Distributed Ledgers

Design and Regulation of Financial Infrastructure and Payment Systems

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E-Payments, E-Messages, and Trusted Third Parties in Payment Systems

In this chapter we compare and contrast Thailand to Sweden and then put Kenya in between as home of an impressive innovation in e-payments with measured, documented welfare gains. The point is that gains can be large even for mundane systems using components of distributed ledger technology (DLT), gains that remain to be harvested in many low-income and developing countries.

4.1 Thailand and the Predominant Use of Paper Currency

In emerging markets, such as those in Southeast Asia, 55% to 90% of all payment transactions are conducted through physical cash payments, fiat money provided by the central bank. The ratio of currency to gross domestic product (GDP) is 11.37 for all of Thailand, the fourth highest among countries listed in a 2015 study (Rogoff 2016). Based on currency and coin outstanding and measurement income and consumption in GDP, Thailand is estimated to have individual per capita currency holdings equal to seven months of consumption, on average. Asian countries have a high ratio of currency to GDP relative to the rest of the world, generally.

Alvarez, Pawasutipaisit, and Townsend (2018) use data that were gathered monthly in the Townsend Thai project,

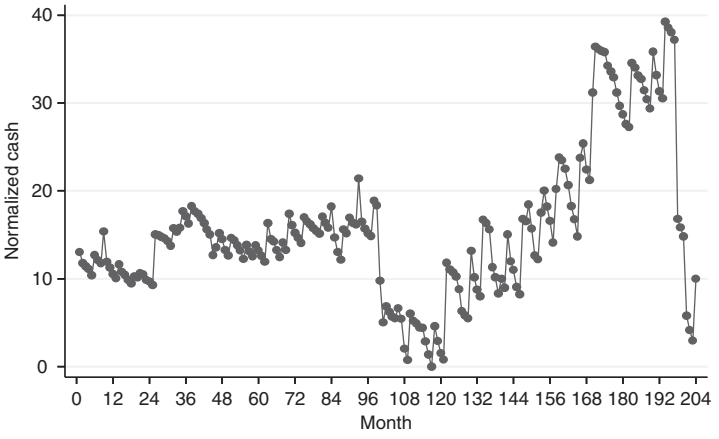

Figure 4.1
Illustrative movement of currency balances for a selected household. Erratic but increasing levels of currency over time, with sharp drop at the end.
Source: Townsend Thai Project (2019) data.

Table 4.1
Money in terms of monthly consumption.

Means, median, quartiles, and standard deviation of currency balances						
	mean	sd	p25	p50	p75	N
Total	45	37	21	32	57	531

Source: Townsend Thai Project (2019) data.

with consumption biweekly, in 16 villages. See figure 4.1 and table 4.1.

They find that typical households running small businesses use paper currency for small and large transactions, spending on consumption in normal times, with spikes in unusual times for durable goods and rotating savings and credit association (ROSCA) transactions. They receive paper currency from

income in normal times, with spikes coming from land sales, loans, and gifts. The costs of cash mismanagement are calculated to be of the order of magnitude of 2% to 9.5% of monthly consumption. The top end of that range corresponds with fitting the Miller and Orr (1966) model for businesses adding an ingredient, occasional free transactions, as for households in the Alvarez and Lippi (2009) study in Italy. Businesses in the Thai setting are household-run small and medium-sized enterprises (SMEs). The calculation of costs uses an optimized value function from a dynamic program, the minimized discounted present value cost of holding cash. The lower end of the range of costs corresponds with the interest rate on bank accounts multiplied by average cash holdings. Costs are nontrivial even at the low end of the range. This is far higher than estimated costs of business cycles, for example, and does not consider the costs of printing and distributing the currency. There are gains to be had from moving away from paper currency to electronic systems that could allow payment of interest.

4.2 Sweden as an Almost Cashless Society

The Riksbank began in the 1980s to make systematic efforts to shift a large part of the cost of managing paper currency to the private sector, so the private sector would internalize cash management. The number of central bank branches was successively reduced, from one in each province to 20 nationally, and now down to one cash distribution center staffed by eight people. Price distortions were corrected as banks were asked to pay transport costs. The Riksbank's role is limited to printing, transportation to the single cash center, and the destruction of defective and obsolete notes and coins. The private sector has coordinated and allowed interoperability: one credit card network for clearing, one single bank ID, and one mobile application (Swish) for low-value payments, with

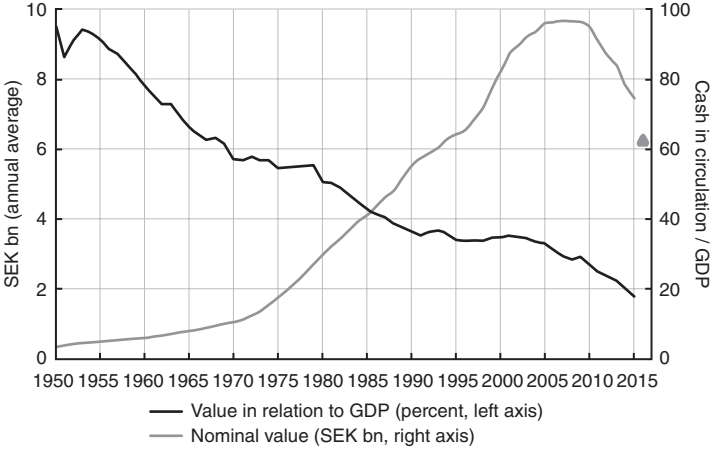

Figure 4.2
Swedish currency (SEK) in levels and relative to GDP.
Source: Statistics Sweden and Sveriges Riksbank (2018).

the single central bank cash center operating as a decentralized wholesaler between banks and the Riksbank (Ingves 2016; Skingsley 2016).

Sweden is currently down to less than 2.5 as a ratio of paper currency per GDP, one of the lowest in the world (see figure 4.2).

Sweden is a highly digitized country, with most transactions occurring in electronic form under debit cards, credit cards, and e-transfers, as reported in a Sveriges Riksbank survey (2018). Card payments per person are among the highest in the world. There are various electronic clearing systems with financial institutions as key nodes intermediating payments: 160 million transactions yearly in the data-clearing system (owned by the Swedish Bankers' Association); 180 million transactions in the Swish system in 2018; 800 million transactions yearly in the Bankgirot system; and 2.2 billion card payments.[1] Not all of these data are public, but they exist in electronic form, obviously.

4.3 Kenya: M-Pesa as an E-Money Innovation with Large Social Gains

Kenya lies midway between currency-intensive Thailand and virtually cashless Sweden. In this context, e-money has had great social value, especially for certain segments of the population. More generally, the potential of new technologies to transform traditional systems is significant. The rate of adoption even among low-income populations is impressive (see figure 4.3).

E-money systems have been endorsed by the Group of Twenty (G20) as an opportunity to build financial markets by constructing new financial systems that increase financial access for large unbanked populations in developing countries (G20 Research Group 2013). Again, the social goal is apparent.

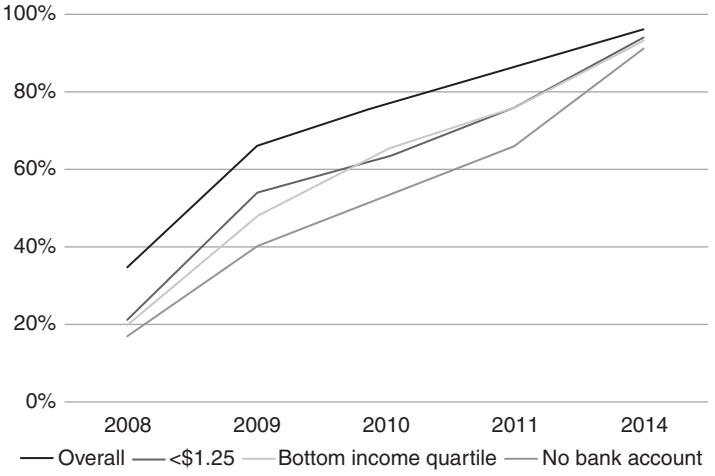

Figure 4.3
M-Pesa adoption rates for the entire Kenyan population as well as for the poor, the lowest income quartile, and those with no bank account.
Source: Jack and Suri (2014) data.

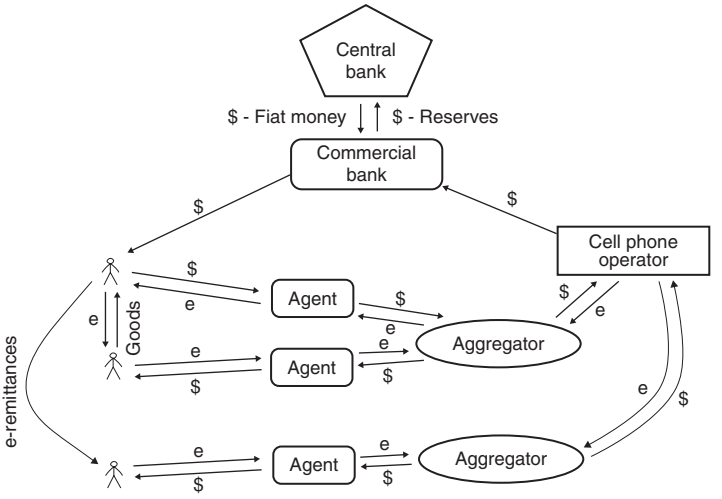

Figure 4.4
A schemata of the operational flows of the Kenyan M-Pesa system. An exchange of Kenya shillings, marked as $, for cell phone credits, marked as *e*, with a Safaricom agent; use of this e-money by the customer for purchases or remittances; and a larger picture of the flows of e-money and the cash throughout the system.
Source: Jack, Suri, and Townsend (2010).

More specifically, M-Pesa is an e-money implemented by Safaricom (see figure 4.4).

Households can go to a company agent and exchange Kenyan shillings for cell phone credits, which can then be used for purchases or money transfers. For example, a migrant worker in Nairobi can send cell-credits back to relatives in the village, where on request an agent there cashes them back into shillings. This is a functional and comprehensive value transfer system in the context of the actual rugged environment of the economy that gave birth to it.

M-Pesa functions as a "stable coin"—that is, with a fixed local exchange rate to fiat currency. Notably, the exchange

between cell accounts and Kenyan shillings is 1–1, apart from a schedule of prespecified transaction costs. These costs are quite low: 6% for tiny values and falling to less than 1% for larger values. This is one-sixth of Western Union's rates and one-twelfth of Postal Pay's rates. In Kenya, Safaricom is a single trusted third party, keeping all of the accounts, though of course customers can see their own accounts and verify that transactions with an agent are happening in real time as requested. The technology uses relatively inexpensive cell phones. Adoption in Kenya among those without bank accounts rose from 20% in 2008 to 90% by 2014.[2]

There is social value to M-Pesa. Studies have shown that M-Pesa aids in economy-wide risk-sharing (Suri 2017). The staggered nature of the rollout allowed a quasi-natural experimental evaluation. Consumption is smoother and more immune from households' specific income shocks. Households are the agents of the general model outlined at the outset. Value can be transferred from households running budget surpluses to those running deficits, for example, and transferred among individual members of a household across regions. Mobile money has also allowed a more efficient allocation of labor and resulted in a meaningful reduction of poverty (Jack and Suri 2014).

Nonbank fintechs such as M-Shwari use M-Pesa to lend to this low-income population, accessing both the record of transactions in a scoring system and using M-Pesa as the payment/repayment medium. There are now over 20 digital credit providers in Kenya.[3] Scoring systems for credit are using the transaction data recorded in M-Pesa.

Yet to be emphasized here, and key to the discussion earlier, Safaricom does not refer to its system as a distributed ledger system. The ledgers are not distributed. They are owned and operated by Safaricom with customers permitted to see individual pieces and make associated approved transactions. Put

another way, customers see Safaricom accounts for balances of their ownership of M-Pesa cell-credits and can verify transfers. Customers could but likely do not keep their own accounts of their currency holdings and transactions. Safaricom has complete accounts for cell-credits for all customers and is the trusted third party running that database. It is trusted not to tamper with and to honor requests for redemption of cell-credits back into currency. Likewise, the e-money M-Pesa is not categorized as a cryptocurrency.

This can be fine. In Kenya, it has worked well so far. One does not need to incorporate all the components of DLT in order for the implementation of a subset of components to have value.

One cannot help but note, though, that Safaricom could be tempted to lend its cash funds and thus would look more like a bank, with fractional reserve banking. Actually its funds are put on deposit in commercial banks and the interest is contributed to charity. The advent of M-Pesa and its approval by Kenya's Ministry of Finance was possible precisely because Safaricom is not classified as a commercial bank. Yet in countries such as Kenya, bank runs and failures are commonplace. For this reason, as they and others began to think about these risks, Safaricom switched to depositing its funds into multiple banks. The point: There are limits to trusted third parties, if not direct then indirect. In some contexts, third-party trust is a real issue for individual institutions and for governments.

4.4 The Role of Broker-Dealers, Shortages, Thin Markets, and Common Concerns about Liquidity in Various Disparate Contexts

Dealers in private e-money and paper currency face shortages of liquidity of one object or another, and this can show up in various ways. Returning to M-Pesa and the example of Kenya, Jack and Suri (2011) surveyed households that used M-Pesa

and the agents that were contractual spatial outposts for Safaricom. As reported in Jack, Suri, and Townsend (2010), agents ran out of one object or the other on a regular basis. Over 60% of agents ran out of e-money anywhere from approximately once a month to multiple times a day. Likewise, close to 50% of dealers ran out of Kenyan shillings. Recall that the exchange is guaranteed to be 1–1 with no variation in prices or transactions fees. Shortages typically occur with fixed prices, of course. In other situations, one might imagine varying prices but with the potentially lingering problems of thin markets (that is, not many participants).

New systems emerge to cope with these challenges. In Kenya, there are transfers and borrowing/lending among Safaricom agents in a kind of informal market, which includes gifts. Interagent markets could be formalized and potentially improved upon, though of course subject to the obstacles of the environment. Here, with costly transport of fiat paper currency, spatial ingredients play an inherent role. While the e-part is virtually instantaneous, paper currency has to get to the agent. No formal system has as yet been designed.

So-called rebalancing is an issue in other developing countries, too. A report by the Helix Institute of Digital Finance (2017) shows that: agents in Indonesia acting on behalf of banks use the nearest bank branch; 51% require more e-float and 23% need cash; and 63% state that they face barriers in managing liquidity, for example, the lack of resources to buy sufficient amounts of cash or float, unpredictable fluctuations in client demand, and time taken to reach the rebalancing point. They want financial support for liquidity management.

In a very different context, in value and location, but quite close conceptually, consider the New York financial market system. There is interbank borrowing and lending of excess reserves and broker-dealers provide liquidity to this market. As documented in Cocco, Gomes, and Martins (2009), the

relationships of traders with dealers who have low correlation in liquidity shocks allow insurance against a shortage of funds. Lagos and Zhang (2018) note the role of liquidity in monetary policy.[4] In this sense, the shortages are a driving force. In this New York context, though, unlike the Kenyan example, the market consists entirely of e-objects. Plus, there are continuing innovations; see Li and Schürhoff (2012) and Hendershott and Madhavan (2015). Still, problems remain; there is considerable scope for improvements in the e-infrastructure systems that are used today.

Likewise, functioning cryptocurrency exchange platforms should be integral rather than peripheral to the debate about tokens and distributed ledgers. They function quite differently. Brokers in markets can provide liquidity through implicit insurance but are, potentially, charging usurious markups and committing fraud. The most popular cryptocurrency exchanges, such as Coinbase, Binance, and Kraken, are implemented as centralized exchanges, thus offering an ironic contrast with so-called decentralized coins. These crypto-exchanges rely on traditional technology, where customers can access and trade using e-mail and simple passwords. This is what has led to hacking episodes. However, contemporary decentralized exchanges using DLT technology, which include 0x, Protocol, AirSwap, and OmiseGO, are thought by some to be difficult to use, have limited capability, and display low volume (Glazer 2018).

In conclusion, innovation in financial infrastructure may be possible. On the other hand, there may not be inherent contradictions, as tokens and exchanges fulfill different economic functions: one to provide record of ownership and the other to facilitate exchange. It is an advantage of economic analysis that we can draw these distinctions, getting beneath the hype. A core issue is whether or not new distributed ledger–based trading platforms lower clearly identified costs relative to legacy systems.