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INDIAN EXPERIENCE OF
FOSTERING COMPETITION
THROUGH STATE INTERVENTION:
LESSONS FROM
CARD PAYMENT SYSTEM AND
UNIFIED PAYMENTS INTERFACE

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Abstract

Diffusion of digital payments in India immensely benefitted from the introduction of Unified Payments Interface (UPI). Introduced in 2016, UPI usage in India has exceeded even the most optimistic prediction; on the other hand, card payments – with a longer history – has grown at relatively modest rates. Placing the analytical framework of ‘Functions of Innovation Systems’ (FIS) within the ‘Technology Specific Innovation System’ (TSIS), this paper uses the market formation function of FIS to understand the market structure and hence competition in each of the two payment systems (UPI & Card payments). Competition within each payment system influences the prices charged and hence their individual diffusion. We first break down the technology involved in UPI and card payments, followed by empirical evidence that delineates their individual diffusion. Under the market structure function, for each of the payment systems the paper then explains the impact of four factors – technology design, complementary markets, regulation, and state intervention – on market structure and hence competition, which influences cost structure and prices charged. Based on the UPI experience the paper concludes that if the State desires faster diffusion, then it should own the technology – preferably based on open standards, with a technology design that builds on lower costs in complementary markets. This reduces entry barriers for firms desirous of entering the payment system and increases competition. From the card payment system, the paper infers that state supported entry coupled with rules/institutions aligned with the state’s goals creates uneven playing field and uncertainty for stakeholders, which impacts market formation activities of that market and slows diffusion.

Keywords: Financial Economics, Card payments, Digital Economy, Innovation, Unified Payments Interface (UPI)

JEL Codes: G21, O31

1 Introduction

Adoption and use of digital payments have been an ongoing technological change in India. Card payments (CP) and the Unified Payments Interface (UPI) are among the gamut of digital payment technologies available for payments in India. Theoretically, adoption of CP and UPI, and, their usage by consumers and merchants for every transaction, will happen if only if the net individual benefits for each are more. Increasing competition within a technology and between technologies will help policymakers increase net individual benefits. At the outset it has to be mentioned different payment systems may be complements or substitutes. If the seller of a good or service accepts any form of digital payment or cash, then the buyer will use the payment system that maximizes her/his benefits; in this case, different digital payments and cash become substitutes. On the other hand, if the seller of a good or service accepts only one form of digital payment or cash, then the buyer will choose the one that maximizes her/his benefits. If an individual chooses two different digital payment systems for the above two payment scenarios, then for this particular case they may be said to be complements. This may not only vary among individuals but also vary for a particular individual as per the situations she/he finds one, and hence, in our opinion, it is very difficult to predict at the individual level if two different or various digital payment systems are complements and substitutes. Hence, CP and UPI may substitute or complement each other.

Introduced in 2016, UPI usage in India has exceeded even the most optimistic prediction, while card payments – with a longer history – has grown at relatively modest rates. Using a functional-structural analysis on CP and UPI, Iyer (2025) argues that the innovation system of UPI was able to keep its cost of adoption and cost of use lower, hence, UPI diffused faster than CP. Keeping this contribution in perspective, this paper uses the UPI

and CP experiences to focus on the impact of four factors – technology design, complementary markets, regulation, and state intervention on market structure, and hence competition. Regulation is a part of state intervention, however, in both CP and UPI the state has not only regulated but also has tried to accelerate diffusion and influence market formation activities by entering the market or becoming an important stakeholder. To help our analysis, we separate regulation from state intervention. The paper analyses the impact of these four factors on the market formation function (F5) of the ‘Functions of Innovation Systems’ (Hekkert et al., 2007) analytical framework within the CP and UPI ‘Technology Specific Innovation System’ (TSIS) (Carlsson & Stanckiewicz, 1991). The paper first establishes these four factors as outcomes of other functions in the FIS; it then focuses on the impact of these factors on F5, thus providing empirical evidence of functions within an FIS influencing each other. At the policy level, the paper highlights the effect of two types of state intervention: a) Base technology is provided by the State (UPI), public and private sector organizations create user side platform and compete for transactions. Technology design induces a market structure that increases competition. Lower costs in complementary markets increases net benefits vis-a- vis competing technologies, enabling faster diffusion and widespread usage. b) In case of CP, technology design does not induce a market structure that increases competition, slowing down diffusion and restricting usage. Hence, to increase diffusion, state enters the market as a player and competes with private sector organizations; rules/institutions are aligned with the goal of the State. This creates uneven playing field and uncertainty for stakeholders. Policy lessons from the experiences are clear, if the State desires faster diffusion, it not only has to own the technology but also ensure a technology design that ensures lower costs. State should then induce competition by sharing the technology with interested public and private firms.

The layout of the paper is as follows; in the next section we briefly outline CP and UPI technologies followed by an analytical framework. Section 3 presents empirical evidence on CP and UPI, which includes State and regulatory intervention. This leads to a section discussing impact of four factors – technology design, complementary markets, regulation, and state intervention – on market structure. The concluding section of the paper suggests few policy prescriptions that emerge from these experiences.

2 CP, UPI & Analytical framework

2.1 CP

CP industry is an example of a two-sided platform; value is created by facilitating interaction of two groups – consumers and merchants. Network externalities play an outsized role for these platforms, higher number of consumers in a platform incentivizes merchants to adopt, higher number of merchants in a platform incentivizes consumers to adopt. Network size acts as an entry barrier for CP industry. For card payments, generally, for a transaction, a consumer presents a card¹ to the merchant which she/he processes using a point-of-sale machine² (PoS). Information from the PoS is transmitted to the card network server, which authenticates the transaction followed by a signal that initiates money flow from the card issuer bank to the acquirer bank (merchant's bank). CP systems are capital intensive, as they must handle data – transmission, processing, and storage – each of which need to be secure and fast. Usually, card networks act as payment guarantors to merchants, for which they invest heavily in fraud detection systems.

¹ For card not present transactions, details of the card must be entered.

² We focus on PoS, which are four party transactions; and not on Automatic Teller Machine (ATM) transactions, which are three party transactions.

Two well-known payment networks are Visa and Mastercard, which originated and continue as bank associations. Payment networks started with credit cards and as a part of onboarding small retailers and increasing network size, networks accepted the credit risk and created a consumer credit network; retailers had to pay a fee for every transaction while risk of non-payment was borne by the network (Zywicki, 2000). This fee is known as merchant discount rate (MDR) and is shared between the card issuer, acquirer³, and card network on a mutually agreed ratio. CP networks recover a major chunk of their fixed costs as well as operating costs from their share of transaction MDRs.

2.2 UPI

UPI is a mobile phone-based technology introduced by the National Payments Corporation of India⁴ (NPCI) to enable real time inter & intra bank transactions. A consumer with an UPI app⁵ can pay a merchant using the merchant's mobile number or virtual ID or a quick response (QR) code. Payments can also be made to recipients who do not have access to UPI. To pay and receive through UPI a bank account is essential. Like card payments, for UPI merchant transactions the acquirer pays an MDR. Sender pays a charge for peer-to-peer (P2P) payments. UPI model allowed non-bank payment system providers and non-bank third-party application providers to facilitate UPI payments, for this each non-bank third-party provider had to partner with a bank, and work out payment and other modalities between them. For all transactions, a switching fee is paid to NPCI (Cook and Raman, 2019). UPI is also a two-sided platform with lesser infrastructure requirements on the consumer and merchant side.

³ In addition, card issuer may charge an annual fee from the card holder, while the acquirer charges for the card reading machine installed at the merchant outlet.

⁴ A not-for-profit company set up by RBI. Ten banks, own ten per cent equity each, in NPCI.

⁵ Bank and third-party apps can also be used.

Table 1 summarizes the above features of CP and UPI.

Table 1: CP and UPI: Few features

	CP (PoS)	UPI
Stakeholders	Consumer, Consumer-Bank, CP network, Merchant-Bank, Merchant	Payer, Payer-Bank, Non-bank providers, Payee-Bank, Payee
Transactions possible	Peer to Merchant	Peer to Peer Peer to Merchant
Requirements for Transactions	Card – Consumer PoS - Merchant	Payer – Mobile with internet connection Payee – QR code / mobile number / virtual id
Charges	MDR, Annual fees for card and PoS	MDR, Switching fee

2.3 Analytical framework

An innovation system has been defined as all institutions and economic structures that affect both rate and direction of technological change in society. As discussed in Iyer (2025), diffusion of CP and UPI depend on the strength of functions (FIS) within each of its respective TSIS. As per FIS, there are seven functions – entrepreneurial activities (F1), knowledge development (F2), knowledge diffusion through networks (F3), guidance of the search (F4), market formation (F5), resources mobilisation (F6) and creation of legitimacy/counteract resistance to change (F7). It has been posited that functions interact and influence each other; a TSIS begins with few functions which over time should trigger other necessary functions if the TSIS has to make an impact.

Iyer (2025) notes that there are three important components of transaction costs⁶ – costs to consumers (C_i^c), costs to merchants (C_i^m), and profits to issuers of the payment system (P_i^{is}) – associated with a payment in any payment system (i). Assume a transaction is about to take place, in the simplest case⁷, a particular payment system (i) will be surely chosen over other (j), ($i \neq j$), iff (i) has $(C_i^c)_{\min}$ and $(C_i^m)_{\min}$ among the available payment systems⁸. Increasing use of a payment system implies consumers and merchants face lower costs while using it. For the payment system (i) to be available for the consumer and the merchant over the long term, it is imperative that $P_i^{is} \geq 0$ as soon as possible. Since network effects are important, larger the network of consumers and merchants, higher the probability of lower costs to consumers and merchants as well as positive profits to issuers. Thus, the market structure of the payment system should aim to build a large network, highlighting the importance of the market formation (F5) function in each TSIS. Now, for both CP and UPI, platform users on both sides need to be onboarded, which should be the initial focus of market formation function of their individual TSISs. With time as the technology improves and users get convinced about the utility of the technology, this market formation function of each TSIS should work towards a market structure that brings prices down and firms earn normal profits. In addition, competition between substitute payment systems will also impact diffusion of a payment system, which each TSIS must factor in.

The components, processes and services at the core of any technology are decided during the technology design stage. Technology can be provided at a lower cost if the underlying components, processes and services are available or carried out or provided at

⁶ Shy and Tarkka (1998)

⁷ There are numerous possibilities including complex ones, we do not expand on the possibilities.

⁸ All factors affecting choice of payment systems can be easily mapped to the minimum cost framework.

competitive costs, this implies that the complementary markets for these components and services be as competitive as possible. Thus, technology design underpins the cost incurred by the consumer and merchant; and, hence, F2 plays a critical part in keeping costs low and thus helps F5.

Hekkert et al. (2007) note that since technological change is not autonomous, F4 is an important function for governments to step in and use regulation to lower costs for users and achieve targets, this catalyses adoption among users. In this case, F4 positively influences F5. Similarly, to counteract the resistance to change by users and achieve targets, the government may decide to provide government transfers or using the new technology. To avail the transfer or service, users will have no option but to adopt the new technology. F7, thus, positively impacts F5.

3 CP & UPI: Empirical evidence of market formation activities

3.1 CP

Pre-RuPay card

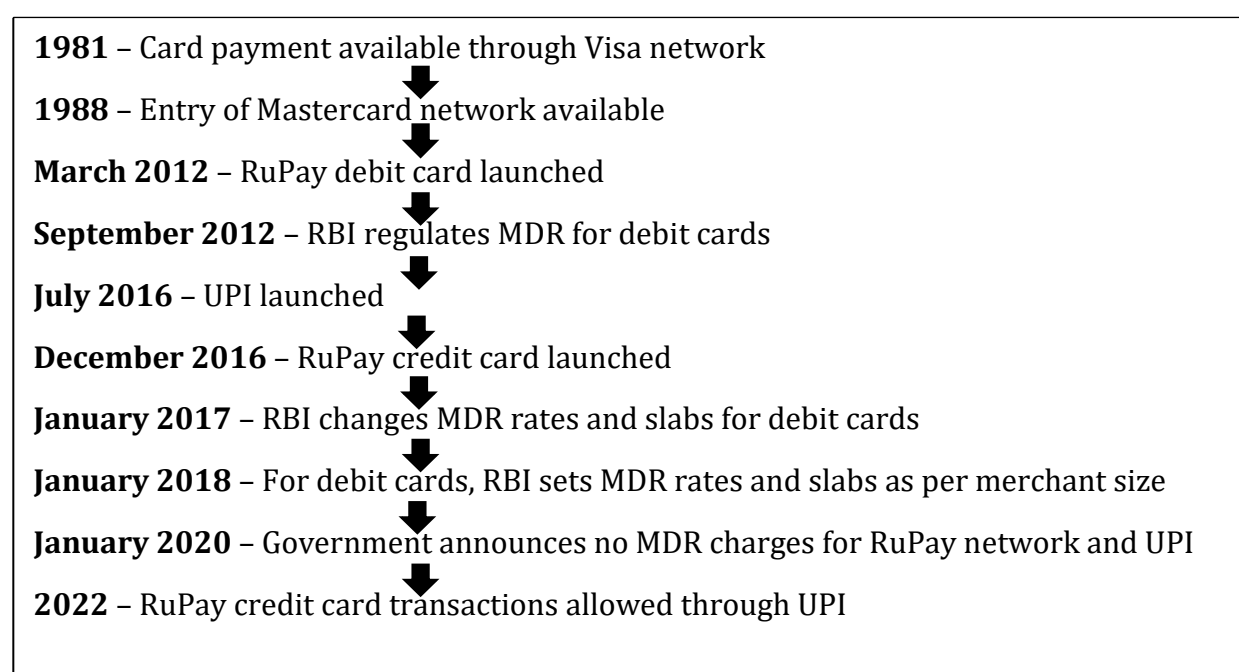
In India, CP started in 1981 when Central Bank of India introduced a Visa credit card. Half a decade later, in the late 1980s, Mastercard entered⁹ the Indian credit card market through Vijaya Bank. By December 1994, credit cards were issued by 12 banks; plastic cards – credit, debit, and smart – were growing at 30 per cent with a yearly turnover of about Rs 900 crores from a million card holders (RBI, 1994). However, bottlenecks – reliable telecommunication lines & card acceptance infrastructure – stifled the growth of

⁹ American Express entered the Indian card market in 1992, however, it has always remained a minor player in the market.

cards till the early 2000s. In terms of our analytical framework, technology design and lack of complementary markets affected market formation activities.

By 31st December 2004, the number of cards issued by banks increased to 43.3 million with the total transactions amounting to Rs 269.51 billion in the fiscal year 2002-03 (RBI, 2005). Total number of cards increased to 245.8 million by 2010-11 (RBI, 2021), indicating robust market formation activities by banks, Visa & Mastercard network. During this period, RBI encouraged card adoption and did not regulate MDR charged by Visa & Mastercard payment networks. In addition to the share in MDR, these card payment networks also charged a modest one-time fee as well as quarterly fee¹⁰ from onboarded banks. Duopoly of Visa & Mastercard dominated card payments in India till March 2012, when NPCI launched the RuPay card. To understand the analysis better, chart 1 delineates the timelines involved.

Chart 1: Timeline of the analysis



¹⁰ JM Financial (2016).

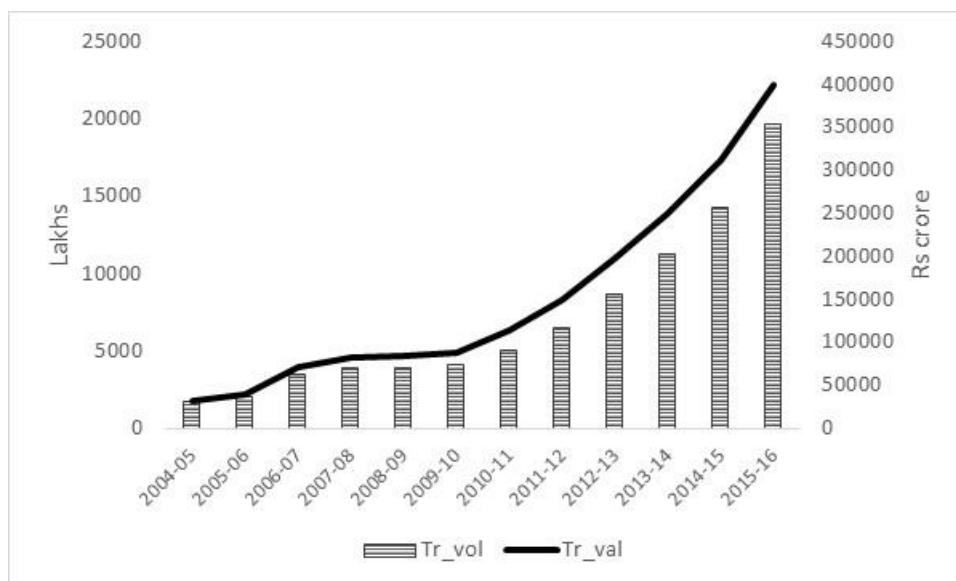
We analyse PoS card transactions for three periods, 2004-05¹¹ till 2011-12 (P1 – pre-RuPay), 2012-13 till 2015-16¹² (P2 – pre-UPI), 2017-18 till 2024-25¹³ (P3 – post-UPI). Volume and value of card transactions for P1 show the impact of robust market formation activities of banks, Visa & Mastercard network (Figure 1). Transactions volume in 2011-12 was almost four times that in 2004-05, with 15.8 per cent compounded annual growth rate (CAGR); while transactions value in 2011-12 was almost five times that in 2004-05, with a CAGR of 21.2 per cent. Average monthly growth rate of credit and debit transactions at PoS (volume and value) in P1 point out a preference for debit cards usage (Table 2). Higher growth rates for debit cards in P1 is due a huge increase in debit card volume and value transactions from August 2006 till July 2007, supported by an unusually high standard deviation. State intervention post April 2012 ensured that number of PoS machines increased from just under six lakhs in April 2011 to almost fourteen lakhs in March 2016 (Figure 2). As a result, the number of PoS per person in March 2016 was double of that in April 2011 (Figure 2).

¹¹ Data available from 2004-05 onwards.

¹² UPI was pilot launched on 1st April 2016; transactions data for UPI is available from July 2016.

¹³ We do not include 2016-17 and 2020-21 to exclude two shocks – Demonetization and COVID, respectively.

Figure 1: Card transactions at PoS – Value and volume



Note: Tr_vol is total no.of transactions at PoS (LHS). Tr_val is total value of transaction at PoS (RHS).

Source: Payment systems indicators, RBI

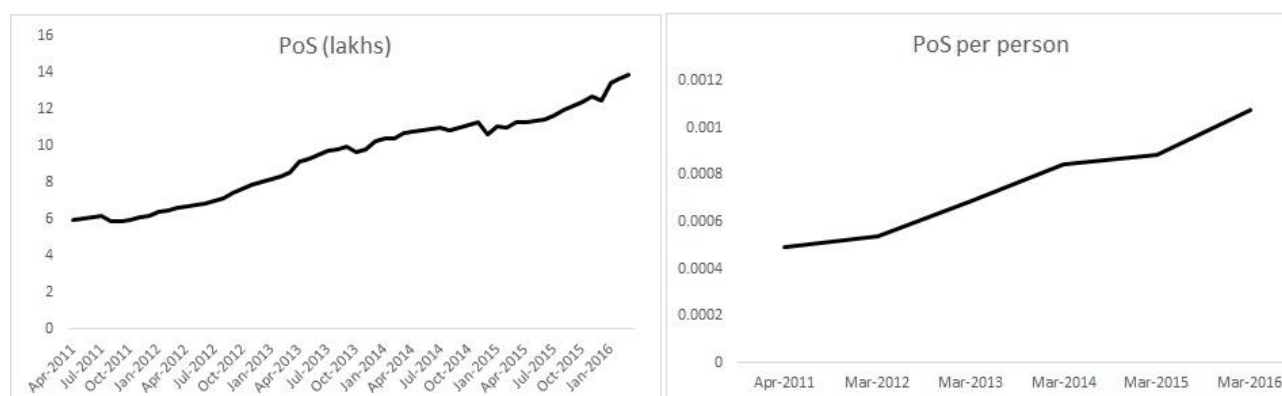
Table 2: Credit and Debit card usage at PoS – average monthly growth rate

		Credit Card		Debit Card	
		Vol	Val	Vol	Val
2004-05 to 2011-12 (P1 – pre-RuPay)	Mean (%)	1.93	2.26	4.9	6.01
	Std. dev	0.93	1.4	9.09	11.71
2012-13 to 2015-16 (P2 – pre-UPI)	Mean (%)	2.19	1.91	3.11	2.49
	Std. dev	0.09	0.57	0.61	0.9
2017-18 to 2024-25* (P3 – post-UPI)	Mean (%)	2.4	2.55	-0.19	0.255
	Std. dev	1.33	1.35	2.39	1.86

Note: * - 2020-21 not included.

Source: Calculated from Payment systems indicators, RBI

Figure 2: Number of PoS machines and PoS per person



Source: Payment systems indicators, RBI for PoS, Indiastat for population

Between April 2011 till March 2012, analysis of average transactions volume and value per PoS for credit and debit cards, informs us that volume of debit cards surpassed credit cards in July 2011, a trend which continued till March 2012. Average transactions value for debit cards was no match to that of credit cards (Table 3).

Table 3: Average monthly transactions volume and value per PoS

Year		Volume (Nos)	Value (Rs. Lakh)
2011-12*	Credit	43.5	1.3
	Debit	44.5	0.7
2012-13 to 2015-16	Credit	46.8	1.4
	Debit	61.1	0.9
2017-18 to Oct 2019#	Credit	41.6	1.4
	Debit	101.1	1.4

Note: * - Data is available only from 2011-12. # - Data from November 2019 is not comparable.

Source: Calculated from Payment systems indicators, RBI

Pre-UPI launch

Policy makers felt that existing card payment networks were unable to scale sufficiently to include low-income customers (Cook and Raman, 2019). Hence, to include the unincorporated, RuPay debit card was launched by NPCI on 26th March 2012. To incentivize early adopters, NPCI offered free insurance (Cook and Raman, 2019); however, the initial response was unenthusiastic (Shukla & Rebello, 2015). The number of RuPay debit cards at the end of July 2014 was 23 million of the total 435 million cards (Tripathy, 2014). In August 2014, the union government launched a financial inclusion scheme – Jan Dhan Yojana – through public sector banks¹⁴, which helped diffusion of RuPay cards; for example, Shukla & Rebello (2015) point that of the 603 million debit cards in October 30, 2015, 222 million were RuPay of which 170 million were issued as a part of Jan Dhan.

At the same time, RBI was of the view that debit cards carried lower risk than credit cards, hence, MDR for debit card transactions should not be the same as that for credit cards. In its efforts to increase the usage of card payments, in September 2012, RBI regulated MDR for debit card transactions at 0.75 % ($\leq$ Rs 2000) and 1% ($>$ Rs 2000), which impacted a significant part of the market and its corresponding cash flow.

Impact of RuPay cards and changes in MDR regulations on PoS transactions – volume and value – is evident from figure 1. Huge increase in issuance of debit cards from August 2014 implied higher average monthly growth rate – transactions volume and value – for P2 (Table 2). Between April 2012 till March 2016, difference between the average transactions volume per PoS for debit cards and that of credit cards kept on increasing; while, average transactions value for debit cards lagged well behind than that for credit cards (Table 3). For every RuPay PoS transaction the issuer bank had to pay just 60 paise,

¹⁴ Public sector banks were mandated to issue only RuPay cards.

while the acquirer bank had to pay only 30 paise to NPCI¹⁵. By November 2015, RuPay already had 20 per cent market share of the 10 million transactions per day with an increasing trend (Shukla & Rebello, 2015).

One can safely assume that the initial investments of card networks would have been to increase the market size. Till 2012, card neutral MDR charges may have been instrumental in funding or investing in market formation activities. Though CP started in India from the early 1980s, India had among the lowest average per capita PoS in 2012; this was because procurement cost of PoS machine was Rs 8000-12000 with operational cost of Rs 3000-4000 per year (Visa, 2016). This indicates the challenges faced by market participants in market formation. The above three interventions – introduction of state supported domestic card and network, regulating MDR for debit cards, and low charges for the state supported network – made the business environment uncertain for stakeholders.

Zywicki (2000) notes that in the operating costs of credit card networks – servicing accounts, soliciting new customers, processing merchant credit card receipts, fraud protection, maintenance of infrastructure account for 60 per cent while cost of funds is 27 per cent of total cost. Executives from Visa & Mastercard were vocal against the above interventions¹⁶, as it not only reduced the cash flowing through their networks but also their share of the reduced cash flow. The average MDR for debit cards prior to regulation was 1.5% (Das et al., 2010), if we assume that all debit cards transactions were charged MDR of 1 per cent from October 2012 till March 2016¹⁷, this implies Rs 2087.25 crores was not collected. This left lesser cash in hands of stakeholders to invest and expand the

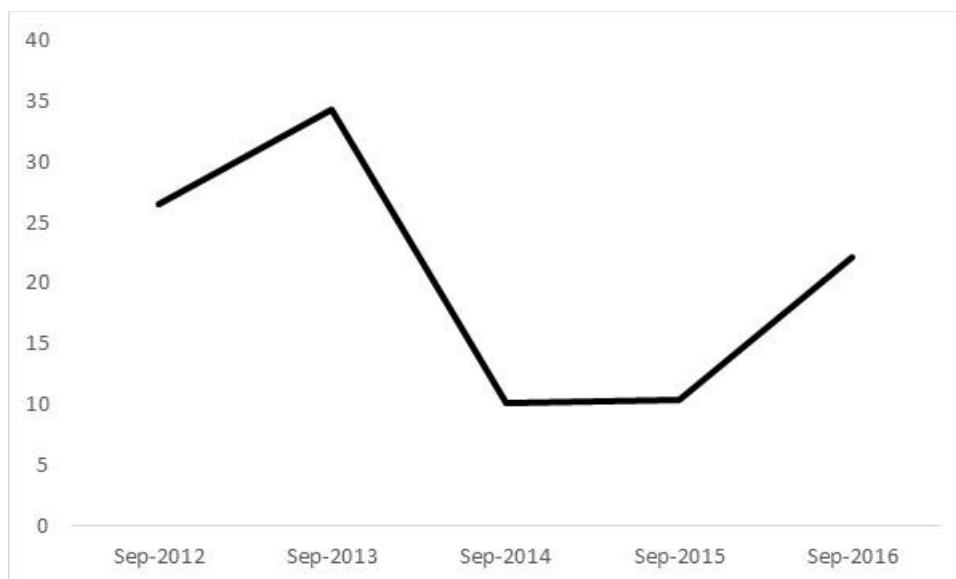
¹⁵ This may be equivalent to the quarterly fees paid by banks to Visa & Mastercard.

¹⁶ See Shukla & Rebello, (2015).

¹⁷ As per Payment systems indicators, RBI, a total of Rs 417450.9871 crores of debit card transactions occurred during this period.

market, which led to deceleration in the rate of diffusion of acceptance infrastructure – PoS machines annual growth rate fell for 2014 and 2015 (Figure 3).

Figure 3: PoS annual growth rate (%)



Note: Sep 2012 implies growth from Sep 2011 till Sep 2012.

Source: Calculated from Payment systems indicators, RBI

Post-UPI

To increase debit card transactions, RBI made some changes in MDR rates and slabs in 2017, another MDR regulation based on merchant size was introduced in 2018¹⁸, the government also announced in January 2020 that RuPay network will not charge MDR. Change in regulations could not sustain the average monthly transactions volume and value per PoS of cards as competition from UPI intensified, leading to lower market share for card payments.

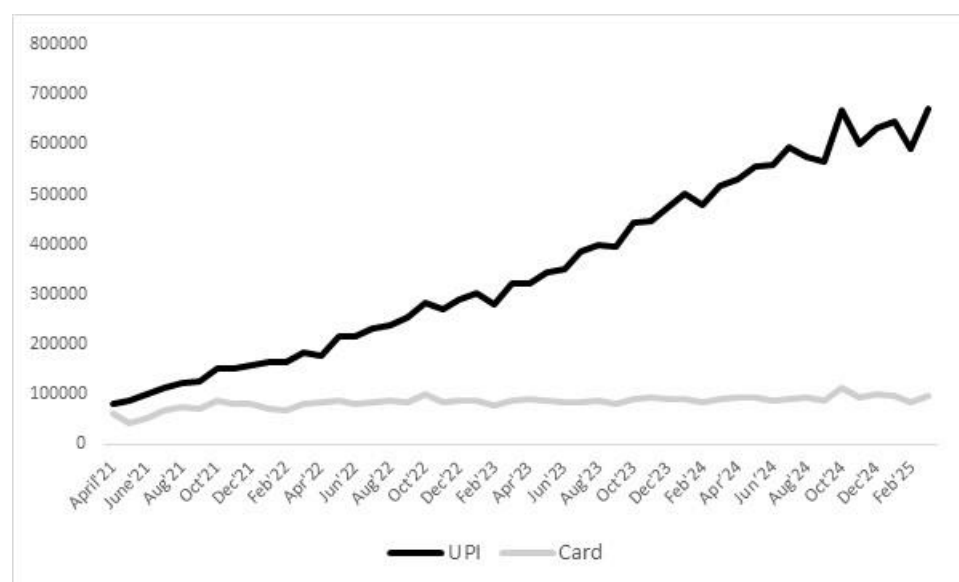
In P3, UPI sucked out the average monthly volume and value growth of PoS debit card payments; credit cards, on the other hand, have been able to grow both in terms of

¹⁸ Refer Table 4, Iyer (2025) for more details.

average monthly volume and value (Table 2). Few factors that would have helped credit card growth were, market was relatively small, customers could have opted for multiple credit cards, also, marketing activities of RuPay credit cards that were launched in December 2016 along with the 2022 regulation allowing RuPay credit card transactions through UPI helped RuPay credit cards grow faster than others. Till October 2019, both average monthly transactions volume and value per PoS for debit cards have increased impressively with volume doing much better than value. On the other hand, average monthly transactions value per PoS for credit cards has remained the same during this period, while the average monthly volume transactions per PoS has seen a 11 per cent drop (Table 3).

From the early part of this decade monthly UPI peer-to-merchants (P2M) payments started substituting monthly card PoS (Figure 4).

Figure 4: Monthly UPI P2M vis-à-vis monthly Card PoS, April 2021-March 2025 (Rs.crore)



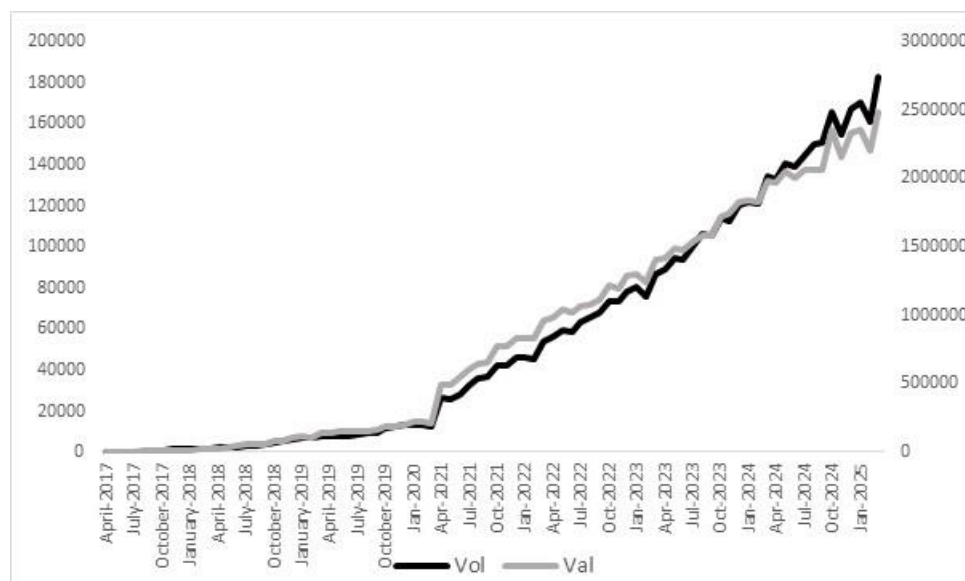
Source: NPCI for UPI and Payment systems indicators, RBI for Card PoS.

During this period, with a compounded monthly growth rate (CMGR) of 4.4 per cent UPI P2M payments have seen stellar growth while Card PoS have seen steady CMGR of 0.9 per cent.

3.2 UPI

By the time NPCI was established, most of India's banks were electronically networked. In its initial years, NPCI introduced the Immediate Payment System (IMPS) which offered customers of two different banks to transact electronically in real time. Customers who had their mobile numbers registered and generated an id with their banks, could use their mobiles for an IMPS transaction. IMPS experience helped NPCI design UPI with mobile phones at its core. NPCI ensured that UPI technology was based on technologies that had already diffused both on the bank side and on the customer/merchant side. Since banks had their limitations, to maximize reach of UPI, NPCI allowed non-banks to participate; hence, initially, banks were reluctant to adopt it. However, efforts by NPCI and the government in promoting UPI, led to surge in demand among consumers, and banks onboarded UPI. Figure 5 shows the exponential trend of monthly volume and value of UPI for P3.

Figure 5: UPI monthly volume (lakhs) and value (Rs.crore)



Note: LHS is volume and RHS is value; 2016-17 & 2020-21 not included.

Source: NPCI & Payment systems indicators, RBI

For UPI, merchants paid an MDR of 0.3 per cent till December 2019, after which no MDR was charged. As figure 5 indicates there has been a structural shift towards UPI payments after December 2019. For example, number of UPI transactions that was 72 lakhs in April 2017 reached 13084 lakhs in December 2019 with a CMGR of 17.6 per cent, value of these transactions during the same period grew from Rs 2271 crores to Rs 202520 crores at a CMGR of 15.1 per cent. Average value per transaction during this period fell more than half from Rs 3155 to Rs 1548 at CMGR of (-)2.2 per cent. From January 2020 till March 2025, number of UPI transactions increased from 13050 lakhs to 183015 lakhs with a CMGR of 5.4 per cent, value of these transactions during the same period grew from Rs 216243 crores to Rs 2477221 crores at a CMGR of 14.3 per cent. Average value per transaction during this period fell around 18 per cent from Rs 1657 to Rs 1354 at CMGR of (-)1.8 per cent.

The share of merchant payments in total UPI payments for the total period (July 2016-March 2024) is not available. However, data from April 2021 – March 2024 indicate a preference for P2P payments (avg value share 77 per cent; avg vol share 49 per cent). Average value share of P2M though less than a quarter of total UPI payments are way higher than card PoS payments (Figure 4).

In the next section we argue that the increasing popularity of UPI vis-à-vis card payments is a result of the market structure, which has been impacted by multiple important factors.

4 Impact of Technology Design, Complementary Markets, Regulation, and State Intervention on Market Structure

4.1 CP

Technology design

In CP exchange of information between stakeholders is critical for a successful transaction. The advent of telecommunication infrastructure allowed faster transactions and settlements but increased the capital-intensity of the technology. For this technology to be commercially relevant, network externalities and payment guarantee extended to merchants played an important role, which further increased costs and acted as entry barriers. Thus, CP technology design allowed for few market players or networks. Globally, the duopoly of Visa & MasterCard networks dominates this market.

Complementary markets

Several complementary markets hold the key for diffusion of CP. For example, CP networks approach customers through banks, a well diffused bank network could lead to

more customers. Growth of bank network has been slow (Table 4) during CP's initial two decades in India, however, growth has been rapid during 2012-22.

Table 4: Number of commercial bank branches

Year	Rural	Semi-urban	Urban	Metropolitan	Total
1982	20401	8809	5693	4274	39177
1992	35269	11356	8279	5666	60570
2002	32380	14747	10477	8586	66190
2012	33716	26528	18219	20102	98565
2022	53164	42352	27506	28291	151313

Source: RBI

Fraud detection system of CP networks is based credit information of merchants and consumers; lack of a readymade market for such credit information will necessitate collection of such information, which will slow down diffusion. Existence of competitive markets for telecommunication and other infrastructure (eg. PoS) required for CP technology will reduce costs for all the stakeholders and accelerate diffusion. However, as table 5 shows tele-density in India picked up pace only in the second decade of 2000s, indicating its high cost from 1980 till 2000s. We have already commented on the high cost of PoS in India, it can be safely be assumed that the situation for other CP infrastructure may have been the same.

Table 5: Tele-density per 100 population

Year*	Tele-density
1992	0.67
2000	2.82
2008	26.22
2018	93.27
2025	85.04

* As on 31st March.

Source: Indiatat.com

Thus, in its initial decades CP network lacked competitive complementary markets which held back its growth.

Regulation

For CP, till 2012, as mentioned above, RBI encouraged card adoption and did not regulate Visa & Mastercard payment network charges, hence, networks were able to execute their market strategies and fund their market formation activities. To accelerate diffusion of debit cards from September 2012, RBI started regulating rate MDR of debit cards based on value of transactions. From January 2018, regulations on MDR rate were based on merchant turnover; in addition, the state ruled that merchants should not be charged MDR for RuPay transactions below a threshold and the government will partly reimburse to banks the loss in MDR; this partial re-imburement was stopped within a few years. Even the recent regulation of allowing only RuPay credit card transactions through UPI has had uneven effects on market participants.

Change in regulations not only create cash flow problems for businesses & banks, but also lead to an uncertain business environment, both of which have hindered market formation activities for all stakeholders (figure 3, for eg.).

State Intervention

NPCI was encouraged by the state to launch a domestic debit card 'RuPay' in 2012. Despite a free insurance incentive, initial acceptance of the card was tepid; however, by tying a welfare scheme with a bank account, the state ensured diffusion of RuPay card in large numbers, making RuPay a substantial player in debit cards. Thus, the debit market structure changed from a duopoly to an oligopoly with three participants.

A similar story has played with RuPay credit card that was launched in December 2016. Exclusive UPI transactions for RuPay credit accelerated its diffusion and changed the market structure from a duopoly to an oligopoly with three participants.

4.2 UPI

Technology design

NPCI built UPI on technologies that had already diffused. Banks were accustomed to using IMPS to complete transactions and ensure settlement. IMPS was available on mobile phones; hence, many bank account holders used this service. From the account holders' perspective, UPI was a significant step forward as mobile phone apps could be used to transfer money without noting the recipient's bank account number. NPCI made this possible by using open standards and application programming interface (API) specifications to facilitate online payments using two messages – one for authentication, other for authorization – which dramatically improved customer's ease of use. Non-bank

firms' capable of developing a UPI application were also allowed to become a part of the payment ecosystem, this multiplied the number of apps available for UPI transaction, improving access for the customer.

Complementary markets

By 2012, most of the banks were already electronic networked. When NPCI launched IMPS, few of these banks grabbed the opportunity to be a part of it. With time the number of banks in IMPS network has increased (Table 6).

Table 6: Number of member banks for IMPS transactions

Year	Number	Year	Number
2014*	60	2020	573
2015	81	2021	638
2016	134	2022	644
2017	236	2023	713
2018	341	2024	867
2019	498	2025	945

* As on 31st March.

Source: NPCI

It helped that UPI was based on IMPS, which automatically onboarded these banks to UPI. As per NPCI, as on March 31st 2024, 661 banks were live on UPI.

Diffusion of mobile phones in India accelerated post 2003 (Table 7), as can be seen mobiles reach almost 90 per cent of the population. It can be assumed that most of the adults may own at least one mobile phone. Thus, marketing UPI as a mobile phones application was a masterstroke as it would help them transact digitally. Those who owned mobile phones but never used it to transact digitally may have been persuaded to

use UPI by seeing someone use it. This is the typical hardware and software part of diffusion that is widely discussed in diffusion models.

Table 7: Wireless subscribers in India in million

Year	Number	Year	Number
2000*	1.9	2013	867.8
2001	3.58	2014	904.51
2002	6.54	2015	969.89
2003	13	2016	1033.63
2004	33.69	2017	1170.18
2005	52.23	2018	1183.41
2006	90.14	2019	1161.81
2007	165.11	2020	1157.75
2008	261.07	2021	1180.96
2009	391.76	2022	1142.09
2010	584.32	2023	1143.93
2011	811.59	2024	1165.49
2012	919.17	2025	1163.76

* As on 31st March.

Source: Indiatat.com

As mentioned above, to maximize reach, UPI model allowed non-bank firms, especially fintech and ICT¹⁹ firms to collaborate with banks. Once again, this turned out to be a great strategy; given the amount of customer transaction data UPI apps would generate, many firms developed their apps and marketed them extensively to consumers and merchants.

¹⁹ ICT – Information communication technology.

Consumers could freely download apps, while merchants received QR codes at no cost; for ease of merchant use, at a nominal monthly cost, few firms also provided voice acknowledgement machines with their QR codes. It is estimated that number of merchants accepting UPI has touched 32 crores²⁰. Iyer (2025) notes that these non-bank firms charge a commission for bill payments and recharge facilities, and few of them are in profits. Table 8 gives a snapshot of the impact this strategy for the past few years.

Table 8: UPI apps transaction for the month of March

Year	Number of Apps [#]	Market share of top 3 (value)
2021	53	93.4
2022	65	--
2023	68	93.97
2024	65	92.56
2025	81	91.86

- At the very least

Source: NPCI

Though the top 3 apps enjoy a significant value market share, competition from other apps seems to be on the rise.

Regulation

The government without consultation with stakeholders announced that from January 2020 there would be zero MDR on UPI transactions. This, undoubtedly increased transactions. However, RBI (2022) notes out that for a P2M transaction of ₹800, stakeholders collectively incur a cost of ₹2. Banks and NPCI bear much of this cost with

²⁰ Refer <https://www.moneycontrol.com/technology/rupay-s-credit-card-market-share-rises-to-12-percent-in-2024-transaction-volume-growing-20-monthly-article-12916512.html>. Accessed on 24 October 2025.

no direct²¹ avenue for reimbursement, this, implies lesser money for investment in their infrastructure to serve the exponential growth in transaction volumes.

State Intervention

NPCI based UPI on technologies that had already diffused and used open-source standards to remove entry barrier at the consumer end and ensure maximum participation. Non-banks collaborated with banks and built apps for end-consumer use and marketed them extensively. Banks and non-banks competed for market share in UPI transactions. Thus, state intervention here facilitated competitive markets.

4.3 Discussion

We use a summary of the relative impact of factors on CP and UPI (Table 9) to link it to analytical framework of the study. In case of cost to consumers, for CP, technology design and complementary markets increase (C_i^c) whereas regulation and state intervention push in the opposite direction; for UPI, all the four factors tend to decrease (C_i^c). This implies among the two, $(C_i^c)_{\min}$ is achieved by UPI. In case of cost to merchants, impact of factors is the same as that in case of cost to consumers, hence, UPI attains $(C_i^m)_{\min}$.

²¹ Banks have other indirect avenues, such as, holding savings deposit interest rate low, monetizing customer data, etc.

Table 9: Relative impact of factors on costs to consumers, costs to merchants, and profits to payment system providers

Factor	Costs to consumers		Costs to merchants		Profits to PSP	
	CP	UPI	CP	UPI	CP	UPI
Technology design	↑	↓	↑	↓	↓	↑
Complementary markets	↑	↓	↑	↓	↓	↑
Regulation	↓	↓	↓	↓	↓	↓
State intervention	↓	↓	↓	↓	↓	↓

PSP – Payment system providers; ↑ - increases; ↓ - decreases.

For P_i^{is} , we have seen that for both CP and UPI, regulation and state intervention efforts have been towards normal profits. For CP, technology design required that PSPs put efforts to increase the number of consumers and merchants, which implies increased costs and hence lesser profits. In case of UPI, since non-banks have contributed immensely to onboarding of consumers and merchants, profits seem relatively higher, especially given the monetization potential of the data generated. From the time CP was introduced complementary markets have tended to be non-competitive, thus reducing profits for PSP's; on the other hand, UPI was introduced at a time when its complementary markets were relatively more competitive, increasing its profit potential. Ceteris paribus, our analysis informs us that relative to CP, UPI has higher potential to achieve $P_i^{is} \geq 0$ for most of the PSPs in the ecosystem.

5 Conclusion

In this paper, using empirical evidence of usage of card payments and UPI, we have drawn out the importance of technology design, complementary markets, regulation, and state intervention on market structure and hence competition. Based on the UPI experience the paper concludes that if the State desires faster diffusion, then it should own the technology – preferably based on open standards, with a technology design that builds on lower costs in complementary markets. This reduces entry barriers for firms desirous of entering the payment system and increases competition. From the card payment system, the paper infers that state supported player entry coupled with rules/institutions aligned with the state's goals creates uneven playing field and uncertainty for stakeholders, which impacts market formation activities of that market and slows diffusion.

About the author

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