# Demonetization as a Payments System Shock under Goods and Financial Market Segmentation: A Short Run Analysis

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28 May 2019

# Demonetization as a Payments System Shock under Goods and Financial Market Segmentation: A Short Run Analysis

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**Abstract**

A surprise demonetization, where certain or all denominations of currency notes cease to be legal tender on a short notice, can be understood as a severe payment system shock requiring agents to immediately shift to alternative payment mechanisms. I use a short-term macroeconomic model based on Willamson (2009) featuring goods and financial market segmentation to analyze the effect of such a shock in an economy with substantial informality and cash dependence. The quantitative characterization of the equilibrium dynamics using a deterministic example shows significant level as well as redistributive effects in the very short run. The households with access to formal financial markets experience an increase in consumption and those without such access experience a decline. Most of these effects come from differential access to formal financial markets as a consumption smoothing mechanism.

Keywords: demonetization, segmented markets, payments systems.

JEL Codes: E26, E42, E52

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# 1 Introduction

The announcement by the Prime Minister of India on November 8, 2016 that deemed ₹ 500 and ₹ 1000 currency denominations illegal as tender is what is usually referred to as "demonetization" in case of the Indian economy. Many developing countries have engaged in such policies where certain or all denominations of currency notes were declared illegal to be used as payments. [1]. In India the denominations that were demonetized in 2016 constituted 86% of currency in circulation at that time. This together with the fact that significant proportion of transactions in India are cash based, the policy announcement brought the economy to a literal halt. As people scrambled to their banks to exchange their old currency notes for new ones, they also resorted to using alternative payment mechanisms to pay for their purchases. In fact, the shift in the government's narrative from controlling corruption to moving the economy to digital payments or 'less-cash' economy in the days following the initial announcement may be partly in response to the persistent cash shortage.[2]

It took about two years for the currency in circulation to be back to the pre- November 2016 level (see Figure 1). Thus, demonetization was not only a major surprise shock to the payments system of the Indian economy, but also a significantly protracted one. To understand the short term effects of this massive and persistent policy shock, this paper uses a macroeconomic model that features assets and goods market segmentation. I adapt the model in Williamson (2009) to represent economic characteristics and structure of a typical developing economy with large informal sector and heavy dependence on cash as a method of payment. This paper could be thought of as a technical extension of Waknis (2017).

# 2 Market Segmentation in the Indian Economy

A typical developing economy like India can thought of being constituted by two groups of households and firms. One group of households and firms that uses formal finan-

[1] For an interesting historical example, see https://scroll.in/article/821406/demonetisation-lessons-how-tughlaqs-unplanned-currency-change-in-14th-century-india-led-to-chaos

[2] See (Rai (2016)) for how the narrative of the government changed in the months following demonetization.

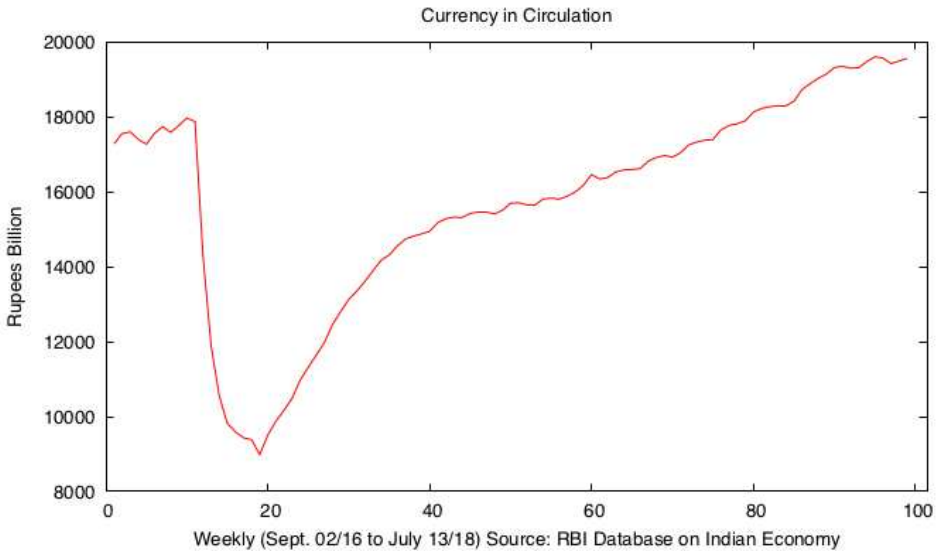



Figure 1: Behavior of Currency in Circulation in India

cial markets for financing consumption and working capital and investment respectively. The other group of households and firms use informal financial markets for financing consumption and working capital and investment respectively. They also use cash more intensively than the first group. Following, Williamson (2009), I call the first group as the 'connected households and firms' and the second group as 'unconnected households and firms'.

The connected and unconnected dichotomy may also manifest in goods markets. For example, connected households may be more likely to shop at shopping malls or chain market stores (More, Big Bazaar, etc) as well as online (Big Basket, Grofers, Amazon, etc) compared to unconnected households. Given that the suppliers of goods and services to such stores are most likely the connected firms, this implies that goods and services produced by connected firms will be bought by connected households more than by unconnected households. Financial market segmentation could also further goods market segmentation where formal financial intermediaries sell financial services to connected consumers to finance their purchases from connected businesses [3].

The connected- unconnected distinction or segmentation could further be extended

[3]The author, who works in the formal sector and uses formal financial markets to smooth consumption, has experienced several episodes of credit cards being offered or marketed while shopping at various shopping malls in Delhi and other cities in India.

Table 1: Market Segmentation in India

| Connected Sector | Unconnected Sector |
|---|---|
| Organized sector firms and households supplying labor and capital to them | Unorganized sector firms and households supplying labor and capital to them |
| Use formal financial markets to manage liquidity | Use informal financial markets to manage liquidity |
| Use electronic payments systems to finance purchases | Use cash to finance purchases. |
| Represents 25-30% of non-agricultural workforce | Represents 70-75% of non-agricultural workforce |

to the organized/unorganized or formal/informal sector. There is considerable overlap between organized and formal sector and unorganized and informal sector respectively. As argued by (Ghani, Kerr, and Segura, 2015, pp.2), "Establishments in the unorganized sector in India are unregistered, do not pay taxes, and are generally outside the purview of the state, which closely parallels common definitions of the informal sector in other countries". Therefore, the terms informal and unorganized as well as formal and organized can used interchangeably. Applying the definition of connected and unconnected firms to this distinction then implies that informal or unorganized firms would mainly constitute the unconnected firms, while the formal or organized firms would constitute the connected forms category. Table 1 gives the general distinctive features of these two groups of households and firms in the Indian economy. This division is also in line with the survey of literature and stylized facts about informal labor and credit markets in Batini, Kim, Levine, and Lotti (2011).

In reality, there may be or is some overlap in these two sectors. For example, many small and medium registered enterprises would be a part of formal sector but may depend on informal financial markets and cash to finance working capital. For simplicity, we assume that such overlap is not quantitatively significant to start with. This assumption can be relaxed later.

This paper is related to the literature on asset market segmentation and monetary policy that grew out of Grossman and Weiss (1983), Lucas (1990), and Rotemberg (1984). In these models monetary policy has real effects despite prices being flexible and this

is a result primarily arising out of asset market segmentation. The key innovation in Williamson (2009) is to integrate the literature on asset market segmentation, goods market segmentation and payment system economics. Payment system research deals with "the interaction between decentralized media of exchange (fiat money) and centralized payment arrangements."((Williamson, 2003, pp.476)). Examples of this research include Freeman (1996), Temzelides and Williamson (2001), and Nosal and Rocheteau (2006).

There have been several journalistic articles and shorter research papers published since November 2016 dealing with different aspects of the demonetization and its effects using economic models.[4]. Chodorow-Reich, Gopinath, Mishra, and Narayanan (2018) present an analysis of demonetization using several datasets arguing that it caused decline in economic activity and therefore cash was essential for Indian economy. The paper closest to this one in spirit and substance is Bajaj and Damodaran (2018) which looks at the effects of digitization and demonetization in a shadow economy model based on Lagos and Wright (2005) and Gomis-Porqueras, Peralta-Alva, and Waller (2014). In their model, demonetizing legal tender comes at a short run cost and can potentially improve welfare but only in the presence of multiple equilibria.

The remainder of this paper is organized as follows. Section 3 presents the model, Section 4 discusses the experiment using a deterministic example. Section 5 provides some concluding thoughts and directions for future research.

# 3 The Model

The economy is populated by a continuum of infinitely-lived households with unit mass indexed by $i \in [0,1]$. The household is constituted by a seller and a continuum of consumers with unit mass. The consumer is indexed by $(i,j)$ with $j$ uniformly distributed on the interval $[0,1]$. The household's preferences are given by:

$$E_0 \sum_{t=0}^{\infty} \int_0^1 log[c_t^i(j)]dj \tag{1}$$

The 't' is the time index and $c_t^i(j)$ is the consumption of consumer $j$ from household $i$ with each household residing at separate location. Out of the total households, $\alpha$ gives the

[4]See Ramakumar (2017)-an edited volume of all the articles published on demonetization and black economy in the *Economic and Political Weekly* over years including after the November 2016 episode.

Table 2: Probabilities faced by households

| Goods sold by | Connected Consumer | Unconnected Consumer |
|---|---|---|
| Connected Seller | $1-(1-\alpha)\pi$ | $\alpha\pi$ |
| Unconnected Seller | $(1-\alpha)\pi$ | $1-\alpha\pi$ |

proportion of connected households. $\pi$ governs the interaction between connected and unconnected households. If $\pi < 1$, then among the households arriving at a connected location to buy goods, higher proportion will be connected households than would be observed on an unconnected location. In other words, when $\pi < 1$, the probability that a connected household trades with a connected one is higher and similarly for the unconnected household. Therefore, $\pi$ also captures "the degree of preference of consumers for goods produced by their own type or the degree of local preference" Williamson (2008). At $\pi = 1$, the population of consumers is identical in composition across locations during shopping or we can think of it as the consumer's preferred good being a random draw. Given these parameters, the following table gives the probabilities for the trades that each of the connected and unconnected households would possibly engage in.

All goods are sold on credit with goods exchanged for IOUs. There are N networks in the economy indexed $i = 1,2,3,...,n$, with member of household $i$ only able to communicate with other households in network $i$ and $i+1$ (modulo N). With probability $\gamma_t$, a seller meets a consumer from his network $i$ and with probability $1-\gamma_t$ a counsumer from network $i+1$. When the seller meets a consumer, she can identify if the consumer is from a connected or an unconnected household. If the seller and consumer belong to the same network then transactions takes place on a *net settlement* basis. On the other hand, if the seller and the consumer belong to different networks, transactions take place on a *cash settlement* basis. The law of large numbers then implies that each seller will sell a fraction $\gamma_t$ consumers from her own network and to $1-\gamma_t$ consumers outside the network. Therefore, $\gamma_t$ also signifies the "net settlement" rate in this economy.

Within network transactions are netted out and payment is made or received in outside money during the same period depending on the net debt position of the household.

Once, the within network debt is settled, outside network transactions are settled with outside money in the next period through cash settlement. Therefore, there is a delay in at the central bank crediting households for receipt of outside money. As described in (Williamson, 2009, p.347),

> a sale of goods in a net settlement transaction results in a within-period credit that can be used to finance consumer expenditure by the household during the period. However, a sale of goods in a cash-settlement transaction yields outside money balances that cannot be spent until the next period.

The connected and unconnected households differ primarily in terms of their participation in the formal financial markets. The connected households hold a bank account with a bank that has reserve account with the central bank. This allows the banks in connected households to convert currency into reserve balances with the central bank. These households also buy and sell bonds and access within period central bank credit. After goods market transactions are over and before the clearing and settlement process begins, the connected households trade with the central bank exchanging three objects- reserve balances, within period central bank credit, and one period nominal bonds. The connected household receives reserve balances at the beginning of the period and repays $r_t$ units of reserve balances at the end of period for each unit borrowed. A one period nominal bond allows the household to earn $R_{t+1}$ units of reserves balances in period $t+1$. The unconnected households, on the other hand, do not trade with any bank or the central bank and hold and use outside money as currency.

Batinietall survey of informal goods and credit markets.

## 3.1 Budget and Finance Constraints

The above description about the financial participation of the households contingent on their being connected or unconnected implies that the households will be optimizing their utility subject to two constraints: a budget constraint and a finance constraint. While the budget constraint states that total expenditure should be less than or equal to income, the finance constraint is similar to a cash in advance constraint. It not only spells out all the available payment mechanisms available to a household to finance its expenditure but also reflects the feature of the model that income from cash settlement transaction is

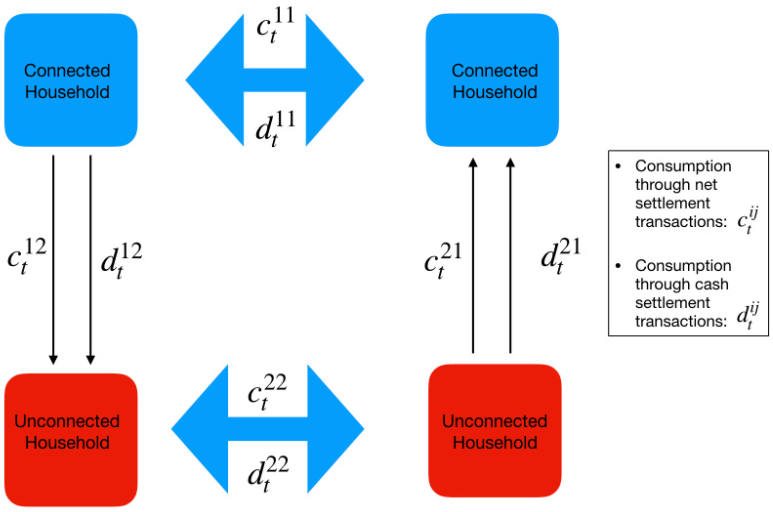



Figure 2: Transactions between households

available for use only in the next period. These constraints will look a little different for each household depending on whether it is connected or unconnected.

The set of transactions that can occur in this economy populated by connected and unconnected households is given by Figure 2. The connected households are indexed by the superscript 1 and the unconnected households by 2. $c_t^{ii}$ denotes consumption through net settlement and $d_t^{ii}$ denotes consumption through cash settlement. $p_t^i$ and $q_t^i$ are the prices of goods sold in net settlement and cash settlement respectively. $x_t^i$ are the total sales through net settlement for a given type of household.

The following is the finance constraint for the connected household:

$$[1-(1-\alpha)\pi][\gamma_t p_t^1 c_t^{11} + (1-\gamma_t) q_t^1 d_t^{11}] + (1-\alpha)\pi[\gamma_t p_t^2 c_t^{12} + (1-\gamma_t) q_t^2 d_t^{12}] + b_{t+1} \leq s_t m_t^1 + p_t^1 x_t^1 + l_t + R_t b_t - \tau_{1t} \quad (2)$$

and the budget constraint for the connected household is:

$$[1-(1-\alpha)\pi][\gamma_t p_t^1 c_t^{11} + (1-\gamma_t) q_t^1 d_t^{11}] + (1-\alpha)\pi[\gamma_t p_t^2 c_t^{12} + (1-\gamma_t) q_t^2 d_t^{12}] + b_{t+1} + m_{t+1}^1$$
$$\leq s_t m_t^1 + p_t^1 x_t^1 + q_t^1 (y - x_t^1) + (r_t - 1) l_t + R_t b_t - \tau_{1t} - \tau_{2t} \quad (3)$$

Equation 2 states "that total household expenditure on goods and nominal bonds must be financed by the money balances with which the household begins the period, plus the IOUs acquired during the net settlement period" (Williamson, 2009, p.348). On the other hand, equation 3 states that total expenditure on goods, nominal bonds, and the amount of money that the household decides to carry to the next period ($m_{t+1}^1$) cannot exceed total income from various sources.

The following is the finance constraint for the unconnected household:

$$\alpha\pi[\gamma_t p_t^1 c_t^{21} + (1-\gamma_t) q_t^1 d_t^{21}] + (1-\alpha\pi)[\gamma_t p_t^2 c_t^{22} + (1-\gamma_t) q_t^2 d_t^{22}] \leq m_t^2 + p_t^2 x_t^2 \quad (4)$$

and the budget constraint for the connected household is:

$$\alpha\pi[\gamma_t p_t^1 c_t^{21} + (1-\gamma_t) q_t^1 d_t^{21}] + (1-\alpha\pi)[\gamma_t p_t^2 c_t^{22} + (1-\gamma_t) q_t^2 d_t^{22}] + m_{t+1}^2$$
$$\leq m_t^2 + p_t^2 x_t^2 + q_t^2 (y - x_t^2) \quad (5)$$

The fact that unconnected households do not participate in the formal financial market is evident from the terms that are absent in their finance and budget constraints as compared to those for the connected households. Equation 4 states that the unconnected households have the amount of money they start with and IOUs from the net settlement trades to finance their total expenditure on goods. The budget constraint given by equation 5 states that total expenditure by a unconnected household on goods and the amount of money to be carried to the next period cannot exceed the proceeds from net settlement sales, cash settlement sales, and money balances at the start of the period.

Another difference between constraints for connected and unconnected households is the absence of tax terms in that of the later. The unconnected households do not pay taxes as is typical of households and firms from the informal sector.

### 3.1.1 Government

Government finances its interest expenditure through lump sum taxes keeping the aggregate net quantity of nominal government bonds constant. The budget constraint for the government is given as:

$$\alpha M_{t+1}^1 + (1-\alpha) M_{t+1}^2 = s_t \alpha M_t^1 + (1-\alpha) M_t^2 - \alpha B_{t+1} + R_t \alpha B_t - (r_t - 1)\alpha L_t - \alpha \tau_{1t} - \alpha \tau_{2t} \tag{6}$$

The taxes financing the interest expenditure of the government are levied in a way not to have any distributional consequences. The expressions are as follows:

$$\tau_{1t} = (R_t - 1) B_t + (s_t - 1) M_t^1 \tag{7}$$

$$\tau_{2t} = -(r_t - 1) L_t \tag{8}$$

The choice variables for the government are $(s_t, B_{t+1}, L_t, \tau_{1t}, \tau_{2t})$ at the beginning of period $t$. The gross interest rates $r_t$ and $R_t$ are determined by the market and the money supply by the equations above.

## 3.2 Equilibrium

**Definition 1.** A competitive equilibrium for this economy consists of quantities and allocations $(x_t^i, c_t^{ii}, d_t^{ii})$ and prices $(p_t^i, q_t^i, r_t, R_{t+1})$ such that:

1. Households maximize their utility function (equation 1) subject to the respective budget and finance constraints.
2. Markets for goods at connected and unconnected locations in net settlement as well as cash settlement clear.
3. Markets for assets clear.
4. Government satisfies its budget constraint in equation 6.

Solving the optimization problem for the households gives the following equilibrium equations. [5]

$$q_t^i = \frac{\psi_t^i}{y\omega_t^i}[(1-\gamma_t)\omega_t^i + \gamma_t] \tag{9}$$

$$p_t^i = \frac{\psi_t^i}{y}[(1-\gamma_t)\omega_t^i + \gamma_t] \tag{10}$$

$$x_t^i = \frac{\gamma_t y}{(1-\gamma_t)\omega_t^i + \gamma_t} \tag{11}$$

for i=1,2. Where

$$\omega_t^1 = \beta s_{t+1} z_t^1 E_t(\frac{1}{z_{t+1}^1}) \tag{12}$$

$$\omega_t^2 = \beta z_t^2 E_t(\frac{1}{z_{t+1}^2}) \tag{13}$$

Consumption allocations are given by:

$$c_t^{ij} = x_t^j \frac{z_t^i}{\gamma_t \psi_t^j} \tag{14}$$

$$d_t^{ij} = (y - x_t^j)\frac{z_t^i}{(1-\gamma_t)\psi_t^j} \tag{15}$$

In the above equilibrium solutions, $z_t^1$ is the nominal expenditure by a connected household and $z_t^2$ by an unconnected household in period t. These are given by:

$$z_t^1 = \frac{[1-\gamma_t(1-\alpha\pi)][M_t^1 + B_t - B_{t+1} + L_t] + (1-\alpha)\pi\gamma_t M_t^2}{(1-\gamma_t)[1-\gamma_t(1-\pi)]} \tag{16}$$

$$z_t^2 = \frac{\alpha\pi\gamma_t[M_t^1 + B_t - B_{t+1} + L_t] + (1-\gamma_t[1-(1-\alpha)\pi])M_t^2}{(1-\gamma_t)[1-\gamma_t(1-\pi)]} \tag{17}$$

[5] Solution details available on request.

Given the above definitions of $z_t^1$ and $z_t^2$, the nominal expenditure on goods produced by a connected and an unconnected household is represented by $\psi_t^1$ and $\psi_t^2$ respectively. These are given by:

$$\psi_t^1 = [1-(1-\alpha)\pi]z_t^1 + (1-\alpha)\pi z_t^2 \quad (18)$$

$$\psi_t^2 = \alpha\pi z_t^1 + (1-\alpha\pi)z_t^2 \quad (19)$$

A monetary policy is a stochastic process for $B_{t+1}, L_t, s_{t+1}{}_{t=0}^{\infty}$ given $B_0 = 0$ and satisfying

$$M_t^1 + B_t - B_{t+1} + L_t > 0$$

and $1 \leq s_{t+1} \leq R_{t+1}$ for all $t$, which then determines a stochastic process for $M_t^1, M_t^2{}_{t=0}^{\infty}$ given $M_0^1$ and $M_0^2$.

# 4 Demonetization- A Deterministic Example

Along with being a massive one time wealth shock, demonetization also acted as a severe payment systems shock that forced people away from using cash to alternative non-cash payment mechanisms. These alternatives could include localized credit arrangements, use of *paytm* or other digital wallets, as well as debit and credit cards. As the unconnected households do not participate in formal financial markets, they would have been restricted to localized credit arrangements as payment mechanisms to finance their purchases. However, in this model such credit arrangements are ruled out.

In terms of the model, if the demonetized currency as proportion of total currency in circulation is significant, then demonetization becomes equivalent to restricting all transactions to clear on net settlement basis until the economy is successfully and completely remonetized. This can be represented as a one time sharp increase in $\gamma_t$ with an eventual decline as the economy is remonetized. Figure 3 depicts the calibration of $\gamma_t$ that tries to capture this behavior of the net settlement restriction.

Along with the forced net settlement requirement, the treatment of money balances that the households hold and choose to carry forward also needs careful consideration.

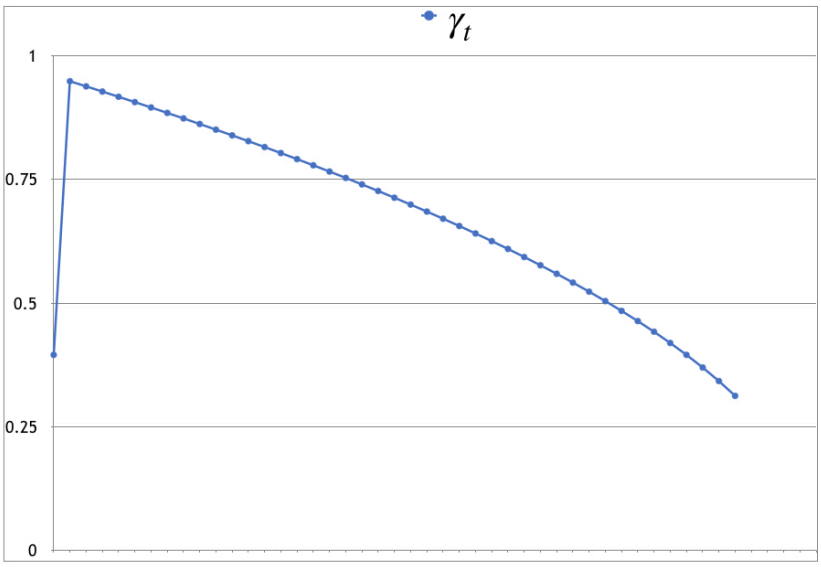



Figure 3: Calibrating $\gamma_t$

The demonetization announcement destroyed the value of 86% of currency in circulation (See figure 1 above). Assuming that the unconnected household would be the ones that we're affected the most by this announcement, I allow $M_t^2$ to fall drastically at first only to steadily recover over the period of simulation. More specifically, both $M_t^1$ and $M_t^2$ start at same level and then keeping $M_t^1$ constant, I allow $M_t^2$ decline initially and then recover according to the following equation estimated using the data on currency in circulation.

Letting $M_t^c$ be currency in circulation in period $t$ (See Appendix B for details.),

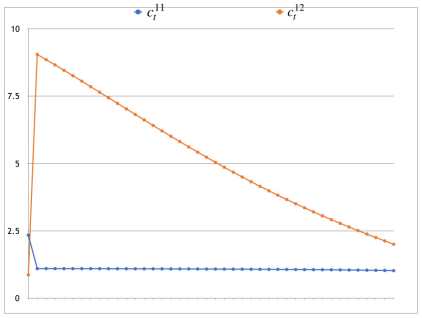
$$M_t^c = \underset{(354)}{148} + \underset{(0.0200)}{0.992}\, M_{t-1}^c \tag{20}$$
$$T = 98$$
$$R^2 = 0.969$$

Suppose $\beta = 0.96$, $\pi = 0.2$, $\alpha = 0.5$, $s = 1.05$, and $B_t = L_t = 0$ for simulating the deterministic example. Figure **??** below gives the calculated responses of different variables to the demonetization announcement implemented as described above.

We can see that for a connected household, consumption from net settlement purchases from another connected household ($c_t^{11}$) falls and then stays at a lower level for the period of simulation (approximately 45 weeks). On the other hand, consumption from net settlement purchases from an unconnected household ($c_t^{12}$) shoots up and then steadily declines as the net settlement restriction is relaxed. From panel c in Figure **??**, it can be seen that the level decline in $c_t^{11}$ seems to be compensated by a level increase in consumption from cash settlement purchases from other connected households, $d_t^{11}$.

For an unconnected household, consumption from net settlement purchases from another connected household ($c_t^{21}$) falls down drastically only to recover marginally while, the consumption from net settlement purchases from another unconnected household ($c_t^{22}$) falls to start with and then increases only to fall with the relaxation of net settlement restriction and remonetization of the economy. This is confirmed by the initial drastic decline and a subsequent steady increase in consumption from cash settlement purchases from another unconnected household, $d_t^{22}$. Despite, these variations in consumption allocations between net and cash settlement, note that in terms of levels, the consumption of connected household remains higher than that of an unconnected household in all the situations.

Both, the price of a net settlement ($p_t^1$) as well as a cash settlement good ($q_t^1$) for the connected household shows a sharp increase and then a sharp decline as the economy remonetizes. However, demonetization forces the initial $\frac{q_t^1}{p_t^1} > 1$ to $\frac{q_t^1}{p_t^1} < 1$ implying net negative interest rate $(r_t - 1)$ on the intra day loans of reserve balances, $l_t$. Given that for this example, $l_t = 0$ this does not affect any of the calculations. The economic implication nonetheless stems from the rise in importance of the net settlement purchases vis-a-vis cash settlement ones as a result of demonetization. In contrast, as the unconnected households do not access formal financial markets, irrespective of the nature of the sale, the cash is available for use only in the next period. Therefore, $p_t^2$ and $q_t^2$ track each other closely over the policy experiment.

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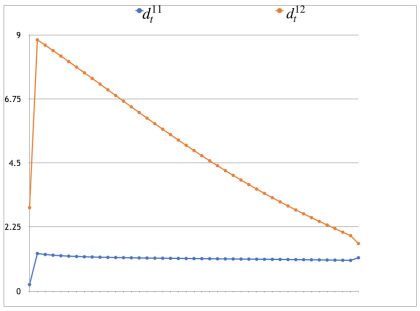


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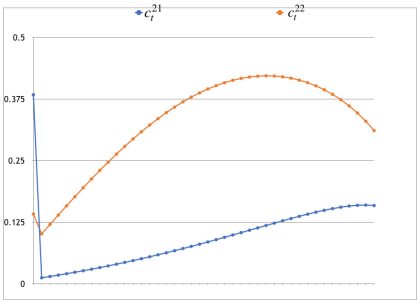


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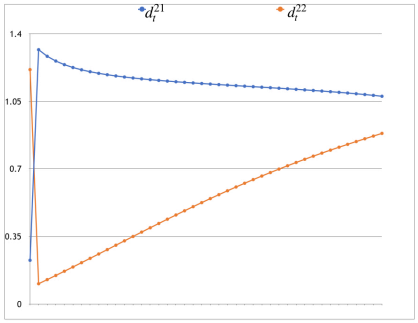


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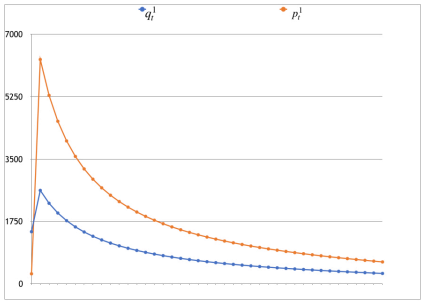


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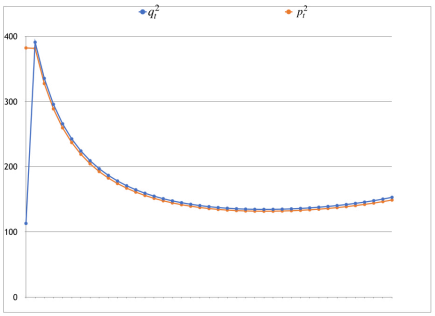


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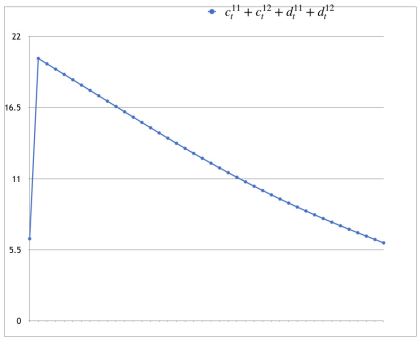


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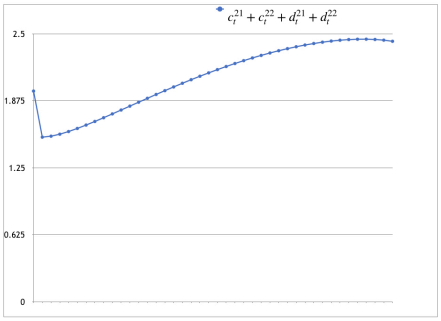



(h)



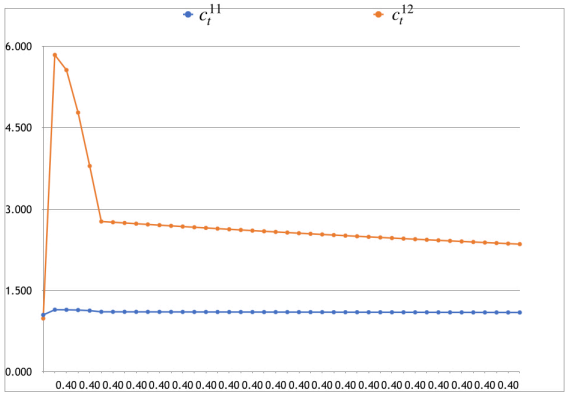
Figure 4: Effects of Demonetization- change in net settlement and money

In general, this being an endowment economy, the transmission of a payments system shock can be expected to play out in the remaining variables. Clearly, consumption from both net and cash settlement experiences variability for both connected and unconnected households. This suggests that households may not have been able to trade all of their endowment as a result of forcing net settlement payment mechanism on the agents in the economy. How has the total consumption behaved for the two groups during this policy experiment?

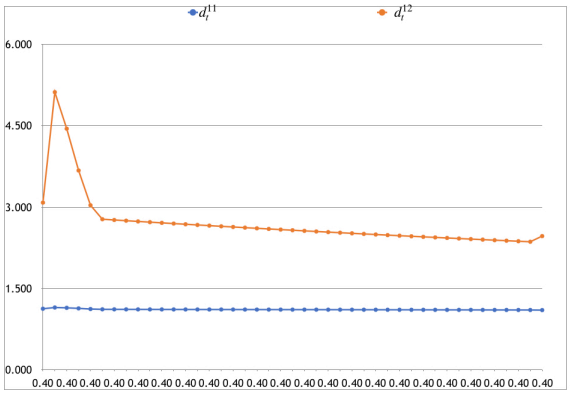
The last two panels in Figure 4 display this behavior of total consumption. Accordingly, the connected households experience a sharp increase in consumption despite the net settlement restriction and then an eventual decline to the pre demonetization level. On the other hand, the unconnected households experience a decline in total consumption initially only to recover slowly. This differential behavior reflects the fact that unconnected households loose the value of their cash balances and regain it only slowly over a period of time. Therefore, they are able to only slowly increase their consumption as new cash becomes available through remonetization. The connected households on the other hand can use their accounts with the central bank for net settlement without actually requiring cash for settling debt and payments. Thus, the impact on consumption critically depends on ability to smooth consumption through formal financial markets.

These movements also suggest some redistribution of consumption from unconnected households to connected households. This is because demonetization reserved the access to goods and services markets to people using electronic payments systems in the very short leading to the redistribution of consumption away from unconnected households. To the extent, localized credit arrangements substituted use of money, this effect may not have been as stark in reality as suggested by the model. The qualitative nature of the impact predicted by the model nonetheless highlights important mechanisms through which money implements allocations in an economy.

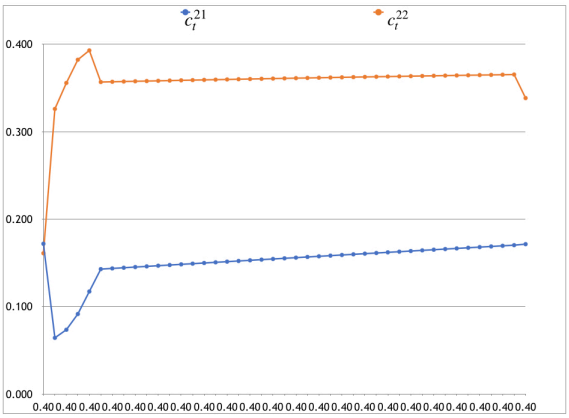
As a robustness check, we also look at the scenario where demonetization manifests only as substantial reduction in the money supply for the unconnected households. As is evident from the first two panels in Figure 5, the connected households experience an increase in consumption in net settlement as well as cash settlement transactions with unconnected households. Both these transactions imply transfer of cash from connected households to unconnected households which is a standard transmission mechanism of money supply shocks in segmented markets models. The next two panels describe the



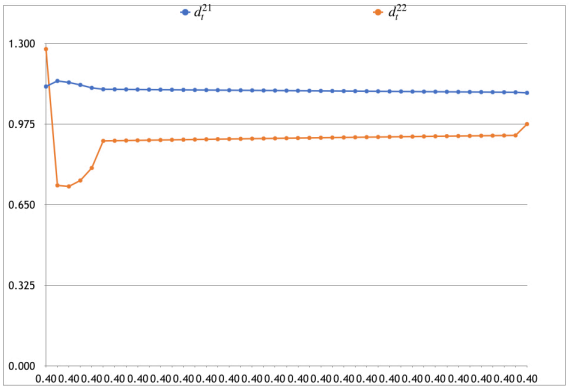

(a)



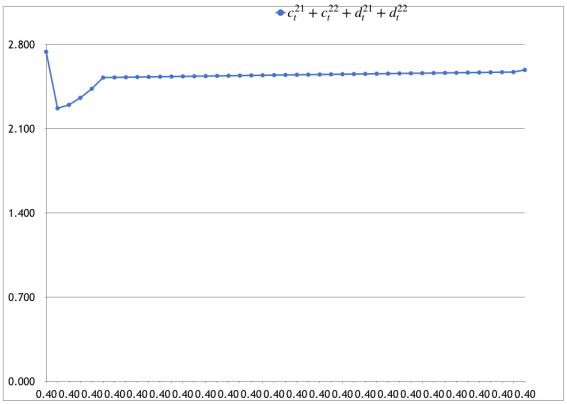

(b)



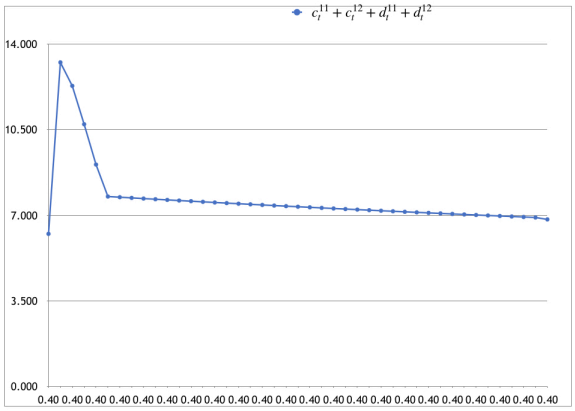

(c)




(d)




(e)




(f)

Figure 5: Effects of Demonetization- change in money for UCH only

behavior of unconnected households. Because the demonetization shock hits these households the most, they experience a decline in consumption from net settlement transactions with connected households. A connected household will not be ready to sell anything to an unconnected household as the later is dependent on cash which is in short supply immediately after the policy shock. On the other hand there is an increase in consumption from net settlements with other unconnected transactions. This could be capturing the dampening effect that localised credit arrangements would have on decline in consumption of these households.

Overall, connected households experience an increase in total consumption immediately after the policy shock and subsequent reversion to its pre-shock levels as economy remonetizes. The unconnected households experience a decline in total consumption immediately after the policy shock and only a partial recovery towards pre-shock level. Thus, considering both the numerical examples above, the most robust finding is an immediate increase in total consumption for connected households and an immediate decline in consumption for unconnected households.

# 5 Concluding Thoughts

In an economy where agents are segmented into two groups based on access to formal financial markets or lack there off making outside money either necessary for payments or not, a payments system shock like demonetization can have substantive real effects. The model above attempts to capture the short run effects of such a policy shock in an endowment economy with goods and financial market segmentation. The households who lack access or do not use the formal financial markets to manage liquidity suffer a temporary fall in consumption, while the households who access formal financial markets to manage liquidity are able to maintain their consumption at or above pre policy shock level. The model suggests some redistribution of consumption from unconnected consumers to connected consumers. The most robust finding is the immediate increase in total consumption after the policy shock for connected households and an immediate decrease for the unconnected households . This differential capacity to smooth consumption suggests that such a payments system shock may not have had a neutral effect on the economy. However, to capture the full effects of demonetization, including production in the above model would be necessary.

# Appendix A Notation Summary:

$p_t^1$ price of a net settlement good for connected household.

$q_t^1$ price of a cash settlement good for connected household.

$p_t^2$ price of a net settlement good for an unconnected household.

$q_t^2$ price of a cash settlement good for an unconnected household.

$x_t^1$ Sales by a connected household in a net settlement transaction.

$x_t^2$ Sales by an unconnected household in a net settlement transaction.

$\tau_{1t}$ nominal lumpsum tax on net settlement transaction.

$\tau_{2t}$ nominal lumpsum tax on cash settlement transaction.

$m_t^1$ starting money balances for a connected household.

$m_t^2$ starting money balances for an unconnected household.

$m_{t+1}^1$ money balances carried to next period by a connected household.

$m_{t+1}^2$ money balances carried to next period by an unconnected household.

$l_t^1$ quantity of within period credit from the central bank.

$r_t$ Gross nominal interest rate on within period central bank loan.

$s_t$ Gross nominal interest rate on reserve balances from period $t-1$ to the beginning of period $t$.

$R_{t+1}$ Gross nominal interest rate on one period government bond issued in period $t$.

$c_t^{11}$ consumption of consumers from connected households from net settlement transaction with other connected households.

$c_t^{12}$ consumption of consumers from connected households from net settlement transaction with unconnected households.

$d_t^{11}$ consumption of consumers from connected households from cash settlement transaction with other connected households.

$d_t^{12}$ consumption of consumers from connected households from cash settlement transaction with unconnected households.

$c_t^{21}$ consumption of consumers from unconnected households from net settlement transaction with a connected household.

$c_t^{22}$ consumption of consumers from unconnected households from net settlement transaction with other unconnected households.

$d_t^{21}$ consumption of consumers from unconnected households from cash settlement transaction with a connected household.

$d_t^{22}$ consumption of consumers from unconnected households from net settlement transaction with an unconnected household.

$\omega_t^1$ relative prices of goods sold in net-settlement transactions to those sold in cash-settlement transactions, in connected markets.

$\omega_t^2$ relative prices of goods sold in net-settlement transactions to those sold in cash-settlement transactions, in unconnected markets.

# Appendix B AR 1 Model for Currency in Circulation

Model: OLS, using observations 2–99 ($T$ = 98)
Dependent variable: CurrencyinCirculation
HAC standard errors, bandwidth 3 (Bartlett kernel)

| | Coefficient | Std. Error | $t$-ratio | p-value |
|---|---|---|---|---|
| const | 147.795 | 353.708 | 0.4178 | 0.6770 |
| CurrencyinCirculation_1 | 0.992094 | 0.0199887 | 49.63 | 0.0000 |

| | | | |
|---|---|---|---|
| Mean dependent var | 15769.21 | S.D. dependent var | 2854.882 |
| Sum squared resid | 24452609 | S.E. of regression | 504.6927 |
| $R^2$ | 0.969070 | Adjusted $R^2$ | 0.968748 |
| $F(1,96)$ | 2463.408 | P-value($F$) | 2.99e–70 |
| Log-likelihood | −747.9927 | Akaike criterion | 1499.985 |
| Schwarz criterion | 1505.155 | Hannan–Quinn | 1502.077 |
| $\hat{\rho}$ | 0.628839 | Durbin's $h$ | 6.350763 |

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