opening bank branches in villages with populations less than one thousand is not cost effective. In the 1980s, India experimented with spreading bank branches to the remote corners of the country using public funds but the experiment proved costly. In the end, that initiative had to be given up on after the launch of the 1991 economic reforms. According to the *Global Findex Report* by the World Bank, only 53% of Indians above 15 years of age had bank accounts in 2014.¹

One of the first major initiatives that Prime Minister Narendra Modi launched after he came to office was Prime Minister's Jana Dhan Yojana (PMJDY). Translated literally, it means People's Wealth Scheme. PMJDY is a large-scale financial inclusion effort through a dramatic expansion of bank accounts. Announced during his first Independence Day address after coming to office by the Prime Minister on August 15, 2014, the initiative went on to set a world record for the largest number of bank accounts opened in one week. This record now finds a place in the Guinness Book of Records, which states, "The most bank accounts opened in 1 week as a part of a financial inclusion campaign is 18,096,130 and was achieved by Banks in India from 23 to 29 August

¹ See <https://timesofindia.indiatimes.com/business/india-has-second-largest-unbanked-population-in-the-world/articleshow/64570254.cms> (Accessed 9 February 2022).

2014.” The government accomplished the task by getting the public sector banks to organize camps around the country where individuals could line up and successfully open a bank account within a few hours. According to the *Global Findex Report* of the World Bank, the proportion of Indians above 15 years of age with bank accounts had reached 80% in 2017. As of February 28, 2018, the total number of accounts under the scheme stood at 312 million and deposits in these accounts amounted to \$12 billion.² A significant proportion of the households still do not use bank accounts as instruments of savings and investment, however.

Since its launch, the government has added several features to the Jana Dhana accounts to promote inclusion. RuPay debit cards can be issued on the accounts. As of January 2016, banks had issued 247 million such debit cards.³ The accounts also entitle the holder to an accidental insurance for \$1500. Six months after opening the account, the holder is eligible for \$75 in overdraft. Account holders can also engage in mobile banking using even feature phones through National Unified USSD Platform (NUUP).

Digital connectivity: a mobile in every hand

Once an individual has the proof of identity and a bank account, she is only a mobile phone away from acquiring the power to transact digitally. India’s good fortune was that by the time the Aadhaar and Jana Dhan Accounts were launched, the mobile revolution was already under way. This revolution spread across the length and breadth of India during the first decade of the millennium.

I grew up in India in an era in which telephone was considered an absolute luxury. If you could afford it, you had to apply for it and then wait for several years before your turn came. Until as late as 1999, there were less than 40 million phones in total in the country translating into just 3.5 phones per 100 individuals. Then, after the government launched the New Telecom Policy of 1999, mobile phones began to spread like wild fire. Entry of private players, rapidly declining costs due to technological advances and tariff-free imports quickly turned this luxury into a necessity. At its peak, every two months, India was adding 40 million phones. This was more than the entire stock of phones created in the first 120 years after the phone was introduced in India. Today, there exist 1.2 billion phones in India with half a billion in rural India alone. On average, there are nearly three phones per household of five in rural India and six phones per household of four in urban India.

Bank accounts and mobile phones are two essential building blocks of a payments system that allows individuals to make money transfers and payments digitally. To turn such bank accounts and mobile phones into effective instruments of these transactions, a platform that intermediates between the payer and payee is required. Here too India has been innovative.

Unified payments interface: a low-cost payments system

The National Payments Corporation of India, a not-for-profit organization owned by a consortium of major banks and promoted by the Reserve Bank of India, is authorized to operate various retail payment systems in the country. The NPCI has developed an instant real-time payments system to facilitate inter-bank transactions. Known as the Unified Payments Interface (UPI), this system allows real-time transfer of funds between two bank accounts on a mobile platform. UPI withdraws funds from the bank account of the payer and deposits them directly into the payee account.

This is in contrast to a traditional mobile wallet, which takes a specified sum of money from the payer’s bank account beforehand and stores it in its own account to affect future transactions. Therefore, the transfer of funds via these wallets is confined to different users of the

same wallet. In contrast, the facility to transfer funds directly from one bank account to another offered by the UPI opens the door to transactions for nearly all customers with bank accounts in one of the 71 banks that subscribed to the UPI as of February 2018.

This is why the decision by WhatsApp to add the WhatsApp Pay feature to its platform created a stir in the electronic payments market. WhatsApp already has 250 million active users, nearly all of them having bank accounts. All users need to do is to link WhatsApp Pay to their UPI account, without having to share any of their confidential bank account information. They can then seamlessly make transfers to or receive transfers from other WhatsApp Pay users. Interestingly, given the large user base of WhatsApp, NPCI, which manages the UPI, did not allow a full-scale launch of WhatsApp Pay in one go. Instead, it chose a phased rollout to allow the application and bank platforms to adjust to the spike in volume.

Transacting digitally through a feature phone

Access to UPI through apps requires a smart phone. While smart phone users are expanding rapidly in India, at present they constitute only one-third of total mobile phone users. That is to say, two-thirds of the mobile users still rely on feature phones. Keeping this in view, the NPCI has created another service called the Unstructured Supplementary Service Data (USSD), which facilitates the use of the UPI on feature phones by dialing a code.

Implications of September 2018 Aadhaar ruling by the Supreme Court

While India has created an impressive low-cost infrastructure to facilitate digital transactions, a ruling on the use of Aadhaar identity by the Supreme Court in September 2018 has thrown some sand in their way. The ruling has given a green light to the use of the biometric identity by the government in taxation and disbursement of its funds to people. But it has denied private sector online access to biometric data for purposes of verification of identity. This second part of the verdict constitutes a major setback to the use of Aadhaar identity by private entities such as commercial banks, mobile service providers and digital wallets. These entities will require an alternative form of identification to fulfill Know Your Customer (KYC) requirements of different regulations. The government is considering bringing new legislation, which will ensure full data privacy while giving access to identity verification facility to private operators upon approval by the Aadhaar holder. But until then, the use of Aadhaar databases for purposes of verification of identity has been denied to private entities.

Rapidly expanding digital transactions

In the month of November 2016, when demonetization was announced, electronic transactions numbered 671.5 million. This figure rose to 1.1 billion in February 2018. This represents a 63.5% jump in just 15 months. In value terms, electronic transactions rose from Rs. 94 trillion (\$1.5 trillion) in November 2016 to Rs. 115.5 trillion (\$1.8 trillion) in February 2018. This represents 22.9% increase over the 15-month period. Therefore, the growth in the number of transactions has far outstripped the growth in value, implying that the strategy of the government to spread digitization among individual customers, who typically engage in lower-value transactions, has been successful [Fig. 1](#). shows the evolution of the transactions in both number and value beginning from November 2016, the month during which demonetization was announced.

Transactions via UPI protocol have grown far more rapidly, although they begin from a low base. In number, these transactions grew from a tiny 0.3 million in November 2016 to 171.4 million in February 2018. In value terms, the increase was from 0.9 billion rupees to 191 billion rupees [Fig. 2](#). shows the evolution in both number and value from November 2016 to February 2018.

The government provides the UPI platform free of charge. The only fee paid on transactions taking place on this platform is that charged by the banks. In so far as competition among banks is likely to keep this

² See <http://pib.nic.in/newsite/PrintRelease.aspx?relid=177851>. (Accessed 9 February 2022).

³ See <https://www.medianama.com/2016/04/223-rupay-cards-38-percent/>. (Accessed 9 February 2022).

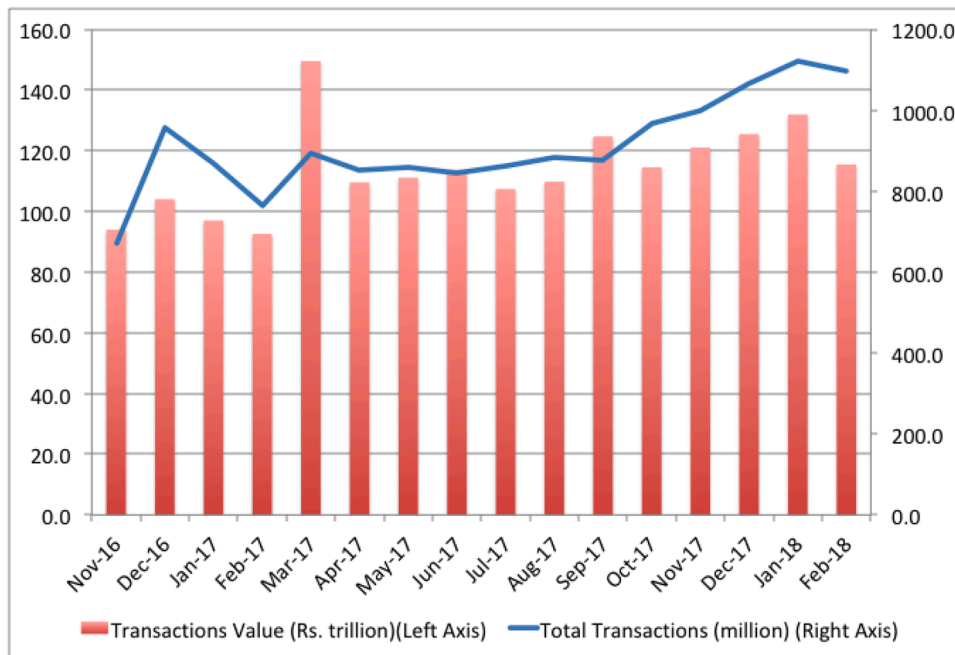


Fig. 1. Evolution of electronic transactions: November 2016 to February 2018 Source: Author’s construction using the RBI data from http://rbidocs.rbi.org.in/rdocs/content/docs/ELECT07022016_FEB18.xls.

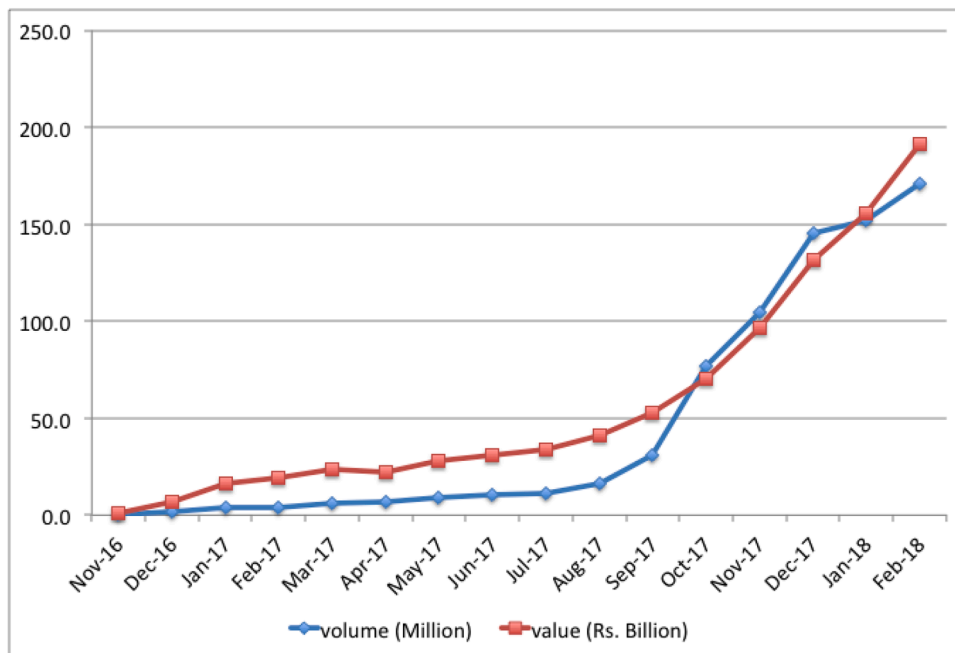


Fig. 2. Transactions via UPI protocol: November 2016 to February 2018 Source: Author’s construction using the RBI data from http://rbidocs.rbi.org.in/rdocs/content/docs/ELECT07022016_FEB18.xls.

charge low, transactions on UPI have the potential to eventually overwhelm those on other platforms. Indeed, given that the transactions on credit and debit cards typically charge much higher fees, in the long run, their survival is a bit doubtful. It is only a matter of time that merchants will recognize the value of accepting payments via the UPI platform.

The business correspondent model: bringing financial services to unbanked areas

While individuals are able to make and receive transfers of funds using bank accounts and mobiles, they also need other banking services.

Most notably, individuals need to be able to carry out cash deposit and withdrawal transactions and use their bank accounts as instruments of savings and investment. But this requires access to a bank branch, which is often very far away from the customer’s village.

To overcome this problem, beginning in 2006, the government has promoted the Business Correspondent (BC) model in areas where bank branches do not exist. A Business Correspondent is engaged by a bank to provide banking and financial services in such locations. The services may include opening bank accounts; collecting cash for deposit in their personal or beneficiary’s account; disbursing small amounts of loans;

recovering installments for loans; and selling bank products such as insurance, mutual funds and pension schemes. Banks are fully responsible for the acts of commission and omission of their BCs.

Entities that the RBI allows to serve as BCs include Non-governmental Organizations (NGOs); Micro-finance Institutions (MFIs); post offices; Section 25 companies; retired bank employees, teachers, government employees and military personnel; individual owners of kirana, medical and Fair Price shops; agents of Small Savings schemes of the Government of India and Insurance Companies; petrol-pump owners; and authorized functionaries of Self Help Groups (SHGs) with links to banks. The RBI advises banks to keep charges of the BC services at levels that are seen as reasonable and fair. BCs use mobile, PoS machines and micro-ATMs to move funds across bank accounts via UPI protocol.

Going by data, the BC model has been highly successful in bringing basic banking services to rural areas. The spread of BCs to Indian villages has far outstripped the pace of brick and mortar branch expansion Fig. 3. provides the total number of branches and BC in rural areas on an annual basis beginning in the end of March 2010 and ending in the end of March 2017.

Data on basic savings deposits tells a similar story in terms of absolute number of transactions though not their value Table 2. reports the key data for years 2009-10, 2015-16 and 2016-17. Starting at a much lower level at the end of March 2010, the number of accounts under the BC model jumped above those at the bank branches by the end of March 2017. But in value terms, the deposits with bank branches remained significantly higher than those with BCs. This is as one would expect given that branches are much larger and located in areas with vibrant commercial activity.

While the data shows impressive progress in spreading bank accounts and deposits through the BC model, critics have noted that this remains a supply driven model. The key evidence supporting this criticism is the presence of a substantial proportion of the accounts being dormant and virtually no credit activity. In addition, the rate of usage of active accounts is low. Compensation to BCs is poor in relation to the services expected of them. Opportunities for the expansion of new bank accounts have also greatly diminished due to near saturation under the Jan-Dhan Scheme. Scope for earning fees on deposit and withdrawal transactions remains limited.

Table 2

Basic savings bank deposits in branches and with bank correspondents.

Entity	End March 2010	End March 2016	End March 2017
Deposits in Million			
Branches	60	238	254
BCs	13	231	280
Total	73	469	533
Value in Rs. Billion			
Branches	44	474	691
BCs	11	164	285
Total	55	638	977

Payments banks: yet another innovation for inclusion

To enhance the reach of digital payments further, the Government of India has introduced payments banks launched in August 2015 with the grant of “in principle” licenses to 11 of the 41 applicants. The recipients of the license were given 18 months to fulfill all requirements after which they could begin operations. Bharti Airtel, a telecommunications company, was the first to go live as a payments bank in March 2017. Others to go live include India Posts and Paytm. A few others such as Tech Mahindra and Sun Pharmaceuticals surrendered their licenses.

Payments banks are registered as public limited companies under the 2013 Companies Act with a license from the RBI. They are not commercial banks, though the license from the RBI grants them the permission to perform some of the banking functions including remittance services, mobile payments, fund transfers, issuance of ATM, debit card services, net banking services and sales of third-party financial products such as insurance and mutual funds. However, payments banks are not allowed to advance loans or issue credit cards.

Currently, payments banks are allowed to accept deposits up to Rs. 100,000 and can pay interest on them. They earn part of their profit by depositing the funds received in banks that pay higher interest than what they pay their customers. They also earn profits by charging a merchant discount rate (MDR) on transactions undertaken by deposit holders. Other sources of revenue may include data monetization, cross-selling of financial products, and forming credit access platforms.

For example, Airtel Payments Bank pays 7.25% interest on savings accounts and charges a 0.65% transaction fee. The Airtel mobile number of the deposit holder also functions as the account number. The bank has

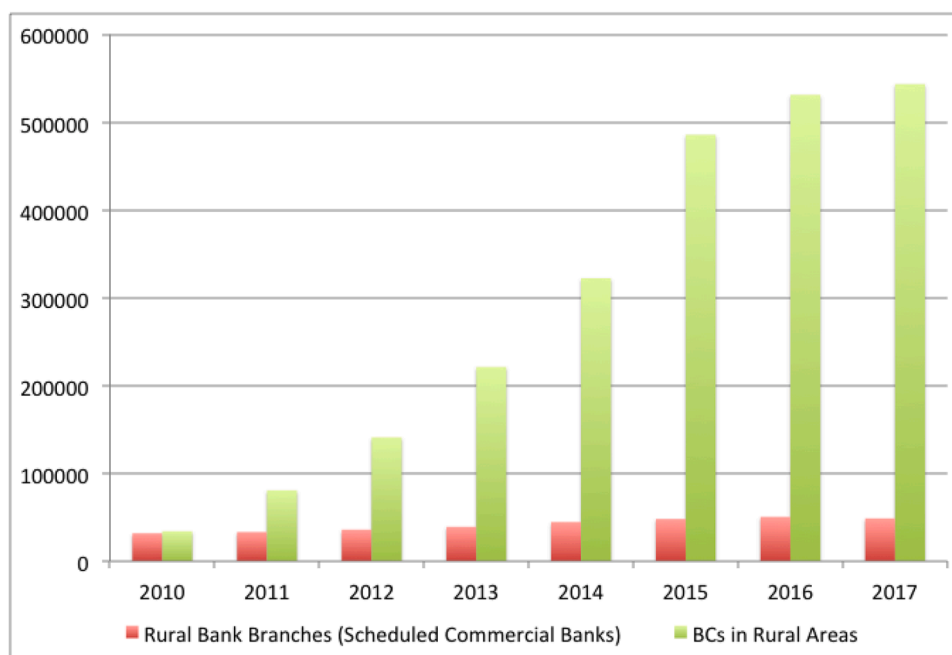


Fig. 3. Bank branches and Business Correspondents in rural India: 2009-10 to 2016-17 Source: author's construction using the data from RBI Annual Reports.

launched an app and an online debit card in collaboration with MasterCard that can be used at online merchant portals accepting MasterCard. The bank also offers customers a free personal accidental insurance cover of Rs. 100,000 on its savings accounts.

Changing landscape of government transactions

As shown in Table 1, in carrying out its business, the government must transact financially with its own ministries, states, and local government as well as with businesses, individuals, and households. Today, technology plays a central role in facilitating these transactions. I shall briefly touch upon some key components of this technology and associated financial flows.

The public finance management system

The government has deployed technology to cut down friction in its own payments system. Initially launched in 2009 as a system for tracking funds released by the central government to states through the erstwhile Planning Commission, the Public Finance Management System (PFMS) has evolved into an end-to-end solution for processing, tracking, monitoring, accounting, reconciliation, and reporting of financial flows into and out of the central government. It is expected to provide a unified platform for tracking releases of financial flows and their utilization down to the last mile. The plan is to eventually integrate all existing stand-alone financial systems to integrate into PFMS. These would include all payments of the Government of India, tax and non-tax receipts, Human Resource Management Information Systems, pension systems and General Provident Funds.

A major strength of PFMS is its integration into the core banking system. This integration gives the system the unique capability to push online payments to almost any entity within the banking system including state governments, local governments, various agencies implementing myriad government schemes, and even individual beneficiaries of such schemes. PFMS already interfaces with core banking systems of 170 banks including all public sector banks, regional rural banks, major private sector banks, RBI, India Post, and cooperative banks.⁴

The benefits of real-time payments and an accounting system cannot be underestimated. First, by allowing just-in-time transactions, it cuts the interest cost that is otherwise incurred when funds sit unused in transit. For example, states are the implementing agencies for various Centrally Sponsored Schemes. The central government may disburse funds for these schemes to the states but states may take some time before they disburse them to implementing agencies. While these funds sit idle with the state governments, the central government incurs interest costs on them. A just-in-time payments system can ensure that the central government has to release funds only when the implementing agencies are ready to receive them. Second, the system can also eliminate the need for manually balancing books, thereby minimizing the cost of accountants. Finally, the system also allows tracking and monitoring of projects and can help improve efficiency by providing real-time data to monitoring agencies.

Direct benefit transfers: PFMS, Aadhaar and bank accounts come together

In India, the central government sponsors several schemes, jointly funded by both itself and state governments, involving payments and cash or in-kind transfers to individuals or households. A food subsidy program under the National Food Security Act, 2013 provides wheat and rice at less than 5% of the market price to 75% of the rural and 50% of the urban population. Cylinders of liquid petroleum gas (LPG) and

kerosene are provided for cooking at subsidized prices. Farmers are provided fertilizer, especially urea, at subsidized prices. The government runs a massive employment guarantee program under the National Rural Employment Guarantee Act (NREGA), 2005, which entitles one adult in every household to 100 days of employment per year at a specified wage. The government also provides scholarships to students and pensions to widows.

In each of these programs, there has been a history of ghost beneficiaries and a collection of benefits multiple times by the same individual. There are leakages in the system through other channels as well. For example, employers under NREGA programs choose to disburse only a part of the wages due to workers while skimming off the rest. Similarly, sellers of LPG cylinders divert a part of the supply to commercial LPG users who are not entitled to subsidized LPG cylinders.

In recent years, the government has been systematically plugging these leakages through the use of Aadhaar verification and direct benefit transfer (DBT). It has been able to eliminate millions of ghost beneficiaries as well as multiple collections of benefits by the same beneficiary. Other forms of leakages have also been plugged by depositing the benefit directly to the Aadhaar seeded bank account of the beneficiary. For example, LPG cylinders are now sold at the market price instead of subsidized prices. Once the seller records the sale to a beneficiary in a centralized system, the subsidy is deposited directly to her Aadhaar seeded bank account. Similarly, once an employer under NREGA files information on a worker having performed work in a centralized system, wages are transferred directly to her Aadhaar seeded bank account. The approach applied to the LPG subsidy is also currently being extended to the disbursement of fertilizer subsidies.

Estimates of savings through the elimination of ghost beneficiaries and DBT of approximately \$2.5 to \$3.3 billion annually over a three-year period have appeared in the media. It is difficult to verify the accuracy of these estimates but they seem plausible. It is also a reasonable guess that these savings will multiply in the years to come as the scope of DBT expands and some of the in-kind transfers are converted into cash transfers, a process that is currently under way.

Government procurement: the government e-Marketplace

In a new experiment, in August 2016, the government launched a Government e-Marketplace (GeM) for its procurement of goods and services in a transparent manner. GeM is a paperless and cashless open platform for procurement of common-use goods and services with minimal human interface. Time-bound payment to sellers selling on the GeM platform is facilitated through integration with PFMS. Effort is also under way to integrate GeM with payment systems of railways, defense, public sector enterprises, and state governments.

The GeM experiment is at present in its infancy. But it holds great promise in a country like India where multiple layers of rules and regulations make procurement opaque, costly and time consuming. In principle, the marketplace can result in speedy procurement at competitive prices and hence major savings for the government. As an example, tickets for air travel by government employees are currently purchased through a monopoly agent. By all accounts, prices charged by this agent are exorbitant. Moving the procurement of the tickets to GeM alone can save the government millions of dollars.

E-National agricultural market

Traditionally, agricultural markets in India have been both opaque and fragmented. Each farmer is required to sell her produce in a government-assigned marketplace called a mandi. In mandis, commission agents and traders collude to buy the produce at minimal prices and then sell to wholesalers and retailers at the maximum prices. Prices within and across mandis can vary by wide margins.

To introduce competition within and across mandis, in April 2016, the government launched the e-National Agricultural Market (e-NAM) initiative. Under it, the government has already connected 470 mandis across 14 states electronically. In these markets, the farmer can use an

⁴ See <http://www.cga.nic.in/Page/PFMS.aspx> (Accessed 9 March 2022) and <https://www.2thepoint.in/public-finance-management-system-pfms-central-sector-schemes/> (Accessed 18 February 2018) for some of the details reported here.

electronic platform for auction to sell her produce to the highest bidder. Open e-auctions have gone some distance towards eliminating dependence on commission agents and bringing transparency to the sales process and also helped speed up payments to farmers. Farmers can bring their produce to the mandi in the morning and generally return home in the evening after auctioning the produce and receiving payment. Because transactions must be done electronically using bank accounts, payments cannot be delayed. In the past, they had to often stay overnight and would not get payment for one to two weeks. Efforts are currently under way to connect another 109 mandis to e-NAM.

Goods and services tax network

Recently, India replaced more than a dozen indirect taxes by a single Goods and Services (GST) tax. Use of a technology-based platform called the GST Network or GSTN has been key to the adoption of this tax. Sellers of goods and services above a threshold are required to register on GSTN with a 12-digit identification number. In March 2018, the total number of such sellers was 10.3 million (6.4 million original taxpayers and 3.9 million new registrants). Each seller must file a return on a monthly or quarterly basis. The return summarizes all information on sales, purchases, tax collected on sales, and tax paid on purchases. Tax due is calculated as the difference between tax collected on sales and tax paid on purchases. A major task of GSTN is to match buyer and seller invoices to ensure that credit being claimed by the buyer matches the tax collected from him by the seller.

Businesses as providers of fintech services

Although reference to businesses' participation in fintech has been made in the context of transactions by governments and households, it is important to highlight their role here, especially in intermediating digital payments.

Digital payments

Private-sector players dominate the market in the provision of digital payments. The largest player currently is Alibaba backed Paytm, which has 300 million registered users and 7 million offline merchants. It is adding 10 million users each month and accounts for 250 million transactions per month. Approximately half of these transactions originate in small towns and villages.

In November 2017, Paytm started accepting UPI payments, which took off immediately. In February 2018, its UPI transactions touched 68 million out of a total of 171.4 million UPI transactions. Current notable competitors of Paytm include Mobikwik, Google Tez and Flipkart-owned PhonePe and Amazon Pay. The biggest disruption is expected to occur when WhatsApp Pay fully enters the market.

An important promise of providers of digital payments services is that they can become sources of credit for their users. Transactions conducted on their platforms provide useful data on payments habits of their customers and may be capable of being leveraged for lending activities. If this turns into reality, credit markets for small borrowers would undergo a major change in India.

Other fintech services by private businesses

Among other important fintech services provided by private businesses, mention may be made of the following:

Amazon, Flipkart, Snapdeal, Myntra, BigBasket, IndiaMart, Make My Trip, Yatra and Trivago are examples of some major players in e-commerce.

BankBazaar is a major loan comparison portal offering personal loans, home loans, credit cards, mutual funds, fixed deposits and savings deposits. It also offers health, life and home insurance policy comparisons. PolicyBazaar and Apnapaisa are the other major players in this space.

Peer-to-peer lending is in its infancy; nevertheless, several sites have emerged. Prominent among them are Lendbox, Faircent, I-lend, Easy

Rupiya, and LenDen Club. Some of these portals have several thousand lenders.

India has about 15 cryptocurrency exchanges of which four are funded. Bitcoin, Ethereum and Ripple in that order are the most popular crypto currencies in use at these exchanges.⁵ The government has neither endorsed nor banned cryptocurrencies. It regularly warns of risks associated with transacting in them, however.

Digital revolution and entrepreneurship

Let us now turn to entrepreneurship in the digital technology space. Implicitly, we have already introduced such entrepreneurship when discussing fintech. Entrepreneurs operating in fintech are all engaged in digital technology entrepreneurship. But we may now consider the entrepreneurship aspect of Digital Revolution more directly.

In the literature on entrepreneurship and digital technology, a distinction is drawn between digital technology entrepreneurship and digital entrepreneurship. The former refers to entrepreneurship based on new ICT [Information and Communications Technology] products such as the iPhone and the latter on products and services based on the Internet. Broadly, the former may be thought of as involving manufacturing and the latter creating services using new software and existing digital devices and platforms as exemplified by WhatsApp (Giones and Brem, 2017). In the following, I discuss entrepreneurship of each kind.

Digital technology entrepreneurship

India has done well in digital-device space at the innovation level. Unfortunately, however, with one major exception, it has not done well at translating the innovations into large-scale commercial enterprises. A recent paper offers a fascinating discussion of highly cost-effective innovations by Indian entrepreneurs that can potentially impact the lives of the masses, not just in India, but worldwide. But in all cases but one, so far, this impact has been extremely limited.⁶

Jio mobile and broadband

The most successful low-cost digital technology innovation that has also made a major difference to the lives of the masses is Jio's Greenfield 4 G Long Term Evolution (LTE) network. Because Jio joined the telecommunications world late, it has no 2 G or 3 G legacy services. Its unique configuration allows Jio to offer free voice calls to any network across India. It has no national roaming charges, making its network seamless throughout the country. The remarkable thing about Jio is that it offers 4 G Internet to customers at just 10 cents per gigabyte (GB). Jio's phone is offered effectively free of cost to customers.

Jio was launched on September 5, 2016 and within the first month, it acquired a record 16 million subscribers. It crossed the figure of 50 million subscribers in 83 days and had signed up 100 million subscribers by February 22, 2017. By July 5, 2018, Jio had 215 million subscribers. This is a feat accomplished in just 22 months. Competitive pressure brought by Jio has sent the prices of broadband services on mobile phones tumbling. The result has been a rapid expansion of the use of digital technologies in India.

While the innovations underlying Jio have made low-cost provision of its services possible, the fact that it is owned by one of the largest conglomerates of India, Reliance Industries Limited (RIL), has been crucial to its rapid spread across India. With its deep pockets, RIL was able to rapidly scale up the operations of Jio. So far, younger

⁵ See <https://inc42.com/features/cryptocurrency-exchanges-ethereum-bitco-in-india/> (Accessed 9 March 2022).

⁶ See Mashelkar, R. A., 2018, "Dismantling Inequality through ASSURED Innovation," K. R. Narayanan Oration at <https://crawford.anu.edu.au/acde/asarc/pdf/narayanan/oration/2018oration.pdf> (Accessed August 31, 2018).

entrepreneurs who are financially less capable have had far less success in scaling up their digital technology startups even though underlying innovations in some cases have been equally cost effective with potentially large markets. At the same time, it needs pointing out that younger Indian entrepreneurs in digital as opposed to digital technology space have had enormous success in attracting and mobilizing investment funds.

iBreastExam

One low-cost digital technology innovation has been a device called *iBreastExam* by young entrepreneur Mihir Shah who launched startup *UE LifeSciences* in 2009. The device offers a painless and non-invasive scan, which can detect breast cancer with great accuracy at a cost of just \$1. The exam is entirely radiation free and can be operated by a community health worker. The device has the United States Food and Drug Administration clearance and has the CE mark required for sales in the European Economic Area consisting of 28 countries of the European Union and three countries of European Free Trade Area. The device is currently sold in more than 25 countries in Africa and Asia. Nevertheless, despite the existence of a vast potential market for the device due to its low cost, ease of operation, and non-invasive nature of the examination, its sales have been relatively limited. The total annual revenues remain between one to two million dollars.

Electrocardiogram Sanket

Another similar innovation is a portable matchbox size Electrocardiogram (EKG) machine called *Sanket*. The device sells for less than \$100. It connects remotely to a smartphone and records and displays EKG on it. The report can be shared instantly with a doctor using the smartphone. *Sanket* has filed for multiple patents. Once again, the device has not had notable commercial success.

There are several other stories of devices such as those that can detect multiple eye diseases and diagnose mosquito-borne diseases at low cost, but they all had difficulty scaling up. So far, outstanding successes in the digital technology space such as that achieved by the *Jio* phone have not emerged in a big way in India.

Digital entrepreneurship

The story has been different in digital entrepreneurship with several entrepreneurs successfully scaling up their operations. In some cases, startups have made inroads even in foreign countries. I discuss a handful of the startups in the digital space below. Some of them have appeared earlier in our discussion of fintech. Nevertheless, it is important to discuss them here to highlight their innovation and entrepreneurship aspects.

Flipkart E-commerce company

The biggest success story in Indian digital entrepreneurship space has been *Flipkart*.⁷ Two Indian Institute of Technology graduates started it in September 2007 as a website offering home delivery of books. In 2018, *Wal-Mart* acquired it for \$16 billion. This is the largest ever acquisition of an Indian startup. In 2007, *Flipkart* made just 20 deliveries in total. The following year, this figure climbed up to 3400 deliveries. In 2009, the startup acquired sufficient visibility to receive a venture capital investment of \$1 million. It began the year by hiring its first employee and ended it with 150 employees. In 2010, *Flipkart* began selling movies and electronic products such as video games and mobile phones. The following year, the company expanded into selling cameras, computers, laptops, large appliances, and stationery. It also launched its digital wallet and acquired two digital content companies and expanded the delivery network to 600 cities.

⁷ My discussion of *Flipkart* is based on the blog at <https://yourstory.com/2018/05/flipkart-through-the-years/> (Accessed 9 March 2022).

In 2013, *Flipkart* adopted a marketplace model and brought third-party sellers to its platform. That year, it also raised \$360 million and the following year, \$1.6 billion. In 2014, it acquired online fashion retailer *Myntra* and majority stakes in after-sales service provider *Jeeves* and payments platform *Ngpay*. By the end of the year, it was valued at \$11 billion. In the following years, the company made several additional acquisitions. By 2016, its mobile app had 50 million users and it had 100 million registered customers. In 2017, *Tencent* invested \$1.4 billion and *SoftBank's* Vision Fund \$1.5 billion in the company. The same year, *Flipkart* also acquired *eBay India*. By 2018, when *Wal-Mart* acquired it, the company had 130,000 third-party sellers and was expanding its product catalog to house 80 million products.

Paytm payments wallet

As previously mentioned, *Paytm* (pay through mobile) began as a digital wallet in 2010. The founder started the company with a \$2 million investment of his own. Based on secondary shares sale at the end of January 2018, it is now valued at \$10 billion. Its operations include a payments bank and an e-commerce business. *Alibaba Group* and *SoftBank* are both investors in *Paytm*.

Paytm wallet allows a user to transfer funds directly into a recipient's account using a QR code or mobile number. In May 2018, the company had seven million offline merchants spread over India's 600 districts. The first of these numbers rose from just one million at the beginning of 2017. Annualized gross transactions value of the company crossed \$20 billion in February. This represented a four-fold increase over the previous year. The number of transactions using *Paytm* far exceeds the total number of debit card transactions.⁸

By August 2018, *Paytm* had 300 million registered users. This figure compares with 520 million *Alipay* users and 237 *PayPal* users around the same time.⁹ On average, one in five Indians already uses *Paytm*.

Ola cab service

Ola, a cab hailing service, represents another major successful Indian startup in digital space. The startup was launched in 2010 in competition with the American cab hailing service called *Uber*. Founded by two young entrepreneurs, it operates in more than 110 Indian cities today. It offers licensed taxis, private hire cars and rickshaws and has a network of approximately one million drivers. The company has been valued at \$7 billion and has raised approximately \$3 billion in investment funds. Its investors include *SoftBank*, *Tencent*, *Didi Chuxing* and *DST Global*. In January 2018, *Ola* launched its service in Australia and currently operates in seven cities there. At the end of August 2018, it also launched licensed taxi and private hire vehicle services in South Wales in the United Kingdom.¹⁰

Rivigo: a logistics startup

An especially creative startup, which can make a major contribution to transformation of logistics sector in India, is *Rivigo*.¹¹ Launched in 2014, the startup says on its website, "We are transforming logistics in India making it human, faster and safer." Under the conventional trucking model, a single driver drives the truck to its final destination hundreds, even thousands, of miles away with multiple stops on the way to catch up on sleep. Stops on the way cause delays in reaching the destination and the driver remains separated from his family for days,

⁸ See <https://economictimes.indiatimes.com/small-biz/startups/newsbuzz/paytm-transactions-reportedly-grew-four-fold-to-20-billion-in-february/articleshow/63375003.cms> (Accessed 22 September 2018).

⁹ See <https://expandedramblings.com/index.php/many-users-epay-platforms/> (Accessed 22 September 2018).

¹⁰ For more details, see <https://techcrunch.com/2018/08/06/ola-is-bringing-its-ride-hailing-service-to-the-uk/> (Accessed 20 September 2018).

¹¹ My discussion of *Rivigo* draws heavily on <https://yourstory.com/2018/03/rivigo-billion-dollar-valuation-journey/>. (Accessed 9 March 2022).

sometimes weeks. Temptation to keep driving the truck for long hours to complete the task sooner can also lead to fatigue and result in accidents.

To overcome these problems, Rivigo has invented what it calls a “relay” model of truck transportation whereby a driver drives the vehicle for four or five hours and, at a designated pit stop, meets another driver driving a truck in the opposite direction. The drivers exchange the trucks with each other at the pit stop and drive back to where they came from. Upon returning to a home pit stop, each driver hands over his truck to another driver who carries it to the next pit stop. This “relay” driving of trucks keeps trucks moving continuously while also allowing each driver to return to his home the same day to be with his family. The model has allowed the startup to substantially reduce the time a truck takes to reach its destination while also saving the drivers from having to spend long periods away from family. With more humane trucking jobs, the startup is also able to recruit drivers with greater ease.

In four years, by March 2018, Rivigo had a fleet of 3000 trucks. The company has created a network of 70 pit stops nationwide. Each driver drives about 250 kms, or five hours, between pit stops. Simultaneous movement of a large number of trucks in many directions requires solving a complex programming problem. A sophisticated algorithm does routing and assignment of drivers. Whenever one or more trucks break down, the algorithm re-optimizes and rejigs the assignments. Each driver carries a mobile app, which provides necessary instructions in real time.

Rivigo also deploys sophisticated technology to monitor pilferage of gasoline and refrigeration of perishables it transports. During its years of operation, it has collected vast volume of data, which it is beginning to use to deploy Artificial Intelligence. In 2017, the company raised \$50 million and was valued at \$1 billion.

OYO hospitality company

Started in 2013 by an 18-year old entrepreneur, OYO (“on your own”) is a hospitality company offering budget hotel rooms. The startup partners with hotels to give guests a similar experience in terms of certain basic amenities across the nation at highly competitive prices. In January 2013, the startup had just one hotel with which it partnered. That number rose to thirteen in July 2014 and rapidly climbed up to more than 8500 by September 2018. In 2018, OYO offered hotel rooms in 230 Indian cities. It has also expanded its operations abroad in Malaysia, Nepal and China. In 2017, the startup raised \$260 million with SoftBank being the largest funder. Although the current valuation of OYO is placed at \$1 billion, it has so far been running in substantial losses and its business model has been questioned.¹²

Startup India

In 2015, the Government of India announced its Startup India initiative. Under it, the government created a simplified set of rules for enterprises qualifying as startups. It also created a fund of 100 billion rupees to provide financing for startups.

Startup India defines a startup as an enterprise that is less than seven years old and has a turnover of less than 250 million rupees. Under the Insolvency and Bankruptcy Code, a startup can exit in 90 days. It can comply with laws through self-certification and is free from inspections for the first three years of operation. It is also exempt from capital gains and other taxes in the first three years. As a part of Startup India initiative, the government also launched the Atal Innovation Mission, which offers funding for incubators and Atal Innovation Labs in schools.

Concluding remarks

In this paper, I have analyzed the manner in which the Digital

¹² See <https://the-ken.com/story/can-oyo-go-from-ponzi-to-profit/> (Accessed 9 March 2022).

Revolution has progressed in India in two areas: fintech and entrepreneurship. In discussing fintech, I have described the key changes that digital technology is bringing to transactions taking place among the government, individuals and businesses. The focus of this discussion has been on inclusion and development aspects of the change spawned by digitalization. The government has played a very active role in driving the change in this area in India.

The key to the ongoing change in fintech, which has a considerable distance to go in India, is a biometric identity known as Aadhaar. Nearly every financial transaction requires definitive proof of identity of the transacting parties. Aadhaar provides this proof without any document via biometric verification. This is a major asset the country now has. Though there remain some legal issues related to data privacy to be resolved, with the matter under consideration by the Supreme Court, the government and businesses are already using this asset effectively in creative ways.

Regarding entrepreneurship in the digital space, a distinction can be drawn between digital technology entrepreneurship and digital entrepreneurship. The former typically involves invention of devices that fulfill one or more needs while the latter relies principally on new software, which is used on existing devices and digital platforms. I have shown that India has had limited success at best in digital technology entrepreneurship. Though startups have innovated highly cost-effective devices, they have not been able to turn them into major commercial successes. This outcome mirrors India’s generally limited success in the manufacturing sector. The story in the digital space has been a happier one with a large number of startups successfully scaling up and even taking their innovations to foreign markets.

Four final points must be made. First, no technology can substitute for growth in so far as inclusion is concerned. In the end, the real empowerment comes from having command over financial resources, and that command comes from income. Indeed, without access to income, even the spread of financial technology risks remaining a supply side phenomenon. Whether or not individuals and households use the supplied technologies critically depends on their incomes. As an example, though the government and banks have been able to proliferate business correspondents, the use of their services has remained limited simply because incomes and commercial activity in the smaller villages are limited.

My second point is that mere availability of technology will not lead individuals to adopt it. Incentives matter. As an example, if tax rates are high, parties involved in a transaction have an incentive to use cash to make payments and not risk creating a digital record of the transaction by making or receiving payment digitally. This is particularly true of small businesses. Likewise, if tax enforcement authorities have a history of harassing taxpayers, small businesses would try to remain out of the tax system. Once again, they would prefer to transact in cash as long as possible.

My third point is that it is important not to fall into the trap of turning technology into an enemy of good policies. Momentum for the removal of policies that are popular but nevertheless promote inefficiency comes from poor implementation of those policies. Large leakages and poor targeting of subsidies can provide critics much needed ammunition to advocate for their removal. To the extent that technology becomes the means to effective implementation of these anti-growth policies, it turns into an enemy of reform. In such circumstances, the task of convincing the policy makers that what is needed is not effective implementation of the poorly thought out policy, but its removal, becomes yet more difficult for economists.

Finally, India needs to keep a level playing field between domestic and foreign investors in the digital space. While India must take all necessary steps to ensure cyber security, it must resist calls for restrictions on foreign investors to promote domestic entrepreneurs. Such restrictions harm the consumer by denying her the best service. They also exert negative influence on productivity by blocking the entry of enterprises employing the latest innovations. Indeed, to the extent that

most successful domestic startups in the digital space themselves achieve high valuations after foreign investors make sizeable investments in them, tilting the playing field in favor of domestic investors is self-defeating. In such situations, they will have to opt out of foreign investment to avail the benefits of being considered as domestic enterprises. It is important to remember that for many years to come, foreign venture capital, angel investment, and private equity will remain critical to the growth of startups in India.

Declaration of Competing Interest

The authors declare that they have no known competing financial

interests or personal relationships that could have appeared to influence the work reported in this paper.

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