NBER WORKING PAPER SERIES

MOBILE MONEY: THE ECONOMICS OF M-PESA

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Working Paper 16721
http://www.nber.org/papers/w16721

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
January 2011

We gratefully acknowledge the support and collaboration of Pauline Vaughan and Susie Lonie, and other staff of Safaricom and Vodafone. The first round of the survey whose results are reported here was commissioned by Financial Sector Deepening, a Nairobi-based multi-donor financial sector development programme, on behalf of the Central Bank of Kenya. Later rounds of the survey were funded by the Consortium on Financial Services and Poverty at the University of Chicago. Thanks are extended to Indrani Saran and Suleiman Asman for excellent research assistance, and to Stephen Mwaura of the CBK, David Ferrand and Caroline Pulver of FSD and to seminar participants at MIT Sloan, Safaricom, the Institute for Money, Technology and Financial Inclusion at UC Irvine and Columbia Business School. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 16721
January 2011
JEL No. O16,O33,O55

ABSTRACT

Mobile money is a tool that allows individuals to make financial transactions using cell phone technology. In this paper, we report initial results of two rounds of a large survey of households in Kenya, the country that has seen perhaps the most rapid and widespread growth of a mobile money product – known locally as MPESA – in the developing world. We first summarize the mechanics of M-PESA, and review its potential economic impacts. We then document the sequencing of adoption across households according to income and wealth, location, gender, and other socioeconomic characteristics, as well as the purposes for which the technology is used, including saving, sending and receiving remittances, and direct purchases of goods and services. In addition, we report findings from a survey of MPESA agents, who provide cashin and cashout services, and highlight the inventory management problems they face.

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I. Introduction

Mobile phone technology has reduced communication costs in many parts of the developing world from prohibitive levels to amounts that are, in comparison, virtually trivial. Nowhere has this transformation been as acute as in sub-Saharan Africa, where networks of both fixed line communication and physical transportation infrastructure are often inadequate, unreliable, and dilapidated. While mobile phone calling rates remain high by world standards, the technology has allowed millions of Africans to leap-frog the land-line en route to 21st century connectivity.

Early on in this revolution, cell phone users figured out that they could effectively transfer money across wide distances. Phone companies have long allowed individuals to purchase "air-time" (i.e., pre-paid cell phone credit that can be used for voice or SMS communication) and to send this credit to other users. It was a small step for the recipient user to on-sell the received air-time to a local broker in return for cash, or indeed for goods and services, thus effecting a transfer of purchasing power from the initial sender to the recipient.

In March 2007, the leading cell phone company in Kenya, Safaricom, formalized this procedure with the launch of M-PESA, an SMS-based money transfer system that allows individuals to deposit, send, and withdraw funds using their cell phone. M-PESA has grown rapidly, reaching approximately 65 percent of Kenyan households by the end of 2009, and is widely viewed as a success story to be emulated across the developing world.

This paper provides a description of the service and a review of the potential economic effects primarily at the household level, but also in terms of macroeconomic and monetary aggregates. It then provides a detailed portrayal of patterns of use across urban and rural populations, using data from the first large household survey focused on money transfer services in Kenya.[4]

II. Context

Mobile phones and mobile banking in Kenya

The adoption of mobile phones has occurred at perhaps the fastest rate and to the deepest level of any consumer-level technology in history. Figure 1 illustrates the speed of adoption compared with a variety of product innovations. While cumulative forces are of course important, making it difficult to compare directly across innovations, it is nonetheless informative to note that cell phones have been

[4] Mobile payment systems have also been developed in other developing countries. In the Philippines, Globe Telecom operates GCASH, and in South Africa WIZZIT facilitates mobile phone-based transactions through the formal banking system (Ivatury and Pickens, 2006). Similarly mobile banking technologies have developed in Sudan and Ghana, and in a number of countries in Latin America and the Middle East (Mas, 2009). For related overviews, see also Mas and Rotman (2008) and Mas and Kumar (2008), as well as other publications of the Consultative Group to Assist the Poor, at www.cgap.org .

adopted more than five times as fast as fixed line telephone services, which took 100 years to reach 80 percent of country populations.

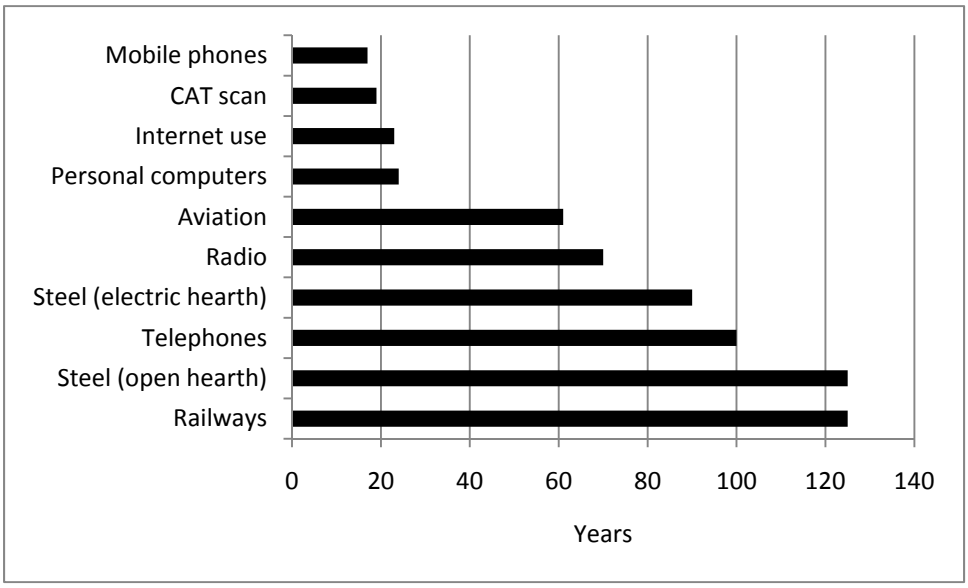

Figure 1: Technology adoption for select innovations (number years to reach 80% coverage)[5]

One of the reasons mobile phone technology has spread quickly is that it has followed other technologies that may have eased the way. Figure 2 confirms this sequencing property is likely at work, at least in the US: many of the new technologies that were introduced before about 1950 (with the exception of radio) were relatively slow to diffuse through the population, whereas those introduced in the second half of the century saw generally steeper adoption rates. Nonetheless, the speed of adoption of cell-phones, especially in the developing world, remains unprecedented.

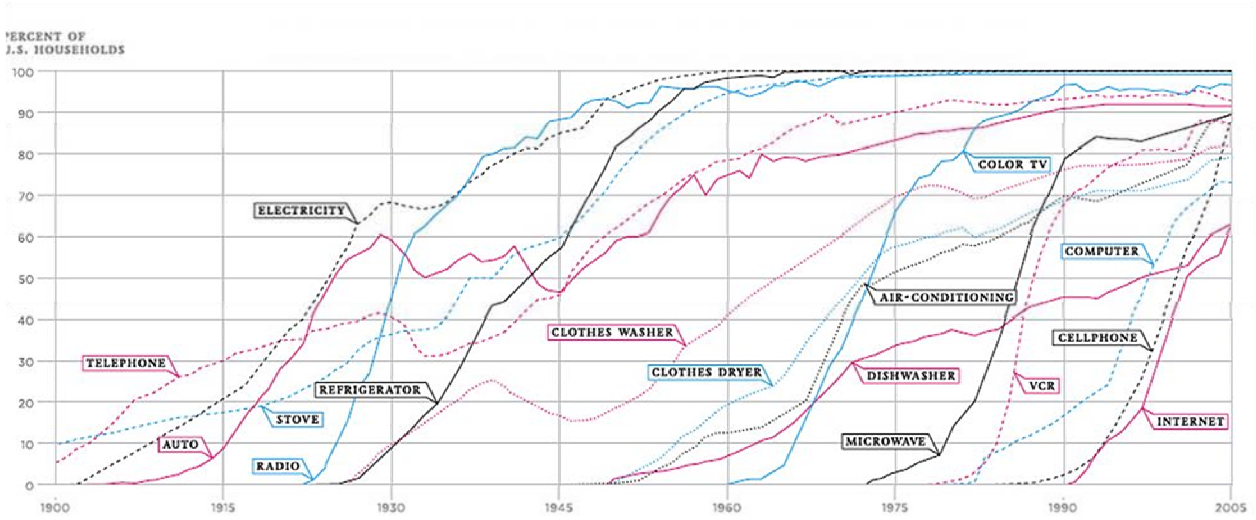

Figure 2: Technology adoption is getting faster[6]

[5] Data from World Bank.

The spread of mobile phone technology has been especially rapid and broad in Africa where penetration rates stood at some 32 percent in 2008, still well below the global average of 60 percent at that time, but much higher than the 7 percent coverage rate that prevailed just four years before. This pattern stands in contrast to the adoption of other technologies such as improved seed and fertilizer, which have been frustratingly weak. Since Solow's (1956) seminal contribution to the theory of economic growth, and following later developments (e.g., Romer 1986 and Lucas, 1988), economists have understood that higher rates of adoption of modern technologies may accelerate the development process.

In Kenya, the first mobile phone companies were publicly owned, and began operations in the mid-1990s on a small scale. Over time, mobile phones in Kenya have eclipsed landlines as the primary means of telecommunication: while the number of landlines had fallen from about 300,000 in 1999 to around 250,000 by 2008, mobile phone subscriptions had increased from virtually zero to nearly 17 million over the same time period (Figure 3).[7] Assuming an individual has at most one cell phone,[8] 47% of the population, or fully 83% of the population 15 years and older, have access to mobile phone technology.

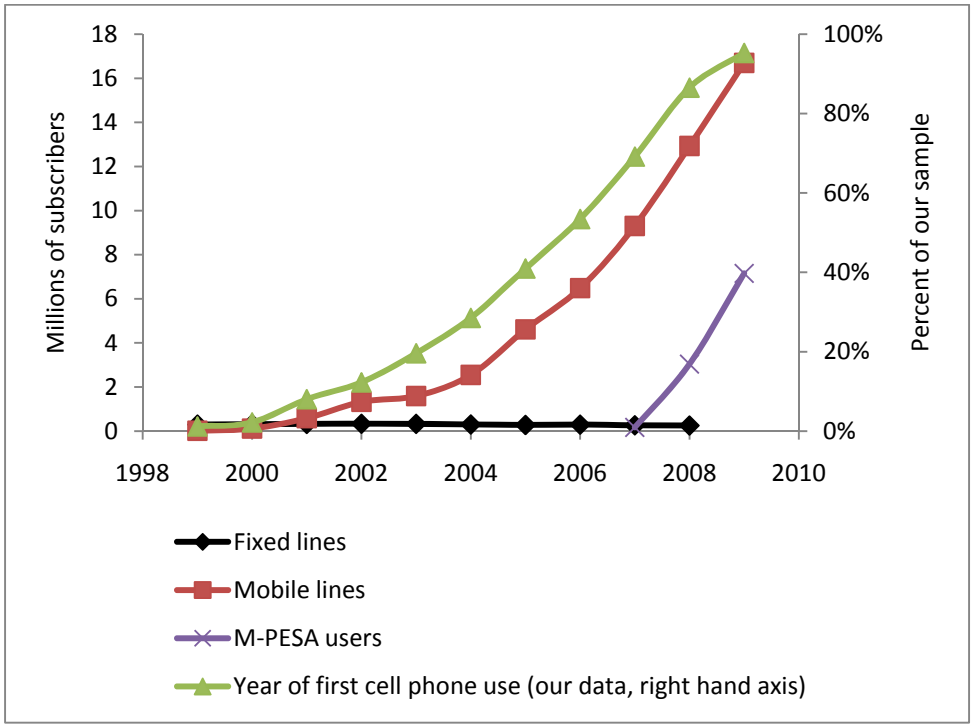

Figure 3: Phone use in Kenya

[6] Source: New York Times, February 10, 2008.

[7] Figure 3 includes information on the share of our sample who had started using a cell phone by year. The evolution of this figure follows closely that from the aggregate data on cell phone use, providing partial validation of our sampling methodology.

[8] This is not quite true, as some individuals own two (or more) phones, so as to take advantage of different tariff policies of the competing providers.

Safaricom, which began operations in 1997, is currently the largest mobile phone operator in Kenya, controlling nearly 80 percent of the market, ahead of its three nearest rivals (Airtel (formerly Zain, and before that Celtel), Yu, and Orange). Recent and prospective entry into the sector is expected to put a squeeze on Safaricom's market share, which some commentators (including its chief executive) expect to fall to around 65 percent over the next 3 to 4 years.[9]

In March 2007, following a donor-funded pilot project, Safaricom launched a new mobile phone-based payment and money transfer service, known as M-PESA.[10] The service allows users to deposit money into an account stored on their cell phones, to send balances using SMS technology to other users (including sellers of goods and services), and to redeem deposits for regular money. Charges, deducted from users' accounts, are levied when e-float or e-money (the currency in which M-PESA balances are denominated) is sent, and when cash is withdrawn.

M-PESA has spread quickly, and has become one of the most successful mobile phone-based financial service in the developing world.[11] The average number of new registrations per day exceeded 5,000 in August 2007, and reached nearly 10,000 in December that year (see Figure 4). By August 2009, a stock of about 7.7 million M-PESA accounts had been registered. There are now about 23,000 agents, and data from late 2009 indicated that even by then more than two-thirds of Kenyan households had at least one member who used the service.

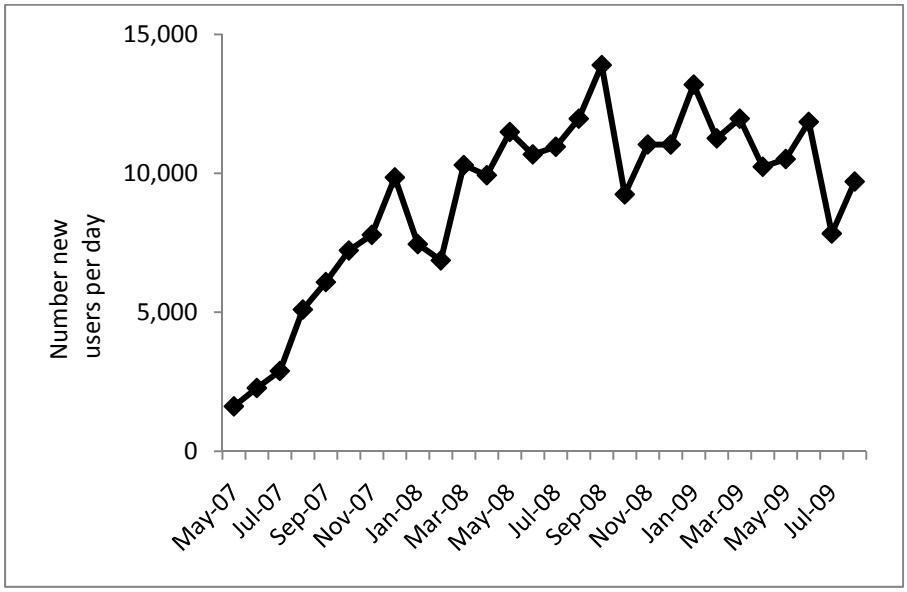

Figure 4: Average daily growth in M-PESA registrations by month

[9] See report by International Telecommunication Union, http://www.itu.int/ITU-D/ict/newslog/Safaricoms+Market+Share+To+Dip+From+80+To+65+As+Competition+Toughens+Kenya.aspx .

[10] Pesa is Kiswahili for "money" – hence M[obile]-Money.

[11] Similar services in Tanzania and South Africa, for example, have penetrated the market much less. See Mas and Morawczynski (2009).

Since the launch of M-PESA, wary of regulation by the Central Bank of Kenya, Safaricom has been at pains to stress that M-PESA is not a bank. On the other hand, the ubiquity of the cell phone across both urban and rural parts of the country, and the lack of penetration of regular banking services,[12] led to hopes that M-PESA accounts could substitute for bank accounts, and reach the unbanked population. Our data, presented in more detail in the next section, suggest this is partially true, although M-PESA has been adopted by both the banked and unbanked in roughly equal proportions.[13]

While the sustained growth in M-PESA registrations is notable, the volume of financial transactions mediated through M-PESA should not be exaggerated. Table 1 reports that the volume of transactions effected between banks under the RTGS (Real Time Gross Settlement] method is nearly 700 times the daily value transacted through M-PESA. On the other hand, the average mobile transaction is about a hundred times smaller than the average check transaction (Automated Clearing House, or ACH), and even just half the size of the average Automatic Teller Machine (ATM) transaction.[14] Thus M-PESA is not designed to replace all payment mechanisms, but has found and filled a niche in the market in which it provides significantly enhanced financial services.

Table 1: Daily financial transactions, Oct 2007 - Sept 2008[15]

	RTGS	ACH	ATM	Mobile
Value per day (billion KSh)	66.3	8.5	1.0	0.1
Transactions per day (thousands)	1.0	39.2	180.2	107.2
Value per transaction (million KSh)	64.67	0.216	0.006	0.003

How does M-PESA work

Although M-PESA does not pay interest on deposits, and does not make loans, it can usefully be thought of as providing financial transaction services and that has operated, until recently, in parallel with the formal banking system.

Safaricom accepts deposits of cash from customers with a Safaricom cell phone SIM card and who have registered as M-PESA users. Registration is simple, requiring an official form of identification (typically the national ID card held by all Kenyans, or a passport) but no other validation documents that are typically necessary when a bank account is opened. Formally, in exchange for cash deposits, Safaricom issues a commodity known as e-float or e-money, measured in the same units as money, which is held in an account under the user's name. This account is operated and managed by M-PESA, and records the

[12] In 2006 it was estimated that 18.9 percent of adults used a bank account or insurance product, and by 2009 this had increased to 22.6 percent. (Finaccess I.)

[13] In the time since our survey was first administered, there has been significant growth in the number of individuals, and households, with a bank account, due to the expansion of such institutions as Equity Bank and Family Bank. In addition, a number of banks have very recently allowed consumers to link their M-PESA and bank accounts. How these changes have affected the relationship between M-PESA registration and access to banking services remains to be seen.

[14] These data refer to a period before M-PESA could be used at ATMs.

[15] Source: Central Bank of Kenya, presentation at conference on Banking & Payment Technologies East Africa, 17-19 February 2009, Nairobi.

quantity of e-float owned by a customer at a given time. There is no charge for depositing funds, but a sliding tariff is levied on withdrawals (for example, the cost of withdrawing $100 is about $1).[16] Figure 5 illustrates the schedule of total net tariffs for sending money by M-PESA, Western Union and Postapay (operated by the Post Office). The M-PESA tariffs include withdrawal fees, and are differentiated according to receipt by registered and non-registered user.

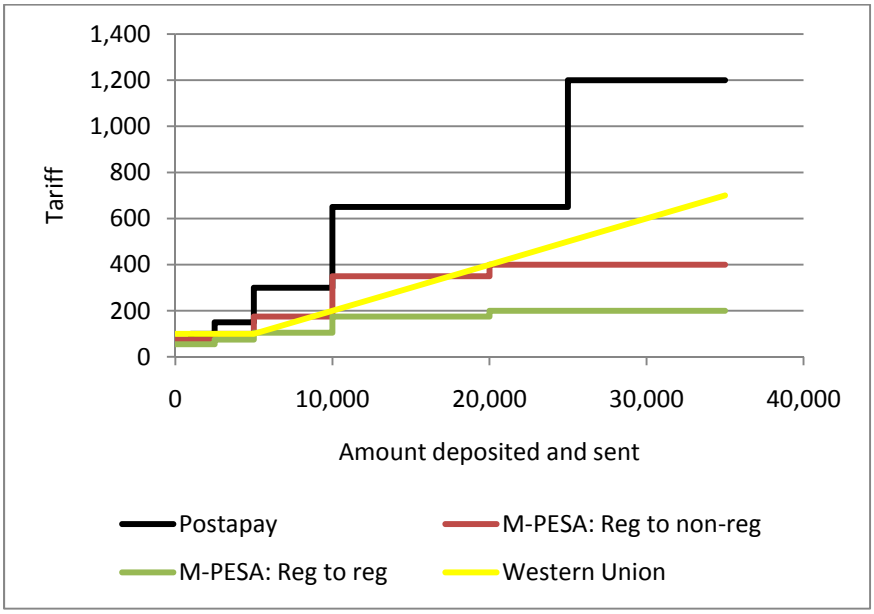

Figure 5: Total net tariff rates for depositing and sending money by Postapay and by M-PESA to a registered user and to a non-registered user

E-float can be transferred from one customer's M-PESA account to another using SMS technology, or sold back to Safaricom in exchange for money. Originally, transfers of e-float sent from one user to another were expected to primarily reflect unrequited remittances, but nowadays, while remittances are still a very important use of M-PESA, e-float transfers are often used to pay directly for goods and services, from electricity bills to taxi-cab fares. The sender of e-float is charged a flat fee of about 40 US cents, but the recipient only pays when s/he withdraws the funds.

Transfers are, of course, subject to availability of network coverage, which has expanded consistently over the past decade. There are now nearly 2,000 Safaricom towers across the country (in addition to towers operated by competing providers), concentrated in areas of high population density. Table 2 gives a breakdown by province, and the most recent network coverage map is shown in Figure 6.

[16] The complete tariff schedule is available at http://www.safaricom.co.ke/fileadmin/template/main/downloads/Mpesa_forms/14th%20Tariff%20Poster%20new.pdf . Fees are charged to the user's account, from which e-float is deducted. Additional cash fees are officially not permitted, but there is evidence that they are sometimes charged on an informal basis by agents.

Table 2: Safaricom cell tower distribution by province

Province	Towers	Population per tower	Area per tower (sq mi)
Nairobi	584	4,872	0.5
Rift Valley	375	22,448	179.0
Coast	247	12,046	130.7
East	214	24,871	288.5
Central	206	19,048	24.7
Nyanza	162	30,771	38.5
Western	90	46,122	35.9
North-East	45	29,467	1,088.8
Total	1923	17,653	117.0

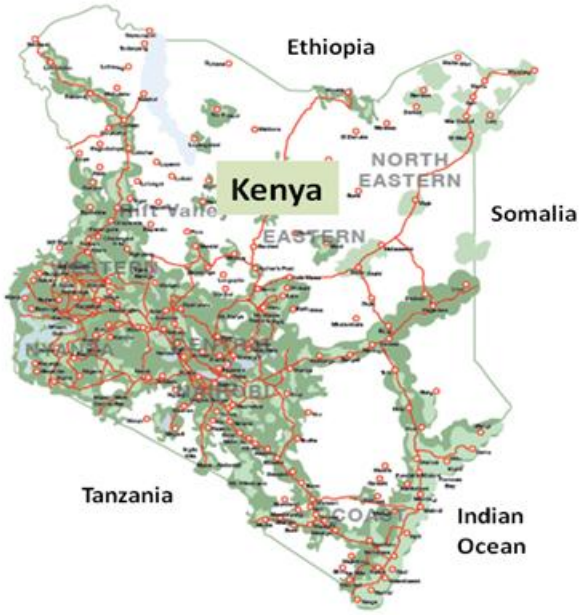

Figure 6: Safaricom network coverage, September 2009[17]

To facilitate purchases and sales of e-float, M-PESA maintains and operates an extensive network of over 23,000 agents across Kenya. As can be seen in Figure 7, which uses data from mid-2009, the growth of this network lagged behind that of the customer base for the first year of M-PESA's operation during which time the number of users per agent increased five-fold, from a low of 200 to a high of 1,000. But from mid-2008, agent growth accelerated and the number of users per agent fell back to about 600 by mid-2009.

Registered M-PESA users can make deposits and withdrawals of cash (i.e., make purchases and sales of e-float) with the agents, who receive a commission on a sliding scale for both deposits and

[17] Source: http://www.safaricom.co.ke/index.php?id=388

withdrawals.[18] M-PESA agents hold e-float balances on their own cell-phones, purchased either from Safaricom[19] or from customers, and maintain cash on their premises. Agents therefore face a non-trivial inventory management problem, having to predict the time profile of net e-float needs, while maintaining the security of their operations.

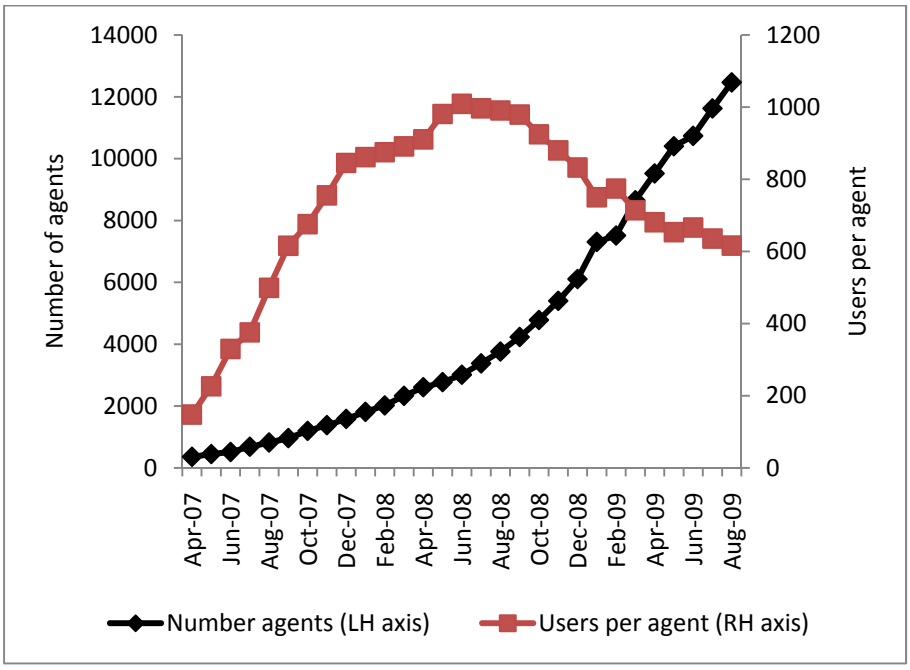

Figure 7: Expansion of the agent network[20]

In practice, agents are organized into groups. Originally, M-PESA required that agent groups operated in at least three different physical locations, so that the probability of imbalances arising within the group could be minimized. There are currently three agent group models in operation. In the first, one member of the agent group (the "head-office") deals directly with M-PESA, while subsidiary agents, which are owned by the head office, manage cash and e-float balances through transactions with the head-office. Both the head office and the agents can transact directly with M-PESA users.

The second model under which agents are organized into groups is the Aggregator model. This model is similar to the first, with the aggregator acting as a head office, dealing directly with Safaricom and managing the cash and e-float balances of agents. However, the agents can be independently owned entities, with which the aggregator has a contractual relationship.

A final and more recent model allows a bank branch, referred to as a "super-agent," to perform as purely an agent for agents. The bank branch can trade cash and e-float with all M-PESA agents, but

[18] The commission amounts are non-linear (and concave) in the size of the transaction. Some reports suggest that in response to this, agents encourage customers to split their transactions into multiple pieces, thereby increasing the overall commission.
[19] M-PESA requires that each agent has a bank account, so that funds can be transferred easily between them.
[20] Source: Safaricom.

unlike the regular and aggregator models, the bank does not trade e-float directly with M-PESA customers.

The super-agent model is one example of the integration of M-PESA services into the banking system. Other developments in this vein have seen users with accounts at certain commercial banks (about 65% of user households in our data in 2009 have at least one bank account – see Table 11 below), being able to transfer funds between those accounts and their M-PESA accounts, both via ATMs as well as directly.

The cash collected by M-PESA in exchange for e-float is deposited in bank accounts, called M-PESA trust accounts. Originally, all funds were held in just one trust account at the Commercial Bank of Africa, but recently Safaricom has opened an account at two other commercial banks to diversify its risk. These accounts are very much like regular current accounts, with no restrictions on Safaricom's access to funds. In turn, the banks face no special reserve requirements with regard to M-PESA deposits, which are treated as any other current account deposit in terms of regulatory policy of the Central Bank. There is no explicit requirement, for example, for Safaricom to give notice of its intention to withdraw "large" quantities of cash at a given point in time. As M-PESA continues to expand, and as these balances grow, the authorities may decide to revisit this arrangement. An alternative approach, adopted in the Philippines, is to institute a 100 percent reserve requirement vis-à-vis mobile banking deposit balances held in accounts at commercial banks. The success of M-PESA has rested in part on the trust that customers have in one of Kenya's most well-respected private companies, the parent. But if faith in the banking system erodes, a run on M-PESA could be sparked, thereby jeopardizing the position of the banks in which it holds deposited funds.

Finally, as M-PESA deposits enter the banking system, they only reduce cash in circulation to the extent that banks comply with or exceed official reserve requirements. But as e-float becomes more widely acceptable as an easily transferable store of value, it will adopt the features of money. The practical implication of this is that M-PESA could increase the effective money supply, with possible impacts on inflation and /or output. Of theoretical interest is the possibility that two monies could co-exist in equilibrium. We will address these issues in more detail in future work.

III. Potential economic impacts on households

M-PESA facilitates the safe storage and transfer of money. As such, it has a number of potential economic effects. First, it simply facilitates trade, making it easier for people to pay for, and to receive payment for, goods and services. Electricity bills can be paid with a push of a few buttons instead of traveling to an often distant office with a fistful of cash and waiting in a long queue; consumers can quickly purchase cell phone credit ("airtime") without moving; and taxi drivers can operate more safely, without carrying large amounts of cash, when they are paid electronically.

Second, by providing a safe storage mechanism, M-PESA could increase net household savings.[21] Third, because it facilitates inter-personal transactions, it could improve the allocation of savings across households and businesses by deepening the person-to-person credit market. This could increase the average return to capital, thereby producing a feed-back to the level of saving.

Fourth, by making transfers across large distances trivially cheap, M-PESA improves the investment in, and allocation of, human capital as well as physical capital. Households may be more likely to send members to high-paying jobs in distant locations (e.g., the capital), either on a permanent or temporary basis, and to invest in skills that are likely to earn a return in such places but not necessarily at home.

Fifth, M-PESA could affect the ability of individuals to share risk. Informal risk-sharing networks have been found to be an important, although not fully effective, means by which individuals spread risk, making state-contingent transfers among group members. By expanding the geographic reach of these networks, M-PESA may allow more efficient risk sharing, although the risk-reducing benefits might be mitigated due to issues of observability and moral hazard when parties are separated by large distances. Jack and Suri (2011) describe the risk sharing impacts it has had in Kenya in more detail.

Sixth, a further risk-related effect arises if M-PESA facilitates timely transfer of small amounts of money. Instead of waiting for conditions to worsen to levels that cause long term damage, M-PESA might enable support networks to keep negative shocks manageable. For example, a household head with access to M-PESA who suffers a mild health shock might receive a small amount of money via M-PESA that allows him to keep his children in school. If this money was delayed, or the sender waited until the recipient "really needed it", the children might have quit school, the effects of which may be hard to reverse.

Seventh, if M-PESA allows households to spread risk, they may be led to make more efficient investment decisions, relaxing the trade-off between risk and return that they would otherwise face.

M-PESA could conceivably alter bargaining power and weaken incentives within households or other networks. Economically weaker family members might expect larger and more regular remittances from better-off city-dwelling relatives, who themselves might find it hard to justify not sending money home. This could weaken incentives for rural household members to work or innovate, offsetting some of the efficiency-enhancing benefits of improved geographic labor allocation and risk sharing.

Conversely, M-PESA could have the effect of empowering certain household members who have traditionally had less bargaining power, in particular women. Especially among poorer segments of the population, remittances and transfers received (and sent) via M-PESA are less visible than those transmitted by other means, such as delivery by a friend or relative. Granted this information advantage, recipients could be in a position to keep more of the funds they receive. Evidence suggesting the spending patterns of women and men differ (see, e.g., Chattopadhyay and Duflo, 2004) then implies that the advent of M-PESA could have real effects on the allocation of household spending. These are issues we hope to explore more fully in future work.

[21] By net, we mean net of losses due to theft, etc.

IV. Survey and data

Survey methodology

In September 2008 we undertook a survey of 3,000 randomly selected households across Kenya. At the time, both cell phone tower and M-PESA agent coverage were very limited in the remote northern and eastern parts of the country, so these areas were excluded from the sample frame. The non-excluded area covered by the sample frame included 92 percent of Kenya's population, and 98 percent of M-PESA agents as of April 2008. We randomly selected 118 locations (the second-smallest administrative unit), in which there were 300 enumeration areas routinely visited by the Kenyan National Bureau of Statistics. Ten households in each enumeration area were randomly chosen to take part in the survey – the GPS-recorded locations of these households are shown in Figure 8. In order to increase our chances of interviewing households in which someone used M-PESA, we over-sampled locations on the basis of the number of M-PESA agents present. All figures presented below have been reweighted accordingly.

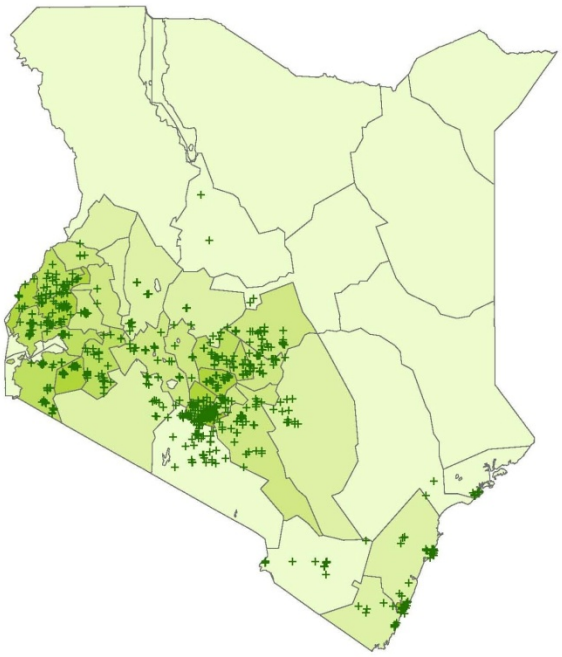

Figure 8: Interviewed households (lighter areas have higher poverty rates)

In 2009, we conducted a follow-up survey which managed to reach 2,016 of the original 3,000 households. For the most part, the statistics presented in this report are based on these 2,016 households. Figures 9 and 10 (directly from Safaricom) show the growth in users of M-PESA and in agents over the period covered by the data (the vertical lines in the Figures indicate the timing of the two rounds of the survey).

From Figure 9, it can be seen that there was a huge increase in the use of M-PESA over the period spanned by the two rounds of the survey. The number of users here is measured by the total number of SIM cards registered to M-PESA. Figure 10 shows a similar expansion in the number of M-PESA agents.

At the time of the first round of the survey, there were just over 4,000 agents across the country, which increased fourfold within a year to reach about 16,000.

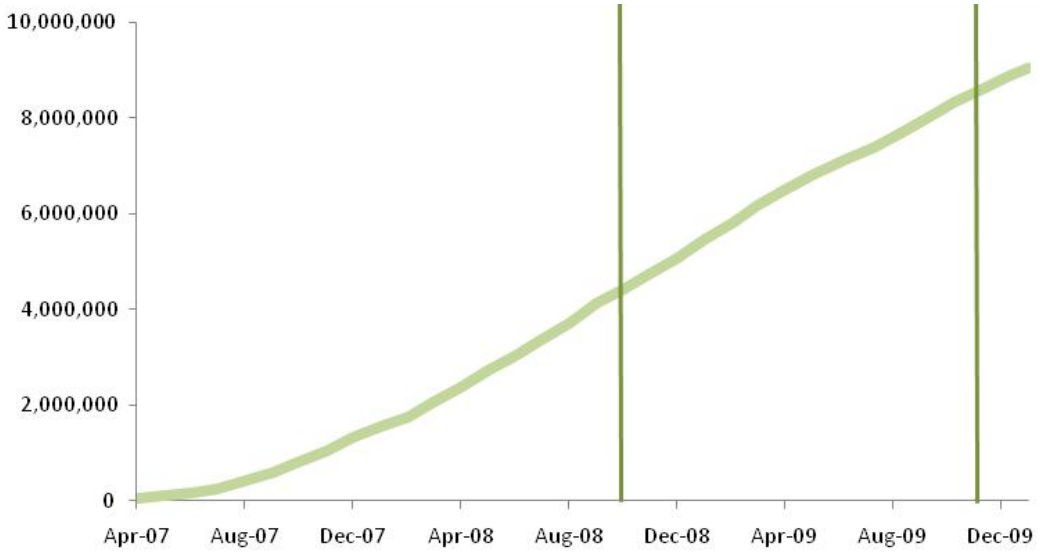

Figure 9: Growth in M-PESA Users

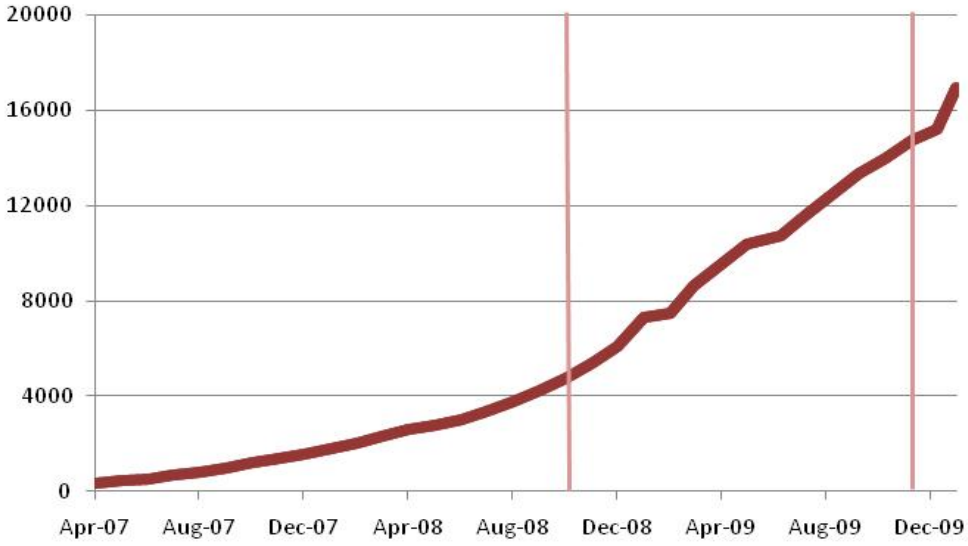

Figure 10: Growth in M-PESA Agents

During the interviews we collected information on basic household composition and demographic data, data on household wealth and assets, consumption, positive and negative shocks, and remittances. We also asked for information on the use of financial services, savings, etc., and collected detailed data on cell phone use and knowledge in general, and use of M-PESA in particular.

Socioeconomic Characteristics

Table 3 reports summary statistics of the households we interviewed, weighted as per our sampling strategy. The upper panel reports the number of M-PESA users in each round: users are defined as those households with at least one member who has used M-PESA for any purpose. The number of MPESA users increased dramatically between the two survey rounds: while in 2008 less than half the households surveyed were M-PESA users (43 percent), by 2009 nearly 70 percent of households were M-PESA users.

The second panel reports household-level income and wealth indicators. In both rounds of the survey, users generally report higher annual expenditures and asset holdings than non-users. However, the composition of each group has clearly changed over time, as the users in Round 2 have lower mean expenditures and assets than those in Round 1. This suggests that while M-PESA use was originally limited to the wealthiest groups, it is slowly being adopted by a broader share of the population. The non-users in Round 2 also appear less well off than those in Round 1, likely because it is the more affluent of them who became M-PESA users by the second round of the survey. However, there appears to have been a decline in expenditures across all households, so it is difficult to parse out the trend and compositional effects.

The numbers in the bottom panel of Table 1 provide further evidence that, by Round 2, a wider cross-section of people had begun to use M-PESA. As might be expected, the percentage of users in the banked population and the urban population increased substantially between Rounds 1 and 2. However, the percentage of users in the unbanked population also increased (from 25 percent in Round 1 to 50 percent in Round 2) as did the percentage of users in rural areas (from 29 percent to 41 percent). Thus, many of those who became users between Rounds 1 and 2 were those in rural areas and those without bank accounts. In addition, the table shows that 52 percent of non-users owned a cell phone in Round 1, while only 39 percent of non-users owned a cell phone in Round2. This suggests that not owning a cell phone is a major constraint to adoption of M-PESA.

Table 3: Household characteristic

	Round1			Round2		
	Non-users	**Users**	**All**	**Non-users**	**Users**	**All**
Number of households	1,143	873	2,016	629	1,387	2,016
Share of total	0.57	0.43	1.00	0.31	0.69	1.00
Income and wealth						
Annual Household Expenditure (KSh)	172,181	305,684	230,005	118,452	245,105	205,599
	(221,960)	(434,581)	(337,712)	(100,437)	(240,852)	(215,626)
Assets (KSh)	77,706	209,769	134,910	55,652	166,478	132,187
	(299,111)	(576,102)	(445,713)	(222,091)	(715,700)	(609,538)
Wealth index	-0.571	0.747	0.000	-0.929	0.416	0.000
	(1.529)	(1.826)	(1.788)	(1.464)	(1.828)	(1.832)
Other characteristics						
Share of households with at least one cell phone	0.52	0.92	0.69	0.39	0.92	0.75
Share of households with at least one bank account	0.34	0.71	0.50	0.23	0.65	0.52
Share of the unbanked population in each category	0.75	0.25	1.00	0.50	0.50	1.00
Share of the banked population in each category	0.38	0.62	1.00	0.14	0.86	1.00
Share of rural population in each category	0.71	0.29	1.00	0.41	0.59	1.00
Share of urban population in each category	0.47	0.53	1.00	0.24	0.76	1.00

Notes: All figures reweighted accordingly. Standard deviations in ( ).

Table 4 shows the proportion of M-PESA user households by annual household expenditure quartiles. As expected, the percentage of households that are considered M-PESA users increases by expenditure quartile. Furthermore, between Round 1 and Round 2, the proportion of M-PESA users increases almost equally for every expenditure quartile suggesting that the new M-PESA user households in Round 2 are relatively evenly divided between the range of socio-economic backgrounds.

Table 4: M-PESA use across household expenditure quartiles

	Round 1			Round 2		
Quartile	**Mean expenditure**	**Max expenditure**	**Fraction of users**	**Mean expenditure**	**Max expenditure**	**Fraction of users**
1	68,871	98,720	0.19	67,579	97,816	0.40
2	122,818	151,144	0.37	122,829	151,492	0.64
3	191,319	245,076	0.53	187,196	235,144	0.79
4	537,384	8,326,328	0.65	445,313	6,365,544	0.93
Total	230,005	8,326,328	0.43	205,599	6,365,544	0.69

Table 5 compares socioeconomic variables for early adopters of MPESA, with those who started using it later and with non-users. Early adopters are defined as those who were MPESA users in Rounds 1 and 2 while late adopters are households that were non-users in Round 1 but became users by Round 2. In the `never' category are non-users in Round 1 who remained as such in Round 2. A clear pattern emerges where the early adopters generally have higher consumption and their household heads have higher education levels than the late adopters, and the late adopters in turn have higher levels of consumption and their household heads higher education than those who never used MPESA.

The same pattern holds for possession of a bank account, and the reverse for using a mattress for saving. This is further evidence that the earliest MPESA users were the wealthiest and most educated, but that over time, it is being adopted by people of more varied socioeconomic levels. The non-users, however, remain the least well off and least educated group.

In addition, saving behavior on M-PESA was compared for the different categories of M-PESA users. In Round 1, about 79 percent of the early adopters saved on M-PESA, and this increased to 89 percent by Round 2. However, a large percentage (70 percent) of the late adopters also saved on M-PESA in Round 2. Thus, households that save on M-PESA by Round 2 are likely to include both early and late adopters.

Table 5: Early vs. Late Adopters

	Round 1			Round 2		
	Never	**Late**	**Early**	**Never**	**Late**	**Early**
Consumption (Ksh)	130,240	210,428	315,365	114,876	201,480	278,136
Bank Account (Anyone in HH)	0.19	0.47	0.72	0.19	0.54	0.73
Mattress (Anyone in HH)	0.82	0.76	0.71	0.89	0.83	0.73
Save on M-PESA (Anyone in HH)	0.00	0.00	0.79	0.00	0.70	0.89
HH Head Years of Education	4.9	7.9	10.2	6.0	8.8	10.5
Other Education (Vocational/Adult/Other)	0.05	0.11	0.17	0.05	0.11	0.18
HH Head Can Read?	0.70	0.88	0.96	0.72	0.93	0.98
HH Head Can Write?	0.66	0.88	0.96	0.72	0.92	0.98

Note: The sample in this table does not include 4% of households that stopped using M-PESA between Round 1 and Round

Table 6 reports demographic data on individuals who were members of the households surveyed, by the individual's M-PESA user status. Note that these statistics are for all adult individuals in the sample, where M-PESA use is defined at the individual level (and not at the household level as it was for the earlier tables).

The average age of both users and non-users is about the same. Although a larger share of the users is male, by Round 2, M-PESA usage is more evenly divided between genders. Users are more likely to be literate than non-users and they are also, on average, more educated than non-users. Furthermore, the data indicates that while a slightly smaller percentage of users in Round 2 have completed secondary or university education than have users in Round 1, a higher percentage of users have completed primary education in Round 2 versus Round 1.

This, once again, points towards a change in the composition of users from Round 1 to Round 2. Note that the numbers in Table 6 are different from those in Table 5 as those in Table 5 are for the household (or household head where indicated), whereas those in Table 6 are over all the adult individuals in the sample.

Table 6: Individual Characteristics

	Round1			Round2		
	Non-users	**Users**	**Total**	**Non-users**	**Users**	**Total**
Count	3,907	958	4,865	2,772	2,327	5,099
Age (years)	36.0	36.3	36.0	36.0	36.7	36.3
	(16.1)	(12.3)	(15.4)	(16.8)	(13.0)	(15.2)
Sex (share male)	0.46	0.62	0.49	0.44	0.56	0.50
	(0.50)	(0.49)	(0.50)	(0.50)	(0.50)	(0.50)
Share who can read	0.87	0.97	0.89	0.84	0.98	0.91
	(0.33)	(0.18)	(0.31)	(0.36)	(0.14)	(0.29)
Share who can write	0.86	0.96	0.88	0.84	0.98	0.90
	(0.35)	(0.19)	(0.32)	(0.37)	(0.14)	(0.30)
Educational attainment (share)						
None	0.24	0.08	0.21	0.10	0.01	0.06
	(0.43)	(0.26)	(0.41)	(0.30)	(0.11)	(0.24)
Primary	0.30	0.20	0.28	0.52	0.32	0.43
	(0.46)	(0.40)	(0.45)	(0.50)	(0.47)	(0.49)
Secondary	0.36	0.46	0.38	0.31	0.45	0.37
	(0.48)	(0.50)	(0.49)	(0.46)	(0.50)	(0.48)
University	0.03	0.10	0.04	0.01	0.08	0.04
	(0.16)	(0.30)	(0.20)	(0.10)	(0.27)	(0.20)
Other	0.07	0.17	0.09	0.05	0.14	0.09
	(0.26)	(0.37)	(0.29)	(0.22)	(0.35)	(0.29)

Remittances

The primary function of M-PESA, at least as it was conceived, is to reduce the costs of making remittances from one individual to another, especially across large distances. We collected detailed data on all kinds of remittances, both monetary and in-kind, and sent by all means. Table 7 reports the shares of households in the sample who sent or received remittances in any form (goods, money, e-float, etc.), by rural/urban location and by M-PESA use.

On average households are more likely to send remittances than receive remittances although this difference is reduced in Round 2. In both Rounds 1 and 2, similar percentages of urban and rural households receive remittances, but a much larger percentage of urban households send remittances. In Round 1, M-PESA users are much more likely to send and receive remittances than non-users, and this difference is even more pronounced in Round 2.

Table 7: Who makes remittances - both money and goods

	Round1		Round2	
	Send	**Receive**	**Send**	**Receive**
Total	46%	38%	49%	45%
By geographic location				
Rural	34%	36%	36%	45%
Urban	55%	40%	58%	46%
By M-PESA use				
Non-user	32%	26%	17%	19%
User	65%	54%	63%	58%

Indicators of frequency and size of remittances sent and received are reported in Table 8. On average, households in Round 1 sent and received remittances every three to four months and households in Round 2 every two to three months.

M-PESA users generally sent and received remittances more frequently than non-users, however the total amount they sent and received is not very different from the average household. Users sent about half their remittances in Round 1 by M-PESA, this increased to about 75 percent of their remittances in Round 2. In both Rounds 1 and 2 they received about half their remittances by MPESA. The value of the remittance sent or received was generally lower for those transactions using M-PESA than for those using other methods.

Table 8: Remittances sent and received

	Round1					Round2				
	All	M-PESA Users			Non-Users	All	M-PESA Users			Non-Users
	Total	Total	M-PESA	Other	Total	Total	Total	M-PESA	Other	Total
	Sending (*N*=1,026)					Sending(*N*=1,052)				
Number per month	0.31	0.34	0.17	0.17	0.25	0.41	0.43	0.32	0.11	0.28
Value per month (% consumption)	4.5%	4.9%	2.5%	2.3%	3.9%	6.7%	7.0%	4.8%	2.1%	4.6%
Value per transaction (KSh)	3,361	3,183	2,919	3,671	3,635	2,956	3,078	2,952	3,321	1,990
	Receiving (*N*=791)					Receiving(*N*=922)				
Number per month	0.23	0.23	0.14	0.08	0.24	0.33	0.34	0.17	0.17	0.26
Value per month (% consumption)	6.1%	7.1%	2.9%	4.1%	4.5%	6.4%	6.5%	2.9%	3.6%	5.9%
Value per transaction (KSh)	4,554	6,008	3,981	12999*	2,187	3,117	3,219	2,952	3,529	2,428

*** Received has two large values of more 700,000 KSh (about USD1,000) for repayments of debts.**

*** Note that M-PESA users send and receive remittances by M-PESA as well as in other ways.**

Table 9: Destination and origin of remittances

	Round1			Round2		
	Non-MPESA transactions	**MPESA transactions**	**Total**	**Non-MPESA transactions**	**MPESA transactions**	**Total**
Destination of remittance						
Spouse	9%	9%	9%	6%	8%	8%
Parent	46%	40%	44%	47%	29%	35%
Child	11%	10%	10%	16%	15%	16%
Other relative	14%	17%	15%	18%	24%	22%
Friend	6%	13%	8%	10%	18%	15%
Other	14%	12%	13%	4%	5%	5%
Origin of remittance						
Spouse	9%	18%	12%	6%	13%	9%
Parent	16%	4%	12%	9%	5%	7%
Child	27%	20%	25%	26%	21%	23%
Other relative	30%	37%	33%	25%	23%	24%
Friend	17%	20%	18%	28%	25%	27%
Other	1%	0%	1%	7%	13%	9%

Table 9 reports the destination and origin of household remittances. About half of remittances seem to go from children to their parents: recipients are most likely to be parents and senders are most likely to be children or other relatives. Remittances sent by MPESA are less likely to go to parents, but more likely to go to other relatives or friends. This holds true for remittances received by M-PESA as well – they are much more likely to be received from friends and other family members than remittances received through other methods. This suggests that M-PESA is used more frequently by younger people and people outside the direct parent-child relationship. This may also signal that M-PESA users have and/or take advantage of much broader networks than non-users (something we will study more closely in future research).

Table 10 compares the remittance behavior of early versus late adopters of MPESA as well as non-users of MPESA. The results are very similar to our earlier comparisons of early versus late users, and comparisons of these two groups with non-users. A higher percentage of the early adopters sent and received remittances than either the late adopters or the non-users. In Round 1, the late adopters were more likely to send remittances than the non-users but about equally likely to receive remittances. By Round 2, the late adopters were much more likely to both send and receive remittances than the non-users, suggesting that there is a relationship between the adoption of MPESA and remittance behavior. The size of the remittances follow the general pattern with the early adopters sending and receiving the highest amounts, and the non-users sending and receiving the lowest amounts.

Table 10: Early vs. Late Adopters II

	Round 1			Round 2		
	Never	**Late**	**Early**	**Never**	**Late**	**Early**
Send Money?	0.26	0.37	0.66	0.18	0.55	0.69
Receive Money?	0.24	0.26	0.55	0.19	0.55	0.59
Amount Sent	3,269	5,814	10,294	1,646	4,438	7,599
Amount Received	2,415	3,357	12,285*	2,428	4,508	5,458
Net Receiver?	0.22	0.22	0.37	0.17	0.35	0.31
Net Receipts	-855	-2,556	2,092	752	82	-2,128

*** Received has two large values of more 700,000 KSh (about USD1,000) for repayments of debts.**

Note the numbers in this table do not include the 4% of households that dropped M-PESA between Round 1 and Round 2

Saving

Because individuals do not need to withdraw or send balances immediately, they are able to accumulate savings on their M-PESA accounts over time. Thus M-PESA has become a savings instrument, as well as a means to send money.[22] Table 11 reports on the different types of savings instruments used by households by their M-PESA user status[24]. In Round 1 about 75 percent of users used MPESA for saving and by Round 2 this had increased to 81 percent. Users are much more likely to use a bank account to save than are non-users. A large percentage of households save money at home "under the mattress" (about 80 percent) although a slightly smaller percentage of users do than non-users. The users in Round 2 are less likely to save in a bank account and more likely to use a mattress for saving than are the users in Round 1- again, this is likely because users in Round 2 encompass a larger share of the population.

Table 11: Savings instruments used by households

	Round1			Round2		
	Non-users	**Users**	**All**	**Non-users**	**Users**	**All**
M-PESA	0.00	0.76	0.33	0.00	0.81	0.56
Bank account	0.34	0.71	0.50	0.23	0.65	0.52
Mattress	0.79	0.71	0.76	0.89	0.77	0.81
SACCO	0.15	0.24	0.19	0.10	0.21	0.18
Merry-go-round	0.39	0.42	0.40	0.38	0.52	0.47
HH member	0.13	0.15	0.14	0.13	0.13	0.13
Family member	0.04	0.04	0.04	0.03	0.03	0.03
Friend	0.03	0.05	0.04	0.02	0.02	0.02
Advance purchase	0.03	0.04	0.04	0.05	0.06	0.06
Stocks	0.05	0.18	0.11	0.01	0.11	0.08

[22] Sometimes money is stored in an M-PESA account simply to save a person from carrying too much cash, especially for example on long and potentially dangerous bus trips.

[24] Here modes of savings are defined to the respondent as any instrument where they have held cash for more than twenty four hours.

In Table 12 we compare the proportion of M-PESA users that save on M-PESA depending on whether the household owns a bank account or not. M-PESA users who own a bank account are much more likely to save on M-PESA than those who do not, and this is true in both Round 1 and Round 2. The proportion of M-PESA users who save on M-PESA increases between Round 1 and Round 2 among both the banked and unbanked population, however the increase is larger for the banked population.

Table 12: Probability of saving on M-PESA across households with and without a bank account

	Probability Save on M-PESA	
	Round 1	**Round 2**
No Bank account	0.65	0.68
Bank account	0.80	0.88
Total	0.76	0.81

Table 13: Reasons for household use and non-use of MPESA for saving

	Round 1		Round2	
Reason	**Non-users**	**Users**	**Non-users**	**Users**
Safety	0.03	0.26	0.01	0.26
Ease	0.01	0.43	0.01	0.41
Cost	0.09	0.07	0.09	0.07
No access	0.20	0.00	0.21	0.01
Confidentiality	0.02	0.02	0.01	0.02
Emergency	0.00	0.12	0.00	0.22
No Reason	0.28	0.07	0.41	0.01
No need	0.17	0.00	0.25	0.00
Other	0.19	0.01	0.01	0.00

Table 13 reports on the reasons why households choose or do not choose to use M-PESA for saving. The major reasons people cite for using M-PESA for saving is ease of use (about 40 percent) and safety (26 percent). The percentage of households saving on MPESA for emergencies increased dramatically from 12 percent in Round 1 to 22 percent in Round2. Of the reasons households mentioned for not using M-PESA for saving (no reason was the primary response), the largest percentage cited the absence of need for it and the lack of access.

Customer experience with M-PESA

We can also look at some factors that relate to customers' experience with M-PESA. Tables 14a and 14b highlight some of the problems experienced by M-PESA users, particularly the delays to withdrawing money from customers' M-PESA accounts. In Round 1, about 20 percent of users experienced some kind of delay, by Round 2 this had decreased to 16 percent. This is rather striking as we know (from Figure 9) that use climbed a lot between the two rounds. However, the number of agents also grew tremendously over this period (Figure 10), which may explain this improvement in delays.

Table 14a: Delays to withdrawing money from M-PESA

	Round1	Round2
Share experiencing delays to withdrawal of money	0.20	0.16
Reason	**Share of delays**	
Deleted sms	0.01	0.00
Agent had no money	0.70	0.30
Public holiday	0.01	0.02
Agent not available	0.01	0.02
Agent system down	0.05	0.11
Safaricom network down	0.11	0.51
No ID	0.07	0.07
Other	0.04	0.05

In Round 1 the majority of delays (about 70 percent) were caused by the agent not having money. This was less of an issue for users in Round 2 although it was still the cause of 30 percent of the delays. In Round 2 the major problem seems to have been the Safaricom network being down, contributing to

about half the delays. However, it is important to note that most of these delays were resolved fairly quickly. About 79 percent of delays were resolved within a day for users in Round 1 and 81 percent were resolved within a day for users in Round 2.

Table 14b: Delay until withdrawal possible

Delay until withdrawal possible	Round1	Round2
Hour or less	0.18	0.34
Half a day	0.28	0.15
A day	0.33	0.32
A few days	0.17	0.03
A week	0.02	0.00
Several weeks	N/A	0.00
Several months	0.02	0.01
Never	0.00	0.00
Went to another agent	N/A	0.14

Users were also asked about their experiences with the agent closest to them (Round 1) or the agent with whom they conducted their last two transactions (Round 2) and these data are reported in Table 15. Note that this question was changed across rounds. The reason was that the growth in use and in the number of agents meant that asking about the closest agent was not very useful (since a lot of respondents had more than one closest agent) and asking about the most used agent as we did in Round 1 did not make sense for Round 2. Therefore, in Round 2, we asked detailed questions about the last two M-PESA transactions that customers did with agents.

In general, users in Round 2 had a better experience with their agents, as a smaller percentage of them experienced problems with withdrawing or depositing money. Furthermore, 95 percent of users in Round 2 were asked by the agent to show ID (as required for security reasons), while only 77 percent were asked in Round 1. In addition, a much larger percentage of users in Round 2 trust their agent (95 percent) than did users in Round 1 (65 percent).

These numbers suggest that the quality of MPESA services have improved dramatically over time, as has the general level of trust that users have in the system. The difference in these numbers over time is all the more striking given that there are a lot more users in Round 2 and that these newer users tend to be poorer households and have less educated heads.

Table 15: Reported experiences with agents

	Round1 (closest agent)	Round2 (last 2 transactions)
Fraction unable to withdraw from agent	0.16	0.05
Fraction unable to deposit money with agent	0.07	0.04
Fraction asked by agent to show ID	0.77	0.95
Fraction who trust agent	0.65	0.95

Overall, users seem to be quite satisfied with their M-PESA services. When asked to rank on a scale of 1 to 10 how happy they were with M-PESA, in Round 1 over half reported a rank of 10 and over 90 percent reported values of 8 or above (Table 16a). The happiness ranks were lower for users in Round2, with about 35 percent reporting a rank of 10 and 88 percent reporting a value of 8 or above.

However, when asked about the impact of MPESA closing down (Table 16b), a higher percentage of users in Round 2 (92 percent) said that it would be large and negative than did users in Round 1 (85 percent). Thus, it is not clear whether users in Round 2 are less satisfied with the quality of the services provided or whether they simply have higher expectations.

Table 16a: Measures of satisfaction with M-PESA: Happiness with M-PESA

		Round1	Round2
Extremely unhappy	**1**	0.008	0.002
	2	0.003	0.002
	3	0.001	0.006
	4	0.001	0.002
	5	0.005	0.022
	6	0.024	0.022
	7	0.055	0.065
	8	0.129	0.199
	9	0.221	0.332
Extremely happy	**10**	0.554	0.347

Table 16b: Measures of satisfaction with M-PESA: Impact of closing down of M-PESA

	Large Negative	Small Negative	None	Small Positive
Round 1	0.85	0.10	0.03	0.02
Round 2	0.91	0.08	0.01	0.01

Individual non-users of M-PESA were also asked their reasons for not using M-PESA, as reported in Table 17. In Round 1, about 18 percent of non-users said that they didn't know about M-PESA, while in Round 2 only 3 percent did, indicating that awareness of M-PESA grew dramatically over the year and is now, therefore, a negligible constraint to adoption of M-PESA. About 14 percent of non-users said that they didn't need M-PESA in Round 1, while 21 percent cited this reason in Round2. The major constraint to adoption of M-PESA, however, appears to be access to a cell phone. In both Rounds 1 and 2, not owning a cell-phone was the primary reason cited although a much larger percentage mentioned it in Round 2 (60 percent) than in Round 1 (28 percent). This suggests that many of those individuals who adopted M-PESA between Round 1 and Round 2 were those who already owned cell phones.

Table 17: Individuals' reasons for non-use of M-PESA

Reason	Round1	Round2
Don't know about it	0.18	0.03
Don't need it	0.14	0.21
No network available	0.00	0.00
Celtel (or Zain) customer	0.04	N/A
Don't own a mobile phone	0.28	0.60
Don't understand it	0.05	0.05
Too complicated	0.01	0.02
Too costly	0.01	0.07
Not safe/Don' t trust it	0.00	0.03
No agents where I live	0.01	0.01
No agents where my recipient lives	0.01	0.00
Happy with existing money transfer service	0.02	N/A
Other	0.17	0.16
No response	0.08	N/A

V. Conclusions

As the developed world begins to rebuild the recently collapsed global financial system, the financial architecture in parts of the developing world is being rapidly transformed. As the costs of mobile phone technology have fallen, and as the technology has been adapted to support financial services, mobile banking innovations have begun to spread across and within poor countries. The low cost, and the widespread unmet demand for financial services, as captured by low rates of bank access, means that mobile banking has the potential to reach remote corners of the socio-economic, as well as geographic, spectrum.

That potential appears to be being realized in Kenya, through M-PESA, a mobile banking system operated by Safaricom. We estimate that M-PESA had reached nearly 40 percent of the adult population after a little more than 2 years of operation, and that now, approaching only the fourth anniversary of its launch, is used by more than two-thirds of households. Part of this success is due to a rapidly expanding network of M-PESA agents, who now number over 23,000. The descriptive statistics across rounds suggest that the product has been adopted by an ever-broadening cross-section of the population. While it has always been used by a non-negligible share of those with lower economic means, it has quickly expanded its reach into these groups, and is now used by households with a wide range of economic, demographic, and educational characteristics.

M-PESA is an innovation that clearly dominates its money-transfer predecessors on virtually all dimensions. Users say it is faster, cheaper, more reliable, and safer, and a very large majority report that they would suffer significant negative consequences if it were to be shut down.

These expressed preferences suggest that M-PESA is valued more by individuals than it costs. On the other hand, the precise source of these benefits – i.e., the specific economic impacts of M-PESA – is not easy to calculate. We have identified a number of potential economic effects of M-PESA at the household level – for example from impacts on saving and investment, to risk spreading and insurance. At the macroeconomic level, there could be important impacts on the money supply and inflation, with implications for the extent of Central Bank regulation and the conduct of monetary policy. We hope to explore these issues empirically in future work.

References

Chattopadhyay, Raghabendra and Esther Duflo (2004): “Women as policy makers: evidence from a randomized policy experiment in India,” *Econometrica*, 72(5), 1409-43.

Jack, William and Tavneet Suri (2011): “The Risk Sharing Benefits of Mobile Money”, Working Paper, January 2011.

Ivatury, Gautam and Mark Pickens (2006): “Mobile Phone Banking and Low-Income Customers: Evidence from South Africa,” Consultative Group to Assist the Poor, Washington DC.

Lucas, Robert (1988): “On the mechanics of economic development,” *Journal of Monetary Economics,* 22, 3-42.

Mas, Ignacio (2009): “The economics of branchless banking,” *Innovations*, 4(2), 57-76, MIT Press.

Mas and Morawczynski (2009): “Designing Mobile Money Services: Lessons from M-PESA,” *Innovations*, 4(2), 77-92, MIT Press.

Mas, Ignacio and Sarah Rotman (2008): “Going Cashless at the Point of Sale: Hits and Misses in Developed Countries,” Consultative Group to Assist the Poor, Focus Note No. 51, Washington DC.

Mas, Ignacio and Kabir Kumar (2008): “Banking on Mobiles: Why, How, for Whom?,” Consultative Group to Assist the Poor, Focus Note No. 48, Washington DC.

Romer, Paul (1986): “Increasing Returns and Long-Run Growth,” *Journal of Political Economy,* October, 94:5, 1002-37.

Solow, Robert (1956): "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics*.