Institute for
New Economic Thinking
AT THE OXFORD MARTIN SCHOOL

'LEAPFROGGING': A SURVEY OF THE NATURE AND ECONOMIC IMPLICATIONS OF MOBILE MONEY

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January 2017

INET Oxford Working Paper no. 2017-02

Economic Modelling

'Leapfrogging': a Survey of the Nature and Economic Implications of Mobile Money

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January-17 (revised)

Abstract

Mobile money is a recent financial innovation giving financial transaction services via a mobile phone, including to the unbanked global poor. Mobile money technology has spread rapidly in the developing world, "leapfrogging" the provision of formal banking services by solving the problems of weak institutional infrastructure and the cost structure of conventional banking. This survey examines the evolution of mobile money, its important role in widening financial inclusion, and the impact of regulation on the development of mobile money systems. It explores the channels of economic influence of mobile money from both a micro and a macro perspective, and presents the first critical survey of the current state of micro and macro empirical literature on the economic impact of mobile money.

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Funding: This work was supported by the Gates Foundation [grant number MQRYDE00], the Open Society Foundations and the Oxford Martin School. Versions or excerpts have been presented at and benefitted from: Gates Foundation-Bank of Uganda-International Growth Centre Policy Workshop on The Impact of Mobile Money, Uganda, February 2015; Peking-Oxford-Stanford Internet Law and Policy Conference, University of Oxford, November, 2015; High-Level Roundtable on Consolidating Africa's Mobile Banking Revolution, Blavatnik School of Government, University of Oxford, February 2016; and a Special Session on the Economics of Mobile Money, CSAE Conference, University of Oxford, March, 2016.
Acknowledgements: Special thanks go to John Muellbauer (Nuffield College, Oxford University). The author also thanks Chris Adam (Oxford University), Tony Atkinson (Oxford University), John Duca (Federal Reserve Bank of Dallas, USA), Colin Mayer (SAID Business School, Oxford University), Ggombe Kasim Munyegera (IGC), David Porteous (Bankable Frontier Associates), Emma Riley (Oxford University), Federico Varese (Oxford University) and Sebastian Walker (IMF) for their helpful comments.

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"*Leapfrog*": to improve a position by going past others quickly or by missing some stages of an activity or process." [Cambridge Business English Dictionary, CUP]

1. Introduction

Mobile money is *novel*: it was barely heard of a decade ago. The first service for the unbanked became active in 2001, but it is probably the phenomenal growth since 2007 of Kenya's M-Pesa system that has brought mobile money to international prominence.[2] Mobile money refers to financial transaction services potentially available to anyone owning a mobile phone, including the under-banked and unbanked global poor who are not a profitable target for commercial banks. An individual installs a mobile phone application on a SIM[3] card, sets up an electronic money account with the mobile money services provider (after providing identity documents), and deposits cash in exchange for electronic money. The electronic money can be stored or withdrawn as cash, or transferred via a coded secure text message to others domestically, without the customer having a formal bank account.

The best known fact about mobile money is its rapid spread in the developing world, "leapfrogging" the provision of formal banking services. The leapfrogging occurs because new technologies solve problems arising from weak institutional infrastructure and the cost structure of conventional banking. Beck and Cull (2013) argue that small size, volatility, informality and poor governance place constraints on the commercial viability of financial institutions in Africa. The cost of maintaining sufficient physical bank branches in rural unbanked locations is prohibitively high, and the poor mostly cannot afford the minimum balance requirements and regular charges of typical bank accounts. Mobile phone technology has the advantage that consumers themselves invest in a mobile phone handset, while the (scalable) infrastructure is already in place for the widespread distribution of airtime through secure network channels. The stark contrast between global numbers of mobile phone and landline subscriptions, and the comparatively low density of banking infrastructure in the developing world, is illustrated in Figures 1 and 2.[4]

Mobile money has filled a lacuna and, as Veniard (2010) has aptly expressed it, has "changed the economics of small accounts". Initially dominated by domestic transfers, mobile money systems have expanded into a broader payments platform for utility bills, rent, taxes, school fees and retail payments. Business usage is expanding rapidly in Kenya through special networks for the payment of suppliers and of wages, and potentially, of pensions. Government usage for the payment of wages and social security has lagged, though the cost gains, especially in insecure environments, are potentially significant.

The poor are especially vulnerable to risk (e.g. from illness, unemployment, death of family members, or natural disasters). Enhancing financial inclusion of the unbanked urban and rural poor, now a goal of the G20 (see Section 4), can help to diversify risk. For decades, inclusion policy has centred on extending access to *formal* financial infrastructure, but progress has been thwarted by the

[2] M-Pesa: "M" is for mobile, and "pesa" is Swahili for money. A detailed anatomy of Kenya's mobile money system is given in Box 1.

[3] SIM cards are the Subscriber Identification Modules of GSM phones. (Abbreviations are listed after the references.)

[4] Before the advent of mobile money in Kenya, there were fewer than three bank branches per 100,000 people (IMF, FAS, see appendix Table A1). Saving was mostly as cash under the mattress. Domestic transfers used scarce post office branches, or insecure intermediaries such as friends or bus-drivers. International remittances were received expensively via money transfer companies (e.g. Western Union) into bank accounts, or through Hawala (Section 3.6).

cost and market failure challenges of formal sector banking[5]. Mobile money can enhance financial inclusion. Adoption of mobile money gives under-served citizens convenient access to secure means of transfer and payments at a lower cost, and safe and private storage of funds. In a second step, registered users of mobile money may obtain a *pathway* to formal sector financial services accessed with a mobile phone: to interest-bearing savings accounts that can protect assets; credit extension to invest in livelihoods; and insurance products[6] to reduce risk. The reason is the technological innovation helps overcome the perennial asymmetric information constraint faced by conventional banks in lending to the collateral-less poor. The movement of cash into electronic accounts gives a *record*, for the first time for the unbanked, of the history of their financial transactions in real time. Using algorithms[7], these records provide evolving individual credit scores or ratings for the unbanked based on expenditure.[8] Moreover, the advent of fast-spreading and cheaper smartphones potentially offers easier and educative access to diverse financial services for huge numbers of illiterate people through well-designed applications.

Attention has focused on the spread of mobile money in Africa; yet it is a *global* phenomenon. By December, 2015, there were 271 mobile money services for the unbanked in 93 countries[9] with more than 134 million (90-day) active registered accounts and almost 40 million unregistered over-the-counter users; the dominant transaction was person to person (P2P) transfer transactions, of which there were 232 million valued at US$13.5 billion in aggregate in December 2015 (GSMA, 2016). Though slow to take off, the rapid growth areas are now in SSA outside the established markets in East Africa, in South Asia and Latin America. The success in Africa, notably the M-Pesa system of Safaricom, a subsidiary of Vodafone, has been exported by Vodafone to Europe (Romania[10] in 2014) and to India (in 2013). Mobile payments have been slower to take hold in advanced countries (where they are linked to bank accounts), but are predicted to grow rapidly in the near future, see Section 4.3. Indeed, the launch of Apple Pay in October, 2014 is seen as a catalyst for the broader adoption of mobile payments, with Facebook, Google, Paypal, Amazon, Visa, and other companies actively seeking partners to offer payments services from 2015.[11]

Mobile money is "big business", but ironically, it is not easily profitable. By 2011, only one scheme (M-Pesa) had achieved operational profitability. The mobile money provider is usually a mobile network operator (MNO) acting alone or in formal partnership with one or more banks. Exploiting wide-spread ownership of mobile handsets, they invest in improving network coverage and the evolution to third-generation (3G) and fourth-generation (4G) systems. Crucial to achieving

[5] Rotating savings and credit associations (ROSCAs) and savings and credit cooperatives (SACCOs) address the problem of asymmetric information, allowing small accumulated sums by groups to help individual members spread risk. The related micro-credit movement offers collateral-free loans to marginalised borrowers at near-market interest rates. However, assessing such micro-finance in a long-running evaluation in India, for instance, Banerjee et al. (2015a) conclude it has had limited success in raising consumption, or improving health, education, or women's empowerment relative to control groups. There have also been wide-spread problems of default and heavy indebtedness of borrowers.

[6] According to the GSMA State of the Industry reports, there were 123 mobile insurance, credit and savings services live by December, 2013, of which 27 launched in 2013; by December, 2014, there were 100 live insurance services, see Section 3.5.

[7] On the use of algorithms by the credit company, Experian, amongst others, see Section 3.4.

[8] A successful example of this is Kenya's M-Shwari product (meaning "calm" or "cool" in Swahili, Box 1).

[9] The Mobile Money for the Unbanked (MMU) Deployment tracker of the GSMA (Groupe Speciale Mobile Association), see appendix Table A1.

[10] In Romania, over a third of the population has no access to conventional banking, and seven million people mainly use cash rather than cards, see Thomas and Manson on 30 March, 2014, the Financial Times.

[11] See for example, Mishkin and Khan on 30 January, 2015 and Dunkley on 5 May, 2015, the Financial Times.

"scale" is a heavy investment in agent networks[12] with training and monitoring, one of the largest start-up and operational costs for entrepreneurial providers. Outsourcing to third parties incurs considerable cost savings in providing branchless banking, and can greatly expand the geographical reach of services. The challenge for national regulators with increasingly sophisticated products is to balance the encouragement of innovation with the promotion of competition and protection of customers. In due course, account-to-account interoperability will need to be implemented to achieve the full potential for digital transactions.

There is a paucity of literature relating specifically to mobile money and its economic impact. There are surveys on the positive impact of access to financial services more broadly defined, possibly suggestive for mobile money (see Bauchet et al. (2011), updated and extended by Cull et al. (2014)). There is a small literature analysing the economic impact of mobile phones (e.g. Aker and Fafchamps (2015) find cell phone coverage reduces the spatial dispersion of producer prices). This overview paper fills a gap by outlining the different possible channels for the economic influence of mobile money from both a micro and a macro perspective, and critically surveys the current state of the micro- and macro-empirical literature on the economic effects of mobile money. New access to terabytes of administrative data from multiple mobile phone and mobile money operators across countries promises a data revolution that may spawn a possible research revolution. Quantitative records of household and business expenditure through mobile money payments could help overcome some serious data measurement problems faced by household surveys (Section 7).

This survey is in three parts. First, background is given on the nature and functioning of mobile money, encompassing the types of transactions, the banking and insurance products it can lead to, its important role in widening financial inclusion, and evidence from usage studies. The market growth, profitability and other market characteristics are discussed, and the implications of cheaper smartphone technology. Second, and the main focus of this survey, are the likely macro-economic and micro-economic effects of mobile money, a consideration of data measurement issues, and a critical review of empirical studies on the economic impact of mobile money. Third, regulatory issues are examined, including the design of network agency structures and agency contracts, and enabling regulation for the development of mobile money systems. The survey concludes by discussing the beneficial impact of charities, donors and international agencies on the growth of mobile money, and providing suggestions for future research.

2. What is mobile money?

Mobile banking is defined in the US Federal Reserve's annual survey of *Consumers and Mobile Financial Services* (Federal Reserve, 2016) as using a mobile phone (and hence mobile networks) to access (your) bank account, either by accessing the bank's web page through the web browser on a mobile phone, via text messaging, or by using an "app" downloaded to the mobile phone. Essentially, mobile banking is a subset of *electronic banking* (or "e-banking"). *E-banking* itself is defined in Basel (1998) as 'the provision of retail and small value banking products and services through electronic channels; these include deposit taking, lending, account management, the provision of financial advice, electronic bill payment and the provision of other electronic payment products and services, such as electronic money.'

There is no standard regulatory definition of *mobile money* (or "m-money") and *electronic money* (or "e-money"), though Di Castri (2013) notes that some jurisdictions define electronic money in regulation or legislation. Mobile money is a form of electronic money allowing the conduct of

[12] Agents manage the deposit and withdrawal of cash, and also register, educate and motivate customers (Section 9).

transactions through a mobile phone. The common characteristics of various definitions of mobile money are: it is electronic money issued on receipt of funds in an amount equal to the available monetary value; it is electronically recorded on a mobile device; the electronic value is redeemable for cash, and the electronic value may be accepted as a means of payment by parties other than the issuer (for example, for person-to-person transfers (P2P), retail payments and payment for services; government-to-person (G2P) transfers (and receipts); donor-to-person cash transfers; and business transfers (and receipts)); and the electronic value is backed up by storage of equivalent funds in one or more banks depending on central banking or other regulations.

From a marketing perspective, Slade et al. (2013) argue that mobile-payments arose as "a solution to an unmet need rather than as a technology-led innovation"; they represent "a culmination of innovations, combining payment systems with mobile devices, to provide users with the ability to initiate, authorise and/or complete a financial transaction in which money or funds are transferred over mobile network or wireless communication technologies to the receiver through the use of a mobile device".

A more circumscribed definition of mobile money, specifically to incorporate "banking the unbanked", is used by the GSMA's Mobile Money for the Unbanked Programme (MMU) to distinguish the phenomenon from e-banking products with formal financial institutions[13]. However, as mobile money systems evolve, and as smart-phones become ever cheaper in less advanced countries, the range of possible services could expand to link with products managed by formal financial institutions such as banks and insurance companies (see Section 3 and Box 1). This will ultimately blur the distinctions between mobile money and e-banking and e-insurance.

Mobile money can be issued by non-banks such as MNOs, or by financial services institutions such as banks, or by a combination of the two, depending on the jurisdiction in the particular country. For example, in Kenya (see Box 1), the MNO, Safaricom, a subsidiary of Vodafone, is licenced to issue mobile money without a formal partnership with a bank, though the net deposits from customers have to be invested in prudentially-regulated banks for safe-keeping. By contrast, the new mobile money guidelines in Uganda (Bank of Uganda, 2013) stipulate a formal partnership between a prudentially-regulated financial institution and an MNO, with the licence granted to the bank.

Anyone with a mobile phone subscription, banked or unbanked, can open a mobile money account, provided that they are able to satisfy "know your client" procedures by the provision of the identity documents locally stipulated, download the relevant "app" onto their mobile phone, and pay the transactions costs for electronic transactions to the operator and its agents. In Kenya, mobile money users can deposit and store money in electronic form in mobile money accounts, can send that electronic value by codes in text messages to other mobile phone subscribers, and can withdraw physical cash from an agent of the operator that is deducted from the electronic money account.

3. How does mobile money work and what financial innovations can it lead to?

Mobile money is characterised by considerable innovation – new products and types of transactions constantly evolve, some in cooperation with financial institutions, the business sector, governments and donors. With the wider availability of the smartphone, the possibilities will multiply, especially for the access and education of the unbanked (see Section 5.5).

There is a distinction between *mobile payments* made electronically using a mobile phone but linked to the user's own bank account and found in countries with greater financial depth, and *mobile*

[13] "Services that offer the mobile phone as just another channel to access a traditional banking product are not included." and "The service must be available even to customers with basic mobile devices" and "Customers must be able to use the service without having been previously banked." (Pénicaud and Katakam, 2014, p4).

money payments in largely cash-based developing or emerging countries, where the user can be unbanked. As suggested above, these distinctions could blur over time. However, even in advanced countries, the proportion of the under-banked and unbanked can be significant[14] with the unbanked deterred from opening back accounts by high minimum balance requirements and fees. Recent moves to attract the US unbanked via mobile technology mirror the financial inclusion processes with mobile money in developing countries.[15]

In more advanced countries, mobile money payment faces competition from entrenched financial products, such as payroll debit cards in the US (enabling employers to pay employees through payroll direct deposit even if they do not have bank accounts). The uptake of mobile money for different payments and transfers has been limited, but the advent of the smart phone is predicted to change this (see Section 4.3). Commercial payments deals between Facebook, Google (Android Pay), Paypal and banks with payments partners in various countries from 2015 aim to exploit the huge demand for the latest smartphones, as exemplified by Apple Pay using the latest IPhone model.[16]

In poorer, cash-based countries, mobile money is predominantly used for private domestic transfers of money where crucially, very small amounts can be transferred, even if this is more costly (Section 3.1). In such economies, mobile money strongly outclasses any competitors, such as transfer via scarce bank branches, expensive money transfer companies (e.g. Western Union) or the risky use of bus-drivers or friends to deliver over long distances. Mobile money transfers are recorded, secure, instantaneous and relatively cheap[17].

Payments innovation through more diverse channels using mobile money has made an appearance in many cash-based countries. The "nuts and bolts" of basic mobile money domestic transfer payments are explained below. Then expanded payments platforms, and financial services innovations linked with the formal sector but flowing from mobile money, are discussed with examples. For financial inclusion, the availability of insurance and credit for the unbanked is key.

3.1 The "nuts and bolts": storage, deposits, withdrawals and domestic transfers

Mobile money systems rely on a network of agents linked under various contractual arrangements with a parent MNO, or a partnership between a prudentially-regulated bank and an MNO. The nature of these agent network structures and the design of the individual agent contracts are important for the successful development of mobile money systems (Section 9). In poorer countries such as Kenya, the network of transactional points lies outside bank branches thereby making the service accessible to unbanked and under-banked people.

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[14] The unbanked and under-banked US consumers comprise 9 percent (i.e. more than 25 million adults) and 22 percent shares, respectively, of all US consumers (US Federal Reserve's annual survey of Mobile Financial Services (Federal Reserve, 2016)). Under-banked is defined as having a bank account but using an alternative financial service (typically from a non-bank provider) such as a payroll card, payday loan, pawn shop loan, cheque casher, money order, paycheque advance/deposit advance, or auto (car) title loan.

[15] See Donnan and Sevastopulo on 30 November, 2015, the Financial Times ("US tries to boost access to 25m 'unbanked'").

[16] From its launch in October 2014, Apple Pay accounted for two out of every three dollars spent via contactless payments on Visa, Mastercard and American Express in the US (http://www.wsj.com/articles/staggering-iphone-demand-helps-lift-apples-quarterly-profit-by-38-1422394222?tesla=y).

[17] Morawczynski (2009) reports the cost of sending 1,000 Kenya Shillings (US$15) from Nairobi to the western provinces via M-Pesa in 2008 was two-fifths of the post office rate and one-fifth of the cost of sending it via bus. Jack and Suri (2014) update this estimate to half the cost of sending through Western Union, about 30 percent of the cost via the postal bank, and a third of the bus delivery cost. Both exclude sometimes substantial additional transport costs. In the latter study, remittances travel on average more than 200 km.

What Villasenor (2013) calls "the bricks-and-mortar component of mobile money systems", the shops, outlets or branches staffed by small business owners, typify the authorized agents[18] of the mobile money services provider. In Kenya, the mobile money system, M-Pesa, distinguishes between wholesalers and retail agents. Retail agents or cash merchants transact with their own cash and electronic money in their own M-Pesa accounts to meet customer demand. Wholesalers (banks or non-bank merchants) are allowed higher limits on electronic money stored in their M-Pesa accounts and perform a cash management service to allow retailers to maintain a liquid float. The latter typically transact daily with wholesalers, depositing cash or withdrawing cash depending on their net intake of cash. The "cash-in/cash-out" function in many cases has diversified from in-store cash merchants to street-based merchants.

Mobile phone users purchase a SIM card containing the mobile money application for their phone, register with a retail agent using their phone number and an identity document[19] and acquire an electronic mobile money account which has to be activated[20]. They deposit money into the electronic mobile money account by giving cash to the agent, and receive, in return, electronic money (or what Klein and Mayer (2011) call "book entry money") via their mobile phone. To withdraw money, they transfer electronic money via their mobile phone to the agent's electronic money account, and receive cash in return. Electronic money can be sent from a customer's account to another account holder, and money can be sent to those who are not account holders. The latter transaction is more expensive, and the remitter's own account is debited. The user transfers money straightforwardly by accessing the service provider via an access code dialled from a mobile phone, entering the mobile phone number of the recipient and the amount to transfer, and authorising via a PIN code. A secure text message (SMS) with a code is sent in real time to the recipient, authorising a retail agent to transfer money from the remitter's account into cash for the designated recipient. Users pay the cost of transferring and withdrawing money, but there is no charge for depositing money. The graduated withdrawal fee in Kenya for M-Pesa ranges from about 0.5 percent for large transfers to 20 percent for the smallest (details in Box 1).

Mobile money accounts are used for storage, and although they do not pay an interest rate, provide a safer (and more private) means of holding money than "cash under the mattress". Depositors must also bear the risk of loss of value through inflation. However, the situation has recently evolved on the payment of "interest"[21] in some countries, see Section 10.2. The evolution to partnerships between MNOs and banks that offer bank accounts linked to mobile money accounts and accessed only via a mobile phone, and paying graduated interest, is discussed in Section 3.4.

With maturity, many mobile money systems in developing countries have broadened beyond person-to-person transfers to a payments platform for utility bills, rents, school fees, retail payments, transport costs (airline, public transport, parking and taxis), taxes, licences and fines, and even, government debt[22] (see details for Kenya in Box 1).

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[18] These third party merchants may not "agents" in a strict legal sense of having the legal authority to act for the service provider – this depends on the local regulation requirements (Section 10).

[19] National Financial Regulators prescribe ID documents for registration to comply with "know your customer" (KYC) regulations (see Section 10). In Kenya, to open an M-Pesa account requires one of a Kenyan National ID, Passport, Military ID, Diplomatic ID, or Alien ID. In the rest of East African Community (EAC), there are no universal or national IDs, and a voter's card, driver's license, valid passport, local village council letter or certificate, company- or employer-issued ID, government-issued ID, or tax certificate may be used to verify a customer's identity (Pénicaud and Katakam, 2014).

[20] Activation instructions are received in a secure text message. But the role of agents is crucial in helping customers to activate and execute their first transaction (Section 9).

[21] Where a trust account is required to back the aggregate of the electronic accounts, the interest income can be allocated by the Trustees to the beneficiaries of the Trust, who are the customers and the agents.

[22] http://www.reuters.com/article/2012/05/04/us-kenya-debt-mobiles-idUSBRE8431E020120504

3.2 Expanding to a business usage and payments platform

The focus in emerging markets has been on domestic transfers based on text messages, whereas that in advanced markets is on contactless payment systems where consumers transact by swiping their phones on a terminal in a retail establishment. According to Lonie (2013), the key to commercial profitability for mobile payments systems is facilitating technology that allows the inter-operability of payments across different mobile money systems for merchants (analogous to payment systems like Visa and Mastercard). In many developing countries demand for the mobile payments service is still growing but has not reached the critical level for interoperability.[23]

However, a *tiered* approach, as implemented by Safaricom in Kenya's "Lipa na M-Pesa" business network[24], makes customers aware of retail payments, draws them in with incentives, and starts to build a critical mass of consumers using retail payments in one mobile money system. Kenya has been a leader in the expansion of a business payments platform and Safaricom perceives this as a growth area (see Box 1). Customer payments in the "Lipa na M-Pesa" network have no transaction fees below a particular threshold and use dedicated business till numbers; the network also enables bulk disbursements such as promotional payments or salary payments. Business usage has grown fast, and the P2B (customer-to-business) payments accounted for 15 percent, and B2P (businesses transferring to suppliers and paying employees) for 18 percent, of the average monthly value of all payments in the six months prior to September, 2015.[25]

Data on business use are limited, but a set of surveys on Tanzania, Uganda, and Pakistan, three-year annual panel studies, has interesting revelations of the growth in business use (the Financial Inclusion Tracker Study (FITS), see appendix Table A1). In the more advanced markets, between a fifth (Uganda) and a third (Tanzania) use mobile money for business transactions. Most of these (about three-quarters) use mobile money to pay suppliers, one quarter to receive customer payments, and a small percentage (7 percent in Tanzania) to pay employees' wages.

3.3 Expanding to government and donor usage of mobile payments

In countries beset by weak governance, corruption and insecurity, mobile money payments from governments (G2P), businesses (B2P) and donors potentially offer a secure and less costly way of delivering wages and social transfers. There are few examples of these types of transfers to date. In Afghanistan, wages are paid securely through mobile payments by some private companies (see empirical work on Afghanistan in Section 8.1.5).

More generally, governments could securely pay policemen and other officials their wages; the national revenue authority could accept payments for taxes, licences and fines and municipalities for parking payments; and public transport could use mobile money payments. Delivery of social welfare or aid with mobile payments could reduce "leakage" and ghost recipients. Some of these types of payments are a reality in Kenya through pilots or fully-fledged systems, but the government-to-person (G2P) salary and social payments have lagged in Kenya relative to Afghanistan, Tanzania and Malawi.

Donor initiatives for the provision of basic services have also used the technology. For example, affordable solar energy-powered electricity systems can be purchased on a pay-as-you-use basis, where mobile payments are used to top-up the credit on the system. M-Kopa Solar was

[23] Interoperability is defined by Scharwatt et al. (2015) as the ability for customers to undertake money transfers between two accounts at different mobile money schemes, or to transfer money between accounts at mobile money schemes and accounts at banks.

[24] "Lipa na M-Pesa" means 'pay by M-Pesa' in Swahili.

[25] Data from the 2015-2016 half-year results of Safaricom.

launched in October, 2014 in Kenya, and by March 2016 had installed over 330,000 residential solar systems in Kenya, Uganda and Tanzania. [26] M-Kopa means "to borrow" in Swahili, and can be thought of as a *hire-purchase* scheme. At the end of the "loan" term, based on the history of repayment, customers may be presented with the opportunity to purchase further goods in this manner, such as upgraded solar sets, smartphones, televisions and fuel-efficient cooking pots, and the company is considering proving small refrigerators.

3.4 Credit ratings and micro-loans

It is difficult for the poor to access even small amounts of credit from the banking sector. Credit extension requires collateral or other guarantees to bridge the gap of asymmetric information between borrower and lender. A traditional route to improving bank loan extension is the creation of public and private credit bureaux to collect and collate credit, collateral and wage information on borrowers. This can facilitate better quality loans, but the bureaux are expensive to set up and run, and mostly cover a narrow range of firms and some wealthier individuals. The World Bank's "Doing Business" website ranks "Depth of Credit Information" from 0 to 8 based on aspects of public and private credit bureaux.[27] It is salutary that Sub-Saharan Africa scores 2.3 (2016), and below this for many of its countries. Yet this underestimates the weakness of credit information, because the score reflects the existence and not the effectiveness of the bureaux (a common problem with qualitative indices, see Aron (2000)). In many developing countries, therefore, credit information systems are undeveloped and lenders seldom share information.

The lack of effective credit reporting systems is also at the heart of problems in micro-credit lending. The unprecedented growth of micro-credit lending through MFIs (micro-finance institutions) in the last decade has not been everywhere sustainable due to the deterioration of loan portfolio quality, attributed in part to greater competition amongst lenders. With deteriorating risk management, borrower over-indebtedness has increased and also arrears.

New technology combined with mobile money leapfrogs over the problem, providing a cheaper way of extending and monitoring credit, and reducing asymmetries of information with rudimentary credit scores. The credit scores are calculated from the stream of recorded financial actions by registered mobile money users over a period. The credit agency, Experian, and a philanthropic firm, Cignifi, for example, assess credit risk for mobile phone users with as little as a month's history of anonymous and encrypted behavioural data from MNOs. Using proprietary algorithms, they identify calling, texting and airtime (and emergency) top-up purchase patterns and habits, and in some cases use mobile money transactional data, to predict customers' creditworthiness from purchasing power and inferred reliability. The scores are dynamic and evolve on a monthly basis.[28]

With credit scores, a financial innovation based on mobile money can give new access to loan products from the banking sector, enhancing "formal" financial inclusion. This requires the electronic mobile money accounts to be linked with interest-bearing bank savings accounts that are accessed only through the mobile money phone application. For example, in Kenya, a savings and loan product

[26] Customers acquire solar systems for a small deposit and daily usage "credits" of about US$0.45 (less than the price of traditional kerosene lighting); after a year of payments, customers own the solar system and can upgrade to more power (http://solar.m-kopa.com/about/).

[27] http://www.doingbusiness.org/data/exploretopics/getting-credit

[28] A pilot conducted in Brazil with Oi Telecom found the Cignifi Risk Score is a significant discriminator of default risk: http://www.gsma.com/mobilefordevelopment/programme/mobile-money/extending-financial-services-using-mobile-based-consumer-scoring.

called M-Shwari was launched in late 2012 by Safaricom and Commercial Bank of Africa in partnership, operated entirely from the mobile phone by M-Pesa users (see Box 1 for details). A positive incentive path is developed for progressively larger loans, based on improved credit ratings each time a loan is successfully repaid.[29] Moreover, the market could evolve and promote easier access to credit underpinned by improved education about credit through applications on smartphones.

One might expect a significant role for uncollateralised credit for small and medium-sized enterprises (SMEs) that could prove useful for development, and a demand for temporary credit for risk management by households that could raise welfare. An IFC study[30] in 2013 found that 30 to 55 percent of SMEs in emerging market countries are capital constrained. Scharwatt et al. (2015) report 37 live mobile money credit services. Important questions are what the take-up and default patterns have been, and how effective these small loans have been. A nationally representative survey conducted by InterMedia found that only 30 percent of M-Shwari users reported taking out a loan.[31] To qualify for a loan requires a prior deposit in M-Shwari. The reported high deposit rate but low take-up of loans might suggest that loans are offered but that the loan size offered is unattractive. In 2016, a measure of the default rate on mShwari loans in 2016 was just below 2 percent, measured by volume and value and on a comparable annualized basis, with an average loan size of Ksh4000 ($40 in 2016).[32]

These early results can be informed by an in-depth evaluation of the role of micro-credit in small business development and in improving household welfare from six randomised evaluation studies of six countries on four continents, and in both urban and rural areas (Banerjee et al., 2015b). They find modest take-up rates of credit among (prospective) micro-entrepreneurs, and a lack of evidence of transformative effects of credit on the average borrower, as reflected in social indicators such as income, consumption (and food) expenditure, and health and schooling expenditure. However, they point out that the low statistical power bedevilling these studies implies there is also a lack of strong evidence *against* transformative effects of credit. Their overview does not consider the possible welfare-raising effects of small loans helping risk management by poor households (welfare-raising in this context does not mean income-improving but income-smoothing).

3.5 A micro-insurance platform

The poor have been neglected by traditional insurance products, owing to the prohibitive delivery costs and low awareness of insurance policies. Extended products for mobile money users leapfrog the traditional channels of delivery with several business models adopted via the mobile handset. The GSMA State of the Industry Report (Pénicaud and Katakam, 2014), which covers about 25 percent of mobile providers of insurance services globally, reported 84 live mobile insurance services, of which almost a quarter launched in the year of the report; and another 8 launches were planned, while 7

[29] So recent is the phenomenon, that the IFC-CGAP report "Credit Reporting at the Base of the Pyramid" (September, 2011), which describes credit bureaus, credit registries, and MFI-specific systems for exchanging client information for the poorest borrowers, does not once mention mobile money as a possible source of data for credit scoring.

[30] The financing gap for SMEs in emerging markets in Africa, Latin America, South and East Asia and ECA countries was estimated to be as much as $2.6 trillion (Stein et al., 2013). The analytical support for finance gap estimations was provided by McKinsey & Company.

[31] More precisely, accounting for the phrasing of the survey question, 39 percent reported using M-Shwari for either a loan or for a future purchase or payment, see the 2014 Kaffenberger report at http://www.cgap.org/blog/m-shwari-kenya-how-it-really-being-used.

[32] I am grateful to David Porteous for this information (April, 2016). See also "US groups tap tech to lend across east Africa", 17 May 2016, Financial Times.

launched previously, had failed and closed. The next year's report (Scharwatt et al., 2015) lists 100 live mobile insurance services across 30 different countries. The adverse selection problem is challenging. Nevertheless, the classic mobile money model of delegating to trained third parties in the field with expertise in insurance, and the appropriate pricing model with incentives, may help these products to be taken up widely.

Most popular is life insurance, including funeral expenses, covering three-quarters of offered products; the remaining quarter provide health insurance, accident coverage, or agricultural insurance ((Pénicaud and Katakam, 2014). In Kenya, an affordable health micro-insurance product was launched in January 2014 linked with M-Pesa and including funeral expenses, but which was discontinued in late 2015 (Box 1). Half of providers allow subscribers to sign up using their mobile device. Just over 40 percent charge a premium to customers with automatically set debits collected through mobile money; the remainder offer free mobile insurance for achieving stipulated airtime usage levels (the free basic cover can be boosted and extra features added by paying a premium: the "freemium" business model) or collect through airtime deductions. Insurance is increasingly used as a loyalty product. Claim disbursements are paid through mobile money or airtime accounts. Of the five "scaled" services (i.e. those with over 1 million policies issued), all are of the loyalty/"freemium" type, pioneered by specialists with expertise in micro-insurance.

3.6 Expanding to international transfers through mobile money channels

Migration, guest workers abroad, and the diaspora from civil unrest and war, have fashioned international networks of families, friends, acquaintances and strangers with ethnic affiliations. Significant cross-border financial remittances are repatriated "home" or to refugees, by legal channels or by unlicensed, untracked and sometimes illegal means, including Hawala (Section 5.4). Remittances are economically important in many developing regions (Section 6.2.3).

The cost of sending international remittances officially is high (Table 1), though the cost of illicit transfers may be higher. The main channel for official, global money transfer is through companies like Western Union and MoneyGram International. The global average total cost for sending remittances in 2015Q4 was 7.2 percent, but the costs vary sharply by region. With high volumes in the Middle East and North Africa, costs have fallen to 7.4 percent; but for smaller remittance corridors, costs are higher, e.g. 9.5 percent in Sub-Saharan Africa. The World Bank suggests that intra-African transfers are exorbitant, e.g. average remittance prices are 18-20 percent for remittance flows from South Africa to nearby countries. Further, many banks impose (non-transparent) additional fees on beneficiaries receiving remittances, which can be as high as 8 percent of the transaction value (World Bank, 2013).

The potential gains from transparent, reliable and cheaper methods of remittances are great. There is a significant opportunity for mobile money operators to enter this market (and mobile money is currently a minute business internationally). Regulation is promoting structural change in the remittances market. Greater interoperability between bank accounts and electronic accounts (as created by M-Shwari in Kenya, for instance) and between operators promotes international remittances as a mobile money service. Refraining from taxing remittance outflows and avoiding exclusive contracts with money transfer operators encourages usage and competition.[33] Compliance regulations set by the Financial Action Task Force (FATF)[34] to prevent money laundering and

[33] Ghana and Nigeria have banned these agreements; in Latin America, competition has risen through the reduction of exclusivity contracts.

[34] The FATF is an inter-governmental body established in 1989 to "set standards and promote effective implementation of legal, regulatory and operational measures for combating money laundering, terrorist

terrorist financing have raised remittance costs since 2001, but eventually will favour money transfer operators with transparent procedures. A *proportionate approach* to risks (similar to the World Bank and Bank for International Settlements (BIS) principles, see World Bank-BIS (2007)) was recommended by the FATF in February, 2013, in an update to its guidance that takes account of *financial inclusion* goals.

In 2012-13, there were closures of the accounts of money transfer operators by correspondent commercial banks, notably involving flows from the US and the UK to Somalia, because of poor compliance at the *receiving* end. This initially increased remittance flows via informal channels worsening the quality of remittance data. The World Bank has emphasised the urgent need to explore alternative service providers (World Bank, 2013). The solution is to develop robust customer due diligence (CDD) in the *receiving markets*. Examples are issuance of cards with biometric identifiers and pins, though there are several caveats about their use in poor countries; higher tier registrations for international remittance customers; and an independent, self-funding "Trusted Third Party" organisation in each target market, performing the functions of an MTO regulator, with powers to audit and penalise *local* money transfer operators (see Makin and Clark, 2014). This could help development of mobile money's share of the remittances market for traceable, safe and secure transmission.

Safaricom in Kenya was one of the first movers in international remittances via mobile money (Box 1). In late 2014, Safaricom announced a partnership with MoneyGram, an international transfer company, with services launched in 2015 enabling the remittances from over 90 countries worldwide to be sent directly to individual M-Pesa accounts. They were granted a money remittance operating licence by the central bank in 2014, allowing both outflows and inflows. In late April 2015, it was announced that the Vodafone Group and MTN Group would interconnect their mobile money services enabling affordable international remittances between M-Pesa customers in Kenya, Tanzania, Democratic Republic of Congo and Mozambique, and MTN Mobile Money customers in Uganda, Rwanda and Zambia. In several countries, MTN Mobile money has partnered with Western Union and international transfers to and from countries where Western Union operates are possible using mobile phones. This is a fast-growing trend in other countries. There was a huge move towards establishing markets in 2015. At the end of 2015, there were 29 cross-border mobile money remittance corridors connecting 19 countries, most in West Africa where member states of the West African Economic Monetary Union (WAEMU) are integrated. Globally, international remittance was the fastest growing product with the volume of cross-border remittances increasing by 52 percent in 2015 (GSMA, 2016). Along with merchant payment, bulk payments and transport payments, the growth of international remittances helps improve profitability of mobile money systems by diversifying away from costly agent-based transfers and cash-in/cash-out, and helps promotes an interoperable payments "ecosystem" (see GSMA, 2016).

4. Greater financial inclusion and mobile money

The term "financial inclusion" is of recent vintage, according to Porteus (2013), entering the "mainstream discourse" only after 2006. This was preceded by decades of activism aimed at scaling up micro-credit structures to promote development. The term has gained currency with policymakers, nationally and internationally, most prominently in the Maya Declaration[35] of 2011, when 80

financing and other related threats to the integrity of the international financial system" (http://www.fatf-gafi.org).

[35] The declaration was made during the 2011 Global Policy Forum of the Alliance for Financial Inclusion (AFI), a Bill and Melinda Gates Foundation–funded charity initiated in 2008.

developing nation regulatory institutions from 76 countries collectively endorsed a set of financial inclusion principles.[36] The G20 group of countries has backed the original Maya declaration, and it has endorsed two sets of indicators to measure "financial inclusion" (Section 4.2). The financial inclusion network is expanding: by September, 2014, 53 AFI institutions had made formal commitments to strategies under the Declaration. These embody ambitious, measurable targets spanning several years. For instance, the Bank of Tanzania committed to increase the share of the population with access to financial services from 27 percent in 2009 to 50 percent by 2015.[37] The role of charitable bodies and multi-lateral organisations[38] in enthusiastically promulgating the ideas, quantification and strategies of financial inclusion has been critical to its current prominence (Section 11).

The proliferation of mobile money services since 2007 has become integral to achieving these inclusion targets. Below, we discuss why and how realistic future targets are.

4.1 Defining financial inclusion

There is no standard definition of financial inclusion; but mainstream definitions share the goal of participation in the *formal* financial sector, rather than in the informal sector (Porteous, 2013). Porteus challenges the bias to formality in the definition of financial inclusion. The economics of formal sector banking has severely constrained progress to inclusion.

Some define financial inclusion in terms of *access* to financial services, and others to *usage* of financial services; more recently these have been combined, and aspects of quality of services and of financial literacy added. Some focus on inclusion; and others on exclusion of particular groups. Some are concerned with comprehensive access, and others with achieving stages of access (or a "tiered" access). Exclusion from access could be *voluntary* through lack of demand for cultural reasons, or because access is indirect through another person. The *involuntarily* excluded may lack access for many reasons. They may be unbankable because they have too low an income, possess limited collateral, are a lending risk, or are discriminated against. The governance and regulatory environment and infrastructure may be inadequate, leading to information failures (no credit ratings and ill-informed consumers), poor contract enforcement, a non-competitive market with price barriers, and regulation that is not enabling. The measurement challenges of usage and access are discussed below.

The Center for Financial Inclusion (CFI)[39] defines "full financial inclusion" as *comprehensive access*: "a state in which everyone who can use them has access to a full suite of quality financial services, provided at affordable prices, in a convenient manner, with respect and dignity. Financial services are delivered by a range of providers, in a stable, competitive market to financially capable clients." The CFI does not itself produce data to evaluate access. By contrast, the World Bank's *Global Financial Development Report* (World Bank, 2014a) bases its definition on *usage*: "the proportion of individuals and firms that use financial services". A data-driven approach measures inclusion, distinguishing between usage and access to financial services.

Experienced commentators present a cautious perspective. Porteus (2013) notes that volatility and fragility of the financial sector is likely to increase when including vulnerable people in formal sector financial institutions: "The age of apparent innocence about the inherent goodness of providing

[36] These principles are given in: http://www.afi-global.org/maya-declaration-afi-member-commitment-financial-inclusion, see also Alliance for Financial Inclusion (2013).
[37] The Bank of Tanzania now has an "explicit" mandate for achieving financial inclusion.
[38] In late 2013, the World Bank Group President Jim Yong Kim called for achieving "universal financial access" for all working-age adults by 2020.
[39] See http://www.centerforfinancialinclusion.org/about, funded by a range of commercial organizations, the Melinda and Bill Gates Foundation and some public bodies.

more financial services for more people has been shattered by the U.S. housing credit bust and by the grim stories coming out of the microfinance sector in certain Indian states." He argues that financial inclusion is a means to end, and not an end in itself; it is a tool to achieve more robust economies, the application of which needs constant evaluation. The GFDR itself acknowledges pursuit of financial inclusion for its own sake may be pointless, if, for instance, most measured new bank accounts are simply inactive accounts,[40] or if too liberal a credit extension leads to heavy indebtedness, housing foreclosures and even systemic instability.[41]

Access to and usage of electronic mobile money has typically *not* been counted as part of financial inclusion under most definitions. Mobile money's role is supposed to be as a *pathway* for registered users to formal sector financial inclusion via products (insurance, credit and a bank account that pays interest on savings) accessed through a mobile phone. Yet mobile payments technology has transformed the lives of vast numbers of poor consumers who can hold recorded cash privately in non-bank electronic accounts and regularly perform financial transfers, easily and cost effectively. Moreover, such users may not embrace the formal sector products *even* if they become available; and if they do access credit, these may be very small loans that are not adequate to purpose, creating a disincentive to participate (see Section 3.4).

A "tiered" definition of financial inclusion is more appropriate, with "semi-formal" initial tiers counting towards inclusion. In practice, this has begun to happen. Finscope defines financial inclusion to the "formal sector" in its recent surveys, distinguishing between the prudentially-regulated and non-prudentially-regulated formal sector institutions (e.g. mobile money providers that are telecoms)[42], thereby including mobile money in the definition of "formal" financial inclusion. For instance, the Bank of Uganda has a Financial Inclusion programme[43] under the Maya Declaration, now in its third year; the Governor acknowledged in 2014 that the rise of the adult population with access to "formal financial institutions" from 28 percent in 2009 to 54 percent in 2013 is largely attributable to mobile money.[44] Similarly, in Tanzania, many inclusion goals are measured by the establishment of electronic mobile money accounts (as well as the potential access they give to broader banking and insurance formal services).[45]

How meaningful are the quantitative metrics that monitor the achievement of such "re-defined" financial inclusion goals? Are these active or inactive mobile money accounts; and when they give or foster access to credit, is this meaningful and useful credit extension from the perspective of the consumer? We consider this below.

4.2 Measuring financial inclusion - and the recent role of mobile money

The measurement of financial inclusion is thus in a state of flux. The available datasets (and associated websites) are summarised in a typology table (appendix Table A1), which differentiates

[40] The Mzansi low cost bank account, launched by the South African banking industry in October 2004, helped raise the percentage of banked adults from 46 percent to 63 percent between 2004 and 2008. But by December 2008, over 40 percent of accounts were inactive or closed.

[41] An example is the indebtedness crisis facing the private micro-credit industry in 2010 in several Indian states such as Andhra Pradesh.

[42] Note that the non-prudentially-regulated telecoms may not intermediate the customers' money themselves.

[43] On the Bank of Uganda's Financial Inclusion Project, see Strategy Paper on Financial Inclusion (Bank of Uganda (2013).

[44] In his speech, Tumusiime-Mutebile (2014), referred to the third Finscope survey in Uganda (2013).

[45] "Formal" is here defined as: "access to and use of financial services from regulated and registered financial institutions. These include banks, mobile money providers, microfinance Institutions and SACCOS (National Financial Inclusion Framework, 2014-16, Tanzania National Council for Financial Inclusion).

amongst provider-based data and types of usage data, indicating clearly where mobile money is measured.[46]

For many years, in keeping with the bias to formality, the only internationally-comparable indicators of financial inclusion (defined as in "access") were supply-side financial data sourced from national financial sector providers. These data cover infrastructural density statistics for banks, insurance products, branches, ATMs, and, recently, mobile money agents. There are demographic statistics on bank depositors and borrowers and mobile money customers. There are data on flows and stocks: the sizes of banks' assets and liabilities and mobile money account balances. Examples of large-scale supply-side databases are the IMF's Financial Access Survey (FAS) and the World Bank's Global Financial Development Database (GFDD), see Table A1. The IMF's annual data have, since 2014, included mobile money data[47]. Supply-side data relevant to international remittances, payments and regulation for mobile money in 2010, are contained in the World Bank Global Payments Survey. Focusing solely on mobile money are the GSMA's Global Mobile Money Adoption Survey and Mobile Money for the Unbanked (MMU) Mobile Money Deployment Tracker.

The supply-side access data can be helpful if there are sufficient data to compare trends within a country, and trends across countries with similar income levels but other differences such as insecurity (e.g. to compare Afghanistan and Burundi). Especially useful are statistics expressed relative to a comparator benchmark such as per 100,000 adults or per geographical area. However, there are limited disaggregated data by income group, education, gender, demographics, and by region (including urban versus rural sectors); a rare example is the FAS data aggregating on the largest three cities in each country. Possibly providers are reluctant to give detailed information for commercial reasons. Monitoring the spread of mobile money requires more geographically detailed data on active agents and active accounts, as, for instance, inclusion in countries such as Niger and others in West Africa is constrained by an inadequate agent network (Aker et al., 2015). An innovative link between provider data on financial access point locations (including mobile money agents) and a map of demographic and poverty data to a 1-kilometer resolution helps measure and track financial access with greater accuracy (see Fspmaps, Table A1).

Infrastructure and the apparent access for some users via bank or electronic accounts are indicative, but give only a *partial* picture of financial inclusion. From the empirical literature on the influences of institutions on investment and growth, it is apparent that the appropriate institutional variables for analysis are those that capture the *de facto performance*, *effectiveness of implementation* or *quality* of institutions, and not merely their *de jure* characteristics or attributes (see survey by Aron, 2000).[48] In the present context, it is unclear whether supplier numbers of accounts are active or inactive; whether numbers of loans are productive or non-performing; and whether the un-weighted loan balances given are mainly swelled by a few large loans to big business in urban areas. There is no information on the quality of financial services offered, only that there *are* services. Interestingly, there is an exception for the new mobile money FAS data (as of 2014), where the word "active" qualifies the numbers of accounts and agents. Simply increasing numbers of bank branches and loan officers and loans, if they are not performing effectively, may not aid inclusion and simply give rise to misleading statistics.

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[46] There are useful online discussions on data, see CGAP, Data Architecture of Branchless Banking, http://www.cgap.org/blog/series/data-architecture-branchless-banking and Nielsen (2014).

[47] These data are: the number of registered and number of *active* agent outlets per population or area; number of registered and number of *active* accounts (and per population); number and value of mobile transactions (and per population); and finally, the stock of outstanding balances on *active* mobile money accounts.

[48] Measuring or calibrating the effectiveness and quality of institutions is usually accomplished with surveys. For instance, the ease of doing business given regulations and the effectiveness of de jure property rights are subjectively ranked in cross-country surveys conducted by the credit rating agencies.

Provider data have only recently been supplemented on a global scale by *user* data from surveys. The demand-side financial data ranges from globally comparative cross-country data to country-specific surveys (Table A1). The World Bank's Global Findex survey (2011) of users of financial services is compiled for 148 countries using the Gallup World Poll Survey.[49] The Gallup Payment Survey covers 11 African countries, and is adding Asian countries. The FinScope surveys conducted by FinMark Trust cover 6 countries for SME surveys and 18 countries for consumer surveys. The Financial Inclusion Insights (FII) and Financial Inclusion Tracking Surveys (FITS) cover several Asia and African countries. All contain information on branchless banking and mobile money.

Gathering the various approaches to measure access to, use *and* quality of financial services together, the G20 leaders in 2012 endorsed the "G20 Basic Set of Indicators" and later, in 2013, an expanded set of indicators, the "G20 Financial Inclusion Indicators". These indicators are a selection from the IMF's annual Financial Access Survey (FAS) of providers, from the World Bank's 2011 Global Findex survey and Enterprise surveys, and supplemented for a narrow set of countries by OECD survey information on financial literacy. Their existence reflects recent endeavours to harmonize and extend comparative data across countries including measures on quality and on barriers to access and usage.[50] However, the Basic Set excludes mobile money and is focused on formal financial institutions; the later set contains one question on mobile money payments, see Table A1. More detailed financial inclusion data incorporating mobile banking and payments data may in future be available from regulators (including the central banks).

In summary, great efforts are being made to standardise and integrate user, demand, and qualitative data. However, a strong bias to formality remains, and mobile money data is missing or limited in many datasets. Definitions of "formal" and "financial inclusion" may not coincide across data providers (see Table A1); and generally, the lack of standardized definitions for demand data can imperil comparability and the transfer of policy lessons across countries.

4.3 Adoption, usage and awareness patterns – what do they show?

Adoption studies have largely been conducted by *non*-economists on qualitative aspects, including the diffusion of the technology. Data problems and difficulties in identification of the influences on adoption have deterred rigorous economic analysis. Selected econometric research on the drivers of adoption is surveyed in Section 8.

A review of the literature by Slade et al (2013)[51] from a *marketing* perspective, examines extensive adoption research evidence on the mixed success of mobile payments in advanced countries. Most of the research is on the US, China, Germany, Switzerland and Finland, but none on the UK. Much of this research failed to generate representative samples. The earliest dates from 2002, but burgeoning research from 2007 covers two-thirds of their review. There has been low adoption of various mobile payment products in Europe and North America by comparison with Asia. Slade et al (2013) find that "a multitude of complex and interrelated factors affects adoption of m-payment systems". Cultural differences matter; successful business models need adaptation for differing economic, technological and social market constraints. There are also feedback effects where technological developers and users react symbiotically to changes made by the other. This naturally

[49] Two studies using Global Findex data to assess financial inclusion are Beck et al. (2015) and Klapper and Singer (2015).

[50] The Financial Inclusion Data Working Group of the AFI is making broadly accessible this type of coordinated exercise, and including mobile money. On AFI Core Set of Financial Inclusion Indicators on access and usage and Second Tier Indicators, see appendix Table A1.

[51] Their review updates previous exhaustive literature reviews relating to mobile payments (Dahlberg et al., 2008; and Karnouskos, Kauffman, Lawrence & Pousttchi, 2008).

complicates modelling adoption. Moreover, adoption factors may differ for *proximity* payments (using the phone and a payment device, including Near Field Communication (NFC)), and *remote* (wireless) payments. The drive to acquire a mobile phone may not be matched by enthusiasm for the application, especially where merchants need to invest in technology and users need an enabled phone (as for NFC). Factors isolated by researchers that positively affect adoption include perceived ease of use, perceived usefulness, compatibility, interest in m-payments, social influence, use context, payment scenario, and trust. Those negatively affecting adoption are costs, risk, and attractiveness of alternative payment systems. However, a significant proportion of the existing research has failed to be validated empirically.

There is also qualitative information for advanced and developing countries from a growing number of surveys, in cross-sections and in panels, some of which integrate administrative data with interviews. These reveal the characteristics of adopters of mobile phones, mobile banking and mobile money, and how adoption trends evolve with development of the markets and products. Such patterns and correlations for adoption, usage and awareness of mobile money are closely linked to understanding financial inclusion.

A detailed perspective on the adoption and use of mobile payments in a representative *advanced* country, the US, can be found in the US Federal Reserve's annual survey of *Consumers and Mobile Financial Services* (e.g. Federal Reserve, 2015 referring to the survey of December, 2014). We summarise selected findings, and particularly concerning the unbanked and under-banked US consumers, comprising 13 percent and 14 percent shares, respectively, of all US consumers in 2014; annual surveys for 2011 to 2014 find the share of unbanked consumers has remained roughly constant. Amongst the unbanked and under-banked, the ownership of mobile phones, and specifically smartphones, is high: of unbanked individuals, 67 percent have access to a mobile phone of which 65 percent (up from about half in 2013) are smartphones; of the under-banked, 90 percent have a mobile phone, of which 73 percent (up from 64 percent in 2013) are smartphones. The relatively high prevalence of mobile phone and smartphone use amongst the youth, minorities, and low income groups, suggests mobile phones could expand financial access of the unbanked or under-banked. However, use of both mobile phones and smartphones increases nearly linearly with income.

The main factors deterring adoption of mobile banking and mobile payments amongst all US consumers are security concerns and preference for existing methods for banking or making payments. Aggregate mobile banking usage increased substantially in 2014. The convenience of mobile banking overtook smartphone adoption as the driving force behind mobile banking adoption. Some 71 percent of mobile banking users installed mobile applications to conduct their banking transactions. Reinforcing previous findings, minorities continue to be more likely to adopt mobile banking. The under-banked population makes substantial use of mobile banking. Almost 48 percent (up from 39 percent in 2013) of the under-banked with mobile phones report using mobile banking in the past 12 months, while 32 percent (up from 22 percent in 2013) report using mobile payments. Use of mobile banking continues to be highly correlated with age.

Mobile payments usage in aggregate increased only slightly from 2012 to 2013. Usage rose slightly among all mobile phone users from 2013 to 2014, with 22 percent reporting having made a mobile payment in the past year. For smartphone users, usage remained at around 24 percent for three years and then expanded to 28 percent in 2014. The implication of this constant rate is that smartphone adoption substantially contributed to the increased use of mobile payments. The main reason most people adopted mobile payments was convenience (37 percent), followed by getting a smartphone (26 percent) in 2013. In 2014, these figures switched, with smartphone ownership (34 percent) dominating convenience (29 percent). As with mobile banking, there is no clear correlation between payments usage and income or education level amongst those who own a mobile phone.

Payments usage significantly lags mobile banking usage for all consumers. Yet mobile payments are disproportionately used by younger consumers, suggesting this may be a growth area.

The main focus of mobile payments is retail purchases (mainly point-of-sale), increasing substantially in 2012, 2013 and 2014, with substantial growth potential when more retailers and businesses are able to accept them at point-of-sale. Use of Apple's particular mobile payments technology, linking with credit card providers, Apple Pay, has grown hugely since the 2014 survey. The extent of payments and receipts via mobile banking indicates the potential substitutability towards mobile payments technology. About 48 percent of mobile banking users made online bill payments from a bank account using a mobile phone, and 51 percent deposited a cheque by phone in 2014.

Some of these findings are paralleled in poorer, cash-based countries. However, unlike advanced countries where security concerns and competition from entrenched financial products discourage use, there are few competitors in developing economies and mobile money instead offers a cost-effective and relatively secure solution to a gap in the market for transfers and payments. The adoption of mobile money has been variable, though sometimes rapid - as in East Africa. Far smaller amounts are transacted, and bank accounts are typically not involved. Globally for the unbanked, the total product mix by value in December 2015 comprised international remittances at 1 percent, airtime top-up at 3.6 percent, merchant payments at 4.1 percent, bulk disbursement at 8.4 percent, bill payments at 11.4 percent and domestic private transfers at 71.5 percent, with an average of 1.7 transfers per active user per month with an average value of US$38.10 (GSMA, 2016).

With the remote payments technology used in mobile money, a pre-requisite for adoption is access (not necessarily ownership) to a mobile phone. Blumenstock and Eagle (2012) examine the characteristics of mobile phone owners in Rwanda using interviews (2009) merged with detailed, transaction-level call histories (to 2008). A third of Rwandans in the sample share their phones. The owners are much more likely to be male, better educated, from larger households, and substantially wealthier than those without mobile phones. Focusing on owners, the highest income quartile used their phones 30 to 100 percent more than lowest income quartile, depending on the measure of use. There is also a difference in usage by gender, particularly in reported phone sharing and the types of calls made.

A related study in cash-dominant East Africa at around the same time has similar findings (Aker and Mbiti, 2010). Sceptical of the validity of causal analyses with poor data and misspecifications (see Section 8.1.2), they examine only mobile phone adoption *correlations* with firm and household surveys.[52] For Kenya, Tanzania and Uganda during 2003-2008, the adoption of mobile phones by *firms* appeared to be correlated with the implicit and explicit costs of poorly functioning landline services. Adoption by *households* in Kenya in 2003 was markedly lower than that for firms, and it appeared that in 2006, the young, male, educated, wealthy, bank account-holding and urban, were the primary adopters. By 2009, perhaps due to cheaper phones and lower denomination airtime cards, the percentages of rural, older, poorer and female users had increased, but without disturbing the preceding pattern. On mobile money usage in Kenya, on average, M-Pesa senders and recipients in 2009 were the wealthier, younger (under-55), better educated, and "already banked" males (see their Table 2), and most transfers occurred in urban areas. The gender differences for recipients were not large, but more males were both recipients and senders. In 2009, just under a third of the 6598 persons surveyed were users of M-Pesa, but only 4 percent paid bills using M-Pesa. This pattern has changed strongly with time (Box 1). Similarly, for Tanzanian households during 2010-13, Riley (2016) notes that adopters of mobile money are educated, more wealthy, urbanised, have a bank account and loans, almost always own a mobile phone, are slightly younger than those

[52] These are World Bank Enterprise surveys of firms and FinAccess surveys of households.

who don't use mobile money, and less likely to work in agriculture than in the private sector or to be self-employed.

A broader snapshot, for 11 Sub-Saharan African countries, details mobile phone ownership, payments and transfer behaviour from a 2011 Gallup survey (Godoy et al., 2012). The above patterns for age, education and the salaried were confirmed for electronic payments (which included bank payments in their survey), and again little gender difference was noted. Even the poorest 20 percent owned or had access to a mobile phone, ranging from 81 percent in Zambia to a low of 38 percent in Mali (with similar figures for those surviving on less than US$1 a day). In the previous month, a mobile payment had been received from a distance by 53 percent of adults (or 134 million people). A startling finding was that 60 percent (79 million people) exclusively used cash-based channels such as informal couriers or sending money by bus. In East Africa, mobile money was predominantly used for domestic transfers.[53] However, the percentage shares for this channel were below 6 percent for all other countries (except South Africa (13 percent) and Botswana (8 percent), with competing well-developed bank channels). Except in Botswana (6 percent), Tanzania (5 percent) and Kenya (2 percent), payments by governments and employers did not utilise the mobile money channel (and in South Africa, bank transfers are predominantly used). Receipt of international remittances and domestic bill payments specifically via mobile payments was not documented.

Finally, there are studies tracking greater awareness of financial services over time. For example, a study by research consulting group InterMedia tracked 2000 Tanzanian adults (aged 15 and older) in Tanzania for a year from September 2011, in quarterly surveys (see appendix Table A1). In the fourth wave of the study, 99 percent of the adults were aware of at least one mobile money service, and 82 percent had seen or heard a mobile money advertisement in the preceding month. In the fourth wave as compared to the first, 45 percent rather than 24 percent were active users (used mobile money services at least once in the past 90 days). There was also greater awareness of different mobile phone operators. It is not clear if the same individuals were interviewed in each wave, in which case one would expect the study itself to have raised awareness, making it difficult to draw firm conclusions.

5. The growth, geographical spread and profitability of the industry

5.1 Trends in the growth of deployment

The global growth of the mobile money industry has been meteoric. The first mobile money service scheme was launched in 2001 (see Figure 3), and after five years there were 6 schemes globally. By the end of 2015, there were 271 services in 93 countries, with 13 new mobile money services launched (GSMA, 2016).54 The rapid growth of M-Pesa, launched in Kenya in early 2007, catalysed the spread in African countries. African growth has since dominated the global rise, but mobile money services are taking strong hold in Latin America, East Asia and South Asia (Figures 3 and 4). Sub-Saharan Africa accounted for around 52 percent of live mobile money services in 2014 and 2015, but half of new launches in both years occurred outside of this region, primarily in Latin America and the Caribbean (Scharwatt et al., 2015; GSMA, 2016). More than a third of all registered mobile money accounts were opened in South Asia in 2015. New mobile money services are expected to grow by as

[53] Percentage shares were Kenya (90 percent), Uganda (68 percent) and Tanzania (60 percent).

[54] In 2013, mobile money schemes began in nine new markets: Bolivia, Brazil, Egypt, Ethiopia, Guyana, Jamaica, Mauritania, Singapore, Solomon Islands, Togo and Vietnam; in 2014, in six new markets: Dominican Republic, Myanmar, Panama, Romania, Sudan and Timor-Leste; and in 2015, in four new markets: Albania, Myanmar, Peru, and Seychelles (Scharwatt et al., 2015; GSMA, 2016).

much as 50 percent in Europe & Central Asia as well as the Middle East and North Africa (GSMA, 2016).

The *geographical expansion by provider* is another striking feature of the industry, creating mobile money "multi-nationals". For instance, Vodacom, based in South Africa and majority-owned by Vodafone, introduced M-Pesa in Kenya in 2007, in Tanzania in 2008, in South Africa in 2010 and Mozambique, Egypt and Lesotho in 2013. Vodafone launched a mobile money service (M-Paisa) in Afghanistan in 2008 (partnered with an MNO, Roshan), in India in 2013 (in a partnership with ICICI Bank), and in Romania in April 2014. Other mobile money services with significant cross-country market presence include Airtel Money (available in 16 African countries including Kenya, Tanzania and Ghana); and MTN Mobile Money (available in 15 African countries including in West Africa and South Africa).

Regional growth data from the GSMA differentiate between active and inactive mobile money accounts ("active" denotes enacting at least one transaction in the prior 90 days), and registered and unregistered users of mobile money (Pénicaud and Katakam, 2014).[55] *Registered* mobile money accounts per 100,000 adults, with clear Sub-Saharan African and North African dominance, is shown in Figure 4a. Active and inactive mobile money accounts since 2010 are given in Figure 4b. By June, 2013, of the 203 million registered accounts, just under one third was active (61 million). This share increased slightly by December of 2014 and 2015: there were 299 million registered accounts of which 103 million were active (Scharwatt et al., 2015); and 417 million registered accounts with 134 million were active (GSMA, 2016), respectively. The challenge of activating accounts is important for profitability, see below.

Slower growth occurred in *unregistered* mobile money users, amounting to 37.4 million users in total by June, 2015. In mid-2014, six services had exceeded 1 million unregistered users, five of which were in Pakistan (Scharwatt et al., 2015). However, the actual number of users may be far higher than is formally reported. South Asia has close to 90 percent of global unregistered customers, and this is down to an over-the-counter (OTC)[56] model where the challenges and costs of establishing identity in registering were circumvented in favour of a drive for early market share[57]. In June, 2015, 29 mobile money services were largely OTC, with 45 percent of these services in South Asia and 28 percent in SSA. OTC comprised 14.4 percent of the global transactions value, with person-to-person transfers the predominant transaction, and about 58 percent by value of global bill payments.

However, registering customers is important for financial inclusion reasons, and to allow access to linked formal banking and insurance products, and application-based services on smartphones (Section 4). It is argued that while easy to implement, OTC services depend heavily on agent-initiated transactions with a significant direct cost in commissions, and putting OTC providers "at an especially high risk of getting squeezed out of the value chain", (GSMA, 2016). Fortuitously, there is a new trend signalled by the slowing annualised growth of OTC users in 2015 (22 percent) compared to the preceding two years (33 percent and 102 percent, respectively), and the far larger growth in registered accounts (GSMA, 2016).[58] There is evidence for Pakistan and for Bangladesh that prior OTC transactions can be an enabler for registered mobile money accounts; and indeed, providers appear to be registering their OTC customers, toward a more profitable "ecosystem" model.

[55] Differentiating between active and inactive accounts, registered and unregistered users, and the fact that a user may have several accounts, are important data considerations in empirical work and for informed policy decisions (Section 7).

[56] A transaction is considered OTC when it is conducted through an agent's account on behalf of the customer.

[57] An example is Easypaisa, a mobile money OTC service in Pakistan, which served more than 5 million customers a month through 25,000 points of service in 2013 (Pénicaud and Katakam, 2014, p21).

[58] By June 2014, the growth of unregistered and (all) registered customers was almost equal, though slower than the growth of active registered accounts (Scharwatt et al., 2015).

Within-country growth can be illustrated by East African examples. For mobile money growth in Kenya since 2007, see Box 1. Uganda's mobile money industry, a later starter in March, 2009, has grown rapidly, though not at the pace that Kenya has recorded (Aron et al., 2015). Mobile money was first introduced by MTN, then the biggest of the mobile telephone operators in the country, and the market is today served by six operators. There were about 18 million registered subscribers by September 2014 (almost doubling since the end of 2012). The total annual volume of transactions rose by 1300 percent from end-2010 to almost 400 million transactions three years later. By mid-2014, the value of monthly mobile money transactions was around Kshs2 trillion (quadrupling since the end of 2011), and total annual transactions in 2013/14 were roughly 37 percent of GDP. MTN has remained the largest provider, with 90 percent of the value of transactions by end-December 2013, though only 36 percent of registered customers. With financial institutions defined by Finscope to include mobile money services (Appendix 1), the share of the adult population with access to "formal financial institutions" more than doubled from 2009 to 2013.

The growth in *diversity of services* toward sophisticated business networks with incentives, and new ventures joint with money transfer companies for international remittances, is exemplified by Safaricom's mobile money evolution in Kenya (Box 1 and Section 5.2). Such "sprinters" contrast with other services which have had lack-lustre or slow growth so that Pénicaud and Katakam (2014) refer to a "two-tiered" pattern of performance[59]. The rise of mobile money services in sprinters has been favoured by several factors including the regulatory and competition framework, and political stability. For instance, mobile coverage and penetration is poor in countries with state-owned telecoms monopolies and civil unrest (in Ethiopia and the DRC mobile penetration rates are, respectively, 22 percent and 25 percent). Regulatory reform has spurred growth of services in Latin America and the Caribbean recently, allowing a role for mobile operators in countries with entrenched banking infrastructure and interests (e.g. in Brazil, Bolivia, Columbia, Paraguay and Peru). While only six of the 19 mobile money markets are classified as having "enabling" regulatory environments, all but six have financial inclusion strategies, which allow tiered Know-Your-Customer (KYC) procedures, for example (Almazán and Frydrych, 2015). After slow growth in earlier years (Figure 4), collectively, therefore, such reform bolstered the fastest regional growth in new registered mobile money accounts in 2015.

5.2 Profitability

Mobile money is a young industry, with three-quarters of the 271 mobile money services launched after mid-2010 (Figure 4). However, by 2011, only one scheme (M-Pesa) had achieved operational profitability. The benchmark to break even and show profit is about a million active subscribers, each performing at least one transaction per month (Lonie[60], 2013). A nascent, high-opportunity industry is likely to attract more entrants in the early stages than the market can support (Villasenor, 2013), and mergers may strengthen the market sway of struggling low share operators. Moreover, in a rapidly evolving market, lessons from successful sprinters may transform profitability for others (Pénicaud and Katakam, 2014). Since 2011, the number of mobile deployments that have "reached scale" has grown. In mid-2013, 13 services had more than a million active users, seven of which passed this threshold in the preceding year (Pénicaud and Katakam, 2014). By the end of 2014, 21 services exceeded one million 90-day active accounts (Scharwatt et al., 2015).

[59] They measure performance by the ratio of transactions (excluding airtime top-ups and cash in-cash-out) to the size of the addressable market (mobile subscribers for MNOs), see their Figures 4 and 5.
[60] Susie Lonie is credited with being one of the creators of M-Pesa, when employed by the Vodafone Group.

What factors account for the difficulties in reaching profitability? Unless a critical mass of clients *adopts* mobile money and they have *active* accounts, a short-fall in cash flow can affect coverage of operational costs and induce a disincentive to invest further. Successful deployment depends on how various internal and external factors influence adoption (Di Castri, 2013). Internal factors include investment in mobile money and organisational structures, and the customer acquisition and distribution strategies. External factors include the extent of mobile penetration, socio-economic factors, competition, and regulation. Lonie (2013) argues that banks and MNOs have failed to appreciate that mobile money requires expensive investment in new teams, operational procedures and marketing, rather than being closely aligned to the existing core business and its infrastructure.

Central to early success is creating, training, incentivising and monitoring a widespread agents' network. Customers require marketing effort and education in how to use the service. Successful adoption requires accounts, once registered, to be active, and this too depends on agents' incentives at registration and thereafter (see Section 9). Diversification to more complex products such as micro-insurance needs a specially trained sales force and consumer education.

Regulation is a key external factor. The piecemeal establishment of mobile money services in many countries has led to different regulatory approaches. Some have been highly restrictive, as regulators confront new challenges posed by new technology. Where banks are involved as partners (or sole issuers) of mobile money, they are disinclined to challenge inappropriate and heavy-handed regulation, even if unsuited to the low risk associated with low value transactions. Lonie (2013) suggests banks are by nature cautious and risk averse, do not wish to jeopardise their complex relationships with the regulators for core banking operations, and are unclear on the risks posed by mobile money. With formal partnerships between mobile operators and banks, banks tend to favour regulation that reduces the costs to banking business posed by mobile money.[61] Lonie argues, on the other hand, that mobile operators, though more entrepreneurial, mostly do not have the internal capacity to understand and challenge inappropriate financial regulation. The regulatory approaches deemed most successful to encourage a profitable take-up of mobile money services are explored in Section 10. Charities and donors have had an important impact in drawing out and disseminating the lessons of "enabling regulation". The success of this effort is evidenced in 2015 by 51 of 93 countries being assessed to have an enabling regulatory framework (GSMA, 2016).

Insights into profitability are given by analysing direct and indirect revenue from mobile money, and operating costs. Based on a sample of 69 MNOs, in June 2013, Pénicaud and Katakam (2014) find that for 5 operators, over 5 percent of total revenues were generated directly by mobile money. The Vodacom subsidiaries in Kenya and Tanzania each generated over 18 percent of total revenues from mobile money. One indirect revenue benefit is savings on airtime distribution. For 10 operators in the sample, more than 10 percent of their airtime was sold via mobile money, totalling US$19 million in June 2013.[62] Another indirect benefit is reduced customer "churn", or savings from customer loyalty (though this is less important in more competitive markets offering similar products). Some services have found the reduced churn to add considerably to revenues. Leishman (2011) found that savings from airtime distribution, reduction in churn, and increased share of wallet for voice and SMS, combined to account for 48 percent of MTN Uganda's gross profit by end 2010. Although M-Pesa contributed 20 percent of company revenues (half year results for 2015-16), it was the largest individual contributor to direct costs, at 23 percent of costs (KSh5 billion (about US$55

[61] There have been frequent instances of dissent and misunderstandings, as in Kenya's attempt to partner with the Equity Bank in 2010 with a product called M-Kesho (see also Section 8.1.6).

[62] Agents' commissions for cash-in, a necessary prelude to topping up using mobile money, are typically below the discounts for selling airtime to the channel; costs are further saved in the scratch cards otherwise used for top-ups.

million)). This was due to M-Pesa agents' commissions and the expansion by 14 percent to a total of 91,249 agents by September 2015. Safaricom's strategy is to increase digital transactions between visits to agents and thereby raise revenue without raising costs. The company is heavily encouraging diversity in payments by promoting services such as rental payments through Lipa Kodi from tenants to landlords, the "Lipa na M-Pesa" network of merchants and international remittances.

Diverse business models for mobile money services have recently appeared in the Latin America and the Caribbean region. These range from the East African type of model serving largely the unbanked (with most revenue from P2P transfers), to mainly bank-driven mobile money partnership schemes, cooperating with mobile operators and retailers with some interoperability (and the majority of revenue from business fees, bulk disbursements and international remittances). There are also hybrids of the two types of models, as in a few African countries and in South Asia. But the GSMA (2016a) survey emphasises that in a more crowded arena, the business case for mobile money will depend on a diversification of services away from expensive agent-driven personal transfers toward "ecosystem" transactions involving third parties: bill payments, merchant payments, bulk disbursements, international remittances and integrated transport payments, and greater interoperability.

5.3 Competition in the markets

There are first mover advantages in establishing mobile money services due to the "natural monopoly" features in creating the infrastructure. A dispensation may be granted to the first mover as compensation for the initial investments to establish the industry, such as exclusive contracts with its agents' network. Ultimately, however, as other companies are established to challenge the incumbent, competition policy will have to erode exclusivity and evolve toward greater "interoperability", given the advantages this offers to consumers and provider-companies alike. Safaricom's agent exclusivity arrangement in M-Pesa was formally outlawed in July, 2014 by the Central Bank of Kenya, to improve competition and encourage lower fees. In Uganda, agent exclusivity was outlawed by the 2013 Guidelines.

The mobile phone market structure has itself has evolved from monopolies in the mid-1990s to largely deregulated markets. For instance, in Africa, partially or fully deregulated markets dominated monopolies by about 2004 (see Aker and Mbiti (2010), their Figure 4). Mobile money markets for the unbanked have become increasingly competitive too, especially in Sub-Saharan Africa and Asia. By end-2015, there were 60 markets with two or more mobile money services, compared to 40 at the end of 2012 and 33 at the end of 2011, and 35 markets with three or more services (Pénicaud and Katakam, 2014; GSMA, 2016). Most new deployments in 2015 were launched in markets with existing mobile money services. On the other hand, there have been mergers between small companies, such as the reduction of players in Uganda from five to four with the 2013 merger of Warid and Airtel, creating a sizeable competitor for the dominant MNO, MTN.

Greater competition is expected to improve quality, variety and innovation of products for consumers as well as to reduce prices. Most current mobile money systems are not integrated with others and electronic money has to be converted to cash on one system before it can be sent on another. The expectation in the industry is that the increased competition will spur interoperability and indeed this is gathering pace (see Section 10.2).

5.4. Effects on Hawala, and illegal or unlicenced international remittances

The old-age method of informal and unregulated money transfers based on trust, and effected through close ethnic or family networks, is called Hawala. Hawala is an Arabic word meaning "transfer", but

is by no means confined to Arabic countries. Overwhelmingly, Hawala is "illegal", as in "unlicensed", although sometimes it is tolerated. Its essence is that money does not physically travel, and the international transfer of the money is almost immediate.

The widely-prevalent Hawala systems are interesting for a survey on mobile money. If licenced mobile money systems for cross-border transfers with low transactions costs increase their current tiny share of the market (Section 3.6), this could create considerable competition for Hawala, as the users of the two services intersect strongly. Western Union and other registered money transfer companies have cut costs in recent years, already providing limited competition for Hawala.
This could transform the role of the unlicensed Hawala.

In its modern variant a client approaches a banker and is provided with a code in exchange for a sum of money. This code is provided by the client to the recipient in a different location (country) by telephone; on being presented to a local "banker" in the same Hawala network in the new location, who is also contacted by telephone, this results in the transfer of the cash.

Hawala is heavily used by migrant workers (Van de Bunt, 2008). It is particularly prevalent in war-torn countries, and in those with poor infrastructure. Several authors have investigated the phenomenon in Afghanistan, Somalia, Pakistan, amongst other countries. Thompson (2006) asserts that there were 900 Hawala bankers in Afghanistan while there were only 13 formal banks. Typically it is a flat network, not hierarchical, with clients and bankers sharing a narrow ethnic background. The coherence and success of the network relies on discipline through trust. Discipline is not induced through violence; rather, misbehaviour is punished by exclusion from the network.

Varese (2015) documents the characteristics of a formerly long-lived pure Hawala network, which "diversified" out of purely family/ethnic networks into riskier international and multi-ethnic activities, including drug money carrying and laundering. This was probably induced by economic pressure from competitive methods of money transfer, and the emigration of migrants in economic downturns. Using criminal prosecution records and transcripts of telephone conversations that led to the arrest of the Hawala bankers, he finds that the expanded networks became hierarchical in nature and disciplined through threats of extreme violence.

Concerns about security and money-laundering in specific countries have constrained the adoption of mobile money for efficient and low-cost international transactions. Yet licenced money payments organisations are bound by "know your client" legislation, require identity documents and record all transactions. Mobile money should facilitate remittances from legal immigrants to war-torn countries like Somalia, with limited or no functional banking, and would take customers from Hawala, bringing informality into the official economy. But it seems inevitable that two populations - serious criminals and illegal immigrants - would both get pushed into using the same service, Hawala or anonymous digital money.

5.5 Cheaper smartphones and technological innovation

The earliest mobile phones in the developing world were basic feature phones without touchscreens, internet access, access to "apps" and other features of the smartphone[63]. The basic feature phone has limited functionality, but it has been adequate to execute simple financial operations, such as the transfer of money using text messages. Basic feature phones have even allowed cash withdrawal at ATMs, payment of bills, access to interest-bearing savings accounts and insurance products, and

[63] A smartphone is defined as: "A cellular telephone with built-in applications and Internet access. In addition to digital voice service, modern smartphones provide text messaging, e-mail, Web browsing, still and video cameras, MP3 player and video playback and calling. In addition to their built-in functions, smartphones run myriad free and paid applications, turning the once single-minded cellphone into a mobile personal computer." http://www.pcmag.com/encyclopedia/term/51537/smartphone [May-14]

access to small loans (Section 3). However, the interface of the basic phone remains restrictive, and it is challenging for those with limited literacy to operate the more complex services.

The smartphone's more flexible display and user interface options could help surmount literacy barriers, and expand the reach of mobile technology (Villasenor, 2013). Cheaper smartphones and *recycled* smartphone handsets marketed in developing countries would provide access to sophisticated features and a spectrum of financial services. Inflexible interfaces on basic feature phones for more advanced products, such as accessing account information, switching between accounts and submitting loan applications, might itself prompt the uptake of smartphones. The adoption of smartphones will likely increase the *usage* of broader financial services.

This contention is supported by evidence in the US (Federal Reserve, 2016). Smartphone adoption substantially contributed to the increased use of mobile payments in the US in 2015 (Section 4.3). In the US, there is a relatively high prevalence of mobile phone and smartphone use amongst younger generations, minorities, and those with low levels of income—groups that are prone to be unbanked or under-banked. And developing countries have predominantly younger and lower income populations.

In 2016, global smartphone sales for the first time exhibited single-digit growth, predicted as 7 percent, as compared with 14.4 percent in 2015.[64] Sales in most emerging markets grew at a slower rate, though countries such as India helped generate new mobile phone user growth. Sales of smartphones in India were predicted to reach 29 per cent in 2016, and will continue to exhibit double-digit growth in the next two years. This slowdown follows a period of rapid global growth in smartphone sales, for instance, of 42 percent in 2013,[65] when smartphones accounted for 54 percent of overall mobile phone sales and exceeded annual sales of feature phones for the first time. Leading the growth then were Latin America, the Middle East and Africa, Asia/Pacific and Eastern Europe: smartphone sales grew by more than 50 percent in the last quarter of 2013 (and in India, alone, grew by 167 percent). China's smartphone sales in 2013 grew 86 percent. Gartner estimates that by the end of 2016, 82 percent of mobile phones will be smartphones,[66] and by 2018, 78 percent of global smartphone sales will come from developing economies.

The price of entry-level smartphones has commensurately declined. ARM Holdings, the market leader in processors, predicted that by 2015 over half the smartphone/tablet shipments would comprise entry-level phones below US$150. Further scaling on the process technology and development of small and power efficient CPU cores, combined with new competition in low-cost markets, suggests a far low price floor for an entry-level smartphone running Android.[67] Highly competitive pricing from Chinese and Indian brands for more capable, affordable, basic smartphones has led to a shift to entry-level smartphones in China and other emerging markets. By 2018, Gartner expects the price for a basic and a utility phone to be US$78 and US$25, respectively, and with improved links to the service ecosystems. This is lower than the prices of feature phones (corrected for inflation) bought in Kenya by the unbanked at the start of the mobile revolution in 2007. The cheapest new android entry level smartphone in Kenya in early 2016 was below 5000 Kenyan shillings (or US$50).

Global smartphone adoption is projected by GSMA Intelligence to increase 1.7 fold, between 2012 and 2017, with a 5-fold increase in smartphone penetration expected in Sub-Saharan Africa and a 2.2 fold increase for Latin America (see Almazán and Sitbon, 2014). Villasenor (2013) suggests a virtuous circle where greater adoption of smartphones prompts MNOs to offer diverse financial

[64] Data: http://www.gartner.com/newsroom/id/3270418, from Gartner.
[65] Data: http://www.gartner.com/newsroom/id/2665715, from Gartner.
[66] Data: http://www.gartner.com/newsroom/id/3187134, from Gartner.
[67] http://www.anandtech.com/show/7993/arm-expects-1b-entry-level-smartphones-in-2018-20-smartphones-coming-this-year

transaction applications for smartphones. Interoperability across networks and between mobile money providers and the banking system will then become easier to implement and to use.

To put these numbers in perspective, fewer than half of all Africans have mobile phones (GSMA, 2016b). A further caveat is that application usage on a smartphone requires affordable access to the internet. The International Telecommunication Union (ITU) estimates that three-quarters of Africans do not use the internet due to lack of data signal and the high costs of downloading data; technological change through improved satellites, solar-powered masts and new cable connections may in future shift internet use in Africa and other under-provided areas.[68] As a result, mobile phone operators tend not to promote innovation with apps in Africa, but simply load them onto the SIM card.[69]

6. The economics of mobile money

The novelty of mobile money and its recent introduction in many countries means few studies[70] have examined the economics of mobile money. None has given a comprehensive overview, from both a micro- and a macro-perspective, of the channels through which mobile money might impact on the economy.

6.1 The micro-view

The mobile money storage and payments system, and its further linkages to interest-paying bank accounts, micro-insurance, and credit via algorithmic credit scores, could affect household and business outcomes through several different channels. We consider six categories and linkages between them.

6.1.1 Reducing transactions costs

Mobile payments substantially reduce the transactions costs of sending and of receiving money over sometimes substantial distances, especially where there are poor and expensive transport links. Jack and Suri (2014) observe that in Kenya, where families and social networks are widely-dispersed from internal migration, remittances on average travel 200km; lowering transaction costs could increase the size and frequency of remittances and the ability to smooth risk. Being a mobile money customer also reduces the costs of acquiring cash, if agents are readily available ("cash-out").[71] The mobile money "infrastructure" has to be in place and working well to reap the benefits; and a poorly monitored agents' network may be subject to "leakages". Aker et al. (2015) and Blumenstock et al. (2015a) both note that a dearth of agents, through a limited network in Niger, or in a highly insecure and unsafe environment in Afghanistan, may make it difficult to access cash from agents, raising transactions costs.

What types of transactions costs are involved? They include the *transport costs* of travel to a bank, utility company or government office; the *travel time* and the *waiting time* in long queues; the

[68] See "Continental disconnect." The Economist, 10 December 2016, pages 45-46.
[69] See "Special Report, Business in Africa", The Economist, 16 April 2016, page 16.
[70] The following authors have examined aspects of the economics of mobile money: Mas and Klein (2012), Jack et al. (2010), Jack and Suri (2011) and Weil et al. (2012).
[71] Withdrawal of cash from mobile money accounts attracts a transactions fee, but this would be lower relative to transport costs and queueing costs at scarce bank branches, and the costs of maintaining a bank account.

coordination costs between individuals, between firms and suppliers or customers[72], and between government and individuals, which can be extensive in both time and money lost; and the costs of delays and "*leakage*" through corruption or middlemen with insecure methods of transfer, acting like a *tax*, and at an extreme, the cost of complete loss through *theft*. The loss of money and loss of time have an *opportunity cost*. The reduced funds could have been invested, spent or saved; the reduced time could have been spent in productive activities, such as agricultural production or innovation.

The diversification of mobile payments allows the rapid and secure execution from afar of a range of transfers. These include retail payments, utility bills, school fees, governmental taxes, rentals by individuals; payments to employees and suppliers by firms; and payments of salary, pensions and cash transfers to individuals from government or donors. The automated delivery of cash transfers, wages and social security funds, and delivery of private remittances by electronic transfer (rather than by bus drivers), increases the *certainty* of the *timing* of cash receipts (including that it arrives at all), which helps *planning*. This further reduces coordination costs, the costs of delays and hence the opportunity costs. The combination of widespread use of mobile money for payments, and a mobile phone to reduce *search and information costs* and *communication costs* (an aspect of coordination), could introduce substantial gains in efficiency.

6.1.2 Reducing asymmetric information and improved transparency

Recording financial transactions not only creates greater financial transparency, but it also reduces asymmetric information. Asymmetric information is at the heart of the failure of the formal banking sector to advance credit to poor customers who lack collateral and financial histories. Moving cash from under the mattress into an electronic account turns it into *recorded* cash. Every deposit, withdrawal, transfer or payment transaction through mobile money recorded in the telecoms log for a customer creates a financial history, and probably for the first time for the unbanked customers. Algorithms can be applied to create credit scores based on the types, timing, frequency and size of mobile payments transactions, and thereby facilitate the granting of credit (see Section 3.4). Thus, having a record of an individual's financial history *itself* becomes an important *indicator* of financial inclusion.

Reducing asymmetric information via credit scores from financial transactions histories is not new. This is how the FICO[73] scores in the US, decisive in 90 percent of US lending decisions, are created. Legislation was enacted only in 2004 requiring US credit reporting agencies to provide extensive credit score information at a customer's request. This privacy issue will surely have to be addressed by regulators for mobile payments credit scores in cash-dominant economies.

Electronic records of payments and purchases also potentially protect consumers against theft, fraud and misinformation. Again this depends on regulation for consumer rights, and will need to be addressed where coordinated business use of payments grows rapidly, as in Kenya's "Lipa na M-Pesa". Greater transparency can help regulate the service, promote competition and protect consumers with the dissemination and posting of information on transactions costs on websites and at agents' stands. Such protection can reduce transactions costs for consumers and increase the use of business

[72] In Kenya's "Lipa na M-Pesa" business network (Box 1), transactions costs are reduced for businesses in a coordinated payments network, and consumer incentives given for remote payment using dedicated business cash till numbers on their phones.

[73] "FICO" derives from the Fair Isaac Corporation, the firm that began data-driven credit scoring in the 1950s, which scores were endorsed in 1995 by Freddie Mac and Fannie Mae, the US housing finance agencies. By 2000, the FICO scores were used for the origination of 75 percent of US mortgages. By 2015 they were used in 90 percent of lending decisions (Financial Times, 5th February, 2015, p.9).

through trust.[74] Radcliffe and Voorhies (2012) also note the "anonymity of cash" may inhibit trust between traders and new vendors, if their anonymous cash-based transactions are not backed up with a digital record.

Recorded transfers with appropriate ID documentation ("know your customer") could also facilitate some crucially important transactions, e.g. international remittance transfers. The closure of vital channels of money transfer to Somalia, following new US money-laundering regulations from the OCC[75] requiring improved information on the sources and destinations of wired funds, could promote the unregulated parallel market in cash transfers (see Section 5.4) and facilitate the channelling of money to militant groups. If the sender and recipient are both members of a mobile money payments network, identified by more stringent ID requirements for international remittances, this could create a complete record of transfers to registered individuals at each end.

Financial record-keeping also has important implications for economic research. The use of administrative telecoms data can create predictive indicators in developing country environments with otherwise very limited available economic information, for instance of wealth based on expenditure (see Section 7.2). To my knowledge, detailed mobile money transactions data have not yet been used in this way, only mobile phone data, suggesting important scope for analysis.

6.1.3 Increasing saving and changing the nature of saving

There are several motives for saving. Life-cycle motives compensate for differences in timing between income and expenditure streams, and these include saving for education, leisure, marriage, consumer durables, housing purchases, retirement and funeral expenses. Precautionary motives (buffer stock saving) reflect the uncertainties of future income and expenditures, and include saving for unemployment, illness, accidents, natural disasters and risks associated with old age. Finally, there is saving for a bequest motive, to give gifts in one's lifetime or to leave a legacy to heirs. Saving thus helps to allocate consumption over time, and to reduce risk.

For the unbanked poor, their "immersion in physical cash creates considerable frictions in their financial lives" (Radcliffe and Voorhies, 2012). Cash-based households have informal savings options, which carry risks of theft or "liquidation": cash under the mattress; accumulation of assets such as jewellery or livestock; and storing savings with informal savings groups. Loss of savings in this manner is common. Mobile money electronic accounts offer safe storage of cash, though without the payment of interest. The safety aspect should nevertheless increase the level of savings, net of theft and losses (Jack and Suri, 2011).

Another advantage is privacy, noted by many authors. The inconspicuous nature of transfers could allow personal savings to accumulate, without the user being importuned by needy friends and relatives or giving way to current consumption needs. Related to this is an economic psychology literature on how the poor could be encouraged to accumulate savings in the mobile money electronic storage accounts (Mas, 2012). Use of "commitment" savings accounts with pre-determined goals or duration have been explored by Ashraf et al. (2006), see also Dupas and Robinson (2013).

Johnson (2014) has written about the effect of mobile money on rotating credit schemes and stressed the continued importance of such schemes for perpetuating trust and coordination in communities. Practically, these schemes do co-exist with mobile money (see Jack and Suri (2011)); there is some evidence of substitution away from them (Mbiti and Weil, 2016); but equally, there is

74 An example is the huge growth in online distance purchases in the UK and the US, e.g. from Amazon, with built-in guarantees and rights of return of faulty products, and influenced by consumer reviews of purveyors.
75 The Office of the Comptroller of the Currency is a Treasury Department arm that regulates national banks.

evidence that the transfer and storage mechanism is actually exploited by these schemes (Section 8.1.6).

6.1.4 Risk and insurance

The poor are at risk of multiple *communal shocks* including flooding, droughts, pestilence, other natural disasters, and sometimes conflict, and medical epidemics; and *idiosyncratic shocks* including theft, damage to the homestead, illness and death in the family. There are very limited opportunities for insuring against these risks. Formal insurance is typically absent, but family, clan and network ties can create informal insurance networks, ameliorating such risks by periodic transfers and monitored by trust relationships amongst members of the network (De Weerdt and Dercon 2006). Jack and Suri (2011) suggest several ways by which mobile money can facilitate risk-spreading. The geographic reach of networks can enlarge, though with more limited observability and hence accountability of remote members. Timely transfers of sometimes very small amounts of money can arrest serious declines that may be impossible or hard to reverse. In general, the mobile money technology allows small and more frequent transfers of money that make for a more flexible management of negative shocks. Thus, informal insurance networks may function more effectively. In turn, more efficient investment decisions can be made, improving the risk and return trade-off. Where mobile money develops sufficiently to allow access to micro-insurance for health (Section 3.5), there is potentially an additional buffer against negative shocks.

6.1.5 Changing family dynamics and changing social networks

Mobile money could change relative family bargaining power. It was suggested above that the reduced observability by others of the timing and sizes of mobile transfers, and of the accumulated electronic balances, could protect savings for the recipient. Greater privacy may influence both inter-household allocations (Jakiela and Ozier, 2016) and intra-household allocations (Duflo and Udry, 2004). If the nature of expenditure by gender differs (Chattopadhyay and Duflo, 2004), there could be welfare changes in the household. Indeed, Aker et al. (2015) measure improved household bargaining power for women in Niger receiving cash transfers, with resulting welfare improvements (Section 8.1.5).

Mobile money could also change the nature of social networks in various ways. According to Chuang and Schechter (2015), there is little research on network formation (or, presumably, dissolution), and on migration and remittance decisions using network data. Better communication and coordination in a social network with mobile phones and instantaneous mobile payments could improve planning and efficiency. The cohesion of the network could be strengthened or weakened. The size of networks could be expanded with the greater geographical reach of the transfer mechanism. The reduced transactions costs (especially reduced theft) of remittances might create a more liberal attitude to migration from the homestead. Jack and Suri (2011) suggest that households could invest in family members working far afield to acquire skills and better salaries. Morawczynski and Pickens (2009) note the greater autonomy of rural Kenyan women as they could more easily solicit funds from their husbands and other contacts in the city. However, raised expectations of larger and more frequent remittances might place pressure on migrant family members, and Jack and Suri (2011) suggest that incentives to work or innovate could weaken within recipient households, creating greater dependency. On the other hand, distant migrants are less observable and accountable. Mobile money may deleteriously affect existing networks (see Mbiti and Weil (2016) for evidence of the reduced use of ROSCAs).

6.1.6 Improving efficiency

Mobile money facilitates trade, making it easier to pay for and to receive payment for goods and services. The enhanced access to credit, both informally and through formal banking services linked to mobile money, can improve investment decisions. Improved informal risk sharing and cheaper, secure, long-range remittances can expand the scope of labour decisions to encompass higher-risk but higher-return occupations or migration to higher-return labour markets (Jack and Suri (2016). The changes wrought by the use of mobile money can lead to better allocation of savings and of labour both within the household and in businesses, and more efficient investment decisions affecting agriculture, business and investment in human capital. The result could be an improvement in returns to investment, and a feed-back to greater savings. The Aker et al. (2015) study brings out further implications of the technology: the improved bargaining power of women through increasing the privacy of a cash transfer, and improved time saving from lower transactions costs which enabled additional productivity through cash-cropping to pay for expenditures, helped improve the nutrition of their children.

The efficiency issue raises the serious question about whether the quality adjustment for Information Communications Technology (ICT) and mobile services in the consumer price index (CPI) are sufficient. If not, this probably means that inflation is overstated and domestic output understated.

6.2 The macro-economic view

The macro-consequences of mobile money have been poorly understood in a limited literature that has mainly focussed on the possible inflationary effects from the increased velocity of circulation induced by mobile money. This focus on velocity is partial, and misplaced. It is also often assumed that there is no creation of money from mobile money[76], but that cash is simply exchanged for electronic money so there is no direct effect on the money supply (e.g. Di Castri (2013), p 10). This is not necessarily correct. We consider the potential impact of mobile money on macro-economic aggregates including the money supply, credit, saving and consumption, investment and productivity, and inflation.

6.2.1 Mobile money, credit and transmission to the money supply

There are several channels through which mobile money could potentially affect the money supply. Some channels will increase in importance in the future as they depend on further innovations in the mobile money technology. One such example is the low-cost linkage of electronic mobile money accounts with formal bank accounts which pay interest, and the potential extension of credit through these linked bank accounts (e.g. M-Shwari in Kenya operating entirely through the M-Pesa platfor006D, Box 1). A second example is the burgeoning low-cost transfers of international remittance to mobile money accounts that are linked with bank accounts (see the Kenyan example in Box 1).

The following statement is from (early) economic commentators on the effects of mobile money: “Yet many m-money systems in developing countries are not technically banking from either a financial or legal perspective: (i) they do not provide interest on savings, or (ii) facilitate access to credit from formal financial institutions, nor (iii) do they insure the value stored in the mobile

[76] An exception in the literature is Mas and Klein (2012, p6).

account" (Aker and Mbiti, 2010).[77] This statement has today to be qualified, following market and regulatory changes that link the electronic accounts closely with the formal banking system. We explain the consequent monetary effects below, illustrating with East African experience.

It remains true that electronic money accounts do not provide interest to customers, though some have argued that they should (Ehrbeck and Tarazi, 2011). Customers face the same loss on their electronic balances as when holding cash.[78] However, innovation in some mobile money systems has created a pathway for registered mobile money users via their electronic mobile money accounts to open special formal bank accounts, accessed only via a mobile phone, and which *do* pay interest. If informal cash can be attracted into such bank accounts from informal savings, there is the potential for increased saving (and decreased consumption). This money, through being on-lent as a conventional bank deposit, would expand the money supply via increasing the money multiplier.

Moreover, under most regulatory regimes, commercial banks are required to act as custodians for the customers' electronic funds in a variety of ring-fencing mechanisms (Section 10.2). Two examples are "trust" accounts and "escrow" accounts[79] held by commercial banks, with funds usually matching the full extent of the electronic deposits. Sometimes these pooled funds are required to be diversified across several banks, especially when the funds are large, as in more mature mobile money systems. These accounts *do* pay interest, and the question of what happens to this interest is currently evolving (see Section 10.2).[80] The escrow/trust account deposits can be on-lent and hence there is credit creation. In effect, the mobile money saving in electronic accounts has moved informal cash into the banking system. The transfer of informal cash will not increase the recorded money supply per se unless the source is unrecorded cash, say in another currency. The shift of informal cash into the banking sector thus has a zero first round effect on the money supply; but because banks can lend on in a second and further rounds, there is a money multiplier which can expand the money stock. The crucial question is what exactly are the regulations that govern the on-lending of escrow accounts? Presumably these differ by country, and may also change over time. Initially, if the electronic "savings" fluctuate, only a proportion of the escrow accounts could be sustainably on-lent; but as the system grows, the escrow balances could become large and more stable. Even then the money multiplier will surely be less than for the direct deposit of informal cash in the banking system, since for an escrow account to be safeguarded there must be limits on the degree of extra risk the bank can take on given an expansion of its balance sheet of this type.

Thus, the MNOs cannot themselves intermediate the funds they mobilize from their customers; they must transfer these funds to a commercial bank which is subject to the prudential regulations applicable to deposit-taking institutions. Uganda's regulations[81] require the MNO to partner with a bank. Kenyan regulations[82] do not require this. However, the function of the Ugandan

[77] Our numbering inserted for expositional reasons.

[78] This can be considerable if inflation is high, but there are no charges for holding the electronic accounts compared with sizeable monthly costs for bank current accounts.

[79] Trust accounts are managed by remunerated Trustees on behalf of a set of specific beneficiaries and governed by established Trust law, typically in Common law jurisdictions. Escrow accounts are typically but not only established in Civil law jurisdictions; the rights of the depositor (e-money issuer) and third person (mobile money accountholder) are determined according to the terms of the contract of the particular escrow arrangement. See also Greenacre and Buckley (2014).

[80] In the case of Kenya's Safaricom this interest is currently paid to charity, though by law the Trustees of Safaricom's Trust Account could allocate all or some of the Trust's income (i.e. the interest) to the beneficiaries of the Trust, who are the agents and the customers.

[81] New Bank of Uganda regulations are:
https://www.bou.or.ug/bou/media/statements/Mobile_Money_Guidelines_2013.html .

[82] Since October, 2007, formal regulation has been light, and based on letters of "no-objection" from the Bank of Kenya (Section 10). New Kenyan regulations are:

partner bank is almost identical to that of the commercial banks required by law to house the assets of Kenya's Safaricom Trust (Box 1). Both hold custodian (trust or escrow) accounts.

Some markets have evolved so that Aker and Mbiti's second point is also no longer true. Small loans backed by transactions-based credit ratings can now be accessed through mobile money (e.g. in Kenya, Box 1 and see Section 3.4). With time, as credit scores improve and the system deepens, these loans could evolve in aggregate to a sizeable sum. Generally, the credit channel for individuals is unlikely to be a major force in the medium-run given the lack of collateral of the most likely users of the new bank accounts. But potentially credit for small businesses could also be extended through such accounts (e.g. when credit scoring and other methods are introduced to try to ease credit constraints on small business), expanding the money supply.

Aker and Mbiti's third point is no longer correct as regulatory guidelines have firmed. The electronic accounts carry no conventional deposit insurance as for a bank account. The legal position is that, if available, the conventional deposit insurance for the escrow account of pooled customers' funds accrues to the customers. The insurance level is typically low (of the order of US$1000). However, if mobile money accounts are small they should mostly be covered, provided that regulation allows pass-through protection for *each* customer up to the insurance limit (as in the US), as opposed to one insurance payout applying to the account as a whole (see details in Section 10.2).

All the above-mentioned funds come from deposits made domestically by users and agents. But extra liquidity will be added by the mobile money operating company for its fluid functioning. The operator can borrow domestically for this top-up, can use its own domestic holdings or import money from abroad if they are a subsidiary. There may also be inflows for infrastructure investment. These inflows will increase the money supply.

A far more immediately important channel to the money supply could be from a surge in recorded international remittances through mobile money channels. Regular foreign remittances if re-channeled through more cost effective mobile money routes, will not affect the money supply insofar as they are already recorded through official channels. But if the ease and lower cost of transfer *enhances* the flow of foreign remittances, this is potentially a channel to increase the money supply. And, if previously *unrecorded* foreign remittances flows are re-channelled through mobile money, the recorded money supply will increase. In some countries, parallel or illegal markets are sizeable (e.g. Somalia). We discuss the potential for a vast increase in international remittances through mobile money in Section 6.2.3.

Putting the above effects into *current* context, several observers have noted that the amounts involved in the M-Pesa network in Kenya are far less than in the official banking network. This, too, could alter. In Uganda, as of June 2014, there was a total of Ushs171 billion (about US$47 million[83]) held on the mobile money accounts of customers of the six mobile money operators in Uganda, some 1.4 percent of the total deposits in the banking system; and mobile money transactions constituted less than a tenth of all the financial transactions in the financial system (Tumusiime-Mutebile, 2014, p.4). The cumulative balance in the mobile money trust accounts held by Tanzanian commercial banks in January, 2014 was TZS 254.6 billion (about US$ 117 million[84]), see di Castri and Gidvani (2014). As East Africa, especially Kenya, is a growth region for mobile money, these figures provide an approximate upper bound for developing economies.

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http://www.gsma.com/mobilefordevelopment/programme/mobile-money/kenyas-new-regulatory-framework-for-e-money-issuers.

[83] Using a November 2016 exchange rate.

[84] Using a November 2016 exchange rate.

6.2.2 Saving, "spendability" and inflation – why the focus on velocity is misleading[85]

How might mobile money matter for inflation? In the monetarist view, if the spread of mobile money promotes increased velocity of circulation, this will increase 'effective money' and hence inflation. This is the mechanism proposed by Simpasa and Gurara (2012), see Section 8.2, but it reflects confusion in the literature on the effects of variations in the money stock on inflation, while neglecting possible benign linkages between mobile money and inflation. For example, because mobile money accounts are secure, their availability might well increase saving, and in the short-run reduce demand. On the other hand, the advent of mobile money might transfer spending power to households with a higher propensity to spend, and so reduce saving. In the very short-run, higher mobile balances might also signal plans for impending spending and so proxy a short-term demand increase. However, there are countervailing forces from the supply side as mobile money improves economic efficiency. Productivity gains and improved competition in markets for goods and services with falling transactions costs due to mobile money could reduce inflation. Cost reductions may not properly be reflected in mis-measured CPI, overstating inflation (see Section 7.2). It is far from obvious therefore, that well-measured inflation should rise as a result of the spread of mobile money.

The monetarist concern with the velocity of circulation[86] and inflation is as follows. The advent of mobile money potentially increases the "spendability" of money, with e-money more "spendable" than conventional cash through reduced transactions costs and the greater personal security of not carrying cash. If transactions costs are lowered by the spread of mobile money so that the ratio of the volume of transactions (payments and transfers) to money stock rises, then the demand for goods and service rises with the greater transactions convenience, given the money stock. This leads to the view that the spread of mobile money causes inflation. Given the measured money stock, an increase in its *effectiveness* according to the monetarists leads to a one-for-one increase in expenditure (by the simple quantity theory of money). But, the focus on velocity is misleading because there is no simple link between expenditure and effective (i.e. spendable) money.

Lower transactions costs will result in a reduction in that part of the money stock that is used for transactions (as opposed to other functions such as the store of value). Therefore less money for transactions purposes will need to be held. People can make do with smaller holdings of money by substituting e-money, which promotes transactions efficiency, and velocity commensurately increases. The money stock and its composition are *choice* variables and, rather than increasing expenditure, households may simply reduce their overall money holdings, while increasing the share in e-money in response to the mobile money innovation. In that case, the velocity could rise without *any* effect on expenditure.

Implicitly the monetarist view regards the effective *money stock* as the main constraint on expenditure. But at the level of the household this is absurd: expenditure is constrained by income, income expectations, the household's portfolio of assets and debt, and its access to credit. This is analogous for firms, but substituting cash flow and expected profits for income and expected income, and recognising the greater relevance of investment spending and access to borrowing for firms. For many households and firms, particularly those with the biggest weight in aggregate spending, the part of the money stock connected with regular transactions is a *choice* variable. As noted above, the response to this financial innovation may simply be to economise on overall money holdings with little impact on expenditure.

The composition of portfolios held by the private sector can be important. A higher fraction held in cash or mobile money form should, *for a given level of wealth*, result in wealth being more

[85] This section owes a great deal to joint work with John Muellbauer.

[86] Velocity is defined as the ratio of nominal GDP to the nominal money stock.

'spendable'. Aron and Muellbauer (2013) and Aron et al. (2012) find that in several industrial countries and in South Africa, net liquid assets of households (deposits minus debt) are about five times as spendable as illiquid financial assets (including stock market and pension wealth), and that the "spendability" of housing wealth is highly dependent on credit availability. Financial innovation (especially credit liberalization) can have marked effects on consumption and potentially on inflation, but with little connection to the transactions demand for money.

Thus, relying on the concept of velocity to address the possible impact of mobile money for household spending is quite misleading, especially in more developed countries with an array of possible alternative assets to money that might fuel demand, and because velocity is unstable. The money stock and with it the concept of velocity in fuelling demand is arguably somewhat more relevant in countries with few alternative assets. However, if the money stock relative to income is small, as is the case in most developing countries, then its role as a source of spending power remains small.

The simplistic monetarist view can be contrasted with a more complex view of the potential linkages between mobile money and inflation. A potentially important channel of transmission of innovations in mobile money to inflation is via the private sector (i.e. firms and households) saving rate. A *first-round* impact of mobile money could be deflationary if a rise in private sector saving lowers expenditure relative to income, and hence lowers the demand for goods and services relative to supply. Increased *saving for return* motives is likely to be enhanced by the development of mobile money accounts, because of the greater security of electronic saving and of interest-bearing bank accounts linked to mobile money accounts (e.g. M-Shwari in Kenya). However, effects in the opposite direction are also possible: the need for *precautionary* saving could decline because of lower perceived credit constraints, thereby reducing the private saving rate. For instance, lower transactions costs for cash transfers with mobile money from relatives or other support networks facilitates households coping with negative shocks (from ill-health or harvest failures), and poor households should then be better able to maintain expenditure. Moreover, *if* such mobile money transfers were from entities with *lower* marginal propensities to spend to entities with *higher* marginal propensities to spend, a *reduction* in the overall saving rate is possible. Overall, it is difficult to predict the effects on the aggregate household saving rate from these offsetting mechanisms.

As noted in Section 6.1, shifting cash out of the informal sector (e.g. from 'under the mattress') into the banking system could generate additional credit through the money multiplier and this credit channel could generate *second-round* effects on spending. Monetary and regulatory policy interventions clearly have an impact on such *second-round* effects: they will depend on economic circumstances such as bank regulation, risk appetite and alternative returns available to banks in the T-bill market. There are also potential '*third-round'* effects. If the increased credit provision goes into productive investment, the subsequent expansion of supply would be anti-inflationary, though the timing of expansion would depend on the investment horizon.

Thus, there is unlikely to be a simple link between the innovation of mobile money and inflation, via the velocity of circulation.

6.2.3 International mobile money remittances and inflation[87]

The future size of foreign remittances, regular or informal, re-channelled through mobile money, could be large. The initial impact on inflation is again uncertain: the remittances could fuel immediate consumption, they could be saved as above, or they could be channelled into productive

[87] This sub-section draws on the World Bank's Migration Briefs and databases, and the World Bank's Remittance Prices Worldwide database (see appendix Table A1).

investments.[88] Furthermore, if inflows of foreign remittances do increase, there could be offsetting effects on inflation via the exchange rate appreciation they are liable to induce.

Global trends in the sizes[89] and costs of remittances are given in Table 1. Annual foreign remittances exceeded the foreign exchange reserves in 14 developing countries in 2013, and measured at least half the reserves in over 26 developing countries (World Bank, 2013). If the balance of payments weakens, the importance of remittances as a source of foreign currency earnings increases. Officially recorded remittance flows to developing countries reached US$418 billion in 2013, up 25 percent from 2010. Global flows reached US$557 billion in 2013. Projections for 2016, using an 8 percent annual growth rate, are that remittances to developing countries could reach US$540 billion, and, worldwide, over US$700 billion.[90] However, the *true* size of remittances, including unrecorded flows, is likely to be significantly larger. Remittances reported by commercial banks in Sub-Saharan Africa do not fully capture flows through money transfer operators, post offices, mobile money transfer operators, and illicit transfers. Kendall et al. (2013) note that two-thirds of remittance recipients in South Asia and Indonesia report using informal channels to make transfers.

A G20 objective has been to reduce the *cost* of international remittances (to 5 percent by 2014, see World Bank (2014b)).[91] The prohibitive costs were discussed in Section 3.6, and see Table 1. The average fee to remit money in Africa is the highest of any world region; see the ODI study by Watkins and Quattri (2014). If the cost and ease of making remittances improved, this could attract a higher level of official remittances, and re-channel "informal" or illicit remittances through official channels, raising recorded remittances. This could also improve official statistics and potentially the economic management of remittances. As there could be effects on the size of the money supply and on the exchange rate, see above, monitoring growth of the segment of international remittance transfers via mobile money is then important.

6.2.4 Some tax implications[92]

Tax collection could be improved by the rise of more *visible* spending through recorded transactions, quite apart from the greater ease of tax collection via mobile money payments (Section 3.3). Access to spending data by central banks and other authorities is discussed below, but there are data privacy considerations which have not yet begun to be addressed. A broader, but lower tax rate could have

[88] The World Bank's African Migration project provides information on leveraging remittances for development.

[89] These data use the new definition of remittances introduced in the Sixth Edition of the IMF Balance of Payments and International Investment Position Manual, which supplements "compensation of employees" and "personal transfers" with a third item: "capital transfers between households", though data for the last are difficult to obtain and missing for almost all countries.

[90] For developing countries, East Asian and South Asian flows (US$115 and US$114 billion, respectively) far exceed those to Latin America/Caribbean (US$61 billion) and Sub-Saharan Africa (US$32 million). The highest recipients of officially recorded remittances for 2013 were India (US$71 billion), China (US$60 billion), the Philippines (US$26 billion), Mexico (US$22 billion), Nigeria (US$21 billion), and Egypt (US$20 billion). Other large recipients include Pakistan, Bangladesh, Vietnam, and Ukraine. As a percentage of GDP, the top recipients of remittances in 2012 were Tajikistan (48 percent), Kyrgyz Republic (31 percent), Lesotho and Nepal (25 percent each), and Moldova (24 percent). Nigeria accounts for more than half of total remittances in Africa. As a share of GDP, the largest recipients are Lesotho, Togo, Cape Verde, Senegal and The Gambia.

[91] Cutting transactions costs to 5 percent from the average of 12.4 percent would "put US$4 billion more in the pockets of Africa's migrants and their families who rely on remittances for survival", http://www.worldbank.org/en/news/press-release/2013/01/28/african-migrants-could-save-US4-billion-annually-remittance-fees-finds-world-bank.

[92] I am grateful to John Duca, Federal Reserve Bank of Dallas, for these points. Paul Collier made similar points on tax at a Roundtable on Consolidating Africa's Mobile Banking Revolution, Blavatnik School of Government, University of Oxford, February 2016.

efficiency implications. Also, if the provision of public goods is restrained below its optimal level by tax evasion conducted with currency, then improved tax collection as a consequence of mobile money may help bolster public investment which could have positive macroeconomic effects. The mobile phone and related companies are an easy source of tax: in Kenya, Safaricom pays more taxes than any other company.

7. Data measurement issues concerning mobile money

With mobile money fast expanding internationally and within countries, there are many economic questions to explore with micro- and macro-focused empirical research. Central banks need to track mobile money growth appropriately for their inflation models and prudential analyses. Country regulators of the ICT industry need to monitor trends. Vast amounts of data are continuously recorded by the mobile money operators from different types of transactions flows, the balance stocks of individuals, businesses, donors and governments, and the numbers of active customers by type. If anonymising procedures could be accepted by mobile money operators, then the benefits from research analysis using anonymised disaggregated data could be reaped. Aker and Mbiti (2010) suggest partnering with data-generating organisations to evaluate new interventions with experimental or non-experimental techniques.

7.1 Global data coverage

The available global statistics (with links) pertaining to mobile money and financial inclusion are comprehensively summarised for macro- and micro-data in appendix Table A1, which also describes their data provision and coverage. Some are freely downloadable; others require subscription.

7.2 Data for macro-analyses

Central banks collect data from operators to monitor the possible economic impact and prudential risk of mobile banking and payments. As an illustration, the Bank of Uganda collects aggregate monthly data by telecoms provider (MTN, Airtel, UTL, (formerly Warid, now merged with Airtel), Orange, Mcash, and Ezeey Money) on: the number of transactions; the value of transactions (Ushs); the number of registered customers; the value of outstanding remittances (Ushs)[93]; the money balance on customers' accounts (Ushs); and the number of agents. These data are illustrated in country totals relative to deflators in Figure 5. In prudentially-regulated banks holding escrow accounts, there is a daily required matching of the escrow accounts with electronic accounts provided by mobile money operators.

In principle, a more detailed understanding of the effects on expenditure and social trends in financial inclusion could be achieved by collecting sub-aggregates of the underlying data from the mobile money operators. This could be useful in "now-casting" for the central bank to get a more contemporaneous view of economic activity when the national accounts are slow to appear.

The *number of transactions* could be disaggregated by donor, government, business and individuals; individuals' transactions could be further disaggregated by gender and age. The *number of agents* could be distinguished by being active or non-active; and by region and municipality. The *number of customers* could be distinguished by donor, government, business and individuals (also

[93] These are funds that have been remitted through the system, but not yet delivered to recipients (funds in transit to final recipients).

gender, age, location and "income group"[94]); but also as active or non-active. There may be multiple-counting, unless customer data are coalesced across providers by customer ID. The *value of transactions* could be disaggregated by types of transaction: private transfers, retail payments to business, business payments to suppliers, payments of wages by business or government, social security payments by governments, cash transfer by donors, payments for goods, payments for services, payments for transport, payments for taxes or fines, payment of school fees, payments for insurance (including funeral insurance) and payments of utility bills. The *money balance on customers' accounts* could be disaggregated in the same way as the *number of customers*.

On *the measurement of inflation*: the weight of ICT in the consumer price index should have increased, while prices of ICT, particularly if quality-corrected, continue to decline. If the quality adjustment for ICT and mobile services is insufficient, inflation will be overstated. The CPI will also overstate inflation by not taking into account time cost savings. It is difficult to measure the quality of services as hedonic methods are not often appropriate, and this is an issue in more developed economies too.[95] Central banks may wish to monitor the *inflationary impact* of mobile money with comprehensive inflation models. In Aron et al. (2015), Ugandan inflation forecasting models are built and tested with measures of mobile money to assess the possible impact of inflation (Section 8.3). The two indicators used are the *total value of transactions* relative to M3 (broad money) and *money balance on customers' accounts* relative to M3.[96] The value of transactions measure is a monthly flow of all transactions that may include individuals transacting with different operators. The money balance on customers' accounts at the end of the month is a stock which is part precautionary or buffer stock saving and part transactional saving.

The much-discussed increase in transactions *velocity* (i.e. value of transactions per unit of money held), see the ADB brief referred to above, has led to attempts to calculate the transactions velocity of M-Pesa, given a number of underlying assumptions. Mbiti and Weil (2013) for August, 2008, and Weil et al. (2012) updating for July 2007 to April 2010, reach *opposite* conclusions on the prevalence of the role of mobile money as a payment medium versus a store of value. The velocity will be *time-varying* as mobile money usage spreads from the wealthy segment down to the poorer segments: velocity will change as the composition of the marginal household changes, and thus may increase at the start and decrease towards the end of the sample. It is therefore necessary to distinguish between the spread over customers and variations over time for existing customers, and these are difficult to disentangle. The above studies do not correct for this. As pointed out in Section 6.2.2, there is unlikely to be a significant causal link between velocity and inflation.

7.3 Administrative transactional data and survey micro-data

At the disaggregated or micro-level, myriad research questions arise. What influences the adoption of mobile money and the adoption of related mobile money financial services on the pathway to financial inclusion (e.g. international remittances, savings accounts, credit and insurance)? Does access to remittances through mobile money improve welfare, for instance as proxied by consumption? Does access to increased and diverse mobile money remittances improve informal

[94] Income group could be deduced by average bands of transactions sizes or a threshold for money balances held.

[95] The Final Report of the Atkinson Review, UK, Atkinson (2005), concentrated on developing this work further and suggested more detailed methods to capture quality change in public service output.

[96] Imprecise measures such as the *number of registered customers* were avoided since individuals could have a registered SIM card with several providers, or be inactive. Such a variable would be a rising trend, as would the *number of agents* (also with uncertain activity), but without clear economic content. The *number of transactions* is not weighted by size of transaction and is not meaningful either.

insurance against shocks and spread risk? What is the impact of savings accounts and access to remittances on women's bargaining power and productivity? What factors determine how people save in such savings accounts and in electronic accounts? How are existing social networks affected by mobile money? What impact has mobile money had on internal migration in the jobs markets?

To study questions such as these, reliable and accurate data at the individual-level, household-level, village-level, and the firm-level, are needed. A small industry is burgeoning in the collection of internationally-comparable usage and quality data, and country-focused micro-data sets (appendix Table A1). Several studies combine existing household expenditure surveys with data from mobile money providers; some surveys already incorporate questions on usage of mobile money services. Researchers have also collected data through surveys and interviews (e.g. a household survey and survey of M-Pesa agents by Jack and Suri (2014)).

Optimism is being generated by the sheer volume of recorded transactions in so many countries by many operators.[97] It is well-known that surveys of assets and expenditure are subject to withholding and mis-reporting (exaggerating, under-stating, misremembering) of data, introducing measurement error. Self-reported social network assessment tends to be rife with measurement error too (Chuang and Schechter, 2015). However, administrative data on mobile money monetary flows has the benefit that the recorded timing and size of flows *reduces* measurement error. Administrative data can be combined with field interview data, as in Blumenstock and Eagle (2012), who analyse disparities in mobile phone access and use in Rwanda (Section 4.3). Administrative data can also be exploited to *create* data that could be used in research analyses and in practice by financial institutions. Innovative work by Blumenstock et al. (2015b), using survey data and terabytes of transaction-level call histories obtained from the mobile telecoms operator, finds that mobile phone records can predict welfare indicators such as the socioeconomic status and asset ownership[98] of individual mobile phone subscribers (that otherwise rely on self-reported data). Such data could also be used to cross-check self-reported data. This approach appears not yet to have exploited *mobile money transactions data*, which could yield far more detailed information linked to asset ownership and expenditure. Administrative telecoms data could also allow the derivation of social network structures via the cross-calls. Geotagged data generated by mobile phones can derive proxies for internal migration patterns (Blumenstock, 2012), potentially relevant for work on remittances. In a survey on social networks, Chuang and Schechter (2015) refer to the high-frequency administrative data used for Rwanda by Blumenstock et al. (2016), see Section 8.1.3), suggesting: "this is just the tip of the iceberg in terms of what can be done with such data"; and indicate new possibilities for exploring mobile money networks, and its effect on existing networks such as group-based ROSCAs.

For the unwary, there are definitional ambiguities using telecoms data (Aker and Mbiti (2010)). Adoption studies aim to capture the individuals who actively use mobile phones. The proxy used is typically the *number of mobile subscriptions* or *numbers owning a mobile phone.* But if individuals own multiple, valid SIM cards with different providers, or if there are inactive accounts, this will exaggerate users. If significant numbers of users are unregistered (e.g. who share a neighbour's phone but do not own a phone themselves[99]), this will under-estimate usage. The precision of the variable is compromised, introducing measurement bias into a regression. There are analogous difficulties in measuring precisely the number of active mobile money adopters. Using the *number of mobile money accounts* or the *number of registered customers* may induce multiple (over)

[97] We have referred to the use of algorithms based on histories of transactional data to create credit ratings where such information is otherwise absent (Section 3.4).

[98] Examples are ownership of assets such as radios and televisions; and social characteristics such as access to plumbing and electricity.

[99] The FinAccess surveys for Kenya (2006, 2009), see appendix Table A1, finds a third of Kenyans shared their mobile phones with friends or relatives.

counting of the same individual if several accounts are held with different providers to take advantage of differing incentives. If registered customers are inactive (and globally two thirds of registered accounts are inactive with a generous 90 day definition), this will exaggerate the participation (see Figure 4). On the other hand, there is undercounting of overall usage where unregistered customers intensively use the service, as in South Asia [100].

Some data are simply absent. Misspecifications in empirical regressions are exacerbated by omitting unmeasurable variables linked to mobile phones and mobile money, such as spill-over effects in the community, and technological and quality changes (i.e. those making phones cheaper, more capable and easier to use).

7.4 Qualitative institutional data: addressing a gap

Documentation of regime changes that could affect the uptake of mobile money is required for all models that include mobile money data (e.g. the Côte d'Ivoire example in Section 8.1.2). Regime changes can be entered as step dummies and interacted with other variables to see whether the behaviour of the variable is affected by the regime change, thus exhibiting non-linearities. Many studies of adoption of mobile money, fail to control for the often-important regulatory determinants and regime changes. With increasing prevalence of mobile payments usage in business, the World Bank's Doing Business website could add a category for how comparatively easy it is to register and make particular payments with mobile money. This type of institutional data is used in cross-country economic studies (see examples and a critique in Aron (2000)).

8. Empirical evidence on the economics of mobile money – selected studies' findings

We survey the empirical literature linking economic outcomes to mobile money. There are qualitative studies, but fewer quantitative studies. Econometric modelling difficulties imply that the conclusions drawn are often suggestive only. Since institutional structures, regulation and demand patterns differ across countries, generalisations of evidence need to be made cautiously. The bulk of empirical work has employed survey data at the household or firm level; and there are a few macro-studies.

8.1 Micro-literature

"Perhaps the 'holy grail' of demand side data is the impact question. How can we understand whether branchless banking services are making a positive difference in client's lives?"[101]

The two main empirical approaches employed in this literature to assess the impact of an intervention such as the introduction of mobile money are presented in Section 8.1.1. Brief comments are made about the non-parametric technique of propensity score matching, on which there is increasing interest in this empirical literature. Then empirical work is considered by six groupings: adoption; private mobile money transfers and risk-sharing; private mobile money transfers and welfare; public, donor or employer mobile money transfers; savings behaviour; and regulation. A detailed, analytical typology table summarises the studies and their conclusions (Table 2).

8.1.1 RCT versus Difference-in-Differences, and other empirical approaches

[100] Growth in the number of unregistered mobile money users has slowed from an annualized growth rate of 102 percent in 2013 to 22 percent in 2015, see Section 5.1.
[101] From McKay and Kendall (2013).

To explore the factors that determine the *adoption* of mobile money (i.e. where a proxy for usage or adoption of mobile money is the dependent variable), Probit or Tobit regressions or Ordinary Least Squares (OLS) regressions are commonly used. The principal empirical problem is the identification of causal relationships. This is discussed in Section 8.1.2.

There are two main ways to explore the *effects of mobile money on micro-economic outcomes* (i.e. where usage of mobile money is *not* the dependent variable). The first approach is the use of randomised controlled trials (RCT), common in medical research, and little used in economics before 2003[102]. RCT evaluates whether a specific, controlled change has a discernible impact relative to a control group. The practicalities of implementing RCT studies in the field are discussed in Duflo et al. (2007). Proponents argue that RCT is a reliable means of assessing micro-level impact because the randomness of the selection in a sufficiently large sample eliminates selection bias. The detractors (who include Deaton (2010), Deaton and Cartwright (2016)[103], Ravallion (2009) and Rodrik (2009)) argue that RCTs are of limited value. Deaton and Cartwright (2016) argue that randomisation does *not* guarantee that the treatment and control groups are identical except for the treatment, i.e. does *not* guarantee that other causal factors are balanced across the groups at the point of randomisation. Further, the standard errors are often erroneously computed so that spurious inferences are made, because t-statistics for estimated average treatment effects from RCTs do not in general follow the t-distribution.

RCTs focus on small interventions that apply in certain contexts so that inferences for other settings, or even scaling up based on the results, may be invalid. Identifying a causal connection in one situation might be specific to that trial and not a general principle; replication in different contexts is likely to lead to a variety of different results, see also Cartwright (2010); even the direction of causality can depend on the setting. Deaton argues[104] that there are actually *two* stages of selection. In the first, researchers choose a group from the entire population that will in the second stage be randomly divided into the study (treated) and control groups. The first stage is *not* random, but may be determined by convenience or politics, and therefore may not be representative of the entire population.[105] Further, the studied populations in RCTs are typically very small, so that an outlier in the experimental group can have a large distortionary effect. Another factor is that the trial or intervention itself can affect behaviour (as in the Hawthorne 1930 studies on productivity, Gillespie (1991)). Deaton argues: "scholars should take "the halo off the RCT" and subject them to the same critical scrutiny as other methods of evaluation"[106]. Deaton and Cartwright (2016) recommend a route to precision through prior information (which is excluded by randomisation) and *controlling* for those factors that are likely to be important. Then, they argue, there is a better chance of "transporting" results more generally to other contexts.

The second approach is to test specific theoretical hypotheses using various regression methodologies on panel or cross-sectional survey data for households or firms, appropriately sampled to avoid selection bias, and comparing control groups with the treated groups utilising mobile money. Difference-in-Differences (DD) estimation consists of identifying an intervention (such as the "roll-out" of mobile money, see Section 8.1.3) and comparing the difference in outcomes, before and after the intervention, for an unaffected control group as against the same difference for groups affected by the intervention. Thus, DD estimation mimics an experimental approach by comparing differences in

[102] The Abdul Latif Jameel Poverty Action Lab, established in 2003, coordinates a global network of researchers using randomized evaluations to answer policy questions in the fight against poverty. http://www.povertyactionlab.org/

[103] See non-technical version at: http://voxeu.org/article/limitations-randomised-controlled-trials, Nov. 2016.

[104] https://nyudri.wordpress.com/initiatives/deaton-v-banerjee/.

[105] Duflo et al. (2007) discusses cases where there are departures from perfect randomisation.

[106] See debate on http://www.nyudri.org/initiatives/deaton-v-banerjee/.

the changes of a control and a treated group. The estimates typically derive from an OLS regression for repeated cross-sections or for a panel of data on individuals in affected (treated) and control groups for one or more periods before and after an intervention. A dummy is included for the intervention as well as a set of control variables and "fixed effects". A panel (but not the repeated cross-sections) offers the advantage of addressing *all* time-*invariant,* unobserved household heterogeneity, the presence of which could lead to bias in standard estimators like OLS. This is done by using household fixed effects, where a dummy variable is included for every household or entity (bar one entity). What may remain is time-*variant,* unobserved household heterogeneity. This can be partially mitigated by including appropriate controls for time-variant household characteristics (demographics, for instance), in both panels and repeated cross-sections. And, in both panels and repeated cross-sections, location-by-time fixed effects can be included, where there is a location (e.g. district, region or country) dummy for each year (bar one location and one year).[107] The location-by-time fixed effects pick up time-*variant,* unobserved location-level heterogeneity. But this may account for only *some* of the time-*variant,* unobserved household heterogeneity, since these dummies imply an averaging over households in a location.

The restrictive assumption is made that in the absence of the intervention, the average change in the outcome for the affected and control groups would have been the same. This is the "parallel or common trends" assumption. The method has the appeal of simplicity, and when the interventions are approximately random, conditional on the time and location fixed effects, and also on household fixed effects in the context of household panels, it can reduce the endogeneity problems from comparing heterogeneous individuals. Problems arise when the intervention is not random, when the linear assumption under OLS is inappropriate, and from serial correlation problems exaggerating levels of significance in standard errors when several years of data are involved (Bertrand et al., 2004).

Much of the debate around the validity of a DD estimate revolves around the possible endogeneity of the intervention (Bertrand et al., 2004). In the mobile money literature, the "roll-out" of mobile money by MNOs and agents may not be random, but affected by household and village characteristics. For instance, there will be an upward bias on the effect of mobile money if the wealth of a village determines agent selection into that village. Several authors regress measures of agent density on village and household characteristics to demonstrate that the bias is likely to be low. However, a second selection problem is undisputed: that of adoption or usage by individuals. Adoption is affected by observable factors correlated with mobile money use, such as urban dwelling, education, wealth and the use of banking services, and by unobservable factors such as communal spill-over effects. One convincing test of the DD strategy is the placebo test. The placebo test uses data from prior periods before the intervention, and the DD is redone aiming for a close-to-zero placebo effect for the included intervention.[108] For instance, future mobile money use should not predict past changes in consumption if the common trends assumption is valid. Otherwise it cannot convincingly be asserted that mobile money drives the results, as opposed to another time-varying characteristic correlated with income, such as willingness to take up technology.

Instrumental variables methods can be used to control for the endogeneity. But finding credible exogenous instruments for mobile money usage is a challenge, raising questions about the direction of causality. Several instruments have been used in the mobile money empirical literature

[107] A *national* time effect is a common effect across time experienced by all *regions*, e.g. from macro-fluctuations. But if you have two regions, North and South say, where North is less affected by drought, then interacting regional dummies with time allows their differential response over time to be captured.

[108] If the placebo DD is non-zero, there is a good chance that estimates using the later data are biased too. Plotting series of average outcomes for Treatment and Control groups when there are multiple time series observations pre-treatment can also indicate whether trends are parallel, and regression methods can be used to estimate any differences in trends. Further robustness tests of DD could employ different control groups.

but F tests tend to find them weak.[109] In using instruments based on agent density and network connectivity, the assumption is made that the roll-out of mobile money and network coverage itself was random.

These difficulties have encouraged the use of Propensity Score methods to demonstrate robustness. There are several different propensity scoring techniques: for an introduction and overview, see Austin (2011). These methods allow one to mimic some of the characteristics of an RCT in the context of an observational (or nonrandomized) study, using non-parametric rather than regression techniques to estimate the effects of treatments on outcomes. Where baseline characteristics of treated subjects often differ systematically from those of untreated subjects, propensity score matching can match samples of subjects who are as similar as possible on *observed* (pre-treatment) characteristics. Differences in post-treatment outcome variables between the matches are averaged and are *attributed* to the treatment (e.g. use of mobile money). Just as randomisation on average results in measured covariates being balanced between treatment groups, so conditioning on the propensity score will, on average, result in measured baseline covariates being balanced between treatment groups. Conditioning on the propensity score, however, need not balance *unmeasured* covariates. The crucial assumptions for the validity of the propensity score technique to assess the effect of treatment on an outcome are that there is no hidden bias (from such unobserved heterogeneity), and that the criteria for adequate balance[110] are clear and satisfied. There is considerable debate and commentary in the literature on the "rampant lack of good practice in propensity-score matching applications", with balance checking one of the most problematic aspects because the criteria for adequate balance are ill-defined (see Hill (2008) and Austin (2011)). Results based on propensity scoring methods should be very carefully assessed, therefore.

8.1.2 Adoption studies

Adoption factors for mobile money differ between developing and more advanced countries. This is driven by institutional differences, financial literacy, inequality and income dispersion, available alternative payments methods, the sizes of transactions, and security concerns, amongst other factors. In the US, adoption factors have been tracked for mobile payments and banking by income and age cohort of the population, differentiating the banked from the unbanked and under-banked, and considering immigrant communities, in the Federal Reserve's annual surveys (e.g. Federal Reserve, 2015). The patterns and correlations found are likely representative of other advanced economies, and some differ from those of developing countries (see Section 4.3). The likely role of regulatory barriers, literacy and limited agent networks as constraints on adoption in nascent mobile money systems in developing countries are suggested by Aker and Blumenthal (2015).

Several academic studies have tried to analyse the *causal factors* behind adoption of mobile phones in particular countries, and more recently of mobile money. The imprecision of the available proxies for the dependent variable can introduce measurement error into a regression (see Section 7.3). Empirical studies may be hamstrung by the poor quality of other data or by limited data. These data errors are compounded by the biases in regression coefficients that can be induced by

[109] Instruments used are: the log of the distance to the closest agent and the number of agents within 5km of the household (Jack and Suri, 2014), the distance to and cost of reaching the nearest mobile money agent (Riley (2016), and the log of the distance to the nearest mobile money agent (Munyegera and Matsumoto, 2016a); the fraction of respondents in the sub-location registered with M-Pesa (Demombynes and Thegeya, 2012) and the proportion of households using mobile money and for those owning a mobile phone at the village level (Kikulwe et al., 2014); household-specific mobile phone network connectivity and the size of the information exchange network of the household (Murendo and Wollni, 2016); and 2006 survey responses (before M-Pesa was introduced) about riskier, slower and more costly transfer methods (Mbiti and Weil, 2016).

[110] The *distribution* of measured baseline covariates will be the same between treated and untreated subjects.

misspecifications, such as omitting key controls from the set of regressors. Some important "observables" are typically poorly measured, such as education (where quality is not assessed) and wealth, which can exacerbate the biases. And some controls are potentially available but not included, like ownership of a mobile phone (to disentangle the adoption of mobile phones per se from the adoption of the electronic payments technology) or having a migrant worker in the family. There are also "unobservable" determinants, for example, spill-over effects from community-learning about the product, and the technological and quality changes that make phones cheaper, more capable and easier to use, see Aker and Mbiti (2010). Similarly, it is difficult to capture the quality of agents and of services, and the effects of advertising campaigns and incentives[111] on customers and agents. These have qualitatively affected uptake in Côte d'Ivoire (see Pénicaud and Katakam, 2014, p15).

Finally, structural breaks may be *crucial* in adoption empirics and should be tested for in models using dummies and dummy-interaction effects (which introduce non-linearities into models). Comparative data on regulation and on regime shifts could be compiled and in principle used in regressions (see Section 7.4). Shifts in the regulatory framework may have an influence; for instance, adoption may be enhanced with liberal registration requirements for low volume users below a threshold of use. Political and economic regimes shift can matter; for instance in Côte d'Ivoire, the cessation of conflict and onset of greater growth and stability from 2012 was the key external shift driving mobile money adoption (Pénicaud and Katakam, 2014, p15). In general there are likely to be shifts over time in the relevance of particular determinants: for instance, smartphones, cheaper and more widely-available today, may have applications to assist the financially illiterate; also a thriving second-hand market in mobile phones means greater ownership now than previously.

Cognisant of such above difficulties, Aker and Mbiti (2010) restrict themselves to examining adoption *correlations* using firm surveys and household surveys (see Section 4.3). However, two studies trying to validate causal links appear to confirm their findings. Weil et al. (2012) use the same FinAccess data from Kenya (for 2006 and 2009) as Aker and Mbiti (2010), but add Finscope data from later adopters Tanzania and Uganda (for 2006 and 2009). These are *not* panel data (appendix Table A1), and hence they cannot control for individual fixed effects. They are not explicit on how their dependent variable is measured, but appear to regress a zero-one dummy: "whether an individual uses mobile money (sends or receives)", on individual characteristics[112] using OLS regressions and robust standard errors. They deduce for all three countries (though with limited significance in the less well-developed markets of Tanzania and Uganda by 2009) that adopters of mobile money are more likely to be younger, wealthier, better educated and to reside in urban areas, but gender differences were not observed. Findings are similar when the dependent variable is the frequency of mobile money transactions per user in Kenya. However, this work suffers from the omission of controls (e.g. a control for whether these individuals were "banked" or owned a mobile phone), and unobservable determinants, see above. The authors do not include location-by-time fixed effects (for regions within countries) to pick up some time-*variant,* unobserved location-level heterogeneity, which in principle was possible at least for the Kenyan data (see Mbiti and Weil (2016)). The results should be regarded as suggestive, and of supporting correlations, as in Aker and Mbiti (2010).

A second study examining the drivers of adoption in Uganda is by Munyegera and Matsumoto (2016a). They analyse a balanced panel of 838 households collected in Uganda in 2009

[111] For instance, if the dependent variable is registration for a mobile money account that is actively used, an important adoption driver to control could be whether customers transact at registration (such incentives for agents to help "make adoption stick" are discussed in Section 9.3).

[112] The controls are dummies for urbanisation, the level of poverty, three different age groups (16-24, 25-39, and 40-54 years), three different education levels (primary, secondary and tertiary), marriage and gender.

and 2012.[113] They take two approaches and find similar results: using a Probit regression, and a linear probability model with fixed effects (to rule out the effect of unobservable time-invariant household characteristics). The dependent variable is a dummy variable which is 1 if household *i* living in village *j* in district *d* uses[114] mobile money services at time period *t*, and 0 otherwise. The regression specifications differ from Weil et al. (2012) in that they control for ownership of a mobile phone and whether the household has a migrant worker, and include district-by-time dummies and household fixed effects. Like Weil et al. (2012) they include age (using age of household head and the square of this, as opposed to age group), gender and education (using a different measure based on household head's years of schooling). Their new regressors are distance to the nearest mobile money agent (also capturing relative remoteness)[115], size of household and the effects of wealth in the form of land size and total assets. They do not differentiate between urban and rural (the survey areas are all rural) and levels of poverty (though wealth is included), both of which Weil et al. find are significant, nor whether these individuals were "banked". As in Weil et al., and qualitative work (Section 4.3), they did not detect a gender effect; unlike Weil et al. they do not find an age effect (though a more differentiated cohort measure might be more successful). The distance to the agent is important, as is education and wealth[116]; and both the dummies for the ownership of the phone and the migrant worker are significant (all with 1 percent significance). The study of Munyegera and Matsumoto (2016a) merits serious attention, given their use of household fixed effects and location-by-time dummies in a panel context, and the inclusion of more individual controls, since potential endogeneity biases are likely to be far smaller than in the Weil et al. (2012) study. It is still possible, however, that there is some *time-variant* household heterogeneity that is not controlled for, as location-by-time dummies only address an average over households in a location.

8.1.3 Private mobile money transfers and risk sharing

We discuss four papers that explore the impact of *private* mobile money transfers on household welfare through risk sharing. Two are studies which consider only participants with a mobile phone number (Blumenstock et al. (2016) and Batista and Vicente (2016)); the other two studies introduce a dummy for ownership of a mobile phone into regressions (Jack and Suri (2014) and Riley (2016)). Thus, each disentangles the impact of the mobile phone technology from the transfer mechanism, though in the former studies this introduces a new selection criterion. In one study by Blumenstock et al. (2016), the transfer is of money as airtime: the authors call it a "rudimentary form of mobile money", but it is not convertible for cash. With geographical separation of giver and recipient, the money transfer channel reduces transactions costs compared to the alternatives when the financial infrastructure is poorly developed. A key result for these studies is that lower transaction costs could affect the size, frequency and (sender) diversity of domestic remittances, and hence, the ability to smooth risk informally after large shocks.

The Blumenstock et al. (2016) study exploits the random timing and location of earthquakes in Rwanda, in a natural experiment, to identify covariate (as opposed to idiosyncratic) economic

[113] These were generated from the third and fourth rounds of household and community surveys collected in 2009 and 2012 in the Research on Poverty, Environment and Agricultural Technology (RePEAT) project.
[114] In neither study does the mobile money "usage" measure appear to match the preferred definition of *active* (90-day) users and could bias the results, see Section 7.3.
[115] Note that agent density (see Section 8.1.1) may not be exogenous. For instance, it is probably correlated with wealth. Wealth is controlled for here, but if it is poorly measured, there will be some remaining unobservable heterogeneity and thus bias on the coefficients blurring the true importance of the determinants of mobile money usage.
[116] Weil et al. probably indirectly capture strata of wealth in their three schooling variables.

shocks[117]. They analyse the patterns of domestic person-to-person transfers of mobile airtime, in a specific window on either side of the disaster, using high-frequency administrative telecoms data. Mobile airtime is a precursor of mobile money; the average amount transferred over the two month period is small at around US $1; the total additional influx (explicit transfers to all 15 cellular towers within 20km of the epicentre) measured about US $84.[118] Their study relies solely on telecoms data and lacks survey measures of welfare or wealth. Their reported link between risk-sharing and money transfer is instead implied, given the consistency between observed patterns of transfers and the characteristics of their theoretical models of reciprocal risk sharing.

This sophisticated study uses daily data in a Difference-in-Differences approach where the random intervention is an earthquake. They use increasing levels of disaggregation: the regional level for all users; the individual level; and the dyadic level of sender-recipient pairs. The dependent variable is the gross transfer of airtime received by all users (regional-level), or received by an individual at a particular location and time, or by an individual at a particular location and time as sent by another individual in the dyadic case. All regressions include a shock dummy and time fixed effects. The location fixed effects in the regional-level regression are replaced by recipient fixed effects in the individual-level regression, and by a fixed effect controlling for the average intensity and direction of transfer flows between two users in the dyadic regression. In the latter two regressions they add a dummy for the user being near the epicentre at any time even in the absence of a shock, which acts like a location-by-time fixed effect of a restricted kind (only two locations)[119]. They report clustered standard errors (see Bertrand et al. (2004); and Section 8.1.1).

In extended regressions they allow for heterogeneity between individuals and use innovative predicted measures of expenditure (to proxy for wealth)[120] and social connectedness (see Blumenstock's work as discussed in Section 7.2) and these are crossed with the shock dummy and a more intense version of this dummy (days of severe shocks). They also allow for heterogeneity of different types of sender-recipient pairs: here the geographic distance between pairs and the history of transfers between them are crossed with the above dummies.[121] They find, perhaps surprisingly, that as well as geographical proximity, transfers to victims near the epicentre after the Lake Kivu earthquake of 2008 are determined by a past history of reciprocity between individuals, and the transfers decrease in the wealth of the sender and increase in the wealth of the recipient. The opposite would be obtained in the case of charity or altruism. The authors foretell the use of mobile money for disaster management, which has indeed come to pass (e.g. Lucini and Sharma, 2016).

Sending tiny amounts of airtime to friends and family in emergencies by mobile phone can be inspired by different motives from that of sending cash to indigent victims. Considering the motive of the giver, a small gesture of support when it may be difficult to find an agent to top-up airtime under disaster conditions easily strengthens an existing reciprocal relationship. One can *conflate* this motive and charity, therefore. Moreover, the wealth of the recipient is likely be correlated with the size of his or her geographical network; the poor may not have the same contact requirements with networks of smaller size and geographical size. Ideally, the differences in such networks should be controlled for, therefore, otherwise there is a selection problem as airtime does not in this sense have the same utility

[117] Idiosyncratic shocks affect individuals or households; covariant shocks affect groups of households, communities, regions or even entire countries.

[118] To put this small figure in perspective, the authors report that only 1400 individuals in the region had ever used the airtime transfer service prior to the earthquake, creating a small population of potential recipients.

[119] In principle, a more general location-by-time dummy could be tested.

[120] The relative wealth of mobile phone subscribers is inferred from their history of mobile phone use.

[121] The robustness of results is checked by varying the time window over which the models are estimated, and by falsification and placebo tests.

in times of disaster for the wealthy and the poor. Finally, selection is induced by the fact that wealth itself determines the ownership of phones in Rwanda in 2008 (see Blumenstock and Eagle, 2012).

The first econometric study to explore risk sharing and mobile money thoroughly is a path-breaking study by Jack and Suri (2014). In considering the reduced transactions costs of the new mobile money channel, they extend the earlier literature on incomplete insurance and risk spreading (e.g. De Weerdt and Dercon 2006). The study shows how the expansion of mobile money in Kenya (M-Pesa, introduced in 2007) and consequent reduced transactions costs for remittances has affected risk sharing amongst informal networks of friends and family, helping households to smooth consumption. In one specification, they use a Difference-in-Differences approach, where the random intervention is a self-reported negative shock to income[122], and compare changes in the response of per capita consumption to shocks across M-Pesa users[123] and non-users. The welfare measure is consumption from a household panel survey conducted between late 2008 and early 2010.[124] The dependent variable is measured as annual per capita consumption for household *i* in location *j* in period *t.* The panel specification controls for household fixed effects, location-by-time dummies and rural-by-time dummies. There is a dummy for a negative shock to income in the last six months, and a dummy for an M-Pesa user in the household during the survey. The validity of the Difference-in-Differences specification depends on the "common or parallel trends" assumption (see Section 8.1.1) and upon the shock being random.[125] The two dummies are crossed to test whether M-Pesa users are better able to smooth risk, the assumption hence being that this interaction term is exogenous.

The authors note that the M-Pesa usage is endogenous "due to selective adoption associated with wealth or other unobservables". The authors include a vector of controls[126] some of which do promote the use of M-Pesa according to adoption studies; self-reported wealth is not in the vector though wealth is measured in the survey rounds and reported in statistical tables and in correlations with the roll-out of agents. The inclusion of household fixed effects controls for all time-*invariant* household unobservables. Since the study focuses on assessing risk-sharing, any included observables should not help households to smooth risk. Therefore, the vector of controls is also crossed with the shock dummy (in *their* equation 9) to help control for possible correlations of M-Pesa with observables that might help smooth risk (e.g. the educational status of the user, use of other financial services and ownership of a mobile phone). The included location-by-time dummies and rural-by-time dummies do in principle help control for time-*varying* heterogeneity by district and by urbanisation (though turn out to have little impact on the Kenyan results).

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[122] They consider "*any* negative shock", which could be communal, like a drought, and hence covariate; and idiosyncratic shocks such as an illness shock.

[123] User data (at least one per household) are M-Pesa registrations from the telecommunications firm. This may differ from a preferred definition of active (90-day) users and could bias the results, see Section 7.3.

[124] A caveat is that self-reported consumption and perception of shocks are typically subject to measurement error. The authors construct a balanced two-period panel of 2,282 households, from three survey rounds, with an attrition rate of about 24 percent. They focus on the non-Nairobi sample where the attrition rate is closer to 18 percent.

[125] The authors argue this is a reasonable assumption as households reported only unexpected shocks; and the reported overall shocks and illness shocks are not systematically correlated with most household characteristics. However, if shocks are correlated with changes (since the model includes fixed effects) in unobservable household characteristics then they would not be random. Likelihood of reporting a shock could also be correlated with changes in unobserved household characteristics. Using actual variation in rainfall will not suffer from a potential reporting bias.

[126] This vector of observable individual characteristics includes household demographics, household head years of education and occupation dummies (for farmer, business operator and professional), the use of financial instruments (bank accounts, savings and credit cooperatives and rotating savings and credit associations), and a dummy for cell phone ownership.

If there are missing interaction effects from time-varying unobservables or time-varying excluded observables (e.g. wealth) that could help households to smooth risk, then the effect of M-Pesa in smoothing consumption could be exaggerated. For instance, there could be an upward bias if a household that is wealthier in the second period is better placed to withstand a negative income shock; or if households wealthier in the second period than the first tend to experience smaller negative income shocks.

The results show that the total consumption[127] of mobile money users is unaffected by a range of negative income shocks (severe illness, job loss, fire, livestock death, and harvest or business failure), while the consumption of non-users drops by 7 percent (the coefficient is significant at the 10 percent level). The effect is more evident for the bottom three quintiles of the income distribution. The same result is found when isolating the impact of health shocks on total consumption. The ability to absorb negative shocks is attributed to increases in the number and the size of remittances received, and to a greater diversity of senders.[128]

The study also surveyed nearly 7700 M-Pesa agents. Using the agent "roll-out" data, consumption responses are compared in reduced form regressions substituting "access to an agent" for M-Pesa usage; and in instrumental variable (IV) specifications (see Table 2), two different measures of proximity to agents are used to instrument for the two endogenous variables: the households' M-Pesa usage and also its interaction with the negative shock. These IV regressions reinforce the conclusions: improved access to agents improves a household's ability to smooth risk.[129] The agent network grew four-fold over the period between surveys, and in using such instruments the authors make the crucial assumption that the roll-out of mobile money itself was random in Kenya.[130] The authors argue that the mobile operators were not systematic in allocating licenses to agents or particularly aware of the location of agents. This does not rule out the self-selection by the agents toward more profitable locations. In practice, partial correlates suggest lack of statistical correlation between the agent roll-out in Kenya and various observable individual and household characteristics (Jack and Suri, 2014, their Table 6C), so that in principle instrumenting could help to control for endogeneity. We argue below in the context of their 2016 study that such *bivariate* correlations do not constitute a comprehensive examination of the predictability of agent density; further, agent roll-out may have some correlation with unobservables or poorly-measured observables such as wealth, that also help households to smooth risk.

Work by Batista and Vicente (2016) on the introduction of mobile money in Southern Mozambique is still in progress, and tests the impact of risk sharing on the consumption of treated and control groups after introducing mobile money into rural areas. Administrative mobile money records are combined with household survey data (over three years from 2012 to 2014). They partnered with Carteira Móvel, a subsidiary of the MNO, mCel, to introduce a local mobile money product, Mkesh, randomly into rural areas,[131] until then mainly available in urban areas. Mobile money agents were selected and trained in treatment areas. Targeted individuals in the treatment locations received education and dissemination about Mkesh. Several criteria were used in the selection of rural

[127] Food consumption, however, appears to be equally well-smoothed by both users and non-users in the sample.
[128] They report that households using mobile money transfer channels are about 13 percentage points more likely to receive remittances after a negative shock from wider network sources and larger fraction of their network, amounting to on average 6 to 10 percent of annual consumption over a six-month period.
[129] The IV regressions have a *more* positive coefficient on the instrument for the shock interacted with mobile money than the OLS estimate (though location-by-time dummies are excluded from the IV panel regression). An explanation for this bias is reverse causation: those who face the probability of larger shocks may self-select to become mobile money users, biasing the OLS regression estimate to zero.
[130] They do, however, cautiously exclude in some regressions the urban centres of Mombasa and Nairobi.
[131] Out of a total of 102 rural Enumeration Areas, 51 locations in 3 regions were randomly selected as treatment areas, with the residual forming the control group.

locations, agents and targeted individuals.[132] These criteria narrow the type of population examined which helps to control for heterogeneity, but with the drawback that it limits the analysis and reduces the generalisability of the results. Their experimental work on saving is discussed in Section 8.1.6.

To test whether consumption was affected by the introduction of Mkesh, they use OLS reduced form regressions in a Randomised Controlled Trial (RCT). The dependent variable is log consumption per capita, and outcomes are compared for 2013 and 2014 for target and control individuals. The regressions include a treatment dummy variable, location (province) dummies, year dummies and individual controls for age and gender; the standard errors are corrected by clustering at the location. They find no significance for the treatment dummy.

Then, following Jack and Suri (2014), they introduce into the regression a measure of negative shocks and interact it with the treatment dummy, to test whether vulnerability to shocks diminished through greater access to remittances. They construct a shock index as a simple average of zero-one indicators for a mix of possible negative shocks: deaths, job loss, significant health problems, loss of valuables in the household, and agricultural losses. It is possibly misleading to conflate these different types of shock: job loss would not be expected to lead to a rise in expenditure, whereas funerals are typically expensive and ill-health may also induce a rise in expenditure. The shocks could instead be divided into two types, those that raise expenditure, and those less likely to raise expenditure. The timing of the survey (mid-2014) after serious flooding in Mozambique's rainy season in 2013, suggests significant agricultural and other material losses could be reported in mid-2014.

The OLS regression including shocks is for a cross-section in mid-2014 (as the shock data were only obtained for the prior 12 months). Over all individuals, when including individual controls, interacting the shock with the mobile treatment dummy gives a positive and marginally significant effect; the treatment dummy alone has a marginal *negative* effect (both at the 10 percent level). Without individual controls, the significance of the interaction effect reaches 5 percent, but no other regressors are significant. The implication is that the treated group increases consumption in response to a negative shock relative to the average log consumption of the control group. This suggests the treated group can fund, for instance, health or funeral expenditures without compromising overall expenditure, by drawing on remittances. The negative coefficient for the treatment dummy in general suggests the treated group is spending less on average, perhaps because they are sending remittances to relatives, or because of a systematic difference between treated and untreated groups (the treated group could be poorer, for instance[133]). Introducing more controls might help to correct for this.

This result is interpreted as improving the rural households' welfare as it is supportive of mobile money contributing to household consumption smoothing. This 2014 cross-section result is potentially affected by the inability to correct for biases from time-invariant household heterogeneity. But support is lent to the insurance result by regressing survey indicators of vulnerability for a panel in 2013 and 2014 on the treatment dummy, year and province dummies and some individual controls. Without fixed effects, the coefficient on the treatment dummy is positive and marginally significant (at the 5 percent level) for the whole sample, suggesting the treated group was less likely to suffer hunger (or from a broader category of vulnerability) in the previous 12 months. But with individual fixed effects added, no variables prove significant.

[132] Rural treatment locations were required to have mCel coverage and at least one commercial bank. Mobile money agents had to have a bank account, a vendor's licence and sufficient liquidity. Targeted individuals had to have a mobile phone number and a migrant member of the family in Maputo with a mobile phone number.

[133] Indeed, the authors do observe a greater likelihood of the control group owning fridges and radios.

The authors also do not find any productive effects of mobile money remittances, since investment falls[134] for the targeted group. They interpret this as evidence that (informal) insurance provided by mobile money may have reduced the incentives for risky investment (given credit constraints). Southern Mozambique was devastated by floods in 2013, causing damages of over US$250 million, of which 50 percent affected the road network and 30 percent the agricultural sector.[135] The absence of time-by-location dummies could prove critical because they would help control for the heterogeneous effects across locations of the devastating flood of 2013. This could have confounded the results for investment.

A thorough and careful analysis for Tanzania by Riley (2016) also draws on Jack and Suri (2014), but it aims to take matters a stage further, examining the potential beneficial *spill-over effects* of the presence of mobile money to the village community (which includes non-users) following an aggregate (i.e. community level) shock, and also to explore the factors that enhance such community effects. The study is implicitly assuming that the appropriate social network for sharing is village-wide, rather than across villages by lineage, for instance; the social network is also assumed constant over time, whereas studies have suggested a broadening of networks (Chuang and Schechter, 2015).

The dependent variable is the log of real consumption per capita. The Tanzania National Panel household panel survey[136] is used with three waves of data and a low attrition rate, as well as Finscope 2013 data. The aggregate shock measure is either for self-reported shocks such as droughts or floods, or for a constructed measure of rainfall deviations (larger than one standard deviation) from a 40 year mean, expressed as absolute value[137]. Difference-in-Differences regressions are run to contrast the impact on control and treatment groups (the latter are users of mobile money or non-users in villages with mobile money). The regressions are run with and without fixed effects (and these reveal how important it is to remove unobserved, time-invariant household heterogeneity). Location-by-time dummies are included to address potential unobserved, time-varying heterogeneity at the village level (including of aggregate village consumption).[138] All regressions include a set of individual controls[139] and standard errors are clustered at the village level. Unlike in Jack and Suri (2014), wealth, expected to be time-varying, is included as a control. The regressions include two mobile money regressors. One is a dummy for mobile money use[140] by an individual in a village, and the other is the proportion of mobile money users in a village. There are three interaction effects: each of the two mobile money regressors is crossed with the aggregate shock; and the set of individual

[134] OLS regressions show that active farm investment and investment in cattle trading falls significantly, across all years and treated and control groups, when including fixed effects, province and year dummies, and individual controls.

[135] "Recovery from Recurrent Floods 2000-2013, Mozambique", Recovery Framework Case Study, The World Bank, August 2014. https://www.gfdrr.org/sites/default/files/publication/Mozambique_August_2014.pdf

[136] The Tanzania National Panel survey for 2008-9, 2010-11 and 2012-13, covers 3,265 households in 26 districts containing 409 Enumeration Areas.

[137] The rainfall measure treats negative and positive deviations symmetrically. It would be more precise to separate the effects of large positive deviations (floods) from large negative deviations (droughts).

[138] Unlike in Jack and Suri (2014), the regressions do not include rural-by-time dummies, but later, however, tests are run for a stratified survey along rural-urban lines and show no confounding results.

[139] These are: a rural dummy, the age and education (years) of the household head, the size of household, a dummy for mobile phone usage and for ownership of a mobile phone, some financial indicators, a wealth index constructed using principal component analysis, and a household head occupational dummy. In 2008-9, 45 percent of households owned at least one mobile phone, increasing to 62 percent in 2010-11 and 71 percent in 2012-13.

[140] The mobile money "usage" measure is not precisely defined; whether households that used mobile money services at least once in the previous year matches the preferred definition of *active* (90-day) users is questionable and could bias the results (Section 7.3).

characteristics is also crossed with the aggregate shock, to control for changes in observable household characteristics which might impact the household's ability to smooth shocks.

The findings are first, that the rainfall (or other) shock causes a drop in consumption of between 6 and 11 percent for all households in the absence of mobile money use. Second, for those villages where at least one person in the village uses mobile money, in the absence of an aggregate shock, the highly significant coefficient (1 percent) on the "proportion of mobile money users" variable suggests average village consumption is 4 to 10 percent higher. This effect is robust to the inclusion of fixed effects, and signals positive spill-over effects of mobile money to non-users in the village in the absence of an aggregate shock. However, for those households with mobile money users, the coefficient on the "usage of mobile money" dummy is insignificant in the fixed effects regressions. This suggests that the consumption of these households is not affected in the absence of an aggregate shock beyond the benefit they get from the spill-over effect. The suggested mechanism is that users of mobile money share remittances with the village resulting in per capita consumption of everyone in the village increasing.

Third, examining the interaction effects with the aggregate shock reveals some interesting risk sharing results. From the interaction with the "proportion of mobile money users" variable, it is apparent that after an aggregate shock there is no benefit to the village of others using mobile money. The interaction of the shock with the "mobile money usage" dummy reveals that households using mobile money benefit from an 8-14 percent increase in consumption (significance is at the 5 percent level). This cancels the effect of the negative shock, and may even slightly increase the consumption level of such households. Thus, after an aggregate shock, mobile money appears to help recipient households to smooth consumption, but there are *no* spill-over effects to the community for non-users. The suggested mechanism is that users of mobile money choose to smooth their own consumption after a shock and not to share remittances. The fourth result is that these benefits to users and to communities (in the absence of a shock) are found to be highest in rural areas and to decrease sharply with distance to the nearest mobile money agent.

As discussed for previous studies, there are problems of endogeneity with the mobile money usage dummy. The author does control for observables that affect adoption, though some perhaps imperfectly, for example, "years of education" can mask differing quality of education. She uses fixed effects to control for time-invariant unobservables, but time-varying unobservable household characteristics (changing risk preference or changing technology preference) may still confound the result. The use of district-by-time dummies is very important as they help control for heterogeneity from the self-selection into districts by mobile money services providers, and also control for localised "herd" effects and learning spill-over effects in the increasing service provision[141] over time. They also may help control for unobservable differential effects of rainfall across districts (for instance, some occupations may be more prevalent in particular districts, so that the rainfall effect across different occupations is partly controlled for). The author also instruments for mobile money usage with the distance to and cost of reaching the nearest mobile money agent and their interactions with the shock variable. The IV results do not reject the above findings, but although a Sargan-Hansen test determines these instruments are valid (exogenous), they are found by Cragg-Donald Wald F statistic tests to be statistically weak which may potentially introduce a large bias. The author also successfully conducts placebo tests validating the common trends assumption of the DD specification.

Propensity scoring (see Section 8.1.1) was used to try to match users and non-users with similar characteristics, confirming results. While Riley (2016) and Kirui et al. (2013), see below, present a detailed analysis, this technique is also used by Kikulwe et al. (2014) and Munyegera and

[141] By 2012-13, 52 percent of communities had a mobile money agent; a further 13 percent were within 5km of one.

Matsumoto (2016b), see below, but with scant information given. Results based on propensity scoring methods should be very carefully assessed, therefore.

8.1.4 Private mobile money transfers and welfare

Given that a reasonable case can be made for negative shocks to be random, the above studies with interaction effects of mobile money usage with shocks are probably more robust and less likely to suffer severe endogeneity problems than those focusing on the effect of mobile money usage alone. The six papers discussed next do not examine risk-sharing but rather the *direct effect* of mobile money adoption or usage on consumption, income, food security and other outcome variables. This puts emphasis on the endogeneity of the mobile money adoption dummy and the need to instrument for it appropriately and to remove as many sources as possible of observed and unobserved time-variant and time-invariant heterogeneity through appropriate techniques and controls. Only three of the studies include a dummy for ownership of a mobile phone into regressions (Munyegera and Matsumoto (2016a), Murendo and Wollni (2016) and Sekabira and Qaim (2016)), thus disentangling the impact of the mobile phone technology from the transfer mechanism.

An exercise for Uganda (Munyegera and Matsumoto, 2016a) draws on Jack and Suri (2014). The essential *difference* is that while the intervention in a Difference-in-Differences specification is the adoption of mobile money, it is the effect of adoption on consumption that is studied, rather than a risk analysis consequent on a negative income shock. The panel has two years, 2009 and 2012, and the dependent variable is the *log* of monthly real per capita household consumption[142]. Both OLS and fixed effects regressions are run, the latter with and without location-by-time dummies. There is a dummy if the household uses[143] mobile money services at the time of the survey, and a dummy for household mobile phone possession. The general set of controls includes household size, the log of value of assets and land endowments, and the age, gender and education level of the household. The panel offers the advantage of addressing time-invariant, unobserved household heterogeneity using fixed effects, and time variation by location.

The problem with this specification has already been flagged by Jack and Suri (2014). The mobile money services dummy is endogenous, as adoption may be correlated with unobservables or even with observables such as income expectations or wealth, if they are not adequately measured in the study. In a fixed effects regression, a 9.5 percent increase in household per capita overall consumption is reported (5 percent significance level), given the adoption of mobile money services. Disaggregating overall consumption into food, non-food and social contributions (ROSCAs, mutual funds, insurance and churches), for the fixed effects regressions they find a similar coefficient for food consumption (most food is self-farmed), but greatly higher coefficients for non-food and social contributions, at 20 percent and 47 percent, respectively, all at the 5 percent level of significance. The last of these points to one likely source of reverse causality, as for instance ROSCA contributors routinely use mobile services for convenience. Thus, these fixed effects estimates may be biased upwards. There are also issues with zeroes or small numbers in the log specification which may account for the implausible disaggregated results.[144]

[142] It is not mentioned anywhere in the paper that the monthly dependent consumption variables are in logs. Communication with the authors revealed that logs *were* used; household per capita consumption was measured in adult equivalence units in real terms, constructed by dividing nominal consumption by household size and each consumption category was also deflated using standard price indices for each category provided by the Uganda Bureau of Statistics (there was high inflation during 2009-2012).

[143] It is not clear here (as in the adoption analysis in Section 8.1.2 and the savings analysis in Section 8.1.6, also by these authors) whether mobile money "usage" refers to *active* (90-day) users, see Section 7.3 on data biases.

[144] Correspondence suggests that they transformed the dependent variable, x, as log (min(x)+a-x), where a is a very small constant e.g. 0.0001 and min(x) is the smallest value among the non-zero values of x. Then when

The authors try to control for the endogeneity of mobile money adoption by using instrumental variables. The instrument used is the log of the distance to the nearest mobile money agent. The validity of the result depends on the instrument not being correlated with household and village characteristics that could affect household consumption. The vexing question again arises: how random is the roll-out of agents? Are there selection biases toward communities which bring greater rewards to the agents, based on population density, wealth, education and other village and household characteristics that we know, from adoption studies, enhance adoption? The authors argue against this, and do not find significant correlation between such characteristics and mobile money agent placement (results not reported). Their findings from fixed effect IV regressions are that per capita consumption increases four-fold upon adoption of mobile money. However, this is an unrealistic result, also sharply at odds with their earlier results.[145] Propensity score methods are used to match comparable households, and weighted regressions are run for total and food consumption. This recovers a coefficient of around 7 percent (at the 5 percent level) for overall consumption, but the coefficient for food consumption is poorly measured. Little information is given on the evaluation of the method, however, see caveats in Section 8.1.1.

In a recent paper, Jack and Suri (2016) argue strongly for a *causal* role for mobile money in welfare.[146] Expanding on their short-term consumption smoothing results discussed above, they aim to estimate the long-term impact of M-Pesa in Kenya on various outcomes, including consumption and saving. They use the same 2008, 2009, and 2010 surveys across 118 locations from their 2014 study on risk-sharing (Table 2), appended by a 2011 survey targeted toward households which attrited from earlier rounds, and a 2014 survey.[147] They run panel regressions to determine the effect of mobile money for households (or individuals) for three categories of outcomes (measured in 2014): average consumption per person in a household and household poverty rates[148]; physical and financial wealth; and occupational choices and migration.

Unlike the other studies in this sub-section, they use the *change in* agent density[149] between 2008 and March 2010 to proxy or substitute for mobile money usage (i.e. they are not using agent density as an instrument in an IV regression for mobile money). They do not use household fixed effects (with the exception of one differenced specification, see below) or location-by-time dummies, but they control for location fixed effects on which a great deal then rests to try to mop up household heterogeneity. They control for age and gender[150], but household physical and financial wealth is not included as a control. Then they compare the 2014 outcomes of households with relatively large increases in agent access between 2008 and 2010, to outcomes of households with relatively small

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x=0 the dependent variable becomes log (a) and when x= min(x) it is also equal to log (a). The assumption to treat 0 the same as the minimum value is a strong assumption. Moreover, in the log transformation, the deviation, say, from 3000 to 3500 matters far more than that from 8000 to 8500, rather unreasonably. It would be preferable therefore to scale using expenditure shares of total consumption or income.

[145] The application of an instrument to the fixed effects regression should make the coefficient less well-determined, but a four-fold increase (from coefficient of 0.0947* (their Table 3A) to 0.390* (their Table 6, column 1), both at the 5 percent level of significance) is unexpected.

[146] "…Thus, although mobile phone use *correlates* well with economic development, mobile money *causes* it." (Jack and Suri (2016), p.1292, final sentence of article, with italics added).

[147] Details are in Table 2. Nairobi was dropped from the sample after 2011 (480 households), and attrition from the original non-Nairobi sample, 2008- 2014, was 35 percent.

[148] Around 43 percent of the sample had per capita consumption less than $1.25 per day (defined as "extreme poverty") and for 66 percent it was less than $2 per day (also used as a measure of poverty).

[149] Agent density is defined as the number of agents within 1 km of the household. Given that agent density would have been low in the incipient stages of mobile money in 2008, this change variable approximates to the level of agent density in 2010.

[150] They include a dummy for gender of the household head in household level regressions (or for the individual in individual level regressions) and household (or individual) characteristics (measured in 2008): age and age squared of the household head.

increases in agent access in the same period. To estimate the marginal effect of an increase in agent density for females, the gender dummy and the *change in* agent density are crossed. The *change in* agent density is also crossed with household (or individual) characteristics[151] to rule out cases where the gender effect was in fact driven by these other characteristics. The study does not compare results with broader measures of agent density such as agents within 2km of the household.

The validity of the estimates rests on several assumptions. By pre-dating the proxy relative to 2014 outcomes, the authors hope to make their proxy exogenous, but there are two problems with this. First, the measure may not be a good proxy for *later usage* of mobile money, that is, it may not be highly correlated with later usage (which is like having a weak instrument in an IV regression). We know that there was no growth in agent density for 55 percent of households during 2008 to 2010. However, the number of agents grew strongly from 23,000 in 2010 to 110,000 in 2014. The spread and adoption of mobile money often relies on a critical mass of agents, and on communal spill-over effects through learning amongst adopters. If there was no change in 2008 to 2010 for many areas, but these were then catalysed to have a large *subsequent* growth in mobile money usage (2010-2014), then the earlier proxies could be poorly correlated with actual mobile money usage, introducing bias to the estimates. This could be empirically tested.

Second, the agent density proxy may not be as exogenous as the authors claim. They contend it is not systematically correlated with observable individual and household characteristics that might have been associated with future outcomes based on partial correlates in their Table 6C (Jack and Suri, 2014). These *bivariate* correlations between agent density at 1 or 2 or 5km and a range of observables[152] also include location-by-time and rural-by-time fixed effects. But this is rather different from trying to explain agent density with a full range of the variables and all relevant interaction effects, to prove it is exogenous or "unpredictable".[153] Moreover, the agent roll-out may also have some correlation with unobservables or poorly-measured observables such as wealth that also affect the outcomes. One factor suggesting roll-out may have been non-random is that Jack and Suri (2014) themselves suggest: "…many of the agents had business relationships with Safaricom prior to the advent of M-PESA, and about 75 percent report sales of cell phones or Safaricom products as their main business." As Aker and Blumenstock (2015) imply for the prior telecom infrastructure: "…decisions regarding expansion of ICT infrastructure and ICT-based programs are typically driven by private sector or policy criteria."

A third assumption is that the included controls adequately capture household or individual heterogeneity. Yet household fixed effects, location-by-time dummies, a dummy for ownership of a mobile phone (thus disentangling the technology of the mobile phone use from the service provided by the phone) and other direct controls such as wealth, education and possession of a bank account are excluded in this panel study. (Only column 2 of their Table 1, which has the change in the log of per capita consumption as dependent variable, effectively excludes household time-invariant fixed effects through differencing.)

Finally, the high level of attrition may have caused some problems: if the attrition was higher in locations where there was less roll-out, then bias could arise. However, the authors conducted several attrition tests which support their findings.

With these caveats in mind we present the results of the study. They find that prior agent density (access to M-Pesa) increased per capita consumption levels and reduced the level of poverty for two measures of poverty (their Table 1). They find these effects are more pronounced for female-

[151] See Table 2: for households, education and wealth are dummy variables for whether the household is below the median value in the sample. There is no wealth measure for individuals.
[152] The log of wealth is one of the observables and there is weak evidence for a *correlation* with wealth.
[153] They also conduct placebo tests using data from before the launch of M-Pesa. These establish that earlier consumption (pre-mobile money) is not affected by data on later agent density.

headed households for the log level of consumption and the level of extreme measure of poverty. The second regression in this table, where the regressors are the same, but the dependent variable is the *change in* the log level of consumption, deserves the most attention as the above (level) regressions are likely to have considerable unexplained heterogeneity. The change in consumption serves to get rid of the household time-invariant fixed effects, though time-varying heterogeneity from unobservables or poorly-measured observables will still be present and may introduce bias. The results here suggest that consumption growth for male-headed households was negative, while that of female-headed households was positive and statistically significant. The result is robust to inclusion of interactions between changes in agent density and other observable household characteristics.

The authors suggest the higher consumption levels for females could be driven by increased labour or capital income or by transfers between individuals with different propensities to consume. They test potential mechanism driving their results (in Tables 2 and 3 of their paper), for whether mobile money access (prior agent density) can explain the log of assets, the log of saving (a stock in 2014) and possession of a bank account. They find no role in explaining the (level of) the log of assets, and there is probably reverse causation in the banking result due to M-Pesa being followed by M-Shwari. The regression of the log of total financial savings (including self-reported cash plus balances in bank accounts, SACCOs, ROSCAs and mobile money accounts) controls for very little found relevant in the work on savings discussed below (Section 8.1.6) such as mobile phone ownership, wealth, marriage, income, education, but controls only for gender, age and age squared of the household head. Given this caveat, however, it finds "usage" promotes saving without a gender effect. They also find that with greater mobile phone access (prior agent density), fewer report their major occupation as farming, for both genders, while there appears to be an increase in females who report their main occupation to be a business, sales, or retail. The same caveats apply. They interpret the results as suggesting mobile money has increased the efficiency of the allocation of consumption over time, allowing the allocation of labour to be more efficient, and resulting in a reduction of poverty.

Another paper to analyse the effects of mobile money on food security is by Murendo and Wollni (2016) for two regions in Uganda, using a small cross-sectional survey of 482 households in 39 villages in November and December 2013. Two different measures of food security are the dependent variables in econometric regressions. They use food insecurity indexes based on the Household Food Insecurity Access Scale (HFIAS), a multi-faceted measure with subjectively perceived risks of food insecurity,[154] and the log of food expenditures (a self-reported, monetary measure).[155] The treatment variable is a dummy variable for the usage of mobile money services (defined over 12 months not the preferred 90 days), or a continuous variable for frequency of use of services or the volume transferred via mobile money. A vector of controls[156] includes information

[154] The HFIAS module consisted of nine questions capturing different experiences of food insecurity over the prior 30 days. A Food Insecurity Index (FIN) was constructed based on the HFIAS using weights obtained from factor analysis, with a higher the score implying greater food insecurity. As an alternative, a binary Food Insecurity Index was constructed on the same data.

[155] They used a 7-day recall for expenditures on food, beverages and tobacco and a 30-day recall for less frequently purchased food items. Aggregated monthly food consumption expenditures were calculated scaled by the number of adult equivalents.

[156] The controls are household demographic and socio-economic control variables: age, education (years) and gender of household head, household size, ratio of dependents (below 15 and above 65 years) to workforce (16-64 years), adult equivalent, land size, log value of farm equipment, dummy for household member(s) engaged in off-farm income activity, dummy for household accessed credit, total livestock units, dummy for household ownership of a motorcycle and/or car (dummy), distance to output market and district dummies. There are also three variables proxying for access to information: "the number of mobile phones owned"; "extension contact"

variables on agricultural extension and market information; these are expected to improve agricultural productivity, incomes, and thus food security.

To account for selection bias, endogenous treatment effect models (for the specification including a dummy for usage) and instrumental variables regressions (for the specifications with continuous volume or frequency variables) are applied. Widely-used instruments (e.g. the proportion of households using mobile money, and owning a mobile phone in the village) were statistically rejected in their study. They used instead two i*nnovative* instruments: household-specific mobile phone network connectivity and the size of the information exchange network of the household. These instruments were created through interviews.[157] Both these instruments are strongly correlated with mobile money use, but, they argue, are unlikely to affect household food security directly. This seems questionable, as the former instrument entails ownership of a phone and proxies for wealth, which may affect food security. The latter information variable is probably correlated with other information controls included in the regression, and may signal a household with good connections and high status in the community, affecting food security.

In the food expenditure regressions, selection bias is statistically rejected[158] and the OLS estimates are relied on. The use of mobile money (10 percent significance level) increases food expenditures per adult equivalent by 9 percentage points; the frequency of use and the volumes transferred (both at the 1 percent significance level) increase food expenditures per adult equivalent by 1.9 percentage points and 1 percentage point, respectively. Farm equipment and livestock units, and household size (with a negative effect), are important co-variates.

For the food insecurity (*continuous scale*) regressions, an instrumented regression[159] is used for the effect of the mobile money dummy; but for the frequency and volume transferred, the OLS regressions are deemed statistically valid. Mobile money usage (significant at the 1 percent level) reduces perceived food insecurity by 0.20 index points (a small shift, amounting to one fifth of the standard deviation). A 1 percent increase in the volumes of mobile money transferred reduces perceived food insecurity by 0.007 index points (significant at the 1 percent level)[160]. Land size and ownership of a means of transport and livestock units are significant for the food insecurity specifications. For all the food insecurity (*binary scale*) regressions, the ordinary probit estimates are valid according to the Wald test of independent equations. Mobile money usage reduces the probability of food insecurity by ten percentage points (10 percent significance level). A one-unit increase in the volume of money transferred via mobile phone reduces the probability of food insecurity by 1.2 percentage points (5 percent significance level). Land size, ownership of a means of transport, livestock units and group membership are significant co-variates.

If these results suggest that mobile money services improve food security among rural households, the suggested mechanism is that readier access to larger remittances, safely delivered, from wider networks and further away, eases liquidity constraints. It is possible that the innovative

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measuring whether a household had accessed information from an extension service; and the variable "group membership" for community learning about agricultural and market information.

[157] The first instrument is based on reported network bars displayed on the mobile phone at the homestead ranging from 0 to 4 (no network to excellent network connectivity). The second instrument contains the number of randomly matched households with which information on mobile money services had been exchanged.

[158] They report results of a Wald test of independent equations for usage regressions and the probits, and a Hausman (endogeneity) test for frequency and volume regressions, to indicate an absence of selection bias.

[159] The OLS estimate of mobile money on food insecurity is negative: having mobile money reduces food insecurity. But the instrumented coefficient is even *more* negative. A way to explain this bias is through reverse causation: those who face greater food insecurity self-select to be mobile money users, biasing the mobile money coefficient to zero. This is in fact the opposite of what the authors deduce.

[160] Thus, a 30 percent increase in the volume transferred would also produce about one fifth of a standard deviation in the index.

instruments are *weak*, though no critical values are reported for instance for the Cragg-Donald Wald F statistic. Where they do report an IV result, the level of significance of the treatment dummy is low. The failure to find appropriate instruments does not legitimate the OLS results. Since cross-sectional analyses are highly vulnerable to the problem of not being able to control for household and village level heterogeneity, these results should be treated with caution. Further, it would have been useful to conduct robustness tests, such as for whether mobile money is more important for poorer households or those lacking transport.

Another panel study for Uganda aims to explore the role of *other* pathways for mobile money to promote welfare than the direct effects on income via higher remittances (Sekabira and Qaim, 2016). Specifically they explore whether mobile money payment arrangements can impact on agricultural marketing, by facilitating farmers' access to higher-value markets where better prices can be obtained. They use panel data from smallholder coffee farmers collected in two survey rounds (2012 and 2015) from two randomly-selected robusta coffee-growing districts in Central Uganda.

Both fixed effects and random effects models are reported for an unbalanced panel[161] for the following outcome variables: total household income (all net earnings from on-farm and off-farm[162] sources, including remittances); per capita consumption[163]; remittances received; the proportion of coffee sold as shelled green beans allowing entry to higher-value markets; and the average coffee price received by farmers in the respective year.[164] The treatment variable is mobile money use, defined as a dummy with value of 1 if at least one household member had a mobile money account, using the services in the year (not 90 days as in the "active user" definition) and zero otherwise. Also included are a year dummy to control for time fixed effects; a general vector of covariates[165]; and dummies for mobile phone use and participation in certification schemes for sustainability standards, such as Fairtrade, to proxy for openness to technical and institutional innovations and to reduce bias from unobserved time-variant heterogeneity.

Most unfortunately for this interesting study, there is a serious error of misspecification. The relationship of the dependent variables is specified to be *linear in levels* with the determinants, but several are expected to have *proportional* rather than *additive* effects on the dependent variable. The dependent variables, real income or real per capita consumption, should be transformed into logs[166]; and some of the determinants should be in logs: household size, productive assets and land owned. Then there will be a *plausible* percentage effect on income or expenditure resulting in the expected proportional scale differences for large and small farms. Determinants not in logs, such as the time dummy (which could reflect weather or inflation or growth), and the distance of the farm from a tarmac road, will then have a *sensible* log-linear proportional relationship with the log dependent variable (for instance, larger farms will benefit *more* from road access). The random effect or fixed effect results are highly sensitive to such misspecifications and the presented results are not credible. Moreover, apart from the bias induced in the parameter estimates, their efficiency will be affected by

[161] The first round covered 419 households; a second round addressed a 6 percent attrition rate and also increased the sample size to 455 households in 2015. The unbalanced panel had 874 observations from 480 households. Unbalanced panels may introduce bias caused, for instance, by non-random attrition in the sample.

[162] Off-farm income includes salaries, wages, and pensions of all household members, land rents and capital earnings, and any net profit (revenue minus cost) from non-agricultural businesses.

[163] The per capita value of food and non-food goods and services consumed in the household, with food consumption data collected through a seven-day food recall, and non-food items as monthly expenditures. All expenditure data were converted to a daily basis.

[164] Net incomes were calculated with production costs subtracted; the income data were inflation-corrected.

[165] Farm and household characteristics: education (years of schooling), age, and gender of the household head; land owned; value of other productive asset; distance to the next tarmac road; and a district dummy.

[166] In the case of remittances, which could be zero, these should be *scaled* by farm income.

the large heteroscedasticity[167] *introduced* by the misspecification. (An aside is that with a more satisfactory specification, location-by-time dummies should also be included to address potential unobserved, time-varying heterogeneity at the village level.)

While log specifications should have been tested[168] in the regressions for the remaining two dependent variables, the proportion of coffee sold as shelled beans and the price received, these regressions are at least interpretable. The findings from the treatment effect in fixed effects models are that the proportion of coffee sold as shelled beans is increased by 19 percentage points which implies almost a doubling, a substantial effect. The suggested mechanism is that less cash-constrained farmers are more willing to sell after drying and processing, and can transact with buyers from outside their location. Important covariates are distance to road and sustainability certification. The effects on coffee prices received in fixed effects models is that mobile money users receive a 7 percent increase over the mean prices received by non-adopters through selling more of their coffee as shelled beans and having better access to buyers in higher-value markets. Important covariates include productive assets (e.g. vehicles and transport equipment) and distance to road and certification. The same caveat applies about unobserved, time-varying heterogeneity not being controlled for, possibly biasing estimates.

The Kikulwe et al. (2014) study is potentially interesting in that it explores the *early* impact of mobile money in Kenya on the welfare of small-holder farm households, shortly after its introduction in March, 2007. They use panel data for end-2009 and end-2010, and the period 2007-2010 showed a very rapid increase in the take-up of mobile money.[169] Both fixed effects and random effects models[170] are reported for a balanced panel, focusing on banana-growing households, for various outcome variables of interest: total household income (the sum of all net earnings from on-farm and off-farm sources, including remittances); remittances received (all transfers from relatives and friends not residing in the household); transactions in agricultural input and output markets; and farm profits.[171] The treatment variable is mobile money, a dummy that takes a value of 1 if mobile money services were used in the particular year (not 90 days) and zero otherwise. A year dummy is included to control for time fixed effects, and a general vector of covariates.[172]

Unfortunately this study suffers from the same problem of misspecification as in Sekabira and Qaim (2016). The dependent variables are not scaled by farm size or expressed as logs[173]; neither are the rainfall dummies or time dummies crossed with farm size to check for a non-linear effect. The implication again is that there are implausible *additive* rather than *proportional* effects from a range of determinants on the level of income. The parameter estimates will be seriously biased and inefficient. Furthermore, not including a dummy for mobile phone ownership means use of mobile money may be picking up this excluded factor.

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[167] For instance, small farm with small incomes are likely to have a small error term, and large farms with large incomes are likely to have large error terms: the variance of the error term will be non-constant.

[168] The productive assets are *unscaled* variables on the right-hand side of each regression.

[169] This study documents that mobile money usage increased in the sample of 320 households from banana-growing villages in the Central and Eastern Provinces of Kenya, from 60 percent in 2009 to 91 percent by 2010.

[170] Where there are censored dependent variables at zero, e.g. where households do not receive any remittances, a (random effects) Tobit estimator is used to avoid the otherwise potentially biased estimates.

[171] Net incomes were calculated with production costs subtracted. Corrections for inflation made the monetary values for 2009 and 2010 comparable (communication with authors); annual inflation exceeded 10 percent in 2009, fell to 4 percent in 2010, but began to rise strongly by year's end.

[172] This includes farm and household characteristics: farm size (land owned), household size, the gender, age, and education (years of schooling) of the household head, the distance of the household to markets and roads, a 'high-potential area' dummy, which takes a value of one for regions with more fertile soils and higher amounts of rainfall, and zero otherwise, and a variable measuring the percentage of households using mobile phones at the village level to capture neighbourhood effects.

[173] Remittances which could be zero, or profits which could be negative, should be scaled by farm income.

The results suggest that mobile money users appear to have greater household income, higher remittances received, to apply more purchased farm inputs, market a larger proportion of their output, and have higher profits than non-users of this technology. Given the above, the reported average treatment effects are implausibly large and unreliable. For instance, there is a 40 percent gain for mobile money users relative to the mean income of non-users and a 35 percent gain for profits over non-users. If a log specification was introduced, the study could benefit from two other improvements. Location-by-time dummies should be included to address potential unobserved, time-varying heterogeneity at the village level.[174] Other included controls may not be sufficient to pick up time-variant heterogeneity over the sample. For instance, the wealth measure used is land size which is largely time-invariant over the short period in which the study was conducted; a broader measure of less illiquid wealth as in the Riley (2016) study is an essential control which could be time-variant over the sample. The authors do instrument for mobile money use with the proportion of households using mobile money and the proportion of those owning a mobile phone at the village level. But the exogeneity of these instruments with respect to income is in doubt, as they may proxy for wealth. They also use propensity scoring as a robustness check, though too little information is given to assess this properly.

Another early study of the Kenyan experience with mobile money, using cross-sectional data, is by Kirui et al. (2013). This small survey examines 379 multi-stage randomly selected households in three provinces of Kenya in March-April, 2010. Only 52 percent of farmers were users of mobile money at the time of the study. The study demonstrated the sharp differences in users and non-user characteristics (their Table 2), linked to income, education, and proximity to banks and agents. They deal with the selection bias when examining the impact of mobile money services on various outcome variables by applying a propensity score matching technique. The outcome variables are: household agricultural input use (value of purchased inputs)[175], agricultural commercialisation (ratio of the value of sales to the value of total production) and farm incomes (value of agricultural revenue) among farm households in Kenya. They match treated individuals with controlled individuals (i.e. users[176] of mobile money with non-users) that are similar in terms of their observable (pre-participation) characteristics[177], using three matching techniques. Any differences in outcome variables between the matches are averaged and are *attributed* to the treatment (use of mobile money).

This paper faces the same problem of biases and heteroscedasticity as the above two discussed papers, in that logs were not used for the unscaled dependent variables, and for the relevant unscaled independent variables. Thus, larger farms or wealthier households are given undue emphasis when taking arithmetic means. At the least, geometric means should have been calculated for robustness checks. The results suggest the largest proportion of money received via mobile money (one third) was used for purchase of seed, fertilizer and top dressing, farm equipment, leasing of land and paying farm workers. The study finds that mobile money transfer services significantly increased

[174] The year dummies the authors do include pick up the differential rainfall across years, but not the differential effects of rainfall and other changes at the village level. The authors (communication) suggest the area is subdivided into villages (sub-locations), but these villages are administrative boundaries that do not always indicate proximity.

[175] The inputs considered in this study included fertilizer, improved seed varieties, pesticides, and hired labour.

[176] It would seem particularly important to get the assignation of users versus non-users right in a propensity matching study, and in a small sample, to avoid significant biases. But there is no indication that the definition of "user" here is for an "active user", see issues raised in Section 7.3 on exaggeration of usage.

[177] The following characteristics were examined: gender, age, distance to nearest mobile money agent, distance to nearest bank, household size, asset endowment variables, household non-farm income, current value of assets, land size, education, group membership and regional dummies.

level of annual household input use by $42, household agricultural commercialization by 37 percent and household annual income by $224.[178]

The crucial assumptions for the validity of the propensity score technique are that there is no hidden bias (from unobserved heterogeneity), and that the criteria for adequate balance are clear, adequate and met. On the former, it is worth reiterating that unobservable heterogeneity is *not* automatically removed through this technique (Section 8.1.1). On the latter, in an adequately-specified propensity score model, the distribution of measured baseline covariates should be the same between treated and untreated subjects. There is plenty of scepticism in the technical literature, particularly on balance-checking (see Section 8.1.1). The paper asserts that the pseudo-R^2 checks applied find no systematic difference in the distribution of co-variates between users and non-users (reductions in the median absolute bias were at least 20 percent), and that Rosenbaum-bound related sensitivity tests suggest even "large amounts of unobserved heterogeneity" would not alter inference. Reducing the bias by 20 percent is not to eliminate it. To help eliminate heterogeneity, it is hoped that observed characteristics will be correlated with unobserved characteristics, but this is not necessarily the case, and cannot be proved. The generalisability from such a small sample is also in doubt.

8.1.5 Public, donor or employer mobile money transfers

We discuss two papers that explore some impacts of *public* or *employer* mobile money cash transfers or wages transfers (Aker et al., 2015; and Blumenstock et al., 2015a). Both use randomised controlled trials. Both identify cost savings from reduced transactions costs for the disbursing party. But there are different results for the recipient: there are cost savings in Aker's study based in Niger, and possible cost increases in the Blumenstock et al. study in the more insecure environment in Afghanistan. Both studies are able to disentangle the mobile money delivery from ownership of a mobile phone by providing new phones to both treatment and control groups. The Aker et al. study finds improvements in household welfare after drought for the recipients of cash transfers, evinced by greater diet volume and diversity, and the reduced depletion of asset levels. The Blumenstock et al. study distinguishes changes in the financial behaviour of recipients of wage transfers, differentiated by size of salaries and shares of salaries in total household income.

Aker et al. (2015) is a randomized evaluation study[179] of a cash transfer programme via mobile money in Niger, one of the poorest countries in the world. Generally there is scant literature on the relative benefits and costs of electronic versus manual transfers.[180] The authors identify cost savings for recipients and the public agency, household welfare improvements and positive spill-over effects. Unconditional cash transfers following a drought were delivered through three channels: manual; electronic, together with a mobile money-enabled mobile phone; and manual, together with a mobile money-enabled mobile phone. By exogenously varying access to both the handset and mobile money, the impact of the technology could be distinguished from the electronic transfer mechanism; the relative costs and benefits of the three channels were compared. Specifically, comparing outcomes between the last two channels allows estimation of the effect of the mobile money transfer mechanism.

A simple reduced form regression specification was used to compare outcomes in December 2010 or in May 2011, and for pooled data from December 2010 and May 2011 rounds when data were available. The dependent variables were various outcomes of interest (costs, uses of the cash transfer,

[178] The exchange rate was Ksh.78 = 1 US dollar at the time of survey.
[179] Household survey of 1,152 recipients in 96 intervention villages: baseline in May 2010, and follow-ups in December 2010 and May 2011 (with the main sample being the 1082 households in Rounds 2 and 3).
[180] Gentilini et al. (2014) document social protection programmes in 119 developing countries which mostly rely on poor infrastructure for costly distributions.

proxies of well-being like food security and nutritional status, and assets owned) of individuals or households in the village. The regressions controlled for indicator variables for participation in the mobile money ("Zap") transfer program, and for whether a mobile phone was received, for geographic fixed effects at the commune (district) level, for a vector of household characteristics that differed at the baseline (age and the raising of livestock for income), and the presence of a seed distribution program at the village level.

For the mobile money channel, there was a reduction in transactions costs through lowering transport costs, travelling and queuing time. Evidence was found for an increase in intra-household bargaining power[181] for women. Compared with other channels, the recipients increased the diversity of their diet: household and child diet diversity was 9-16 percent higher among households who received mobile transfers, mostly due to increased consumption of beans and fats (1 percent significance level), and children consumed a third more of a meal per day (5 percent significance level). Recipients were more likely to cultivate and market cash crops conventionally grown by women, and had fewer depleted durable and non-durable assets. There was no evidence of "leakage" (i.e. of the transfer to corrupt intermediaries). The authors note that cost-savings rely on a well-established agent infrastructure, often absent in West African countries where mobile money adoption has been low. Costs could otherwise rise if access is difficult. Thus, the generalisability of these very promising specific results may be limited for poor countries with poor literacy and greater financial exclusion, without sufficient investment in the necessary payments infrastructure that is a pre-requisite to realise savings.

A randomized evaluation of a mobile money *wage payments* programme in Afghanistan, by Blumenstock et al. (2015a), examined the employees of a large development organisation[182] and the effects of the transition of a random subset of these from a cash-based salary system to one based on mobile money. The majority of Afghan firms pay their employees in cash. Less than 5 percent of the population is banked, and transactions costs are high for delivering wages as cash because of unreliable transport infrastructure and security concerns. Half the employees in each of seven regions participated in the study; of these 341 employees, half were in a treatment group and half in a control group. Both sets of employees were given new phones, a new SIM card and training on how to use the mobile money system, M-Paisa. The treated group received mobile salary payments, the object being "to provide a "random shock" to the propensity for some individuals to use mobile money, in order to isolate the causal effect of mobile money use".

A simple fixed effects model was estimated with the dependent variable being the use of a particular M-Paisa service, such as saving, transfer and airtime purchase, and two dummies were included for a treated individual and for whether the observation was made after treatment and a cross-effect between these dummies included. The regression included individual level fixed effects to capture time-invariant individual factors, and survey wave fixed effects for temporal patterns affecting individuals similarly; clustered standard errors were reported. Using the more transparent and efficient means of payment, the authors found significant reductions in the disbursing firm's net costs from fewer ghost workers and other leakages, coupled with savings on financial employees' time. With lower transactions costs, the behaviour of employees randomly assigned to the mobile salary payments groups was altered. They made larger, more frequent airtime purchases each month and spent more in total on airtime (an extra US$2 per month). They increased usage of mobile transfers and mobile savings. On average, they left 20 percent of the average monthly salary in the account,

[181] The authors found that mobile money cash-transfer recipients were able temporarily to conceal the arrival of the transfer, and were more likely than their manual cash recipient counterparts to obtain the transfer on their own, travel to weekly markets and sell household grains.

[182] The authors partnered with the Central Asia Development Group (CADG) which delivers technical development assistance to challenging geographical areas.

with the average cumulative balance after 8 months at about US$68. Account usage patterns were heterogeneous: larger balances were maintained by previously banked employees, those with larger salaries, and those contributing higher shares of their household's total income; but non-heads of households rapidly withdrew funds after the salary transfers. Surprisingly, the survey indicated that savings balances of the treated group fell with greater perceptions of insecurity, perhaps linked with limited agent access during periods of insecurity[183], or the greater demand for cash with uncertainty over future consumption decisions. Total savings did not improve relative to the control group but the method of saving changed to M-Paisa; transfers were also no more likely than in the control group which had no access to M-Paisa.

Given the short time period of observation and also the small sample size, the study was not able to find improvements in welfare indicators such as consumption and self-reported satisfaction (e.g. improved sense of security) from Difference-in-Differences estimates of the treatment effect. Further, no individual controls were included: while these do not generally change estimates for treatment effects, in helping to explain the dependent variable, they may lower the standard error of the treatment coefficient.

The positive welfare results in Aker et al. (2015) are linked to a considerable lowering of transactions costs, which may not be the case in this study. The transactions cost saving for employees between the salary transfer and a cash payment may have been relatively minor (halving the cost per employee per month to around $7). Further, employees randomly assigned to the mobile salary payments group had to incur the costs of finding (liquid) agents in cases where adequate mobile network and agent coverage actually existed; moreover, some had privacy concerns for security reasons.

8.1.6 Analyses of savings behaviour and credit

There are several qualitative studies with localised implications for savings behaviour, and we give a few examples. Wilson et al. (2010, Chapter 9) describe how members of informal savings groups in Nairobi find it cost and time effective to move their cash into a group M-Pesa account weekly from the deposit collector's own account (especially with larger savings, as transactions costs for transfer are then lower). Jack and Suri (2011) conducted household surveys in 2008 for early adopters of Kenya's M-Pesa, and in 2009 in a subsequent round. They find that by 2009, 90 percent of early adopters used M-Pesa for saving (amongst other savings instruments and continued use of cash). The reasons for saving include improved security (including safety of cash during travel), greater privacy, increased ease of use, reduced transactions costs and precautionary saving against emergencies (their Table 13). Mbiti and Weil (2016) find related results using the FinAccess 2009 survey for Kenya. They document similar socio-economic characteristics for savers as are explored econometrically by Demombynes and Thegeya (2012), see below.

There are problems with how savings are measured in the empirical studies. Deaton (1989) emphasises the pervasive data inadequacies that have hampered progress in answering basic questions on saving. The studies below deal with flow concept of saving, but the focus on liquid savings is potentially misleading. The purchase of an illiquid asset (e.g. a cow) is saving though it reduces liquid savings; and a loan may swell liquid assets without this representing savings. Problems are posed too by "zeroes" when the log of an amount of saving is used as the dependent variable; the log of a small number close to zero can be large and negative, thus amplifying tiny variations in savings amounts

[183] Blumenstock et al. (2015c), still in progress and not discussed in this survey, exploits the quasi-random timing of several thousand violent incidents in Afghanistan to show that individuals exposed to violence are less likely to adopt mobile money, and users transact less and hold lower balances in preference for cash, especially when motivated by concerns about future violence.

(and thereby *introducing* heteroscedacity). It would be an improvement to look at saving as a ratio to a scaling variable, for instance as a fraction of income, or of imputed income if income is noisy and difficult to measure. A saving ratio also allows dissaving.

We discuss four papers that analyse the effect on savings behaviour and credit of mobile money cash transfers: two are cross-sectional studies (Demombynes and Thegeya (2012) and Munyegera and Matsumoto (2016a)), one uses experimental data (Batista and Vicente (2016)) and one makes a balanced panel of locations not individuals (Mbiti and Weil (2016)). Of these, only the experimental study, which restricts participants to those with a mobile phone[184], disentangles the technology from the service it provides (mobile money); the other studies do not control for the ownership of a mobile phone.

A potentially interesting finding from the quantitative work of Mbiti and Weil (2016) is that adoption of M-Pesa reduces both the use of informal savings groups and the need to hide cash in secret places. These authors have no data on the amounts saved, only on *methods* of saving. They create a balanced panel of *locations* by combining the 2006 and 2009 FinAccess surveys (see appendix Table A1). A first-differenced instrumental variable regression for saving methods is used, controlling for education (primary school or below), gender, age, marriage rate, and wealth[185]. The differenced specification removes biases due to any time-invariant unobservables.[186] The variable representing M-Pesa adoption (defined as the proportion of individuals that use M-Pesa in a sub-location) is instrumented. The set of instruments is based on 2006 survey responses (before M-Pesa was introduced) about riskier, slower and more costly transfer methods; the instrumenting assumption is that the 2006 perceptions should have no direct impact on outcomes. However, the actual definition of the instruments used to predict M-Pesa usage, namely the *proportions* of residents who identify the post office or a money transfer company or a friend as relatively more risky than each other, is not intuitive. It would make more sense to have scaled each of the three transfer methods on grounds of riskiness, costliness and slowness. Even with such scaled instruments, biases might be introduced if they were correlated with unobserved, time-*varying* characteristics of households that could be associated with the dependent variables (e.g. ability, dynamism). Bias could also arise if instruments were correlated with included time-*varying* observables such as wealth, if wealth was not well-measured (as is typically the case); or with omitted, potentially time-*varying* observables such as banking status.

Another Kenyan study, Demombynes and Thegeya (2012), uses cross-section survey data[187] to explore patterns of savings, and the factors driving two types of savings in Kenya, "basic mobile savings" and "bank-integrated mobile savings". The former refer to M-Pesa savings balances which attract no interest rate. The latter is M-Kesho[188], a bank account for M-Pesa users paying interest and accessed only via a mobile phone, also offering financial services beyond pure money storage and transfer, such emergency loans or insurance. Probit regressions were run for methods of saving,

[184] The restriction is actually to having a mobile phone number, which could simply be from ownership of a sim card rather than the phone hardware, especially when a sharing culture of mobile phones is present. In either case there is control for the phone technology.

[185] A wealth measure is constructed with principal component analysis applied to household assets and durable goods; wealth quantile dummies are defined, and "poor" refers to individuals in the bottom two wealth quintiles.

[186] The time fixed effect and sub-location fixed effect included in the regression to address sub-locational time variation, will drop out in the differenced specification.

[187] The survey was conducted by the Financial Sector Deepening Kenya organization covering 6,083 individuals, during October and November of 2010.

[188] M-Kesho was the ill-fated savings product of a partnership between Safaricom and Equity Bank launched in 2010, but which quickly foundered because of difficulties Equity Bank and Safaricom had in managing the partnership. It was poorly promoted. The successor, M-Shwari, has flourished (Box 1).

beginning with savings "in general"[189], where the dependent variable is a dummy equal to one if there are any reported savings in a given period (a flow), and zero otherwise, with controls for age, marriage, gender, wealth[190], education (unclear how this is measured), location (rural or urban) and the log of household income. Saving is found more likely for older individuals who are male, rural, married, and with higher levels of education, reported income and wealth. With these controls, the coefficient on a dummy for registered users[191] of M-Pesa suggests that M-Pesa users are 32 percent are more likely to report having savings (1 percent significance). Few people used M-Kesho, but a Probit where the dependent variable is a dummy equal to one for reported M-Kesho savings (and zero otherwise), yielded a similar outcome: greater saving by the wealthier, married, more educated and male.

However, the M-Pesa usage dummy is endogenous, as discussed above. Instrumenting for M-Pesa usage in the same regression (the instrument is the fraction of respondents in the sub-location registered with M-Pesa), drops the dummy coefficient from 32 to 20 percent (1 percent significance). This location-level instrument averages over individuals within locations, and eliminates *some* unobserved district-level heterogeneity[192]. This caveat suggests that the result, that saving appears greater for M-Pesa users, is indicative only.

The authors also regress the log of average monthly savings (a flow)[193] amounts on various controls (rural-urban status, gender, age, marriage, education, wealth, income, and a dummy for M-Pesa registration) using OLS and an IV estimation (with the same instrument used above). Controlling for these variables in the OLS regression, M-Pesa users save 12 percent more than those not registered (5 percent significance). In the IV regression, however, the coefficient for M-Pesa users is not statistically significant. It is not clear whether the endogeneity is severe and the instrument is so successful in dealing with it that mobile usage is not relevant to saving, or whether it is simply a poor instrument for M-Pesa usage.

A related exercise for Uganda, also in cross-section, applies greater econometric sophistication to the analysis of household savings flows (Munyegera and Matsumoto, 2016b). Household and community characteristics data derive from the fourth round of Uganda's RePEAT survey in 2012; these were supplemented in repeat interviews with 820 of these households in mid-2014, to acquire data on money saved, borrowed and received via remittances in the preceding 12 months.[194] As with Demombynes and Thegeya (2012), there are both Probit analyses for usage of financial services (for savings, credit and remittances) and regressions for the amount of saving, credit and remittances, in logs.

In the Probit regressions, the dependent dummy variable is 1 if a household made any form of savings or received any credit (formal or informal) or remittances in the preceding year (a flow), and 0 otherwise. There are controls for household characteristics of household size, log of total asset

[189] Savings via M-Pesa, M-Kesho, PESA PAP, KCB-connect, bank accounts, SACCO accounts, ASCA, ROSCA, micro-finance institutions and "other" means.

[190] The authors created a wealth index using principal components analysis, grouping survey respondents by wealth quintile; four wealth quintiles were introduced into their regressions.

[191] Concerns with this definition have been mooted above, see also Section 7.3.

[192] The instrumenting equation would be improved if other locational means could be included to reduce heterogeneity at the district level, such as the mean literacy rate, mean affluence, district-level ownership of wells or piped water, which might impact on the dependent variable.

[193] Average monthly savings was calculated by combining responses to questions concerning the frequency of savings and the average amount saved each time. There may be problems with zero-observations, however, as many users will not have had savings. It is not known what percentage of zero observations there were nor how they were dealt with. The log transformation also introduces problems with tiny amounts of savings, see above.

[194] The authors could not utilise a panel data set because the RePEAT surveys do not have information on financial access and usage.

value, and the age, gender and education level (in years of schooling) of the household head; district dummies are included; and a village characteristic is added in alternate regressions: the log distance to the nearest mobile money agent, which is a proxy for the density of mobile money agents. To test whether mobile money use enhances the probability of saving, borrowing or remittance, a dummy variable is included equal to 1 if at least one household member "used" mobile money services[195] and 0 otherwise. The Probit regressions for savings and credit yield no significant variables at the 1 percent significance level, save for the mobile money usage dummy. The Probit regression for remittances approximates to a Probit for mobile money adoption, since remittances flow largely through this channel; indeed, the results echo their earlier work on adoption (Munyegera and Matsumoto, 2016a), though the current specification excludes important dummies for the household owning a mobile phone and having a migrant worker. The specification for savings is not comparable with the Kenyan savings work of Demombynes and Thegeya (2012), which includes log income (highly significant), wealth quintiles and marital status for a far larger survey.

To assess how mobile money stimulates the amount of financial transactions, a Tobit approach is used. The logs of annual savings made (a flow), credit received and remittances received are regressed on similar drivers to the above[196]. This technique serves to censor observations at zero as the lower limit, since households not using financial services will not yield an outcome.[197] Again there are no significant variables at the 1 percent significance level, save for the mobile money usage dummy, except in the remittances equations. Mobile money is potentially endogenous, and as these data are not panel data it was not possible to include household fixed effects to control for time-invariant household heterogeneity. Two approaches are adopted to help address endogeneity (though not the instrumental variables approach used by Demombynes and Thegeya (2012)).

First, the residual from a first stage Probit regression for mobile money adoption is added in alternate Tobit regressions to help control for the endogeneity of mobile money.[198] This proves significant in the savings regression only (and the coefficient on the mobile money usage dummy remains fairly stable), but not in the credit and remittances Tobit regressions. In all regressions, the mobile money usage dummy is positive and significant and the authors suggest a role for mobile money in encouraging savings and as a channel for loans and remittances. Asset variables are significant in all regressions where the residual is not included, and also in the regression for remittances where it is included. A female household head and presence of a migrant worker matter also for the remittances regressions, and household size reduces savings significantly (at the 5 percent level).

Second, to *reduce* observable (time-invariant) household heterogeneity the authors use propensity score matching though with scant information on methods used and robustness checking (see the caveat above on propensity scoring in Section 8.1.3). They run OLS regressions weighted by the propensity score, including most of the above controls and additional controls of the distances to various financial institutions. Nothing is significant except the dummy for "use of mobile money" for all three dependent variables for savings, remittances and credit (and the coefficient on the mobile money dummy drops for the first two relative to the previous regressions), and also the value of assets (at the 5 percent level) for savings. The authors suggest this is because heterogeneity has been

[195] This variable compares with the "Registered to M-Pesa" dummy in Demombynes and Thegeya (2012). In both cases, there are possibilities for mis-measurement and bias if the definition is not precise (see Section 7.2).

[196] Additionally, they include distance in logs to the nearest town rather than nearest mobile money agent, dummies for a migrant worker in the household and a SACCO in the district, and a land wealth variable.

[197] While this address zero observations, there remains the problem, referred to above, of the log transformation unreasonably amplifying tiny variations in savings amounts close to zero.

[198] A few extra controls are added in these Tobit regressions: dummies for the presence of a migrant worker and for the presence of a SACCO, and the log value of land is separated out from total assets.

successfully removed, emphasising the role of mobile money in significantly increasing saving, credit and remittance transactions. In general, cross-sectional OLS needs to be taken with the proverbial large pinch of salt. The conclusions are probably optimistic, because despite heroic attempts by the authors to reduce it, in cross-section it is very difficult to control for unobserved heterogeneity. Whether the significance of mobile money usage is indeed important or whether the coefficient is biased strongly upwards as it proxies for unobservables is unclear.

Finally, work by Batista and Vicente (2016) on the introduction of mobile money in Mozambique was discussed in Section 8.1.3; their novel approach through experimentation lends insights into the desire to save through mobile money. Games were conducted in treatment and control locations in rural provinces with experimental subjects. The authors examine willingness to save and remit *to* migrant family members in Maputo, and to save and remit particularly using Mkesh. Decisions[199] were made using real money. Using OLS reduced form regressions in a Randomised Controlled Trial (RCT), the dependent variable is binary and they compare outcomes for target and control individuals with a treatment dummy variable, year dummies, province dummies and individual controls for age and gender; standard errors are corrected by clustering at the location.

They find that the willingness to save through Mkesh and to remit through Mkesh (as opposed to alternative channels) increases when comparing target and control individuals. Across 2012 to 2014, the effect for savings is 21 percentage points and that for remittances is 25 percentage points, both significant at the 1 percent level. They conclude that the dissemination of Mkesh raised willingness to send money transfers in general, and particularly through mobile money. However, the overall marginal willingness to save in areas where mobile money is made available does not increase across the three years so that at the margin, Mkesh substituted for traditional methods of saving. They argue that these are credible pointers to a future use of Mkesh for savings and remittances. The conclusion is perhaps unsurprising: the switch to the M-Kesh channel would be expected if the training exercise was thorough and persuasive (see Aker and Blumenstock (2015) on the problems of interpreting a treatment effect when an intervention depends also on the type of information provided). A further caveat is that while remittances appear to increase, these are tiny amounts in a small sample, and in the rural to urban direction.

8.1.7 Regulation and mobile money usage

A cross-country study by Gutierrez and Singh (2013) tries to relate the usage of mobile money to enabling regulation, using regulatory indices and micro-data on usage[200] from Global Findex (see appendix Table A1) for 35 countries. They construct the indices from six sub-components, each associated with an enabling regulatory principle as outlined by Porteous (2009); and these sub-components are either equally-weighted or assigned weights through a Principal Components methodology. Sub-components of the index are classified as either supporting openness or certainty in various degrees, and an ideal enabling legal and regulatory environment favours a high degree of openness and certainty (Porteous, 2009). The authors are aware that *de facto* rather than *de jure* regulations should enter an index, or in other words, that it is the quality or performance of the existing regulations that matter (Aron, 2000). The *de jure* nature of their index, therefore, places a caveat on the validity of the results.

[199] In the savings game the respondents were given about $1 which they could keep or save. If they saved then they either deposited in an Mkesh account (no interest paid), or in a sealed envelope where 25 percent would be added if the envelope was still sealed at the (uncertain) next visit of the enumerators. See Batista and Vicente (2016) for details of the randomisation, the experimental design and the remittances game.

[200] The Global Findex survey questions reveal the definition of usage to be over 12 months not 90 days, so users may not be "active" as in the GSMA-preferred definition, hence potentially introducing biases (Section 7.3).

The dependent variable is a dichotomous variable (receive, send or pay bills with mobile money or a combination of these) and a logit regression includes controls for both country characteristics and individual (micro-) characteristics (see Table 2). Unfortunately, the authors face the problem that the index may be correlated with omitted country characteristics. Most possible instruments for the index have the same potential problem of correlation with omitted country characteristics. By using location (country) fixed effects to *reduce* omitted variable bias, they are unable to include the index itself, but only its interaction with individual characteristics. The interaction effects nevertheless yield some plausible insights. A regulatory framework that supports interoperability appears to promote higher usage among the poorest. Stronger consumer protection appears to reduce usage by the poorest, perhaps through raised costs, while amongst the educated, greater consumer protection promotes usage.[201]

8.2 Macro-literature

There are few papers examining the impact mobile money using macro-data, and these mainly concentrate on the effect of mobile money on inflation. To isolate an impact of mobile money on inflation, however, it is essential to use well-specified *multivariate* inflation models with comprehensive controls. Failure to include proper controls will lead to biases, and the erroneous attribution of effects to mobile money that belong to omitted economic regressors in the model.

The inflation fears based on the rapid spread of mobile banking in Kenya seem to be mainly linked to an African Development Bank (ADB) Economic Brief by Simpasa and Gurara (2012), which should be treated cautiously from a policy perspective (see Section 6.2.2).

The 'monetarist' notion that a stable demand for money function (derived from an extended version of the Quantity Theory identity) which attempts to link demand for money *causally* with inflation can be reversed to give an inflation equation has long been discredited (Hendry, 1985), and lacks micro-foundations. The micro-economics of price setting should give a role to both demand side and supply side factors, and to expectations, whether based on auction markets, competitive markets, oligopoly or administrative price setting.[202]

The ADB Economic Brief adopts a highly restrictive and mis-specified empirical inflation model of the monetarist type, excluding key variables such as rainfall. The time period of 1964-2009, with annual data, also spans two different monetary regimes where the structure of inflation was likely different: the inflationary period of the 1960s and 70s, and the more recent lower inflation period. However, the model does not take account of this structural break. Since mobile money in Kenya began in 2007, there are only three data points in the model for mobile money. Thus, any inflation shocks in the period, such as triggered by the violence that erupted in late 2007 to early 2008

[201] Another wave of Global Findex usage data could potentially allow the direct effect of a regulatory index to be tested, if there was sufficient variation in the index across time for different countries. If the same individuals were followed, so producing a panel of data, then a fixed effects panel regression could mop up all time-invariant household heterogeneity. If different individuals were surveyed in the second wave (i.e. if the usage data do not form a panel) then the direct effect of the index could still be examined in a pooled cross-section, time series regression, but without including household fixed effects to deal with the omitted variable bias from time-invariant household heterogeneity. In both cases, however, inclusion of the country regulation index by time means that location-by-time fixed effects could not be included, possibly leaving some time-variant household heterogeneity unaccounted for.

[202] Another reason sometimes advanced justifying a link between money growth and inflation is for the *special case* of hyper-inflation, in Cagan (1956). This *correlation* essentially arises through fiscal stimulus: large, expansionary fiscal deficits, financed by printing money, drive demand for goods and services. Constraints on supply (and hence on government revenue) usually precede the resort to the printing press. The disruption caused by hyper-inflation further contracts supply of good and services. However, this channel is also not likely to generate a time-invariant link (i.e. a stable relationship) between money growth and inflation.

after Kenya's disputed election, and not otherwise taken into account, could be captured by the mobile money data.

It is far from obvious that the role of the money stock in this model is capturing fundamentals or whether it is merely correlated with the relevant omitted variables. In other words, one needs a better-specified inflation model. Note that, money growth can for some samples be *correlated* with the expansion of credit supply to firms or households, resulting in greater private sector spending. However, this correlation is not guaranteed and may be time-varying or absent. A *causal* channel between money growth and inflation can arise because, as noted in Section 6.2.2, liquid assets are the most spendable part of private sector wealth.[203]

The ADB Economic Brief also ignores the possible countervailing forces. First, the spread of mobile banking is likely to lead to significant productivity gains (e.g. in agriculture, as noted in World Bank (2010)). If the supply of goods expands with demand, there need not be inflationary implications. Second, there could well be improvements in competition in markets for goods and services with falling transactions costs, so reducing the pricing power of price setters. Third, increased household saving is also likely with greater security and interest payments, and could take pressure off inflation.[204] Fourth, the weight of ICT in the consumer price index should have increased, while prices of ICT, particularly if quality-corrected, continue to decline. It is far from obvious therefore, that (well-measured) inflation should have risen as a result of the spread of mobile money and banking.

Only two other empirical papers to our knowledge address these issues with macro-data. Weil et al. (2012) acknowledge that without the presumption that the behaviour of monetary aggregates has a major bearing on inflation, "this area of policy would scarcely be worth much research effort". The authors try to assess the effect of M-Pesa as a financial innovation on the stability of macro-money aggregates. They find evidence of instability from 2007 (when M-Pesa was launched), from a CHOW test with pre-chosen breakpoint of 2007q1, and using quarterly data on the M3 income velocity of circulation and other aggregates. Obviously no causal effect of M-Pesa on these aggregates can be attributed from this *univariate* test.

Aron et al. (2015)[205] model and forecast monthly inflation in East Africa to test for the possible effects of mobile money. They apply to Uganda, sophisticated econometric forecasting models successfully used in an emerging market country, South Africa, and in an advanced country, the US (Aron and Muellbauer (2012, 2013b)). The starting hypothesis is that inflation is a heterogeneous, state dependent process. Heterogeneity suggests that adjustment to relative price disturbances is part of the inflation dynamics. Further, if the probability of price changes is state dependent, this implies that non-linearities are likely to be important. For instance, energy and food price shocks can be sizeable, and the speed of price changes tends to rise with larger shocks.

Stable models for the 1-month and 3-month-ahead rates of inflation in Uganda, measured by the consumer price index for food and non-food, and for the domestic fuel price, were estimated over 1994-2013. Key ingredients were the use of multivariate models with equilibrium correction terms in relative prices; introducing non-linearities to proxy state dependence in the inflation process; and applying a 'parsimonious longer lags' (PLL) parameterisation allowing far longer lags than when using the information criterion commonly used in VARs to select lag length. International influences through foreign prices and the exchange rate (including food prices in Kenya after regional

[203] But this suggests the importance of controlling in the model, where data exist, for the full portfolio of private sector assets and debt and income, taking account of different propensities to spend out of different components to proxy private sector demand.

[204] There is micro-evidence from Demombynes and Thegeya (2012) that household saving has risen as the result of the expansion of mobile banking.

[205] This work was commissioned by the Melinda and Bill Gates Foundation (grant 23231).

integration) have an important influence on all three dependent variables, as does the growth of domestic credit. Rainfall deviation from the long-run mean is an important driver for all, most dramatically for food. The domestic money stock is irrelevant for food and fuel inflation, but has a small effect on non-food inflation. Other drivers include the trade and current account balances, fiscal balance, terms of trade and trade openness, and the international interest rate differential.

There is no serious evidence of a link between mobile money and inflation. For food inflation, mobile balances relative to M3 and mobile money transactions value relative to M3 have no significant effect, given the controls. For non-food inflation, mobile money effects are again insignificant. These findings suggest that concerns regarding the potential velocity-inflation linkage of mobile money are misplaced. The hypothesis that mobile balances (relative to M3) represent a planned build-up of liquidity just ahead of a significant increase in expenditure which might be inflationary is also not supported. There is no evidence that the advent of mobile money might transfer spending power to households with higher propensity to spend, so reduce saving and increasing demand. Increases in mobile balances (relative to M3) more probably reflect the expansion of the mobile money infrastructure and its more widespread acceptance. It is more likely that the productivity and efficiency gains of mobile money have reduced inflation, even when quality improvements may not be fully measured in the CPI. For example, mobile money could make the effects of droughts and floods less disruptive by improving the matching of supply and demand of goods and services, and with lower transactions costs. With only five years of data since mobile money was introduced in Uganda, there must be considerable uncertainty over its long-term consequences for efficiency gains. But the evidence strongly suggests there is no reason for any alarm over its potentially inflationary consequences.

Adam and Walker (2015) take a different approach and adapt an existing Dynamic Stochastic General Equilibrium (DSGE) model, by introducing the technology of secure and instantaneous mobile money transfers between urban producer and rural households. Their simulations of the extended theoretical model suggest that the advent of mobile money improves macroeconomic stability especially benefitting rural (lower-income) households. Their results support the enabling cross-border transfers with mobile money ahead of the East African Community Monetary Union planned for 2024. Beck et al. (2016) develop and solve a DSGE model with heterogeneous entrepreneurs in small and medium enterprises, which has imperfect credit markets and theft, where theft both erodes an entrepreneur's money balances and may, if this causes defaults on borrowing, produce a discontinuation of access to trade credit. Access to trade credit generates demand to use M-Pesa as a payment method with suppliers and the use of M-Pesa in turn raises the value of a credit relationship and hence the willingness to apply for trade credit. The model is calibrated to match a set of moments in Kenyan enterprise data (FinAcess Business 2014). Eliminating the use of M-Pesa from SME-supplier relationships reduces the aggregate output generated by the enterprises by 0.33 percent. If access to trade credit in the model is endogenised, the lack of a mobile money technology lowers the fraction of trade credit relationships among SMEs, causing a total contraction in output by 0.47 percent.

9. Incentives: the design of network structures and network agency contracts

A cause of financial exclusion is the prohibitively high cost of maintaining sufficient bank branches in remote areas to reach the population. With mobile phone technology, the consumers invest in the handset and the infrastructure is present for the distribution of airtime. The challenge is to create a wide-spread, efficient and *active* agents' network to service electronic money accounts, and to register and promote *active* customers.

The structure of agency networks and the design of agents' contracts in mobile money systems affect profitability (Section 5.1). Delegation to a network of "agents"[206] by the "principal" (the mobile payments provider) will function well if the training of agents is sound, if well-designed contracts between principal and agents contain appropriate incentives that can be altered over time, and where adherence to the contract is regularly monitored.[207] Then an agency network can *proxy* for a wide-spread set of bank branches, operating at a fraction of the cost. The scope for contract design depends on the institutional structures allowed by regulation. The differing success rates and profitability of mobile money systems depend greatly on regulatory constraints; there are stark regulatory differences amongst countries.

9.1 The exclusivity, shape and size of networks

Creating an agency network is not a *necessary* part of the business of the mobile payments provider. There could be independent agents paid directly by the customers. However, as Claessens (2009) observes, the high fixed costs and large sunk costs in the production of wholesale financial services imply significant first mover and scale advantages, possibly leading to natural monopoly. The dearth of agents to begin with, and the goal of a transparent and non-corrupt system that observes "know your client" regulations, means that to catalyse the operation, and promote adoption of the new mobile technology, a *critical mass* of reliable agents is required to reach a *critical mass* of customers. M-Pesa's profitability in Kenya owes its success in large measure to the extensive agents' network established by Safaricom (Box 1). Klein and Mayer (2011) observe that establishing the network, and the selection, training, monitoring and payment of the agents, represented a considerable investment by Safaricom to develop the market, and there are considerable ongoing costs (Section 5.2). In recognition of the sunk costs, the Kenyan regulator at first allowed Safaricom to conclude exclusive agreements with the members of their distribution network.

There are important challenges for regulators in the choice of pathway for the development of these nascent markets (Section 10). The Kenyan choice of light regulation initially, with exclusive advantages to the first mover, needed later to be countered to allow evolution of a deepening, efficient and competitive market. Di Castri (2013) argues that agent exclusivity is a matter for competition policy as ongoing exclusivity can constrain other providers from establishing effective distribution networks, stifling competition. Exclusivity for Safaricom's agency networks was disallowed by the Competition Authority of Kenya as of 18 July 2014.

Networks can assume different shapes, with various tiers of agents. Kenya and Uganda offer a contrast. The M-Pesa agent network is a *uniform* network where there is only one tier of agents by function, though retail and wholesale agents face different thresholds on their M-Pesa accounts and wholesalers typically serve to restock the retail agents. Uniformity can foster trust, enhance transparency of service, and make for a more seamless registration and activation of accounts. The MTN-Uganda network, on the other hand, is non-uniform. It has two tiers of agents by function: the usual cash-in/cash-out agents as in M-Pesa, but also field registration agents, who do not transact, but sign-up new customers. This seems to be a model that can quickly acquire customers with more mobile registration agents, and the promotion of the service may be more vigorous with a separation of the roles. They may also engage in ongoing management of the network.

[206] The following nomenclature is also used for third parties who act as agents for the principal: facilitators, cash merchants, and correspondent. Note that agents may not necessarily be true "agents" in the sense of having the legal authority to act for the principal, see Section 10.

[207] Enforcement does not depend on ethnicity or family ties, as in the case of Hawala networks.

The optimal number of agents in a network is considered by Davidson and Leishman (2011). They suggest a three-phased approach to scaling the network. Initially, a sufficient number of agents is needed to launch the product with a geographical distribution linked to potential demand.[208] Then resources should be deployed in a drive to acquire customers. When the customers appear to have convenient access to (liquid) agents then equilibrium can be judged to have been reached, and the number of agents can be grown in proportion to active customers.[209] Davidson and Leishman consider that it is difficult to generalise about the ratio between customers and agents, given differing market conditions. Markets should not be over-saturated with agents, and they should be able to perform sufficient transactions to be more than compensated for their initial investment in mobile money.

Networks can also have tiers of customers and this was partly discussed under adoption in Section 4.3. To facilitate the growth of networks, for very small transactions more liberal registration requirements[210] can be allowed. When transactions exceed a threshold, and more stringent requirements are needed, registration can be completed and the status of the account altered with greater storage and transactions thresholds (or automatically activated if the customer has registered previously). This has the advantage of encouraging transaction immediately after signing up, see below. An example of a market with tiered access of this sort is the multi-tiered deposit account scheme established in mid-2011 for poorer customers of Mexican banks. Business customers can further be distinguished from other customers by allowing a larger threshold for transactions and lower transactions costs for bulk delivery (see Box 1 on Kenya).

9.2 On the recruitment, training and regulation of agents

Differences in managing a mobile money agency network as against airtime distribution have been poorly understood by many operators (Lonie, 2013). Potentially mobile money providers can leverage retailers, rural banks, MFIs, money changers and airtime resellers as agents. But Davidson and Leishman (2011) suggest that recruitment of the *right* type of agent for mobile money is crucial. Mobile money agents are not merely selling a product (like airtime retailers), but a service. They need to register and educate often illiterate customers, and promote awareness and activation. To maintain the cash-in/cash-out function, they need to conduct far more complex liquidity management of stocks of electronic money and of cash (than airtime retailers). Commensurately, oversight and training are both different and more intensive for mobile money agents than airtime resellers. Recruitment is one of the most time-consuming and costly aspects of launching a new mobile money service. Some companies use "aggregators" with local informational advantage to sign up trusted agents. With special incentives for signing up new agents, they do speed up the growth of a reliable agent network.

Accounts of best practice and country experiences in recruitment methods and training are given by Davidson and Leishman (2011). Training is partly regulated to protect customers and providers against fraud; but it is important for the operator too to retain customers through quality of service and reputation. Some regulators prescribe training on the KYC procedures and detection of fraud, and may need to preapprove training materials. Eligibility criteria for agents are regulated but typically supplemented by the MNO (see Davidson and Leishman, op. cit. p.11, for Safaricom's

[208] Potential demand can be gauged by operators from the geographical distribution of airtime transfer services between customers (a precursor of mobile money); and the banking partners of operators may already conduct a revealing domestic remittance service (an expensive substitute for mobile money).

[209] For M-Pesa, the launch began with a few hundred agents; the ratio of customers to agents was quickly scaled to 1,000 in less than 18 months, whereupon Safaricom began to recruiting new agents more quickly than new customers.

[210] Vodacom in Tanzania also accepts reference identification, where a family member, employer, or friend with a recognized ID document, vouches for a customer's identity during registration (Pénicaud and Katakam, 2014).

requirements). Regulators may stipulate the types of allowed agents (commercial, non-profit, individual, or other), the minimum criteria to be registered as an agent (e.g. a business license or minimum capital), and the manner of approving agents (e.g. simple notification of the regulator by the operator, or a cumbersome authorisation procedure).

Regulatory practice concerning agents varies by country. Di Castri (2013) asserts that: 'building an efficient mobile money distribution network depends on proportional and cost-effective regulation'. An important feature is protection of customers, and depends on where the ultimate responsibility for the actions of agents lies. Good regulatory practice can exploit the appropriate incentives for the mobile money providers. Di Castri observes that if the provider is made liable for the actions of its agents, this guarantees that the provider will set up and monitor the distribution of its products properly. By relying on provider liability expressed through legal agreements, other restrictions can then be eased on the regulated criteria for recruiting agents.[211] This is happening increasingly in practice, and should facilitate the development of the networks.

9.3 Incentives and payments for agents

Contracts between operators and agents vary considerably across markets, but common clauses include: operators and agents being able to terminate the contract at any time; prohibition of sub-licencing or delegating by the agent; agents maintaining a stipulated level of float; agents carrying out AML/CFT checking (for which they are trained) and meeting any reporting obligations of the operator; operators reserving the right to vary commissions at any time; and agents using only marketing materials of the operator with which they are furnished.

The strategies of the mobile operator need to be dynamic to reduce the costs of inactivity. Globally, only 30 percent of registered accounts were active in June 2013 (Pénicaud and Katakam, 2014), and only about half the 886,000 mobile money agents were active[212]. Agents can be motivated through incentives and via the different tiers of agents that have been created in some countries. "Gaming" by agents can be reduced through tailored incentives and monitoring.

What commission is paid to agents? Lonie (2013) expresses the potential agent's opportunity cost thus: they must invest their cash in an e-money float account[213], which could otherwise be used to purchase inventory for their core business; incentives in the initial contract must therefore be sufficient to provide a return on their mobile money investment that makes it worthwhile to divert resources from their core business until the service reaches critical mass and produces a significant income stream. Agents are paid a flat fee to register customers which covers their costs of verifying documents and educating the customer. Agents are paid a portion of the transactions fee, sometimes by the mobile money operator, sometimes directly by customers. The median percentage of transaction revenue paid to agents globally is 50 percent (Pénicaud and Katakam, 2014). Some operators pay different commissions to different categories of agents.[214] Davidson and Leishman

[211] In this case, a notification regime of agents with occasional regulatory inspection of agents can provide the same protection as a more unwieldy and slower authorisation regime of agents, but at a lower cost for the regulator, the provider, and the customer (Di Castri, 2013).

[212] Active agents need to maintain inventory of electronic float and cash that is sufficient to preclude stock-outs most of the time. An agent should be performing at least 10 transactions a day, and the most successful perform 60-70 transactions on average a day (Pénicaud and Katakam, 2014).

[213] Agents use their own cash and are not custodians of cash or electronic money that belongs to users or to the mobile money provider.

[214] For instance, South Africa's Standard Bank Community Banking has small shops, bank branches and bill-payment counters as agents, each with a different tariff structure for customers and reflecting different allowable transactions values.

(2011) predict that separating classes of agents based on the transactions which they are empowered to perform could in future make the service more attractive to high and low value customers.

Some operators have raised the level of commission temporarily to drive the accumulation of new customers. Econet Zimbabwe sacrificed short-term profits in the launch of Ecocash to build a strong distribution network, paying their agents 80 percent of the earnings, and achieving a million active users with 18 months (Levin, 2013). Incentives can also be provided to agents to create active customers. Pénicaud and Katakam (2014) report data from an anonymous operator which suggests that customers who transact at the point of registration are more likely to be future active customers (26 percent *more* likely)[215] and produce significantly higher mobile money revenue per user (95 percent higher) than those who register without transacting. Commission can be added to the flat fee for registration if the customer transacts after account verification. To avoid gaming at registration, there can be delayed incentives whereby the agent is paid not just after one transaction at time of registration, but after further stipulated transactions in a subsequent fixed period.

The use of growth targets or tiers can also motivate and differentiate agents. Short-term campaigns to reach a target with rewards may help the business to grow, or act as a "tipping point" to accumulate a critical mass of customers. Tiers of agents serve to differentiate top performers from others based on performance measures (e.g. growth) and this creates incentives through rankings. Higher tier agents may receive greater support and promotional material than lower tiers. The monitoring of the network is thereby also improved.

10. The impact of regulation on the spread, uptake and growth of mobile money

"*The question for policymakers and regulators is whether to impose rules on market participants that lead to greater connection among account providers or whether to let matters develop so as not to interfere with incentives to innovate given the rapid technical developments and the difficulty in assessing fully the consequences of regulatory action."* (Klein and Mayer, 2011).

With the novelty and the rapid growth of mobile money systems, the parallel regulatory development has been caught somewhat off-balance. The multi-faceted role of a financial regulator of mobile financial services should include the protection of consumers, dispute resolution, setting operational and security standards, ensuring a stable financial system through appropriate prudential regulation, and fostering market competition (Cousins and Varshney, 2014). In emerging market economies, transformational models of mobile payments make financial inclusion a further objective. The regulation of the mobile money systems in principle spans several areas of existing law, including banking, consumer protection and commercial law; competition policy; international law[216]; and ICT law. An added complication is that although non-bank operational entities entail financial risks, they fall outside the regulation of the formal financial sector (e.g. the telecommunications companies operating mobile money, like Safaricom in Kenya, or in the Philippines).

Some countries have responded with stringent protective restrictions in the early stages, stultifying growth and innovation, and creating barriers to entry (e.g. India, GSMA (2013)). Others, notably Kenya, initially adopted a light-touch regulation and then adapted and tightened regulation over time as markets grew. While this flexible approach fosters investment, innovation and new entry, it nonetheless carries risks for investors and customers. Thus, a delicate balancing act in an evolving and uncertain situation is required, often with limited regulatory capacity, and even limited means of

[215] A customer making a first transaction at sign up is 49 percent likely to become an active customer, but 39 percent likely without transacting on registration.

[216] For instance, compliance with the Financial Action Task Force (FATF), the global standard setting body for anti-money laundering and combating the financing of terrorism (AML/CFT).

national identification of consumers. There has been little empirical research on the implications of regulation for outcomes in this new market (Cousins and Varshney, 2014), but early experience suggests it is crucial to get regulation right at the outset, as it shapes the viability and variety of business models, competition and innovation in the sector, and affects financial stability.

We explore if there are regulatory lessons already for the newer mobile payments systems. We take a two-pronged approach, presenting an extended Klein-Mayer table of disaggregated components, risks and regulatory requirements for mobile systems (Klein and Mayer, 2011); then we look at accumulated cross-country experience in a separate table, and review the general lessons.

10.1 The Klein-Mayer approach to the regulation of mobile payments

The new payments systems involve various "partnership models", non-bank-led or bank-led joint ventures, depending on the rules in individual countries. They also "unbundle" functions that traditionally have been the domain of banking organisations. Klein and Mayer (2011) suggest little thinking had developed in addressing how the new mobile money services differed from traditional banking. The fact that regulation straddles several areas of the law led to some confusion in adapting existing law to the new systems. The Klein-Mayer approach is systematically to unbundle the new systems into component services, to assess which "slice of risk" is associated with each distinct function, and to judge whether existing commercial law or prudential regulation sufficiently covers the risks, or whether further law needs to be enacted. This concurs with the recommended approach of the Bank for International Settlements (BIS) for regulating international remittances by type of service rather than by type of entity offering services, to avoid market distortion (World Bank-BIS, 2007). Thus, regulation of mobile money systems should address the functions and characteristics of the services offered, proportionate to the specific risks of each service (see also BIS (2012)).

Table 3 extends the original table of Klein and Mayer (2011) to include further service functions for mobile money systems.[217] The component functions are registration of customers, exchange of electronic money for cash (and vice versa), storage of electronic money, saving with interest in mobile money-linked bank accounts, domestic transfers, foreign transfers, provision of credit scores, extension of credit via mobile money-linked bank accounts, extension of insurance, and investment of customers' funds. Issues of pricing and subsidies, and interoperability fall within the ambit of competition policy. A key point is that the function of "investment" is not carried out by non-bank operators. They are not allowed to invest or intermediate customers' pooled funds, but this is done within the prudentially-regulated banking sector by a partner bank. (This was discussed in part in Section 6.2.1, when examining creation of money.)

10.2 Cross-country experiences

Of the many external features influencing the design and implementation of mobile money services and of those that impede a mobile money service attaining scale, 'only regulation seems to pose challenges too great for a service to overcome' (Di Castri, 2013). The regulatory environment affects the design and viability of mobile payments systems. Regulatory barriers may compromise effective distribution networks, operational efficiency and cash generation, limit growth of the customer base and financial inclusion, and act as a disincentive to innovation and investment.

Several authors describe the regulatory experiences of a range of early adopters (e.g. Gutierrez and Singh, 2013; di Castri, 2013; Pénicaud and Katakam, 2014). Table 4 compiles a

[217] A full risk analysis of mobile money systems, for consumers, agents, operational entities, and banks holding trust funds, is given in USAID (2010).

comparative typology of regulatory features for a selection of countries. The table contrasts such features as the financial inclusiveness of regulation, the type of partnership model between banks and non-bank entities, where responsibility for the customers' pooled deposits lies, formal guidelines, whether agents are used and who bears ultimate responsibility for their actions, and whether there is interoperability.

We summarise the critical lessons toward 'an enabling policy and regulatory framework (that) creates an open and level playing field that fosters competition and innovation' (Di Castri, 2013). The first and most important is that regulators' qualms about licensing non-bank operators to offer mobile money services are misjudged, and this is deleterious to the development of such markets. An MNO-led operation is better suited in terms of infrastructure, skills and incentives than a bank-led operation. MNOs have experience in building and operating an established network, there is brand recognition and marketing skills, and at low cost, mobile money can be appended to existing services (airtime and data provision) for current and new customers. Section 5.2 on profitability pointed out that MNOs benefit both directly and indirectly from the revenue from mobile services, helping to sustain the overall service. Banks lack these assets and incentives; bank-led models may be conservative and risk-averse in deployment (for instance, by not allowing a multi-tiered registration procedure[218]), and may even resist deployment if they consider mobile services to be in competition with their own services (e.g. payments). Sharing thin profits equably between the two players may further impede the success of the operation.

Two main factors explain the rejection of non-bank-led mobile money deployment. They provide limited financial services to customers, contrasting with "full" financial inclusion through the formal banking sector. But this misunderstands the barriers to financial inclusion which mobile money has helped to solve (see Section 4.2), and how mobile money platforms have provided a pathway to later formal banking inclusion through credit extension, insurance and savings products (Sections 3.4 and 3.5). The more cogent objection is against licensing a non-bank to offer financial services with financial risks, but without being legally subject to prudential oversight. This objection has been neatly surmounted in many countries by requiring a partnership between the (service-leading) MNO and one or more fully prudentially-regulated banks, where the electronic value in the customers' mobile money accounts is fully or partially backed up in bank accounts. The role of the partner bank is thus only as custodian of the funds[219] and it is not involved in the commercial aspect of the deployment.

Best practice would see a 100 percent cash backing of customers' electronic funds by the provider, with diversification of the pooled funds into more than one bank account to spread risk for more mature deployments. Some jurisdictions may allow investment in low risk securities like government bonds. If the accounts are required to be trust or escrow accounts[220] then liquid funds are held on behalf of customers, and are ring-fenced from the issuer's funds, and protected from claims by the issuer's creditors. If the *non-bank provider* becomes insolvent, then the funds accrue fully to the consumers, in accordance with the regulatory procedures for that country. The non-bank provider, which is not prudentially-regulated, may not intermediate these funds, therefore; however, the banks

[218] Licenced bank operators frequently insist on the same level of identification for mobile money users as for bank customers.

[219] In Uganda, for example, the partner bank has to satisfy the fiduciary responsibility in all transactions concerning these escrow funds. There are requirements for customer identification documentation, daily reconciliation of the escrow account and the e-money, and the bank's authority to distribute the funds in the escrow account to mobile money account holders in case of insolvency or bankruptcy of the mobile money service provider, see the Mobile Money Guidelines, Bank of Uganda (2013).

[220] Both escrow and trust accounts are managed by an independent third party, but a Trustee often has broader duties than an escrow agent. Escrow accounts can be considered a special and narrow type of trust relationship. In France, the relevant concept is a fiduciary agreement (Di Castri, 2013).

do intermediate the pooled funds by lending them on, and in consequence they provide interest on the deposits (Section 6.2.1). If the *bank* should become insolvent (for instance, if there is a run on the bank), the pooled funds are protected by deposit insurance, should this be available.[221] Even when it is available, the coverage is typically low, e.g. up to US$1060 currently in Kenya for individual deposits (where a depositor has more than one account in an institution, all accounts are consolidated for a single settlement). Diversifying into several banks, see Afghanistan in Table 4, partially mitigates against bank failure, as would raising the ceiling for deposit insurance on such pooled funds. In the US, for pooled custodial accounts, there is pass-through protection for *each* customer up to the insurance limit. This may not automatically apply in developing countries, and should be regulated for, or one insurance payout would apply to the account as a whole presenting a considerable risk to mobile money customers in the event of bank failure.[222]

There are differing arrangements for what happens to the interest (see Table 4). In Kenya it is paid to charity; but by Trust Law, and this is stated explicitly in the Kenyan Guidelines, this Trust income could be allocated to the beneficiaries of the trust (i.e. the customers and agents), as in Tanzania since 2014. It makes sense for the customers to be compensated *pro rata* from Trust account income given the inflationary degradation of their deposits, while the custodial bank earns loan interest on these funds.[223] This should promote savings in electronic accounts.

A second lesson is that tiered regulatory requirements for the registration of new customers to mobile payments schemes should be adopted. The Klein-Mayer principle of regulating according to specific risk by function applies here. Sometimes onerous identity requirements have impeded the adoption of mobile money. In developing countries, a system of national identity cards may not exist; few poorer customers will have identity documentation (e.g. voter's card, driving licenses, tax certificate, social security cards, and passports); and the addresses of customers are often unclear or without utility bills to prove them.[224] Since the poorest customers require a low threshold of transactions and consequently pose a low risk, a *tiered* registration requirement can promote adoption with fewer formalities in the initial stage that can be geared up when higher thresholds are required. Adopting *proportionate* Know Your Customer (KYC) procedures entails making use of other mitigation tools, such as transactions limits, and hence can simplify the required customer due diligence (CDD). Proportionate registration requirements are crucial to realizing the objective of financial inclusion of the unbanked without compromising financial integrity at higher levels of usage. Table 4 shows that most of the developing countries have adopted the Financial Action Task Force (FATF)[225] recommendation of a proportionate approach to risks posed by money laundering and the financing of terrorism. Generally, the move from cash to recorded transactions in electronic mobile money accounts enhances financial integrity by reducing anonymity and making money

[221] For example, Rwanda and Ghana are still developing deposit insurance schemes.

[222] An alternative solution is mentioned by Di Castri (2013): that of insuring deposits through an insurance company, but entails the payment of premia, the effect of which on customers' costs would need to be transparently revealed.

[223] Some have earlier argued that the *electronic* deposits of the non-bank providers should pay *interest* to motivate savings (Ehrbeck and Tarazi, 2011). However, this concept of non-bank *interest* is prudentially challenging as mobile providers do not intermediate the funds.

[224] To combat absent ID documentation flexible approaches have been adopted in various countries (e.g. Fiji) allowing reference letters from prescribed referees (e.g. local village council letter or certificate, company- or employer-issued ID, government-issued ID). Di Castri (2013) observes that in many of the markets where mobile money is working best, digital photos and physical forms are not requirements.

[225] The FATF updated its Guidance on AML/CFT and Financial Inclusion in February 2013, reinforcing the development of risk-sensitive frameworks to build a more inclusive formal financial system (http://www.fatf-gafi.org/topics/financialinclusion/documents/revisedguidanceonamlcftandfinancialinclusion.html).

traceable.[226] Providers have stringent regulatory requirements to keep full records and backups. Most systems have automated single transactional limits as well as daily and monthly transactional limits, and limits on stored balances, which "place sand in the wheels" of instantaneous finance. Unusual behaviour can be detected by systems monitoring.

This traceability is of great importance in extending mobile money systems to include international transfers, as discussed in Sections 3.6 and 6.2.3.

A third lesson concerns the regulation of agents, and this has been discussed in detail in the preceding Section 9. Table 4 shows that in the high uptake countries, agent networks were deployed. An efficient distribution network has been crucial to M-Pesa's success in Kenya. Again, proportionate and cost-effective regulation is recommended to accelerate the adoption by active customers. A model that works well in terms of the provider's incentives to monitor properly is where providers are made liable for the actions of agents executed on its behalf within a contractual principal-agent agreement. Regulators are then more comfortable to leave the choice of agents and training to providers, and only to set standards for vetting and training of agents. This helps avoid regulation that restricts the types of agents that may be employed. Another aspect that benefits from "light touch", flexible regulation is where the authority (central bank) is notified of the recruitment of agents and has the prerogative to inspect such agents, but does not have to authorize these agents before they can operate.

A fourth lesson concerns the beneficial promotion of transparency through market conduct regulation for consumer protection, including price and fees disclosure and simple clear contracts on customers' rights and obligations. Against this, complex and expensive standards should be avoided for low value transactions. Customers should also be made aware of effective complaints procedures. Di Castri (2013) observes that issues of privacy and data protection are partly addressed by national privacy laws, telecommunications regulation, and financial regulation, but are mostly addressed by business practice. Compliance costs with regulated requirements for data privacy, including backups of data, should be assessed with operators.

Finally, there is the issue of interoperability. Few countries in Table 4 have adopted interoperability.[227] The execution of interoperability is technically complex and compliance costs will rise, challenging the business viability of mobile money. Sophisticated contractual agreements will be required amongst market players for platform level, distribution level or customer (SIM card) level interoperability. The current position seems to be that interoperability will in due course become a desirable (market-led) goal with mature and viable deployments with strong and active customer bases. However, the increased complexity for regulation and also sensitive decisions on competition policy will be challenging in governance-constrained environments.

11. Charities, donors and international agencies and the beneficial growth of mobile money

It should not be forgotten that the most successful mobile payments system, the first to reach operational viability, and the one that grew the fastest (giving impetus to copycat systems throughout Sub-Saharan Africa), M-Pesa in Kenya, began as a donor initiative by DFID (see Box 1).

A solid model is provided more generally for how an enormous impact can be forged by the joint commitments of aid agencies, other donors, charitable foundations and international agencies

[226] Apart from the mobile phone number, a unique PIN identification is required for transactions, and the unique Mobile Station International Subscriber Directory Number (MSISDN) is recorded for each transaction.

[227] GSMA (2016a) reports interconnections in Madagascar, Rwanda, and Thailand in 2015, and in Indonesia, and Sri Lanka, in 2014, countries not in the table; and in addition, forthcoming full account-to-account interoperability in mobile money in Bolivia, Peru and Mexico.

working alongside governments, academics and private commerce. The specific impact on the beneficial growth of mobile money systems has spanned design, usage, monitoring, statistics provision, tracking, regulation, transparency, public information, and analyses of various types. Flexibility has been shown and adaptation too, for instance in the evolving provision of innovative data and redressing the lack of demand and usage data. Moreover, much effort has been aimed at international coordination and cooperation, not only amongst countries and organisations, but also amongst researchers from different academic disciplines. The process has been democratic, open, educative and transparent.

Appendix Table A1 reports on funded data provision. Examples are the IMF, the World Bank and donor-funded contributions for quantitative measures of remittances and data on financial services provision and usage, which are largely publically available. CGAP[228] estimates that in 2012 over US$29 billion was committed to support financial inclusion by 22 international funders of financial inclusion. The role of the Bill and Melinda Gates Foundation has been pivotal.[229] The invaluable work of GSMA Mobile for Development Foundation Inc. and its extensive web-based educative and documentary products and data collection is also supported by Bill and Melinda Gates Foundation[230], in conjunction with independent philanthropic foundations such as the Mastercard Foundation and the Omidyar Network, and governments (such as the UK, through DFID).

12. Conclusions: whither mobile money, and future research

This survey has introduced the burgeoning phenomenon of mobile money, its geographical reach and growth (Section 5), its evolution into diverse payments segments and new products (Section 3), the difficulties in achieving profitability and the related issue of well-incentivised, large agency networks (Section 9). It has addressed the fine balance faced by regulators between encouraging innovation and commercial viability on the one hand, and enabling market competition and consumer protection through appropriate regulation on the other. A proudly African-initiated product, nurtured in Kenya by light touch regulation, mobile money has now reached far, into Eastern Europe, Asia and Latin America, where cash use is often dominant and significant proportions of the populations are unbanked. In these economies, mobile money users do not require a formal bank account, but have "pre-paid" electronic accounts with mobile money operators. After a period, however, aided by a credit score based on their recorded mobile money transactions, users may qualify for low cost formal-sector bank accounts and new credit, savings and insurance products, accessed only via the mobile money platform.

By contrast, in the USA and other advanced economies, institutional differences and deeper markets may mean that mobile payments are predominantly linked with *pre-existing* bank accounts; mobile payments are rapidly gaining market share after a slow start, catalysed by new technology and commercial partnerships (e.g. Apple Pay). But in the US too, mobile technology is being harnessed to enhance financial inclusion for the almost one third of individuals who are unbanked or under-banked

[228] http://www.cgap.org/data/trends-international-funding-financial-inclusion.

[229] Initiatives funded include the Alliance for Financial Inclusion (AFI), a network of financial inclusion policymakers founded in 2008 as a Bill and Melinda Gates Foundation-funded project, but now evolving into a permanent member-funded international organization; mapping projects such as MIX's Geospatial Maps and Fspmaps.com; and demand side data commissioned from Gallup and via Intermedia (The Financial Inclusion Insights (FII) program, The Financial Inclusion Tracker Study (FITS) and Tanzania Mobile Money Tracker Study (TMMTS)), and in the 2011 Global Financial Inclusion (Global Findex) Database, now being updated.

[230] A search of the funding database of the Gates Foundation revealed 10 grants for mobile money between 2010-2014 totalling nearly $37million, including substantial support for GSMA Mobile for Development Foundation Inc.. Other expenditure in the area of mobile money includes commitments of $35 million to the AFI and $24 million to the Consultative Group to Assist the Poor (CGAP).

(see Section 2) and who mainly use "pre-paid" payroll debit cards or similar.[231] Technological change has promoted ever-cheaper smartphone use, even in developing countries (Section 5.5), and innovative graphic-based applications to aid financial learning. In due course, with the evolution of deeper markets and more complex products, there will be strengthening links with *formal* sector banking via the mobile phone, and the distinction between *unbanked* and *banked* mobile money users will probably blur.

There is survey evidence of reduced concerns with security in the US as compared with earlier years, perhaps shaped by industry efforts to enhance security (Federal Reserve, 2015). This may presage a more widespread use in less advanced economies, especially in business and government payments and in more secure and transparent international remittances, a fast-growing area. Biometrics may in due course allay security concerns in less advanced economies, with the move to a virtually cashless[232] economy, and possibly a new role for some banks beyond traditional payments.

Financial inclusion

This survey has examined definitions of financial inclusion, arguing that they need to encompass *tiers* of inclusion (embracing gradualism) and not focus primarily on *formal* banking sector inclusion, and it has discussed the measurement of such inclusion. In practice, the proliferation of mobile money services and the sheer numbers of new users actively signed up has become integral to achieving ambitious targets for the many developing countries that have adopted formal financial inclusion strategies under the 2011 Maya Declaration (Section 4). For instance in Tanzania, goals are measured by the establishment of electronic mobile money accounts, as well as the potential access they give to broader formal banking and insurance services. A future global role for mobile money in enhancing financial inclusion for the unbanked will depend on the commercial market profitability of mobile money systems, and technological innovation, especially via cheaper, more capable smartphones and their applications.

Regulatory framework and 'formalisation' of the economy

The critical lessons toward an enabling policy and regulatory framework that fosters competition and innovation have been summarized in this survey (Sections 9 and 10). Atkinson (2015) argued that economic inequality is often aligned with differences in access to, use of, or knowledge of information and communication technologies. He stressed that researchers, firms, policymakers and governments have the possibility to *shape* the direction and path of technological change. There are two key *general* lessons from differently-regulated mobile money systems for the unbanked. The first is the importance of *gradualism* in institutional change in segmented markets. By allowing different tiers and thresholds to apply for varying levels of risk in segmented markets, even the poorest customer transacting with tiny amounts can gain some access to financial services. Progressive adaptation toward such enabling regulation has also fostered the early movers in the industry. For transfer of international remittances via mobile money systems, high thresholds and levels of compliance to international law may be required.

The second lesson is the far-reaching impact of enhancing *transparency* and reducing *asymmetric information* through the electronic record of payment transactions. The movement from

[231] Financial Times: "US tries to boost access to 25m '*un*banked'", Donnan and Sevastopulo, November 30, 2015.

[232] On the merits of a cashless economy, which may apply even more forcefully to developing economies, see Rogoff (2016). In November 2016, after the controversial demonetisation of large denomination bank notes, the Prime Minister of India revealed a concerted move to less cash-based economy through promoting digital wallets and close substitutes to help fight corruption and money-laundering.

cash to electronic accounts produces a record, for the first time for the unbanked, of the history of their financial transactions in real time. Technology has solved the economics of small accounts, recording even tiny transactions at low cost. Using algorithms, such records reduce asymmetric information by providing individual credit scores for poor and unbanked borrowers without collateral, and promote their access to banking credit. The increased transparency of records also protects customers' rights and fosters trust in business, promoting the growth of efficient payments networks. Tax collection could be improved by the rise of more *visible* spending, quite apart from the greater ease of tax collection via mobile money payments. But there are data privacy considerations concerning access to and use of these mobile money records which have not yet begun to be addressed.[233] Finally, mobile money should in principle make international transactions more readily traceable and therefore facilitate identification of money laundering. Far from encouraging money laundering, a move to mobile money should allow for a greater degree of control over it.

In essence, mature mobile money systems and the records they produce, help foster the "formalisation" of the economy, integrating informal sector users into business networks, formal banking and insurance, and linking to government through social security, tax and wages payments. Another aspect of this is that in highly dollarised economies (and see Corralesa et al. (2016) for the extent of this phenomenon in Africa), mobile money through the reduced transactions costs may reduce currency substitution, thereby deepening their financial systems.[234] There are also numerous externalities and side-effects from the development of mobile money services. One example is far-reaching research implications from the huge quantity of recorded "administrative" data on payments, discussed below. In conflict situations, and for disaster relief, see Lucini and Sharma (2016), mobile technology can provide vital humanitarian assistance to displaced populations through digital cash transfers. Start-ups like affordable solar energy-powered electricity systems in rural areas can be purchased at a distance on a pay-as-you-use basis using mobile payments. Empowering account holders though granting privacy is a side-effect which has benefitted some female householders (see Aker et al., 2015).

Revealed preference, positive externalities and empirical analysis

The rapid global growth of domestic payments markets (over-the-counter (OTC) included, depending on regulation), domestic transfers and international remittances, speaks of mobile money providers satisfying an apparent demand for types of financial services not previously adequately met. The *revealed preference* to adopt and use mobile money for a range of transactions despite costs suggests a net welfare improvement. Moreover, positive externalities suggest a greater total benefit than private benefit, as greater connectedness and network depth in the system occurs with each adoption. *But can empirical studies measure the discernible economic benefits and local if not system-wide externalities?* Given its novelty, few academic studies have examined the economics of mobile money. None has given a comprehensive overview, from both a micro- and a macro-perspective, of the channels through which mobile money might impact on the economy. The macro-consequences are especially poorly understood. The main contribution of this survey has been to clarify the channels of possible economic impact (Section 6), and to survey critically a new body of empirical economic research that has tried to assess the adoption and the welfare and risk-sharing impact of mobile money (Section 8). These are mainly micro-economic studies (Table 2), and a few macro-studies.

[233] See for example, Dixon and Gellman (2014).

[234] I am grateful to John Duca (Federal Reserve) and Chris Adam (Oxford) for this point. The argument is that the hedge against inflation provided by foreign currency is reduced by mobile money, though it is also vulnerable to the inflation tax along with domestic money. Mobile money has a lower "base" for the tax because smaller mobile money balances need be held per unit of economic activity given the reduced "shoe leather" or transactions costs.

Challenges for data and methods

To reach robust conclusions on the economic benefits, the bar is set very high for empirical analysis. First, it is important to *analyse the appropriate data*, but often this is hard to achieve. Data may be proprietorial, and it may be difficult to design surveys optimally in advance. Definitional ambiguities using telecoms data can cause both over-and under-counting when measuring mobile money "usage" (details in Section 7.3), and this problem is present in virtually all the studies reviewed (see Table 2). Self-reporting on wealth and expenditure in surveys may be inaccurate. In surveys, using a traditional definition of household head may mean they are less *au fait* with new technology than younger members of the household. In cross-sections, frequently there are differences in definitions across countries, affecting comparability of results. Some constructed measures on shocks are wanting, see Section 8.1.3. While unreliable data on some determinants introduce measurement error, other data are simply unobservable (see examples below). Against these difficulties, if privacy concerns can be overcome, new access to a rich seam of "big" data from administrative mobile money transactions from business and individuals represents an enormous research opportunity. For example, mobile money payments could be used to help forecast hard-to-gauge household assets and expenditure, often subject to severe measurement error through misreporting in household surveys, and to derive proxies for migration patterns and explore social networks, potentially relevant for work on remittances (see Section 7.3, and Aker and Blumenstock (2015)). One important issue raised repeatedly by Aker (e.g. Aker et al., 2015) is the failure of many studies to "disentangle" adoption of the technology (the phone) from adoption of the service (mobile money) it provides. How and whether the different studies address this point to reduce bias is explicitly clarified for each study in Table 2.

Second, there are considerable *methodological challenges* in the empirical work, which means that results need to be very carefully assessed, and not always taken at face value. Research on mobile money faces two "selection" problems, introducing the problem of endogeneity into the empirical analysis. The "roll-out" of mobile money by MNOs and agents may not be random, if they select into areas on the basis of household and village characteristics such as wealth. Some authors contest this, and find little statistical correlation between agent "roll-out" and household *observables* (e.g. Jack and Suri, 2014, though using partial correlates only, see below).[235] But while the bias is likely to be low for Kenya, there may be greater selectivity biases in countries such as Niger, Tanzania and Uganda with relatively less developed technological infrastructure.

A second selection problem is incontestable: that of adoption or usage of mobile money by individuals, influenced by factors both observable (e.g. education and wealth) and unobservable (e.g. community learning spill-over effects and changes in technology preference) that may be correlated with mobile money use. The survey has critically outlined empirical methodologies to assess the *adoption* of mobile money (i.e. where a proxy for usage or adoption of mobile money is the dependent variable) and the *effects of mobile money on micro-economic outcomes* (i.e. where usage of mobile money is *not* the dependent variable). The methods (Randomised Controlled Trials (RCT), quasi-experiments with a Difference-in-Differences estimation strategy or the non-parametric method of Propensity Scoring, and Instrumental Variables) have differing degrees of success in dealing with observed and unobserved heterogeneity at the individual or household level. The choice amongst the methods is not uncontroversial (details in Section 8.1.1), and a consideration is whether results can be "scaled-up" or "transported" to allow generalisation to other contexts. An aspect raised by Aker and Blumenstock (2015), and especially applicable in the RCT analyses, is that the measured effect of an intervention is also influenced by the nature and quality of information provided about the intervention.

[235] This does not rule out correlation with unobservables and poorly measured observables such as wealth.

Adoption

Beginning with the *adoption* studies, these face the problem of the identification of causal relationships (Section 8.1.2). Some important determinants such as education and wealth are typically poorly measured, introducing bias. Other important controls are potentially available, but when omitted introduce bias (such as owning a bank account or distance to the nearest agent). A range of key "unobservable" determinants are difficult to proxy, inducing further bias, e.g., spill-over effects from community-learning about the product; technological and quality changes of the handset and services; the quality of agents and trust in the system; and the effects of advertising campaigns and incentives to register. Changes in quality and learning can induce shifts over time in the relevance of other determinants. Such non-linearities are crucial in adoption empirics but are typically ignored: for instance, shifts in the regulatory framework such as adopting tiered Know-Your-Customer requirements, and economic regime shifts and political shifts such as cessation of conflict, can catalyse adoption (Section 8.1.2). Network effects matter since a critical mass of users and a critical mass of reliable agents are both important for sustainable adoption and for users to obtain significant benefits.

Given these challenges, it is unsurprising that studies of adoption in different countries have focused largely on qualitative aspects, or have examined mobile phone adoption *correlations* with firm and household surveys. These find that adopters of mobile money are more likely to be younger, wealthier, better educated, have a bank account, own a mobile phone and to reside in urban areas. A convincing *causal* study has validated these links (Munyegera and Matsumoto, 2016a) and deserves attention. This panel study removes *time-invariant* household heterogeneity with household fixed effects and some *time-variant* household heterogeneity with location-by-time dummies in a panel context in rural Uganda. It includes many individual controls (e.g. control for ownership of a mobile phone and a migrant worker) further helping to reduce endogeneity. They find no gender effect or age effect for rural adopters, but distance to the nearest mobile money agent proved important, and education and wealth; and both the dummies for the ownership of the phone and the migrant worker are significant (all with 1 percent significance).

Welfare and risk sharing

Turning to studies that examine the *effects of mobile money on micro-economic outcomes,* several use randomised controlled trials (RCT) to assess whether an intervention linked with mobile money has a discernible impact on a treated group relative to a control group. Others apply Difference-in-Differences (DD) estimation which mimics an experimental approach by comparing differences in the changes of a control and a treated group after such an intervention. Several studies apply Propensity Score methods which mimic some of the characteristics of an RCT in the context of an observational (or non-randomised) study, using non-parametric rather than regression techniques to estimate the effects of an intervention on outcomes between treated and control groups.

There are some (e.g. Deaton) who dispute the strong claims made for RCT methods, suggesting they should not be the "gold standard". They argue for instance that unexplained unobserved heterogeneity across treatment and control groups is *not* guaranteed to be eliminated by randomisation, that selection may not be wholly random, that outliers can have distortionary effects, and that small interventions that apply in certain contexts are not easily generalised (Section 8.1.1). A recent paper suggests that RCT studies can be enhanced by using other explanatory variables to control for imbalances between control and treatment groups resulting from heterogeneity in such variables in small samples (Deaton and Cartwright, 2016, p.13). Unexplained unobserved heterogeneity is also a problem for Propensity Scoring because although there is matching of samples of treated and control subjects on observed (pre-treatment) characteristics, conditioning on the

propensity score need not balance *unmeasured* covariates. And even the balance-checking between *measured* co-variates is problematic because the criteria for adequate balance are ill-defined (Section 8.1.1). Crucially, the validity of a Difference-in-Differences (DD) estimate rests on the intervention being random, and for mobile money this is compromised by the two selection problems discussed above.

Amongst the most convincing analyses of mobile money impact are the *panel data studies* using a Difference-in-Differences approach that explore how mobile money has fostered improved *risk-sharing* amongst informal networks of friends and family, helping households to smooth consumption. The intervention is a negative shock, and a reasonable case can be made for assuming such shocks are random (though see caveats in the text, Section 8.1.3). The focus is thus not on the *direct effect* of mobile money usage on outcome variables like consumption, but rather on the interaction of mobile money usage with the shock (and controlling for household characteristics to interact with the shock). This puts less emphasis on the endogeneity of the mobile money usage dummy. The best of these studies exploit the panel data to remove sources of unobserved *time-invariant* household heterogeneity with household fixed effects, and include location-by-time dummies and rural-by-time dummies to help control for time-*varying* heterogeneity according to location or the rural-urban divide, and also (mostly) include appropriate controls.

A key result for the studies is that lower transaction costs could affect the size, frequency and (sender) diversity of domestic remittances, and hence, the ability to smooth risk informally after large shocks. The path-breaking study of Jack and Suri (2014) finds total consumption of Kenyan mobile money users is unaffected by a range of negative income shocks while that of non-users drops by 7 percent (with 10 percent significance), and the effect is more evident for the bottom three quintiles of the income distribution. A similar result is found when isolating the impact of health shocks on total consumption. For Tanzanian mobile money users, a similar set-up by Riley (2016) takes matters a stage further, examining the potential beneficial *spill-over effects* (local externalities) of mobile money to the village community (which includes non-users) following an aggregate shock. Unlike in Jack and Suri (2014), wealth, expected to be time-varying, is here included as a control. She finds that there are spill-over effects in the absence of a shock, as mobile money users share remittances with the village resulting in per capita consumption of everyone in the village increasing. After an aggregate shock, however, households using mobile money benefit from an 8-14 percent increase in consumption (with 5 percent significance) compared with non-users cancelling the effect of the negative shock; but there are *no* spill-over effects to the community of non-users.

Attempts to apply the IV technique and *instrument* the usage dummy and its interaction with the shock are less successful, typically with weak instruments based on agent rollout data such as agent density (details in Section 8.1.3). It is difficult to disprove self-selection by the agents toward more profitable locations. Even with little apparent correlation with household characteristics (and a flaw of some studies is to base evidence only on *bivariate* or partial correlates, see text, Section 8.1.3), agent roll-out may correlate with unobservables, or poorly-measured observables such as wealth, that also help households to smooth risk. One factor suggesting roll-out may have been non-random is that Jack and Suri (2014) themselves suggest: "…many of the agents had business relationships with Safaricom prior to the advent of M-PESA, and about 75 percent report sales of cell phones or Safaricom products as their main business." As Aker and Blumenstock (2015) imply for the prior telecom infrastructure: "…decisions regarding expansion of ICT infrastructure and ICT-based programs are typically driven by private sector or policy criteria." If there is indeed low correlation in Kenya, the bias will be small. One would expect far greater selectivity biases in countries such as Niger, Tanzania and Uganda with relatively less developed technological infrastructure.

It is still possible that there is *time-variant* household heterogeneity that is not controlled for in such studies. One specific example of time-variation in characteristics would be where in the first

wave of the panel, a fifteen year old is not in work, but by the second wave, three years later, he is working, which affects his ability to purchase a mobile phone and use of mobile money. It would be important to control properly for age structure in this case. More difficult to deal with is systematic unobserved heterogeneity from interaction effects. For example, there can be a systematic difference between households interacting with the state of the economy and this can introduce non-linear effects. If inflation is high in 2009 and low in 2012, rich households may have inflation protection and poor households may not, and this could introduce differences in their respective attitudes to the use of mobile money over the panel.

Far less satisfactory are the (non-RCT) welfare studies reviewed, where results are generally judged unreliable by this survey (details in Section 8.4 and Table 2). Endogeneity problems for the usage dummy are centre-stage and the instrumentation and other methods to mitigate it are not always convincing. One of the studies uses cross-sectional data with serious problems of controlling for unobserved heterogeneity; two use inappropriate linear specifications likely to introduce heavy biases; and a fourth employs propensity scoring with a very small cross-sectional sample, but is subject to the same problems of unobserved heterogeneity. The analysis for Uganda of Munyegera and Matsumoto (2016a), which fully exploits panel data to control for heterogeneity where possible (Table 2), claims an increase of 9.5 percent (with 5 percent significance) in total household per capita consumption for mobile money users. But their specification requires the agent "roll-out" to be random, which is questionable; and the agent density-based instrument for mobile money usage requires lack of correlation with unobservables or with poorly measured observables that may influence consumption.[236] The Instrumental Variable result, which shows the above coefficient increasing four-fold, is problematic and casts doubt on the results. A panel study of the direct effect of agent density proxying for later mobile money usage on a range of outcomes (Jack and Suri, 2016), is at its most convincing in a differenced specification for consumption, which at least controls for household fixed effects. They find consumption growth for male-headed households was negative, while that of female-headed households was positive and statistically significant, driven by either increased labour or capital income, or simply by transfers between individuals with different propensities to consume. The other specifications do not use household fixed effects or location-by-time dummies, or include wealth, but control for location fixed effects on which a great deal then rests to mop up household heterogeneity. The assumption of exogeneity of the mobile money proxy rests on bivariate correlations, discussed above, and a placebo test (see discussion in Section 8.1.4).

Of the few RCT studies in Table 2, some deal with very small amounts of transfer and small and specialised samples, not easily generalisable. An impressive RCT study on household welfare by Aker et al. (2015) found strong conclusions in favour of receipt of cash transfers through mobile money accounts promoting intra-household bargaining power for women and their productivity in Niger, with reduced travelling and queuing time. This resulted in improved child nutrition and increased diet diversity, and fewer depleted durable and non-durable assets than for control groups. They also identified cost savings from reduced transactions costs for the disbursing party, and no evidence of leakage. However, they cautiously note the mobile money "infrastructure" has to be in place and working well to reap the benefits. Repeating such RCT studies across many locations, cultures, continents and time periods may help reinforce the conclusions and generalisability. This challenge of scalability for RCT studies to be able to inform policy is addressed in Banerjee et al. (2016).

Saving and regulation

[236] They too report only bivariate regressions for observables with agent density.

On savings and methods of saving, several non-RCT studies encompassing a variety of techniques (Table 2) all suggest the *beneficial* influence of mobile money. For instance, instrumented regressions by Demombynes and Thegeya (2012) suggest saving appears greater for M-Pesa users in Kenya. A Tobit regression incorporating the residual from a first stage Probit regression for mobile money adoption to control for endogeneity finds mobile money encourages saving in Uganda (Munyegera and Matsumoto, 2016b). However, all face the problem of a highly endogenous measure of mobile money usage as a determinant. Most employ cross-sectional analyses for which addressing unobserved heterogeneity is a particular problem, and attempts to instrument the mobile money dummy are not successful. There are also concerns with how saving is measured in the empirical studies and the issue of "zeroes" when the log of an amount of savings is used as the dependent variable (see Section 8.1.6). No convincing and conclusive results are reached, therefore. Two RCT studies were the only two of the saving studies that disentangled the mobile technology from the service it provides. One RCT experimental study (Batista and Vicente, 2016) uses cross-sectional data and narrows the type of population tested in its selected sample; it is also subject to the problem of interpreting a treatment effect when intervention depends also on the type of training information provided. Both aspects limit the generalisability of the results that mobile money increases the willingness to save, though the former helps deals with heterogeneity. A second RCT panel study controlling for individual and survey wave fixed effects, based in Afghanistan, was applied to a small and specialised sample. Increased usage of mobile savings differed by the prior banking status and size of salary of recipients, and liquidity preference and savings withdrawal increased with perceptions of physical insecurity. However, recipients had to incur the costs of finding liquid agents (where adequate mobile network and agent coverage actually existed), and some had privacy concerns for security reasons. Again, the results are suggestive but not generalisable.

The effects of regulation on mobile money usage yielded plausible (indirect) *interaction* effects for constructed (*de jure*) regulatory indices with some individual characteristics (such as a regulatory framework supporting interoperability promoting higher usage among the poorest), see the cross-country study of Gutierrez and Singh (2013) and Table 2. But heterogeneity remains present in cross-section, and the *direct* effect of regulation could only be tested if a panel of Global Findex usage data should become available (Section 8.1.7).

Best practice and the way ahead

What then can be reliably said for policy, what appears to be best practice from the body of surveyed work, and what is the way forward? The data issues should be taken seriously, such as measurement of usage of mobile money. The wary and discerning policy-maker should give greater weight to micro-studies using balanced *panel data* to apply the above techniques, when they employ their considerable potential advantages for controlling for unobserved time-*invariant* heterogeneity using household fixed effects, and for time-*varying* heterogeneity according to location (i.e. by including interactive location-by-time dummies) or the rural-urban divide. What may remain is time-*variant,* unobserved household heterogeneity. This can be partially mitigated by including appropriate controls for important time-variant household characteristics (e.g. demography, wealth, having a migrant worker in the family and being formally banked). It is important to disentangle phone ownership from usage of its services (which might be through including a dummy for phone ownership, Table 2).[237] The survey suggests that studies do grapple with unobserved heterogeneity but often not sufficiently. Such a panel approach is probably as good as it gets in terms of ameliorating biases from unobserved heterogeneity. In areas where mobile money is still fairly new, panel survey data collection should be encouraged (see "on concerted action" below). In cross-section, time-invariant household

[237] Several studies above omit some of these important controls and fixed effects even when using panel data.

heterogeneity may be able to be addressed, but not time-variant locational effects as in panel studies. Moreover, it is often particularly difficult to find exogenous instruments for cross-sectional regressions.

Finding credible exogenous instruments for the endogenous mobile money usage measure in instrumental variable (IV) methods has proved highly challenging. Most are based on agent density and network connectivity, thus assuming the "roll-out" of mobile money and the network coverage itself were "random", which we have cast doubt upon above; moreover, statistical F tests generally find the instruments weak; these raise questions about the direction of causality and suitability of the instruments in dealing with endogeneity. An increasing trend is to present propensity score analysis to reinforce the results when IV results prove ambiguous. However, much more detail and clarity on evaluation and assumptions should be required given the debate and controversy in literature (Section 8.1.1), so that the propensity score application is transparent and is not a black box result.

Given drawbacks with all the techniques, it would be most satisfactory if studies could apply and contrast a range of techniques.[238] Applying a best practice approach to panel data both with *and* without fixed effects can ascertain the size and direction of the bias. The bias may be positive or negative; authors need to consider the direction of the bias, since then OLS methods can give useful upper or lower bounds on estimates. Not controlling for unobserved heterogeneity and lack of instrumenting or weak instruments probably results in an upward bias of the importance of mobile money for the level of consumption or saving. But, if looking at interactions with a negative shock, there is more likely to be a bias to zero[239]; hence the micro-studies could be *under-stating* the absolute size of the beneficial effect of mobile money on risk-sharing. And while Jack and Suri (2016) characterise the risk-sharing result as more short-term in nature, if illness and death are prevented by improved insurance of this type, then there are long-term implications too. With a range of techniques, the impact on biases of the IV technique and of the propensity score can also be ascertained, which is highly informative. Where there is an under-statement of the bias, this qualitatively strengthens conclusions from noisy micro-studies.

Unobserved household heterogeneity is not the only potential problem. Another, universally neglected by the surveyed studies, is non-constant parameters, e.g. because of spill-over effects and technological improvements. By its very nature, the development of mobile money systems entails regime changes, structural breaks and changing behaviour through increased penetration, uptake, changing networks and improved technology. These shifts are frequent and need empirical attention: they introduce potential non-linearities that need to be tested for in both micro- and macro-work.[240] These changes could result in earlier estimates being an *underestimate* of later effects. Structural breaks or time variation could be important with improving technology and falling costs, so findings of studies can be hard to generalise. The micro-studies ignoring spill-over effects may be picking up only part of an effect, and hence may be a poor guide as to the economy-wide effect of a policy.

Robustness testing and the thorough testing of the validity of instruments (their strength and exogeneity) are patchy over the studies.[241] Researchers should also try harder to illuminate those dimensions where welfare improvements are greatest by checking for differences in responses

[238] Several authors apply a range of techniques, e.g. Jack and Suri (2014), Riley (2016) and Munyegera and Matsumoto (2016a).

[239] For instance, if wealthy households are more likely to adopt mobile money but have less need of the insurance than the poor when a negative shock strikes or are less likely to experience a large negative shock than the poor, then there is a bias toward zero.

[240] Dummies for periods of institutional change should be precisely defined (examples in Section 8.1.2).

[241] Riley (2016), Blumenstock et al. (2016) and Jack and Suri (2014) are amongst rarer examples that thoroughly test the validity of instruments, the robustness of results from various techniques, and present clear assumptions and caveats for the techniques.

between more and less affluent households and other types of non-linearity, and by gender (see also Jack and Suri (2016)).

Macro-data

There are few papers examining the effects of mobile money with macro-data, which concentrate on the impact of mobile money on inflation. To isolate the possible impact of mobile money on inflation, it is essential to use well-specified *multivariate* inflation models with comprehensive controls. Failure to include proper controls will lead to biases, and the erroneous attribution of effects to mobile money that belong to omitted economic regressors in the model. The inflation fears based on the rapid spread of mobile banking in Kenya seem to be mainly linked to Simpasa and Gurara (2012), whose findings are clearly not robust. It uses only three years of annual data on mobile money, risking confusing other major shocks such as droughts with the impact of mobile money. It also reflects some of the confusions in the literature on the effects of variations in the money stock on inflation, while benign linkages between mobile money and inflation are neglected. Application of an econometric forecasting model to Uganda, with comprehensive controls, found no serious evidence of a link between mobile money and food and non-food inflation (Aron et al., 2015). These findings suggest that concerns regarding the potential velocity-inflation linkage of mobile money are misplaced. The evidence strongly suggests there is no reason for any alarm over its potentially inflationary consequences.

Claims for growth and the importance of complementary inputs

On the impact of IT (and by implication, mobile money) on economic growth, Aker and Mbiti (2010) and Aker and Blumenstock (2015) are at pains to stress that it is not clear-cut to make the link. The Economist magazine concurs in late 2016: "The precise impact of (mobile) phones on economic growth is notoriously difficult to measure (although that does not stop trade bodies and consultants from issuing gushing reports filled with unnervingly exact numbers)."[242] The GSMA in 2012, for instance, predicted for developing markets, that a 10 percent expansion in mobile phone penetration could improve productivity in the long run by 4.2 percentage points, and doubling mobile data usage could increase annual growth in GDP per capita by 0.5 percentage points (GSMA-Deloitte-Cisco, 2012). A recent study by McKinsey (2016) applies a proprietary general equilibrium macroeconomic model to macro-data for seven countries[243], extrapolating the results globally for all emerging market countries; they predict that adoption and use of digital finance (referring not just to mobile money for the unbanked, but to mobile banking in general) could increase the GDP of all emerging economies by 6 percent, or $3.7 trillion, by 2025.[244] It is difficult to assess such macro-studies with their optimistic assumptions about micro-adoption and usage of mobile money, the successful take-up of diversified services including credit, and the government's tax take. They generate an aspirational "ceiling": but as a reality check there is an important role for micro-studies in evaluating their assumptions, especially the barriers to adoption and the welfare impact. Little research has been done on the changing nature of social networks with the advent of mobile money, which networks could expand or contract; and how pre-existing systems like ROSCAs could co-exist with mobile money, increasing efficiency through using mobile money.

[242] See "Continental disconnect." The Economist, 10 December 2016, pages 45-46.
[243] Limited details on assumptions and methods are provided in an Appendix to the report.
[244] They predict that 1.6 billion unbanked people (more than half being women) could gain access to formal financial services; an additional $2.1 trillion of loans to individuals and small businesses could be sustainably extended; governments could gain $110 billion per annum from reduced leakage in public spending and tax collection; and that nearly 95 million new jobs could be created across all sectors.

Digital finance is one of few areas where there has been a *real* revolution in services and leapfrogging over inept traditional infrastructure. However, the improved access to financial services and payment opportunities and greater transparency and trust through recorded transactions with lowered costs, exist in a sea of market failures that impede progress. Significant amongst these failures, according to a recent Economist survey, are corruption, lack of electricity generation, and appalling road infrastructure. Complementary action is required to address such problems which otherwise hinder the translation of greater efficiencies from digital finance to growth. Moreover, governments may impede adoption and efficient and competitive markets through poor regulatory choices (e.g. encouraging an OTC structure, see Section 5.1, or prohibiting non-bank led MNOs), and developing areas typically have weak regulatory governance. The crucial relevance of the micro-studies is to show how difficult it is to quantify accurately the outcomes and to extrapolate from individual studies of different countries, scaling up the effects to make policy pronouncements. Given the lack of complementary inputs discussed above, there could be sharp returns to scale in the short-run from mobile money, but not in the long-run given the constraints. On the other hand, the micro-benefit established by several studies could be multiplied greatly through spill-over effects in the presence of well-functioning general infrastructure and transparency (lack of corruption) – especially if mobile money itself reduced corruption.

Concerted action

This survey has emphasised the key role of aid agencies, other donors, charitable foundations and international agencies in the beneficial growth of mobile money and the associated financial inclusion. Indeed, the Oxford Martin School's far-reaching report, "Now for the Long Term" (Oxford Martin School, 2013), urges inter-disciplinary thinking more generally, beyond short-term political concerns. In highlighting the technological advance through the information and communications revolution, there is the potential to enhance education opportunities, improve health outcomes, promote free speech and democracy and offer greater access to global markets. The report urges creative coalitions and the investment in multi-stakeholder partnerships to prompt such deeper change, learning and practical action. One important application is to academic research on the usage and impact of mobile money. This survey has shown that poor quality data and sub-optimal data collection and analysis severely compromise the conclusions that can be reached from empirical work. A *concerted* attempt by donors, regulators such as central banks, the regulated MNOs themselves and academics could harness the type of data that can be used for the best practice in analysis. The survey has highlighted the best practice techniques that when applied to academic empirical analysis can reach more reliable conclusions and help justify sustaining the huge commercial and donor expenditure on mobile money.

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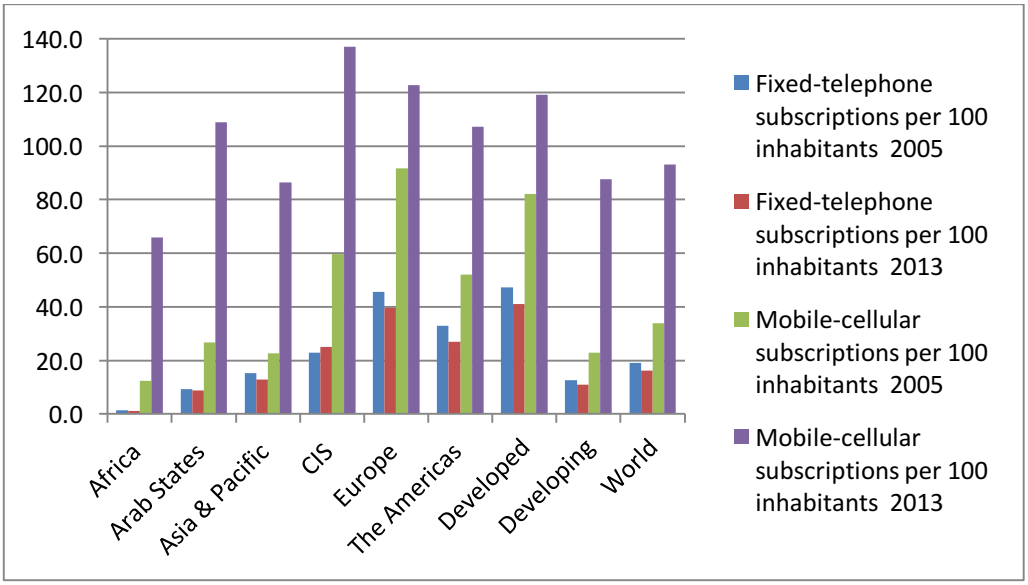
Abbreviations:

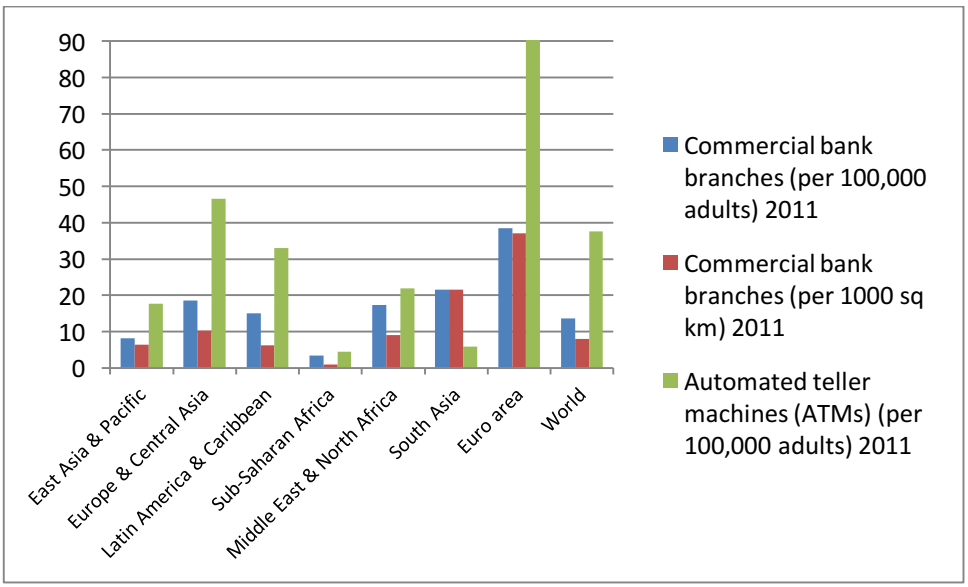
African Development Bank (ADB)
Alliance for Financial Inclusion (AFI),
Anti-Money Laundering (AML)
Business-to-Person (B2P)
Center for Financial Inclusion (CFI)
Combating the Financing of Terrorism (CFT)
Consumer Price Index (CPI)
Customer due diligence (CDD)
Central Processing Unit (CPU)
Department for International Development (DFID)
Difference-in-Differences (DD)
Fair Isaac Corporation credit scores (FICO)
Financial Action Task Force (FATF)
Financial Inclusion Insights (FII)
Financial Inclusion Tracking Surveys (FITS)
Global Financial Inclusion Database (Global Findex)
Government-to-Person (G2P)
Global System for Mobile Communications, originally Groupe Spécial Mobile (GSM)
Groupe Speciale Mobile Association (GSMA)
Identity Document (ID)
International Finance Corporation (IFC)
IMF's Financial Access Survey (FAS)
Information Communications Technology (ICT)
International Telecommunications Union (ITU)
Know Your Customer (KYC)
Mobile Financial Services (MFS)
Mobile Network Operator (MNO)
Mobile Money for the Unbanked (MMU)
Mobile Station International Subscriber Directory Number (MSISDN)
M-Pesa ("M" for mobile, "Pesa" for "money" in Swahili)
M-Shwari, Lipa na M-Pesa and MKESHO (mobile money system offshoots in Kenya, see Box 1)
Near Field Communication (NFC)
Ordinary Least Squares (OLS)
Over-The-Counter (OTC)
Personal Identification Number (PIN)
Person-to-Business (P2B)
Person-to-Person (P2P)
Randomised Controlled Trials (RCT)
Research on Poverty, Environment and Agricultural Technology (RePEAT)
Rotating Savings and Credit Association (ROSCA)
Savings and Credit Co-operative (SACCO)
Short Message Service or text (SMS)
Small and medium-sized enterprise (SME)
Subscriber Identification Module of GSM phones (SIM card)
Tanzania Mobile Money Tracker Study (TMMTS)
Third-Generation wireless (3G) and Fourth-Generation wireless (4G)
World Bank's Global Financial Development Database (GFDD)

Figure 1: Global landline availability and mobile phone subscriptions: 2005 and 2013



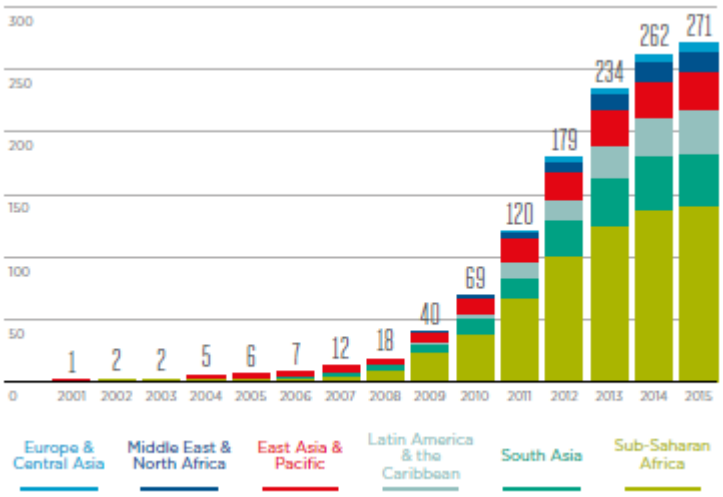
Source: ITU World Telecommunication, ICT Indicators database, see appendix Table A1.
Notes: "Mobile phone subscribers" refer to active SIM cards rather than individual subscribers.

Figure 2: Global commercial bank branch and ATM densities: 2011



Source: G20 Financial Inclusion Indicators database, World Bank, see appendix Table A1.
Notes: 2011 is the latest available year. The first five regions refer to "developing only".

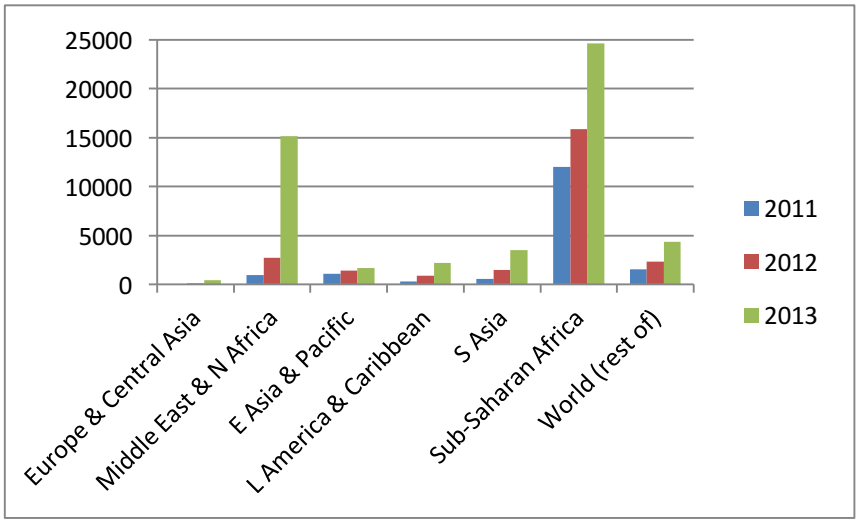
Figure 3: Number of live mobile money services for the unbanked by region



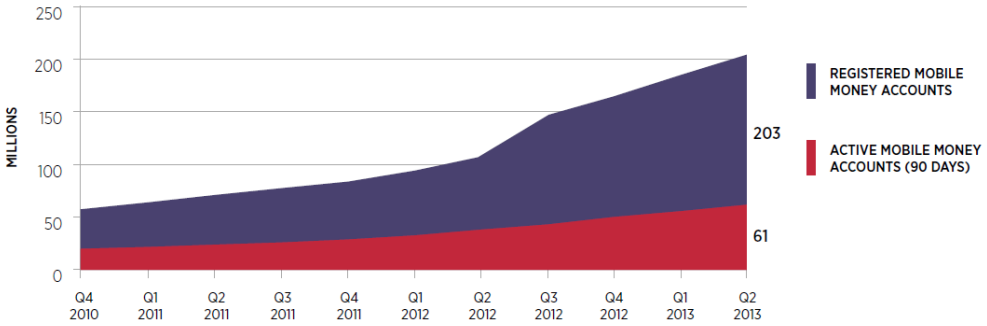
Source: Adapted figure from GSMA State of the Industry report (2016), Figure 1.
Notes: Dated December, 2015. The numbers of services in some years have been revised from earlier reports.

Figure 4: Numbers and growth of mobile money accounts

a. Mobile money accounts per 100,000 adults

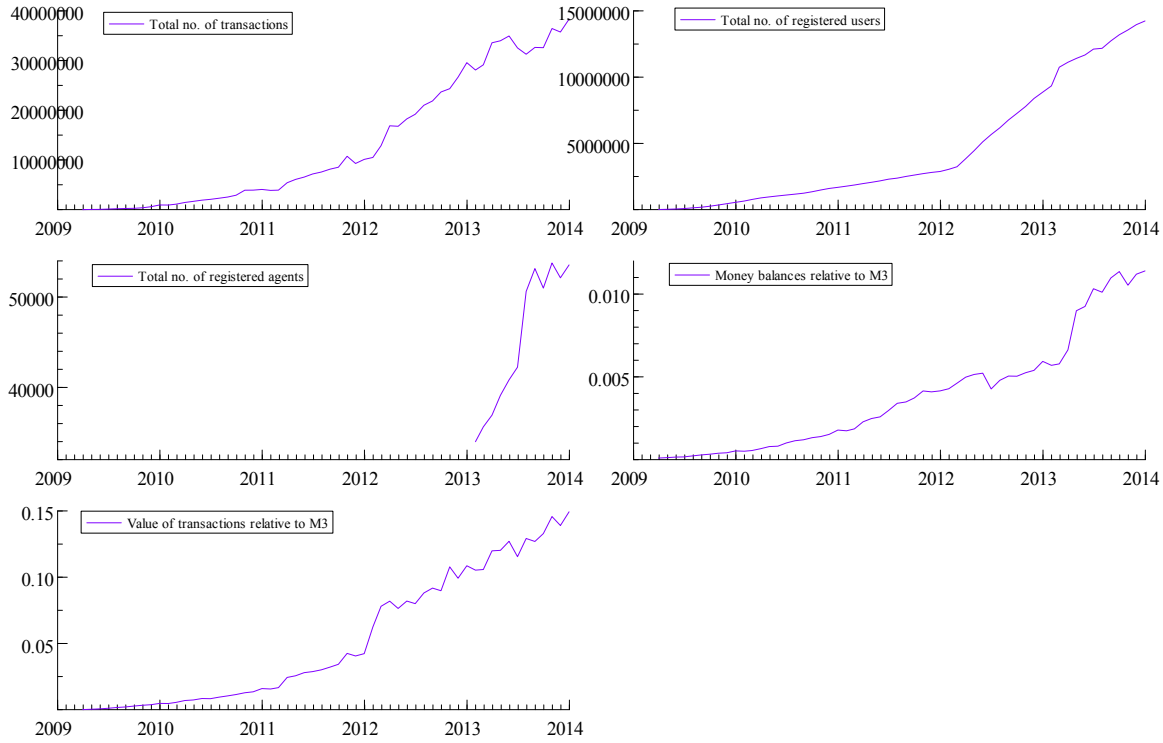


b. Numbers and growth of total registered and active (90 day) accounts



Source:
a. Data from Pénicaud and Katakam (2014), updated with https://gsmaintelligence.com/topics/3363/dashboard/;
b. Adapts Figure 6 for the unbanked, only (Pénicaud and Katakam, 2014). By December 2014, there were 299 million registered accounts of which 103 million were active (Scharwatt et al., 2015). By December 2015, there were 417 million registered accounts of which 134 million were active (GSMA, 2016).

Figure 5: Aggregate Ugandan mobile money data



Source: Bank of Uganda
Notes: The value of transactions and the money balance on customers' accounts (Ushs).

BOX 1: A detailed anatomy of Kenya's mobile money system: 2006-2016

Origin and Size:

Kenya's mobile money system was the first in Africa. It originated in 2006 in an experiment for loan payments via mobile phones in micro-credit schemes, initiated by a donor (the Department for International Development (DFID), UK) with Vodafone Plc. In Mar. 2007, Safaricom, the Kenyan (40%-owned) subsidiary of Vodafone, listed on the Nairobi bourse, launched a payments service, M-Pesa, with the slogan "send money home", exploiting the proliferation of mobile phone ownership in Kenya. Within seven months there were over a million active customers, and by the end of 2010 over half of adult Kenyans signed up. M-Pesa allows instant domestic transfers of money by secure SMS message from a registered M-Pesa customer's electronic mobile money account to any other individual, whether registered or not, without using formal bank accounts. The transactions are authorised and recorded in real time, with graduated transactions costs. M-Pesa filled a void in the market since bank branches are poorly distributed, few can afford bank accounts, and alternative long distance payments methods (Western Union, and via bus drivers) are expensive or insecure. The success of the M-Pesa relies on a well-monitored network of agents to process transactions, see below. Nearly 10 years on, 6 operators serve the market in Kenya, though Safaricom still controls 65% of the market. There were 24 million registered M-Pesa customers by Mar. 2016 (an 8% increase in the year), of whom 16.6 million were "active" (transacting in the previous 30 days). M-Pesa revenue grew by 27% to Kshs 41.5bn (about US$409m at Aug. 2016 exchange rate) in the 12 months to Mar. 2016, comprising nearly a quarter of Safaricom's total service revenue. The Bank of Kenya records that in Jun. 2015, taking into account all operators, the monthly value of transactions was Kshs 227.9bn (US$2.25bn), or about half of average monthly GDP. The FinAccess (2013) survey revealed that the proportion of the adult population using formal financial services rose to 67% in 2013 from 41% in 2009, driven by mobile money (which they classified as "formal" financial services but with "non-prudential" oversight).

Systems structures and regulatory regimes:

In Kenya in Aug. 2014, the National Payment System Regulations were issued under the National Payment System Act, providing a legal framework for mobile money, and formalising and extending prudential and market conduct requirements for mobile money providers as previously articulated in the letters of no-objection from the Central Bank of Kenya (CBK). The CBK has duties of oversight, inspection and enforcement. There are mechanisms for consumer protection, redress and confidentiality of data.

In Kenya, banks and non-banks, including mobile network operators (MNOs), may provide mobile money services. The MNOs operate the telecommunications infrastructure, and may contract, train and monitor the widespread networks of agents that interact with the customers to register users, offer cash deposit and withdrawal functions, and transfer payments from electronic accounts held outside the formal banking sector. The net deposits from customers have to be invested in prudentially-regulated banks for safe-keeping in "Trust" accounts, which back 100% of the money of the participants in the mobile money service; the banks are required to satisfy fiduciary responsibility in all transactions concerning the Trust funds (customer identification documentation, daily reconciliation of the Trust account and the e-money, and authority to distribute the funds in the Trust account to mobile money account holders in case of insolvency or bankruptcy of the MNO). No investment of Trust funds is allowed; the funds are strictly separated from the service provider's own accounts and safeguarded from claims of its creditors. The Safaricom interest income is covenanted to charity.

The early agent exclusivity arrangement for M-Pesa was formally outlawed in Jul. 2014, when the Central Bank of Kenya ordered Safaricom to open up the agent network to other operators to improve fair competition and encourage lower fees for customers. There is not yet interoperability of platforms; users of mobile money services have to affiliate with multiple mobile providers, but an interconnection deal between Vodafone and MTN was announced in Apr. 2015.

Agency network:

By Mar. 2016, there were 100,744 M-Pesa mobile money agents countrywide (compared with about 2.43 commercial bank branches per 1000km^2 in 2013). Establishing an agency network and the training and payment of agents is a considerable early investment by operators to develop the market. M-Pesa distinguishes between

wholesalers and retail agents, but they are not "agents" in a strict legal sense of having the legal authority to act for the service provider. Retail cash merchants transact with their own cash and electronic money in their own M-Pesa accounts to meet customer demand. Wholesalers (banks or non-bank merchants) are allowed higher limits on electronic money stored in their M-Pesa accounts; they perform a cash management service for retailers, who typically transact daily with wholesalers, depositing cash or withdrawing cash depending on their net intake of cash. Retail agents open accounts observing identity checks required by anti-money laundering legislation, and the cash provision function spans in-store cash merchants to street-based merchants. Agents are compensated by M-Pesa out of the transaction fees charged to customers; but a different model in Airtel in Kenya delegates the payment of agents to customers. The FinAccess (2013) survey indicates that for 85% or urban dwellers and 58% of rural dwellers, the nearest agent is in walking distance. Thus, transport, waiting time and other transactions costs are much reduced.

A payments platform for individuals:
Mobile phone users purchase a SIM card with the mobile money "app" for their phone, register with a retail agent using a national identity card and acquire an electronic mobile money account. They deposit money into the account by giving cash to the agent, and receive, in return, "electronic money" via their mobile phone. To withdraw money, they transfer electronic money via their mobile phone to the cash merchant's mobile money account, and receive cash in return. Electronic money can be sent from a customer's account to another account holder, and money can be sent to those who are not account holders. The latter transaction is more expensive, and the remitter's own account is debited. A text message (SMS) with a code is sent to the recipient, authorising a retail agent to transfer money from the remitter's account into cash for the designated recipient. The maximum allowed account balance is Ksh100,000 (~US$1100), the maximum daily transaction is Ksh140,000, the maximum per transaction is Ksh70,000, and the minimum allowed transfer is Ksh10 (US10cents). The predominant transactions are non-bank payments services such as buying airtime, paying bills and school fees, and P2P transfers. But there have been innovations, see below.

Transactions costs:
Depositors do not receive interest on their electronic accounts and bear the risk of loss of value through inflation. They pay the cost of transferring and withdrawing money, but there is no charge for depositing money. The graduated withdrawal fee pays for the cost of the M-Pesa account, ranging in 2015 from about 0.5% for large transfers to 20% for the smallest. The costs of transfer are 10% for the smallest transfers, falling by half at transfers of Kshs 20,000, and to 0.16% for Kshs 70,000. Costs are greater to transfer to unregistered users.

Expanding to business usage and payments platform
Corporate Kenyan M-Pesa accounts have higher transaction limits than for individuals, and bulk business to customer payments can be made. The "Lipa na M-Pesa" network of 43,603 active merchants (Mar. 2016) facilitates customer payments without or with low transaction fees for goods and services (between 10 and 70,000 Kshs), entering the business till number via the M-Pesa "Buy Goods" option. In Mar. 2016 payments on this platform totalled over Kshs20bn. To encourage cashless business payments, in Dec. 2014 Safaricom announced an instant rewards system to promote petrol payments using the Lipa Na M-Pesa platform, following schemes such as Lipa Kodi for rent and Lipa Karo for school fees payments. In Nov. 2014, Safaricom launched M-Ledger, its first (free) branded smartphone app, with basic accounting tools for individuals and small businesses. Business usage has grown in Kenya with P2B (customer-to-business) payments accounting for 15%, and B2P (businesses transferring to suppliers and paying employees) for 18%, of the average monthly value of all payments in the six months prior to September, 2015 (half-year Safaricom 2015/16 results). The business related average transfers exhibited 90% growth on 6 months earlier as compared to 16% for person-to-person average transfers.

Expanding to a savings and micro-credit platform
In Kenya, M-Shwari is a savings and loan product operated entirely from the mobile phone, launched in Nov. 2012 by partners Safaricom and Commercial Bank of Africa. By Mar. 2016, (30-day) active customers numbered 3.9m, with Kshs 8.1bn on deposit. Customers can move funds between their M-Pesa account and M-Shwari bank savings account (with no minimum balances or charges, and paying graduated interest rates of 2-

5%). The new Lock Box service pays higher interest rates for *fixed* deposits. M-Pesa subscribers of 6 months standing can apply for an M-Shwari loan sans fees or paperwork: an algorithm based on their M-Pesa transactions history creates an initial credit score and initial loan limit. Loan disbursement and repayment is via M-Pesa, without loan interest charges, but with a facility fee of 7.5% (note, however, that this resembles an interest rate and at a high annual compounded rate of 138 percent). Loans sizes (ranging from US$1to US$235) have a 30-day term but can be rolled over at a monthly fee of 7.5%. By Mar. 2016, there was Kshs 7.4bn on loan, with non-performing loans numbering only 1.93% of the portfolio. Follow-up loans depend on savings and loan repayments history. In Mar. 2015, Safaricom and KCB launched the KCB M-PESA account with higher loan limits and a 6-month repayment term, and Equitel (Equity Bank) is another recent rival product.

Expanding to a micro-insurance platform

In Sep. 2015, an M-Pesa health micro-insurance product, launched in partnership with a Micro Insurance firm in Jan. 2014, was discontinued through failure to gain traction. The annual premium (Kshs12,000) had bought family cover worth Kshs 290,000 for maternity, dental and optical care, and hospital and funeral expenses. In Dec. 2015, M-Tiba ("mobile care"), a dedicated health savings "wallet" to pay for care at selected affordable health providers was launched by Safaricom with two partners, a Netherlands non-profit organization and a Kenyan payment platform enabling users to save and pay for healthcare. The Pfizer Foundation is the first donor to use the platform for low income users.

Expanding to international (diaspora) remittances

Kenya received an estimated US$1.6bn of international remittances in 2015 (World Bank Migration Brief 26). Safaricom was an early mover in international remittances via mobile money. In Nov. 2014, it partnered with MoneyGram, to enable remittances from over 90 countries worldwide to be sent directly to M-Pesa users. Safaricom now has similar agreements with Western Union and several other partners. In Apr. 2015, Vodafone and MTN announced an interconnection of mobile money services enabling affordable regional remittances between M-Pesa customers in Kenya, Tanzania, Democratic Republic of Congo and Mozambique, and MTN Mobile Money customers in Uganda, Rwanda and Zambia. In 2016, Vodafone partnered with HomeSend (a joint venture created by MasterCard, eServGlobal and BICS) to extend remittances for M-Pesa users in Africa, Albania and Romania.

Government and donor usage of mobile payments

Mobile money services could be used for governments to securely pay officials their wages, for the national revenue authority to receive tax and licences payments and fines, municipalities to receive parking payments and public transportation payments, and to deliver social welfare or aid payments. Some of these are a reality in Kenya, with M-Pesa and Airtel, through pilots or fully-functioning systems. However, the government to person (G2P) salary and social payments have lagged in Kenya relative to Afghanistan, Tanzania and Malawi.

Geographical expansion of the successful M-Pesa model

Vodafone has concentrated on proliferation of its mobile money platform in markets that are heavy cash users. Currently, M-Pesa is used in nine countries other than Kenya, by order of roll-out: Tanzania, Fiji, South Africa, Fiji, DRC, India (launched in 2013), Mozambique Egypt, Lesotho, Romania (2014) and Albania (2015).

Table 1: Global trends in international remittances and their costs

Global trends in remittances			
Region/country	*US$ billions*		
	2010	2013	2015(e)
All developing countries	**332**	**417**	**432**
East Asia & Pacific	94	113	127
Europe & Central Asia	31	48	35
Latin America & Caribbean	56	61	67
Middle-East & North Africa	39	49	50
South Asia	82	111	118
Sub-Saharan Africa	30	35	35
World	**461**	**573**	**582**
Global transactions costs of remittances			
Region/country[a]	*Total average transactions cost of sending US$200(including fees and exchange rate margins)/% of amount sent*		
	2010q1	2013q4	2015q4
East Asia & Pacific	9.3	8.3	8.0
Europe & Central Asia *(excl. Russia)*	8.3	6.3	6.5
Latin America & Caribbean	8.1	7.0	6.0
Middle-East & North Africa	8.2	7.8	7.4
South Asia	6.0	6.6	5.4
Sub-Saharan Africa	10.9	12.6	9.5
World	**8.7**	**8.6**	**7.4**

Sources: Remittance Prices Worldwide; World Bank Migration and Remittances Data, Migration and Development Brief no. 24 and 26 (April, 2015 and April, 2016). See websites in appendix Table A1.
Notes: **a**. Excludes Remittance Service Providers that do not disclose the exchange rate applied.

Table 2: A typology of micro-empirical studies on the economic effects of mobile money

Study	*Data*	*Method*	*Endogeneity & other issues*	*Claimed result*
Adoption				
Munyegera and Matsumoto (2016a) **Dependent variable:** Probit/FE: Zero-1 dummy: for whether household i living in village j in district d uses mobile money services at time period t. **Definition of M-money usage:** Exact definition of "use" unclear.	Uganda Balanced panel of 838 households generated from the 3rd &4th rounds of household and community surveys in Uganda, 2009 & 2012 (RePEAT) project.	Probit regression; and linear probability model with household fixed effects *Controlling for:* district-by-time dummies; dummy for ownership of a mobile phone; and vector of household characteristics (age (and age squared), gender and education (years of schooling) of household head, dummy for migrant worker in household, distance to nearest mobile money agent, size of household, and household wealth (land size and total assets)). [Robust standard errors]	Household fixed effects and location-by-time dummies are used in a panel context, and many individual controls (including control for ownership of a mobile phone and a migrant worker) reducing potential endogeneity; possibly some *time-variant* household heterogeneity may remain. **Disentangle technology/ service?** Yes. Mobile phone dummy used.	*Adoption of mobile money* Cannot find a gender effect or an age effect for these rural adopters; distance to the agent is important as is wealth; and dummies for ownership of the phone and migrant worker are significant.
Weil et al. (2012) **Dependent variables:** OLS: Zero-1 dummy: for whether an individual uses mobile money; Frequency of mobile money transactions per user. **Definition of M-money usage:** Exact definition of "use" unclear.	Kenya, Tanzania and Uganda Repeated cross-sections. FinAccess data from Kenya (2006 and 2009); Finscope data for Tanzania and Uganda (2006 and 2009). (These are not panel data.)	OLS regressions *Controlling for:* vector of individual characteristics (dummies for urbanisation and the level of poverty, 3 age cohorts, education (primary/secondary/ tertiary), marriage, and gender). [Robust standard errors]	There are endogeneity problems. Omission of measurable controls e.g. banking status, wealth and mobile phone ownership. Unobservables like spill-over effects cannot be controlled for. But location-by-time fixed effects were not included for repeated cross-sections to control for (some) time-*variant,* unobserved regional-level heterogeneity. The results are thus only suggestive. **Disentangle technology/ service?** No.	*Adoption of mobile money* They deduce for all three countries (limited significance in the less well-developed markets of Tanzania and Uganda) that adopters are younger, wealthier, better educated and urban dwellers. Analysis of frequency of mobile money transactions per user, yields similar findings. Cannot find a gender effect.
Private domestic remittances using mobile money or an early version of mobile money (prepaid airtime): risk-sharing studies				
Batista and Vicente (2016) **Dependent variables:**	Mozambique Panel data (some analysed as cross-section) generated in rural	Randomised Controlled Trials (RCT). *Random intervention:* treated individuals receive training about a new mobile money	The first stage of selection may not be random, and there are other problems of potential heterogeneity (see Deaton's	*Total Consumption* No significance for the treatment dummy for consumption in the absence of shocks.

Study	Data	Method	Endogeneity & other issues	Claimed result
OLS: log consumption per capita; DD: Binary variables for investment in agricultural categories (e.g. active farm or pesticides) or business categories (e.g. cattle trading). **Definition of M-money usage:** Treated individuals receive training about a new mobile money product, M-Kesh.	provinces: Maputo-Province, Gaza, and Inhambane, March 2012 (102 rural Enumeration Areas: 51 locations in 3 regions randomly selected as treatment areas; the residual is control group). Administrative mobile money records combined with household survey data (3 years, 2012-14). [*Selection criteria*: rural treatment locations required mCel coverage & 1 or more commercial banks; targeted individuals required a mobile phone number and a migrant family member in Maputo with mobile phone number.] [*Shock index*: simple average of zero-1 indicators for mix of negative shocks: deaths, job loss, health problems, loss of valuables, agricultural losses.]	product. OLS regression specification for consumption, comparing differences in outcomes for targeted and control individuals for 2013, 2014 and these years pooled. *Controlling for:* treatment dummy variable; province dummies; year dummies; and individual controls for age and gender. OLS regression specification for consumption and risk sharing, comparing outcomes for a cross-section in mid-2014. *Controlling for:* treatment dummy variable; a shock index; locational dummies; and individual controls for age and gender. o The shock dummy and M-money dummy are crossed to test if M-money users are better able to smooth risk. OLS Difference-in-Differences (DD) regressions for investment outcomes, comparing outcomes for 2013 and for 2014. *Controlling for:* treatment dummy variable; locational dummies; year dummies; and individual controls for age and gender. [Clustered standard errors]	critique, Section 8.1.1). Other selection criteria (see LHS) narrow the type of population which reduces generalisability. There is a problem of interpreting a treatment effect when intervention depends also on the type of training information provided (see Aker and Blumenstock (2015)). The constructed shock index is misleading as it conflates shocks that raise and those that lower expenditure; a simple average is used. Absence of time-by-location dummies: yet are critical to control for heterogeneous effects across locations of the 2013 flood. They do not cross individual characteristics with the shock index (as in Riley (2016) and Jack and Suri (2014). **Disentangle technology/ service?** Yes. Only individuals with phone numbers are selected.	*Total consumption after idiosyncratic, reported negative shocks* The treated group increases consumption in response to a negative shock (e.g. health or funeral expenditures drawing on remittances); the control group has to reduce other expenditure. The negative coefficient for the treatment dummy suggests the treated group is spending less (perhaps because they are sending remittances to relatives or if there is a systematic difference between treated and untreated groups e.g. are poorer). Suggests improving rural households' welfare as mobile money contributes to household consumption smoothing. *Investment* No productive effects of remittances: for mobile money users, active farm investment and investment in cattle trading falls significantly, but household ownership of "safe asset" livestock is higher. Interpret as evidence that (informal) insurance from mobile money reduced the incentives for risky investment (given credit constraints).
Blumenstock, Eagle, and Fafchamps (2016) **Dependent variable:** DD: three degrees of disaggregation: (i) total gross transfers of airtime received by all users in location *r* at time *t*.	Rwanda Panel data. 2005-09, daily primary telecom operator's log of activity (50 billion transactions: calls, text messages, and airtime transfers and purchases), 1.5 million subscribers; 2005 Rwanda	Panel Difference-in-Differences (DD) regressions *Random intervention:* an earthquake shock *Controlling for:* (i) shock dummy equal to 1 for location *r* receiving a shock at time *t* and 0 otherwise; time dummies; and location fixed effects. (ii) shock dummy equal to 1 for user *i* in	The earthquake shock is exogenous if unpredictable. Potential time variance in location could be tested for with broader location-by-time dummies than the epicentre-by-time dummy. There is imaginative use of fixed effects, and interaction effects with innovative wealth and social	*Airtime transfers after covariate negative earthquake shock* As well as geographical proximity, transfers to victims near the epicentre after the Lake Kivu earthquake of 2008 are determined by a past history of reciprocity between individuals, and the transfers decrease in the wealth of the sender and increase in the wealth of the recipient. The magnitude of these

Study	*Data*	*Method*	*Endogeneity & other issues*	*Claimed result*
(ii) total gross transfers received by user *i* in region *r* at time *t.* (iii) total gross transfer of airtime sent to an individual *i*, located in region *r* at time *t*, from another individual *j*. **Definition of M-money usage:** MNO record of pre-paid airtime (a precursor of mobile money) transferred.	Demographic and Health Survey; 2009/2010 phone survey of 1,000 individuals on household asset ownership and housing characteristics.	location *r* receiving a shock at time *t* and 0 otherwise; epicentre dummy for user *i* near epicentre at any time; time dummies; and recipient fixed effects. (iii) as in (ii), but replacing the fixed effects by a fixed effect controlling for average intensity and direction of transfer flows between two users. Heterogeneity amongst individuals: add in (ii), the interactions of predicted measures of expenditure (to proxy for wealth) and of social connected-ness with the shock dummy, the epicentre dummy and a dummy capturing the day of a severe shock. Heterogeneity amongst sender-recipient pairs: : add in (ii), the interactions of information on the geographic distance between i and j, and the history of transfers between them with the shock dummy, the epicentre dummy and a dummy capturing the day of a severe shock. [Clustered standard errors]	connectedness measures and others, to control for types of heterogeneity. There may be selection problems associated with social networks, see Section 8.1.3. Selection is also induced when wealth itself determines the ownership of phones as in Rwanda in 2008, though in a sharing culture some may own only the SIM card and borrow a phone. **Disentangle technology/ service?** Yes. Only individuals with phone numbers are selected.	transfers is small in absolute terms.
Riley (2016) **Dependent variable:** DD/ IV: log of consumption per capita **Definition of M-money usage:** Households that used mobile money services at least once in the previous year.	Tanzania Panel data. Tanzania National Panel household panel survey (NPS) for 2008-9, 2010-11 and 2012-13, covers 3,265 households in 26 districts containing 409 Enumeration Areas: 3 waves of data and a low attrition rate; and Finscope (2013) data. [Treatment groups are villages where mobile money is available.] [*Shocks*: self-reported aggregate income shocks	Panel Difference-in-Differences (DD) regressions *Random intervention:* a negative income shock *Controlling for:* M-money dummy equal to 1 for households that used mobile money services and 0 otherwise; a dummy for aggregate shock; household fixed effects, location-by-time dummies, a dummy for the proportion of mobile money users in a village; and household characteristics. ○ The shock dummy and M-money dummy are crossed to test if M-money users are better able to smooth risk. ○ The shock dummy and village M-money dummy are crossed to test if there are spill-over effects. ○ The vector of household characteristics is	The specification requires the shock to be random. If correlated with changes (given fixed effects) in *un*observable household characteristics, shocks would not be random. A more precise rainfall measure would separate large positive from large negative deviations. Possibly restrictive to assume the social network for sharing is only village-wide, and constant. Time-*invariant* unobservables are controlled for by household fixed effects. Village-by-time dummies average over individuals in villages, and	This study examines potential beneficial spill-over effects of mobile money to the village community (which includes non-users) following a aggregate (co-variate) shock. *Effect of shock on consumption* The rainfall (or other) shock causes a drop in consumption of 6-11% for all households without mobile money use. *Effect on consumption without shock* For villages where at least one person uses mobile money, average village consumption is 4-10% higher (1% significance level and robust to the inclusion of fixed effects): signals positive spill-over effects of mobile

Study	Data	Method	Endogeneity & other issues	Claimed result
	e.g. droughts or floods; or a constructed measure of rainfall deviations (> 1 standard deviation) from a 40 year mean, expressed as an absolute value.]	crossed with the shock dummy. [*Household characteristics:* a rural dummy, age and education (years) of the household head, the size of household, a dummy for ownership of a mobile phone, some financial indicators, a wealth index constructed using principal component analysis, and a household head occupational dummy.] Instrumental Variables; *Controlling for:* as above [*Instruments for mobile money and for its interaction with the income shock:* distance to and cost of reaching the nearest mobile money agent, and the interactions of each with the shock] Propensity score model Matched users and non-users with similar characteristics. [Standard errors are clustered, village level]	eliminate some (not all) unobserved, village-level, time-varying heterogeneity (e.g. self-selection into villages by providers; localised "herd" effects and learning spill-over; differential effects of rainfall by occupation across districts). But time-varying, unobservable, household heterogeneity may remain. The IV results do not reject their findings; but though the instruments are statistically exogenous they were found to be weak, introducing bias. **Disentangle technology/ service?** Yes. A mobile phone dummy used.	money to non-users in the village; For households with mobile money users (fixed effects included), their consumption is unaffected. *Effect on consumption after shock* There is no spill-over benefit to the community for non-users. But for households using mobile money, consumption increases by 8-14% i (5% significance level), cancelling the effect of the negative shock, helping these households to smooth consumption. Benefits to both the users and community are highest in rural areas and decrease sharply with distance to the nearest mobile money agent.
Jack and Suri (2014) **Dependent variable:** DD/IV: log annual per capita consumption for a household at a particular location and time. **Definition of M-money usage:** M-Pesa registrations from the telecommunications firm (at least one per household).	Kenya Panel data. Household panel survey conducted in Sep. 2008 (3000 HHs), Dec. 2009 (2017 of these HH) and Jun. 2010 (1,595 HHs from 2008 sample, but 265 not interviewed in 2009). They construct a 2-period balanced panel of 2,282 (or 2017+265) HHs, with attrition rate of ~24%, controlling for round (time) dummies in regressions. Excluding Nairobi lowers the attrition rate to ~18%.	Panel Difference-in-Differences (DD) regressions *Random intervention:* a negative income shock *Controlling for:* M-money dummy equal to 1 for an M-Pesa user in the household in survey and 0 otherwise; a dummy for negative shock to income in last 6 months; household fixed effects; location-by-time dummies; rural-by-time dummies; and household characteristics. ○ The shock dummy and M-Pesa dummy are crossed to test if M-Pesa users are better able to smooth risk. ○ The vector of household characteristics is crossed with the shock dummy. [*Household characteristics*: household demographics, household head years of	The specification requires the shock to be random. If correlated with changes (given fixed effects) in *un*observable household characteristics, shocks would not be random. Self-reported wealth is not in the vector of characteristics. Time-*invariant* unobservables are controlled for by household fixed effects. Location-by-time dummies average over individuals within locations, eliminating some (not all) unobserved, *location*-level, time-*varying* heterogeneity. Ditto the inclusion of rural-by-	*Total, food and health consumption after idiosyncratic, reported negative shocks* For Kenyans with access to mobile money, total consumption is unaffected negative income shocks, while the consumption of non-users drops by 7% (significant at the 10% level). The effect is more evident for the bottom three quintiles of the income distribution. Same result for the impact of health shocks on total consumption; but food consumption is equally well-smoothed by users and non-users. Transactions cost savings mean users are better able to smooth consumption following negative income shocks, from the greater frequency, geographical diversity and size of mobile money

Study	*Data*	*Method*	*Endogeneity & other issues*	*Claimed result*
	A March 2010 survey of nearly 7,700 M-Pesa agents, who also reported when they began business. [*Shocks*: negative shock could be covariate like a drought; or idiosyncratic like severe illness, job loss, fire, livestock death, and harvest or business failure.]	education and occupation dummies (for farmer, business operator and professional), use of financial instruments (bank accounts, savings and credit cooperatives and rotating savings and credit associations), and a dummy for cell phone ownership.] Note that wealth is not included. Reduced form regressions *Controlling for:* as above, but without crossing vector of household characteristics with the shock dummy. o Simply substitute "access to an agent" for M-Pesa usage. Instrumental Variables *Controlling for:* as above. [*Instruments for M-Pesa user in the household at the time of the survey and for its interaction with the income shock:* distance to the closest agent, the number of agents within 5 km of the household, and the interactions of each with the shock] [Standard errors are clustered, village level]	time dummies. But time-*varying* unobservable *household* heterogeneity may remain; also, if there are missing interaction effects from time-varying unobservables (e.g. wealth) that could help households to smooth risk, this may bias the role of M-Pesa in smoothing consumption. Their claim for validity of instruments relies on lack of systematic correlation between agent density and observable household characteristics that may help households to smooth risk (their Table 6C uses only *bivariate* correlations, however; see text on more comprehensive testing). There may still be correlation with *un*observables or poorly-measured observables (e.g. wealth) that may help households to smooth risk. F tests suggest instruments are not weak; no tests are reported for whether they are exogenous. They do successfully conduct placebo tests. **Disentangle technology/ service?** Yes. A mobile phone dummy used.	remittances. Evidence suggests higher expenditure after negative shocks, rather than "stable" consumption, perhaps on repairs and medical treatment. The IV regressions reinforce the conclusions: improved access to agents improves a household's ability to smooth risk. The agent roll-out proved statistically to be uncorrelated with observables including self-reported wealth (though using only *partial* correlates, see LHS); in principle instrumenting could help to control for endogeneity.
Private domestic remittances using mobile money: welfare studies				
Jack and Suri (2016) **Dependent variable:** OLS: the outcome (measured in 2014) for household (or individual) i	Kenya Panel data. Household panel survey conducted across 118 locations, in Sep. 2008 (3000 HHs),	Panel OLS regressions *Controlling for:* the change in agent density between 2008 and 2010; location fixed effects; a dummy for gender of the household head in household level regressions (or for the	*Proxying mobile money usage* Pre-dating the agent density proxy relative to 2014 outcomes intends to make it exogenous. There are 2 problems. It may be	*Consumption, growth in consumption, poverty* Prior agent density (proxies access to M-Pesa) increased per capita consumption levels (2014) and reduced the level of

Study	*Data*	*Method*	*Endogeneity & other issues*	*Claimed result*
in location j for 3 categories of variable: (i) the log of average consumption per person in a household, the change in this variable, and the level of household poverty rates (consumption pc below $1.25 per day or "extreme poverty", and below $2 per day); (ii) physical and financial wealth: the log of assets, the log of total financial savings, and presence of a bank account; and (iii) occupational choices: farming, business and sales, or secondary occupations. **Definition of M-money usage:** they proxy usage by the change in agent density (i.e., the number of agents within 1 km of the HH) between 2008 and 2010.	Dec. 2009, Jun. 2010, 2011 and 2014 (1608 HHs); the 2011 survey was targeted specifically toward attrited households from earlier rounds; Nairobi was dropped from the sample after 2011 (480 HHs).; attrition from the original non-Nairobi sample, 2008- 2014, was 35%. A March 2010 survey of nearly 7,700 M-Pesa agents, who also reported when they began business.	individual in individual level regressions); and household (individual) characteristics. ○ The gender dummy and the change in agent density are crossed to estimate the marginal effect of an increase in agent density for females. ○ The change in agent density is crossed with household (or individual) characteristics to rule out cases where the gender effect was in fact driven by these other characteristics. [*Household (individual) characteristics* used in the regressions (measured in 2008): age and age squared of the household head.] [*Household/individual characteristics* used in the interaction effect (measured in 2008): (i) for individual regressions: education; (ii) for household level regressions: education, wealth, and a dummy for the household being unbanked (education and wealth are dummy variables for whether the household is below the median value in the sample).] [Standard errors are clustered, location level]	a poor proxy for *later usage* of mobile money, as usage growth is catalysed 2010-14 (see text on statistics). The exogeneity assumption relies on lack of systematic correlation (using only *bivariate* correlations) with observable household characteristics possibly associated with future outcomes (see text on testing more comprehensively). There may also still be correlation with unobservables or poorly-measured observables (e.g. wealth) that affect outcomes. *Unexplained heterogeneity* There is probably considerable unexplained heterogeneity in the *levels* regressions. House-hold fixed effects, location-by-time dummies, ownership of a mobile phone, wealth, education and possession of a bank account are excluded. More weight should be placed on regression of the *change in the log level of consumption* which serves to remove household fixed effects (though time-varying heterogeneity may still introduce bias). **Disentangle technology/ service?** No.	poverty for 2 measures of poverty (2014). Effects are stronger for female-headed households for the levels of consumption and of extreme poverty. Consumption *growth* for male-headed households was negative; that of female-headed households was positive and statistically significant. (The result is robust to interactions between changes in agent density and other observable household characteristics.) *Mechanisms* Mobile money access (prior agent density) cannot explain the (level of) the log of assets. The regression of the log of total financial savings (including mobile money accounts) does not control for mobile phone ownership, wealth, marriage, income, education as in other savings studies, but only for gender, age and age squared of the household head. That said, "usage" promotes saving without a gender effect. With greater mobile money access (prior agent density), fewer report their major occupation as farming, for both genders, and more females report their main occupation to be in business, sales, or retail. The results are interpreted as saying mobile money has increased the efficiency of allocation of consumption over time, allowing allocation of labour to be more efficient, reducing poverty.
Murendo and Wollni (2016) **Dependent variable:**	Uganda Cross-sectional survey of 482 households in 39 villages in two regions in	OLS regressions/ endogenous treatment effect models (for food consumption or the continuous food security index and treatment variable: mobile money usage dummy)	Only one IV result is reported: (i) *Food expenditure:* OLS estimates are relied on; (ii) *Food insecurity (continuous measure): IV* regression used	*Food expenditures* Mobile money use (10% significance level) increases food expenditure per AE by 9 percentage points; frequency of use and volumes transferred (both with 1%

Study	Data	Method	Endogeneity & other issues	Claimed result
2 measures of "food security": (1) Food consumption: OLS/IV: per capita aggregated food consumption expenditures (monthly per adult equivalents (AE): 7-day recall for regular purchases, 30-day recall for less frequent purchases); (2) Food Insecurity Indexes: OLS/IV: continuous Household Food Insecurity Access Scale (HFIAS), using weights from factor analysis *or* Probit/Probit (IV): binary Food Insecurity Index (constructed on HFIAS data). **Definition of M-money usage:** Households that used mobile money services at least once in the previous year.	November and December 2013.	OLS/Instrumental Variables regressions (for food consumption or the continuous food security index and treatment variables: continuous volume or frequency of transfer) Probit and Probit (IV) models (for the binary food security index and all treatment variables) *Treatment variables:* M-money dummy equal to 1 for households that used mobile money services and 0 otherwise; or continuous variables for frequency of use of services or the volume transferred via mobile money. *Controlling for:* treatment variable; and household characteristics. [*Household characteristics*: age, education (years) and gender of household head, household size, ratio of dependents (below 15 & above 65 years) to workforce (16-64 years), adult equivalent, land size, log value of farm equipment, dummy for household member(s) engaged in off-farm income activity, dummy for household-accessed credit, total livestock units, dummy for household ownership of a motorcycle and/or car, distance to output market and district dummies; *& 3 proxies for access to information*: "the number of mobile phones owned"; "extension contact" for whether a household accessed information from an extension service; and "group membership" for community learning about agricultural and market information.] [*Instruments:* innovative instruments: household-specific mobile phone network connectivity & the size of the information exchange network of the household. These instruments were created through interviews] [Robust standard errors]	for mobile money usage; OLS used for frequency of use and volumes transferred; (iii) *Food insecurity (binary measure):* ordinary probit estimates used. It is possible that the instruments are weak: no critical values are reported e.g. for the Cragg-Donald Wald F statistic. For the reported IV result, the level of significance of M-money dummy is low. The first instrument entails ownership of a phone and proxies for wealth, which may affect food security. The second instrument may be correlated with other information controls in the regression, and may signal a household with good connections and high status, affecting food security. Failure to find appropriate instruments would not legitimate the OLS results. Cross-sectional analyses are highly vulnerable to failure to control for household and village level heterogeneity. **Disentangle technology/ service?** Yes. A version of a mobile phone dummy is used.	significance) increase food expenditure per AE by 1.9 percentage points and by 1 percentage point, respectively. Farm equipment and livestock units, mobile phone ownership and household size (negative effect), are important co-variates. *Continuous measure of food insecurity* Mobile money use and the volumes transferred (both with 1% significance) reduce food insecurity by 0.20 index points (1/5th of the standard deviation) and by 0.007 index points, respectively. Land size and ownership of a means of transport and livestock units are significant co-variates. *Binary scale food insecurity* Mobile money use reduces the probability of food insecurity by 10 percentage points (10% significance). A one-unit increase in the volume of money transferred via mobile phone reduces the probability of food insecurity by 1.2 percentage points (5% significance). Land size, ownership of a means of transport, livestock units and group membership are significant co-variates.
Munyegera and Matsumoto	Uganda	Panel Difference-in-Differences (DD)	There are issues with zeroes or	*Total and food, non-food and social*

Study	*Data*	*Method*	*Endogeneity & other issues*	*Claimed result*
(2016a) **Dependent variables:** DD: log of monthly real per capita household consumption: - Total consumption for a household at a particular location and time; - Disaggregated food, non-food and social expenditure (expenditure on ROSCAs, mutual funds, insurance and churches). (*IN logs, not mentioned in article, but see footnote in text*) **Definition of M-money usage:** Exact definition of "use" unclear.	Balanced panel of 838 households generated from the 3rd &4th rounds of household and community surveys in Uganda, 2009 & 2012 (RePEAT) project.	regressions *"Random" intervention:* the introduction of mobile money services *Controlling for:* M-money dummy equal to 1 for households that used mobile money services and 0 otherwise; household fixed effects; location-by-time dummies; dummy for household mobile phone possession; and household characteristics. [*Household characteristics:* household size, log of value of assets and land endowments, age, gender and education level of the household.] Instrumental Variables *Controlling for:* as above [*Instrument for mobile money adoption at the household level:* with log of the distance to nearest mobile money agent] Propensity score model Matched users and non-users with similar characteristics. [Robust but not clustered standard errors]	small numbers in the log specification, see text; this may account for the disaggregated results. Household fixed effects control for all time-*invariant* unobservables. Inclusion of location-by-time dummies averages over individuals within locations, and eliminates some (not all) unobserved, *location*-level, time-*varying* heterogeneity. Thus, time-*varying* unobservable *household* heterogeneity may remain. The specification requires agent roll-out to be random, which is questionable. The validity of the instrument relies on lack of systematic correlation between agent density and observable household characteristics that could affect household consumption (they refer to (do not report) only *bivariate* correlations). There may still be correlation with *un*observables or poorly-measured observables (e.g. wealth) that may help households to smooth risk. F tests suggest instruments are not weak; no tests are reported for whether they are exogenous. They do successfully conduct placebo tests. The IV result (where the FE coefficient increases 4-fold) is	*consumption* FE model: given the adoption of mobile money services, there is a 9.5% (5% significance level) increase in total household per capita consumption; an insignificant coefficient for food consumption (most food is self-farmed); and greatly higher 20% increase for non-food and 47% increase for social expenditure (both at 5% significance level). IV model: total per capita consumption increases 4-fold upon adoption of mobile money (but with 17% standard error). Propensity score methods for comparable households recover a coefficient of around 7% (5% significance level) for overall consumption, but for food consumption are insignificant.

Study	*Data*	*Method*	*Endogeneity & other issues*	*Claimed result*
			problematic. Propensity scoring was used, though too little information is given to assess this properly. **Disentangle technology/ service?** Yes. Mobile phone dummy used.	
Sekabira & Qaim (2016) **Dependent variables:** FE/RE: outcome variables: - Total real household income (all net earnings from on-farm and off-farm sources, including remittances); - Per capita consumption; remittances received; - Proportion of coffee sold as shelled green beans allowing entry to higher-value markets; - Average coffee price received by farmers in the respective year. (*inflation-adjusted income, see text footnote*) (*NOT IN logs*) **Definition of M-money usage:** Households with at least one member who had a mobile money account and used services at least once in the previous year.	Uganda Unbalanced panel data from survey of smallholder coffee farmers; 2 randomly-selected robusta coffee-growing districts in Central Uganda [Round 1(2012) covered 419 households. Round 2 (2015) addressed a 6% attrition rate and also increased sample to 455 households. Unbalanced panel: 874 observations from 480 households. Mobile money questions only in 2015 Round] [*Definitions*: per capita value of food and non-food goods & services; food consumption data from 7-day recall; non-food items monthly; all expenditure data converted to daily basis. Off-farm income: salaries, wages & pensions of household, land rents and capital earnings, and net profit from non-	Panel fixed effects and random effects regressions *Controlling for:* M-money dummy equal to 1 for households that used mobile money services and 0 otherwise; year dummy to control for time fixed effects; dummy for mobile phone use; dummy for participation in certification schemes for sustainability standards; and household/farm characteristics. *(no location-by-time dummies)* [*Farm and household characteristics*: education (years of schooling), age, and gender of the household head; land owned; value of other productive asset; distance to the next tarmac road; and a district dummy.] [Ordinary standard errors]	Consumption and income results are badly biased as they use inappropriate linear specifications, see text. Log specifications should have been tested for the remaining two dependent variables, but these regressions are at least interpretable, see RHS. Unbalanced panels may introduce biases. Time fixed effects are included; but location-by-time dummies should also have been included to address potential, unobserved, time-varying heterogeneity at the district level. **Disentangle technology/ service?** Yes. Mobile phone dummy used.	This study aims to explore the role of agricultural marketing and off-farm economic activities to promote welfare. *Household income and per capita consumption* We do not report the seriously biased consumption and income results. *Valued added production and prices received* FE model: for mobile money users, the proportion of coffee sold as shelled beans increases by 19 percentage points (almost doubling), as less cash-constrained farmers are more willing to sell after drying and processing, and can transact with buyers from outside their location; mobile money users receive a 7% increase over the mean prices received by non-adopters through selling more of their coffee as shelled beans and having better access to buyers in higher-value markets. Important covariates in both cases are distance to road and sustainability certification, and additionally for coffee prices, productive assets (e.g. vehicles and transport equipment).

Study	Data	Method	Endogeneity & other issues	Claimed result
	agricultural businesses.]			
Kikulwe et al. (2014) **Dependent variables:** FE/RE: outcome variables: - Total real household income (the sum of all net earnings from on-farm and off-farm sources, including remittances); - Remittances received (all transfers from relatives and friends not residing in the household); - Transactions in agricultural input and output markets; and farm profits. (*inflation-adjusted income, see text footnote*) (*NOT IN logs*) **Definition of M-money usage:** Households that used mobile money services at least once in the previous year.	Kenya Balanced panel data for end-2009 and end-2010, focusing on 320 households from banana-growing villages in the Central and Eastern Provinces of Kenya.	Panel fixed effects and random effects regressions *Controlling for:* M-money dummy equal to 1 for households that used mobile money services and 0 otherwise; year dummy to control for time fixed effects; and household/farm characteristics. *(no location-by-time dummies)* [*Farm and household characteristics*: farm size (land owned), household size, the gender, age, and education (years of schooling) of the household head, the distance of the household to markets and roads, a 'high-potential area' dummy, which takes a value of one for regions with more fertile soils and higher amounts of rainfall, and zero otherwise, and a variable measuring the percentage of households using mobile phones at the village level to capture neighbourhood effects.] [Ordinary standard errors] Instrumental Variables *Controlling for:* as above [*Instrument for mobile money use at the household level:* with the proportion of households using mobile money and for those owning a mobile phone at the village level] Propensity score model Matched users and non-users with similar characteristics.	The results are badly biased as they use inappropriate linear specifications, see text. Not including a dummy for mobile money ownership means use of mobile money may be picking up this excluded factor. Location-by-time dummies should have been included to address potential, unobserved, time-varying heterogeneity at the village level. The wealth measure of land size is largely time-invariant over the short period of the study; a broader measure of less illiquid wealth is an essential control which could be time-variant over the sample. The exogeneity of the instruments with respect to income is in doubt, as they may proxy for wealth. Propensity scoring was used, though too little information is given to assess this properly. **Disentangle technology/ service?** No.	*Income, remittances, profits, inputs, marketed outputs and profits* FE models: the results are seriously biased because of several model misspecifications. They suggest that mobile money users have greater household income, higher remittances received, to apply more purchased farm inputs, market a larger proportion of their output, and have higher profits than non-users of this technology. The reported average treatment effects are implausibly large, e.g. a 40% income gain relative to the mean income of non-users, and a 35% profits gain over non-users.
Kirui et al. (2013) **Dependent variables:** outcome & input variables: - Household agricultural input use (value of	Kenya Cross-sectional data, from a small survey of 379 multi-stage randomly selected farm households	Propensity score model Match treatment with controls (i.e., users of M-Money with non-users) that are similar in terms of their observable characteristics using 3 matching techniques. The differences in	Biases and heteroscedasticity as in the above two papers, as logs were not used for the unscaled dependent variables, and for the relevant unscaled independent variables. Thus, larger farms or	*Income, inputs and commercialisation* The results are biased because of model misspecification. Propensity Score methods: they find that mobile money transfer services significantly increased the level of annual

Study	*Data*	*Method*	*Endogeneity & other issues*	*Claimed result*
purchased inputs); - Agricultural commercialisation (ratio of the value of sales to the value of total production); - Farm incomes (value of agricultural revenue). *(NOT IN logs)* **Definition of M-money usage:** Exact definition of "use" unclear.	in 3 provinces of Kenya in March-April, 2010. [*Definitions*: inputs included fertilizer, improved seed varieties, pesticides, and hired labour.]	outcome variables between the matches are averaged to obtain the average treatment effect on the treated. [*Matching characteristics*: gender, age, distance to nearest mobile money agent, distance to nearest bank, household size, asset endowment variables, household non-farm income, current value of assets, land size, education, group membership and regional dummies.]	wealthier households are given undue emphasis when taking arithmetic means. At the least, geometric means should have been checked for robustness. Propensity scoring: reduction of the bias by 20% does not eliminate it. Moreover, it is assumed that observed characteristics will be correlated with unobserved characteristics; this is not necessarily the case, and cannot be proved. The generalisability from such a small sample is also in doubt. **Disentangle technology/ service?** No.	household input use by $42, household agricultural commercialization by 37% and household annual income by $224.
Public/donor cash transfers using mobile money				
Aker, Boumnijel, Mcclelland, and Tierney (2015) **Dependent variables:** OLS: various outcomes of interest (costs, uses of the cash transfer, food security and assets) of individual or household in village. **Definition of M-money usage:** Selected participants (see Col.4.) were given mobile money-enabled mobile phones.	Niger Cross-section or pooled cross-section. Household survey of 1,152 recipients in 96 intervention villages: baseline in May 2010, follow-ups in Dec.2010 and May 2011 (main sample: 1082 households in Rounds 2 & 3); village-level survey; anthropometric data on children, for 691 households in May 2011; weekly price data in 45 markets, May 2010 to Jan.2011. [Most regressions use the Dec.2010 household data, straight after the transfer.	Randomised Controlled Trials (RCT). *Random intervention:* treated participants received cash transfer through mobile payments. Simple reduced form regression specification variously comparing differences in outcomes for the 3 channels in Dec.2010 or May 2011, or for pooled data from Dec.2010 and May 2011 rounds. *Controlling for:* indicator variables for participation in the M-money transfer program, and for whether a mobile phone was received; geographic fixed effects at the commune level; vector of household baseline covariates; presence of a seed distribution program at the village level. [*Household characteristics that differed at baseline*: age, raising livestock as an income source]	The first stage of selection may not be random, and there are other problems of potential heterogeneity (see Deaton's critique, Section 8.1.1). They do, however, control for household characteristics that differed between groups at baseline. Cost-savings rely on a well-established agent infrastructure. The results may not be generalisable. **Disentangle technology/ service?** Yes, 3 channels: manual; electronic plus mobile money-enabled mobile phone; & manual, plus mobile money-enabled mobile phone.	*Various outcomes* Transactions costs reduced, especially travelling and queuing time. Increased intra-household bargaining power for women. Increased diet diversity; better nutrition for children; women more likely to cultivate and market cash crops; fewer depleted durable and non-durable assets. No evidence of "leakage".

Study	Data	Method	Endogeneity & other issues	Claimed result
	When available, data for Dec.2010 & May 2011 are pooled and a linear time trend added.]	[Clustered standard errors]		
Salary payments using mobile money				
Blumenstock, Callen, Ghani and Koepke (2015a) **Dependent variables:** FE: Various outcomes of interest (saving, transfer and airtime purchase through M-Paisa, and welfare indicators such as consumption and self-reported happiness) of employees. **Definition of M-money usage:** Participants received mobile money-enabled mobile phones.	Afghanistan Panel data. Seven provinces, Jul. 2012 to April. 2013. Sample: 341 employees of Central Asia Development Group. Mobile operator Roshan transaction records, interviews, administrative records. Pre-baseline survey, baseline survey (before receipt of phones and training) and endline survey, and monthly phone surveys between the latter two.	Randomised Controlled Trials (RCT). *Random intervention:* treated participants received salaries through mobile payments. Simple fixed effects regression specification comparing outcomes in the endline and baseline rounds. *Controlling for:* indicator variables for a treated individual and for whether the observation was made after treatment, and the cross-effect of these two dummies; individual level fixed effects; survey wave fixed effects. *(No individual characteristics were included)* [Clustered standard errors]	The first stage of selection may not be random, and there are other problems of potential heterogeneity (see Deaton's critique, Section 8.1.1). No individual controls were included. But fixed effects and survey wave effects would help control for heterogeneity. The results may not be generalisable from this special group of individuals; the time period of observation is short and sample size is small. **Disentangle technology/ service?** Yes. Mobile phones provided to both treatment and control groups.	*Effect of wages payment through M-Paisa on employer' costs, and savings behaviour of employees* Significantly reduced net costs for disbursing firm; larger and more frequent airtime purchases and more spent in total by recipients; increased usage of mobile transfers and mobile savings by recipients, but with usage patterns differing by prior banking status and size of salary. Greater liquidity preference and savings withdrawal with increased perceptions of physical insecurity. *Consumption/ self-reported happiness)* No significant result obtained.
Saving				
Munyegera and Matsumoto (2016b) **Dependent variables:** Probit: Zero-1 dummy: for reported savings, credit and remittances; Tobit: log of annual savings, credit or remittances; OLS: log of annual savings, credit or remittances.	Uganda Cross-section of 820 households interviewed in 2014 on financial access and usage; household characteristics for same HHs from 4th round of household survey in Uganda, 2012 (RePEAT) project.	Probit regressions *Controlling for:* M-money dummy equal to 1 if at least one household member "used" mobile money services and 0 otherwise; district dummies; and vector of household characteristics (household size, log of total asset value, age, gender and education (years of schooling) of household head, the log of distance to nearest mobile money agent). Tobit regressions *Controlling for:* the above, with additional characteristics (distance in logs to the nearest town not nearest mobile money agent; dummies	Two approaches address endogeneity: adding residual from a first stage Probit regression for adoption in regressions; and propensity score matching. Little is significant beside the usage dummy (see RHS). The authors suggest this is because heterogeneity has been successfully removed. However, in cross-section it is very difficult to control for unobserved heterogeneity.	The authors suggest a role for mobile money in encouraging savings and as a channel for loans and remittances. *Savings and credit* Probit models: yield no significant variables at the 1% significance level, save for the (positive) mobile money usage dummy. *The monthly flow of savings* Tobit models: yield no significant variables at the 1% significance level, save for the (positive) mobile money

Study	*Data*	*Method*	*Endogeneity & other issues*	*Claimed result*
Definition of M-money usage: Exact definition of "use" unclear.		for a migrant worker in household and a SACCO in district; and a land wealth variable). Variant regressions: (i) the residual from a first stage Probit regression for mobile money adoption is added to help control for endogeneity of mobile money and the log value of land is added; and (ii) the distance to the nearest mobile money agent is used as an exogenous measure of mobile money access. OLS regressions weighted by the propensity score *Controlling for*: as for Probit regressions, plus additional characteristics (log value of land, log of distance to 3 other financial institutions and to district town). [Clustered standard errors]	Whether the significance of mobile money usage is indeed important or whether the coefficient is biased strongly upwards as it proxies for unobservables is unclear. **Disentangle technology/ service?** No.	usage dummy. Partly controlling for the endogeneity of mobile money by adding the residual from a probit adoption regression: this is significant in the savings and credit regressions (the coefficient on mobile money usage remains stable). Assets promote savings and credit (10% significance level) in savings models without the residual; household size reduces savings (5% significance level). Propensity score matching models: nothing significant save for the (positive) mobile money usage dummy (coefficient on mobile money drops), and the value of assets (5% level) for savings.
Mbiti and Weil (2016) **Dependent variable:** FE IV: a set of outcome variables including saving *methods.* **Definition of M-money usage:** the proportion of individuals that use M-Pesa in a sub-location, but exact definition of "use" unclear.	Kenya Balanced panel of *locations* (note: not of households), from combining the 2006 and 2009 FinAccess surveys. [Wealth measure constructed with principal component analysis applied to household assets and durable goods; grouping respondents by wealth quintile.]	First differenced, fixed effects Instrumental Variables regression *Controlling for:* a time fixed effect; a sub-location fixed effect; and vector of individual characteristics (education (level), gender, age, marriage rate and wealth (index and quantile dummies)). [*Instruments for M-Pesa usage*: 2006 perception responses (before introduction of M-Pesa) about riskier, slower and more costly transfer methods: the proportions of residents who identify the post office or a money transfer company or a friend as relatively more risky *than each other*] [Clustered standard errors]	Differenced specification removes biases due to time-invariant unobservables. The definition of the instruments is *not intuitive* (see text, Section 8.1.6). F tests suggest instruments are not weak; no tests are reported for whether they are exogenous. They do conduct some placebo tests. The instruments might be correlated with unobserved, time-varying characteristics of households that could be associated with the outcomes (e.g. ability, dynamism) and time-varying wealth if self-reported wealth is poorly measured and with (potentially) time-varying omitted variables like banking status. **Disentangle technology/**	*Saving methods* Effect of M-Pesa adoption is to reduce both the use of informal savings groups and having to hide cash in secret places.

Study	*Data*	*Method*	*Endogeneity & other issues*	*Claimed result*
			service? No.	
Batista and Vicente (2016) **Dependent variables:** OLS: binary dummy variables: - willingness to save and remit to migrants in Maputo; - willingness to save and remit using Mkesh (mobile money). **Definition of M-money usage:** Treated individuals receive training about a new mobile money product, MKesh.	Mozambique Experimental data generated in rural provinces: Maputo-Province, Gaza, and Inhambane, March 2012 (102 rural Enumeration Areas: 51 locations in 3 regions randomly selected as treatment areas; the residual is control group). Administrative mobile money records combined with household survey data (3 years, 2012-14). [*Selection criteria*: rural treatment locations required mCel coverage & 1 or more commercial banks; targeted individuals required a mobile phone number and a migrant family member in Maputo with mobile phone number.]	Randomised Controlled Trials (RCT). *Random intervention:* treated individuals receive training about a new mobile money product. Simple OLS reduced form regression specification comparing differences in outcomes for targeted and control individuals for the years 2012, 2013, 2014 and for these years pooled. *Controlling for:* treatment dummy variable; province dummies; year dummies; and individual controls for age and gender. [Clustered standard errors]	The first stage of selection may not be random, and there are other problems of potential heterogeneity (see Deaton's critique, Section 8.1.1). Other selection criteria (see LHS) *narrow* the type of population tested, which reduces the generalisability of results. There is a problem of interpreting a treatment effect when intervention depends also on the type of training information provided (see Aker and Blumenstock (2015)). The results may not be generalizable. Remittances flow in the unusual rural to urban direction. Sample size is small and quantities saved/remitted are tiny. **Disentangle technology/ service?** Yes. Only individuals with a phone number are selected.	*Saving and remitting through M-Kesh* Willingness to save and to remit through Mkesh increases for targeted individuals. The effect for savings is 23-25 percentage points and for remittances is 26-27 percentage points (both at 1% significance level). Dissemination of Mkesh raised willingness to send money transfers regardless of transfer method, and at the margin Mkesh substituted traditional methods of saving.
Demombynes and Thegeya (2012) **Dependent variables:** Probit: Zero-1 dummy: fo**r** reported general savings; & zero-1 dummy; for reported M-Kesho savings (savings account with interest accessed via phone for mobile money users); OLS, IV: log of average	Kenya Cross-section, survey conducted by the Financial Sector Deepening Kenya organization covering 6,083 individuals, during Oct.-Nov.2010. [Total savings: M-Pesa, MKESHO/PESA PAP, KCB connect, bank	Probit and IV Probit regressions for total savings & for M-Kesho savings *Controlling for:* M-money dummy for M-Pesa registration or instrument; and vector of individual characteristics (gender, age, age squared, marriage, education (unclear how measured), location (rural/ urban), log of household income, and 4 wealth index quintiles). OLS & IV regressions *Controlling for:* as above.	Instrumenting for the endogenous M-Pesa usage dummy with a *location*-level instrument in both types of regression averages over individuals within locations, and eliminates some but not all unobserved location-level heterogeneity. The results are suggestive only. There are no statistics examining the validity of the	*Total savings and M-Kesho savings* Probit models: savings in general more likely if older, male, married, living in rural areas, with higher levels of education, reported income and wealth; with these controls, M-Pesa users are 32% more likely to report savings (1% significance). (Few used M-Kesho, but the same outcome was reached: wealthier, married, more educated, and male.) Instrumenting for M-Pesa usage drops the coefficient to 20% (1% significance).

Study	*Data*	*Method*	*Endogeneity & other issues*	*Claimed result*
monthly savings. **Definition of M-money usage:** M-Pesa registrations from the telecommunications firm.	account, SACCO account, ASCA, ROSCA, Microfinance Institution and "other" means.] [Wealth index created using principal components analysis, grouping respondents by wealth quintile.]	[*Instrument for M-Pesa registration:* the fraction of respondents in the sub-location registered with M-Pesa.] [Ordinary standard errors]	instruments. **Disentangle technology/ service?** No.	Using OLS: M-Pesa users save 12% more than those un-registered (5% significance). Using IV: the coefficient for M-Pesa users is not statistically significant.
Regulation and mobile money usage				
Gutierrez and Singh (2013) **Dependent variable:** Logit: Zero-1 dummy: for whether an individual uses mobile money (receive, send or pay bills with mobile money or a combination of these) **Definition of M-money usage:** Households that used mobile money services at least once in the 12 months surveyed.	35 countries Cross-section, using Global Findex (2011) usage micro-data; and constructed regulatory indices based on Porteous (2009), either equally-weighted or assigned weights through a Principal Components methodology.	Logit regression *Controlling for:* country fixed effects; the interaction of regulatory indexes with individual characteristics; and vector of individual/country characteristics. [*Note: the regulatory indexes themselves are not included*] [Vector of individual characteristics: education (secondary schooling), gender, access to formal banking, age (and age squared) and income quintile). In some regressions, vector of country characteristics: log of GDP per capita, % unbanked population, % urban population, % population owning a mobile phone, concentration of banks, population density and total population.] [Ordinary standard errors]	The index is *de jure* rather than *de facto*. The index may be correlated with omitted country characteristics; most possible instruments for the index have the same potential problem. By using location fixed effects to reduce endogeneity, they are unable to include the index itself, but only its interaction with individual characteristics. **Disentangle technology/ service?** No.	*Effect of regulation on mobile money usage* The interaction effects suggest: a regulatory framework that supports interoperability promotes higher usage among the poorest; and stronger consumer protection reduces usage by the poorest (costs) but promotes usage amongst the educated.

Sources: Constructed by the author from sourced papers in column 1.

Notes: 1. **Disentangle technology/ service?** Some RCT studies are able to disentangle the mobile money services delivery from ownership of a mobile phone by providing new phones to both treatment and control groups, or by considering only participants with a mobile phone number. Other studies achieve this by introducing a dummy for ownership of a mobile phone into regressions. 2. **Definition of M-money usage?** For the unwary, there are definitional ambiguities using both telecoms and self-reported data, see Section 7.3. If individuals own multiple, valid SIM cards with different providers, or if there are inactive accounts, this will exaggerate users. If registered customers are inactive (and globally two thirds of registered accounts are inactive with a *generous* 90 day definition), this will exaggerate the participation. On the other hand, there is undercounting of overall usage where unregistered customers intensively use an over-the counter service, as in South Asia.

Table 3: Expanded Klein-Mayer table of disaggregated functions, risks and regulation for mobile money

Component service/function	*Conducted by*	*Risks by service*						*Business Regulation?*	*Prudential Regulation?*	*Implications for inclusion, competition and institutional capacity*
		International	Systemic	Operational	Reputation	Liquidity	Legal			
REGISTRATION	Retail or specialised registration agents register customers.			x	x		x	- Set *Know Your Customer* (KYC)/ *Customer Due Diligence* (CDD) guidelines commensurate with the risk of the service. -Existing *Commercial Law* covers contractual relationships. -Implement best practices for data security maintenance and data sharing. -Guidelines in case of death.	Not required.	1. A universal nation ID system removes the potential for exclusion. If difficult to implement, then risk-based tiers assure access. 2. Consumer protection against fraud should be embodied in the contract to encourage adoption. 3. Contract enforcement requires an effective court system.
		e.g., Fraud; Inaccurate records; Inappropriate disclosure of information; inability to access funds by bereaved family in case of death.								
EXCHANGE	Retail agents provide withdrawal and deposit services by exchanging cash for electronic money and vv.. Wholesale agents replenish the liquidity of retail agents.			x	x	x	x	-Existing *Commercial Law* covers contractual relationships: customer-agent; retail agent-wholesale agent; and agent-MNO. -Dispute resolution covered in existing *Consumer Protection*. -Licensing authority to set an "acceptable level of disputes" and require service transparency and standards on discriminatory practice. -Adopt a flexible regime for registering agents.	Not required.	1. Transparent, published service standards (incl. fees and disclosure of agent network coverage) to minimize the cause of disputes. 2. Requires operator monitoring of agents for compliance. 3. Poor consumer protection discourages adoption. 4. A competitive environment with an active, independent press encourages resolution. 5. Notification regimes limit agent network barriers.
		e.g., Fraud; Discrimination against customers including due to liquidity management for profit; Unavailable agents; Limited liquidity								
STORAGE (in non-bank electronic account without payment of interest and transacted on mobile phone only, e.g. M-Pesa)	Retail agents process transactions; the money payments operator records and backs-up the transactions data.			x	x	x	x	-As above under EXCHANGE. -Requires: recording accounts; access restrictions on accounts; and disclosure requirements about balances and transactions (parallels banking law). -Need back-up systems to recover account in case of physical destruction or theft; requires audit procedures.	No, but regulation for the INVESTMENT function concerning the pooled customer deposit funds is given below.	
		e.g., Inaccurate records; Theft; loss of deposits through inadequate INVESTMENT function, see below.								

Component service/function	*Conducted by*	*Risks by service*						*Business Regulation?*	*Prudential Regulation?*	*Implications for inclusion, competition and institutional capacity*
		International	Systemic	Operational	Reputation	Liquidity	Legal			
SAVING (in bank account with payment of interest, linked to electronic mobile money account and transacted on mobile phone only, e.g. M-Shama)	The money payments operator records and backs-up the data for transfers to and from the bank. Bank agents process transactions; the bank records and backs-up the data.			x			x e.g., Inaccurate records	-Covered by existing *Banking Law*.	Yes, but no new regulation is required. Covered by existing *Prudential Regulation* of licenced banks.	
TRANSFERS – DOMESTIC (via electronic accounts, e.g. M-Pesa).	Retail agents process transactions; the money payments operator records and backs-up the transactions data.			x			x e.g., Transmission errors; Accounting errors.	-As above under STORAGE. -Customers access to the system for verification requires pins or passwords for integrity.	Not required for the transfer of money domestically.	1. Implies regulatory verification of account provider systems, policies, procedures and its capacity to comply.
TRANSFERS – INTERNATIONAL (e.g. MoneyGram with M-Pesa)	Processed by money transfer company linked with money payments operator, and data recorded by the money payments operators.	x	x	x	x		x e.g., Transmission errors; Accounting errors; Money laundering; Systemic risks.	-Harmonize mobile financial service definitions across trading and remitting countries in AML/CFT regimes, in context of FATF Special Recommendation VII (SRVII).	-Regulate to allow foreign exchange conversion using mobile financial services, with proportional trader transaction/ remittance size categories. -Normal central bank monitoring of inflows effect on money supply and exchange rate required.	1. Allowing trade and transfer flows permits official recording of flows and sources and destinations of flows. 2. Lower costs for customers will encourage adoption given high demand for remittance flows.
PROVISION OF CREDIT SCORE	Company linked with money payments operator (e.g. Experian)			x	x		 e.g., Errors in score affecting access to credit; Inappropriate disclosure.	- Set disclosure requirements to customer (e.g. FICO, USA; in the US, legislation was enacted only in 2004, see Section 6.1.2).	No. If credit was to be wrongly extended from an inappropriate score, this would have limited, localised consequences.	1. Could limit access to credit and more generally discourage use of credit facility
EXTENSION OF CREDIT (via bank account linked to electronic mobile money account, transacted on mobile phone only, e.g. M-Shama)	The money payments operator records and backs-up the data for transfers to and from the bank. Bank agents process transactions; the bank records and backs-up the data.			x			x e.g. Default; Accounting errors.	-Existing *Banking Law* applies. -As above under STORAGE. -Regulators may wish to monitor interest rates/fees applied to the products and set standards for transparency of services (see Section 3.4)	Yes, but no new regulation is required. Covered by existing *Prudential Regulation* of licenced banks.	
MICRO- INSURANCE (linked to electronic mobile money account, transacted on mobile phone only, e.g. M-Shama).	Insurance company partnered with money payments operator.			x			x	-Existing *Commercial Law*	Not required.	

Component service/function	*Conducted by*	*Risks by service*						*Business Regulation?*	*Prudential Regulation?*	*Implications for inclusion, competition and institutional capacity*
		International	Systemic	Operational	Reputation	Liquidity	Legal			
INVESTMENT of pooled customer deposit funds	Mobile money payments provider pools customers' funds in an account/ trust account/escrow account held at partner bank/s. Money payments operator reconciles daily balances with partner bank. Commercial banks report to the central bank. Mobile money payments provider reports to the central bank. Trustees monitor Trust accounts.		x	x	x	x	x	- Existing bank deposit insurance rules may need enacting or amendment to allow deposit insurance to be paid at the customer rather than the pooled account level. -Regulation on Mobile money payments providers should incorporate insolvency procedures and assure regulatory access to transaction records and trust funds that back items in transit.	-Customers electronic funds should be 100% backed by Trust accounts held in bank/s. -Clear segregation of trust funds covering customer funds from operating funds and assets of the account provider. -Trust accounts should be divisible (to spread risk) and transferable to another Trustee (if trustee fails to perform). - Bank regulation limiting risk concentrations should apply to the size of trust fund/s (percentage of risk-weighted capital). -Trust fund investment policy to protect against impairment of value (avoid marketable securities or short maturity governmt debt), and provide liquidity for cash-out. -Allocate interest income paid on the Trust accounts transparently as Trustees fees, and to the beneficiaries of the Trust (the customers and agents).	1. Requires trust law, and a court system that empowered to enforce trust law and has the requisite capacity. Altern-atively, Escrow accounts have been used to protect funds. 2. Diversification of trust accounts adds complexity for payment providers. 3. Requires periodic reporting by banks/providers to regulators. 4. Regulators require the capacity to effectively monitor and verify reports, and the adequacy of trust funds
		e.g., Systemic risks; Investment failures; Funding concentration risk for Trustee bank/Liquidity risk; Failure to maintain 100% backup of funds, including payments in transit; Trustee failures; Inadequate deposit insurance, or if available, capped at the account level rather than customer level; Mismanagement of interest on funds; Reputational risks; risk of disintermediation.								

Sources: Constructed from various sources: the compact 4 x 3 risk table in Klein & Mayer (2011) motivated the layout; USAID (2010) has a 60 page detailed assessment of risks by player but excludes functions that later developed via mobile money, e.g. credit scores, insurance, savings and credit products, and international remittances.
Notes: Risk definitions are taken from USAID (2010), but slightly modified: **1. Systemic:** A risk that could cause collapse of, or significant damage to, the financial system. **2. Operational:** A risk which damages the ability of one of the stakeholders to effectively operate their business or a risk which results in a direct or indirect loss from failed internal processes, people, systems or external events. **3. Reputation:** A risk that damages the image of one of the stakeholders, the mobile system, or of a specific product. **4. Legal:** A risk which could result in unforeseeable lawsuits, judgment or contracts. **5. Liquidity:** A risk that lessens the ability of a bank or Mobile Money payments provider/agent to meet cash obligations upon demand. **6. International:** A systemic risk that could have cross-border contagion effect.

Table 4: Comparative country regulatory regimes

	Afghanistan	Brazil	Cambodia	India	Kenya	Pakistan	Philippines	S. Africa	Tanzania	Uganda
Members of Alliance for Financial Inclusion 2015 [a.]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Has an enabling regulatory approach 2015 [b.]	Yes	Yes	Regulatory barriers still exist	Regulatory barriers still exist	Yes	Regulatory barriers still exist	Yes	Regulatory barriers still exist	Yes	Yes
Payments system model [c.]	Transform.	Transform.	Additive	Additive	Transform.(M-Pesa) and additive (Eazzy247)	Additive	Transform.	Additive	Transform.	Transform.
Partnership model: bank-led or non-bank-led?	Banks, non-bank financial institutions, or other non-banks governed by their respective rules and regulations.	Non-bank	Bank	Bank. But draft rules aim to license 'Payments Banks', as 'differentiated or restricted banks'.	Non-bank (M-Pesa); and bank/ non-bank partnerships; from 2011, also bank-led (Eazzy247)	Bank (e.g. bank subsidiary wholly owned by an MNO: Telenor and Tameer bank)	Banks, non-bank financial institutions, or other non-banks goverrned by their respective rules and regulations.	Bank, non-bank in joint venture with mobile operator	Non-bank, but must partner with a Bank of Tanzania licensed bank	Non-bank, but must partner with a Bank of Uganda licensed bank
Service provider/s 2015[d.]	M-Paisa, mHawala, My Money	Meu Dinheiro, Oi Carteira, TIM, Multibank, Caixa, Zuum	Wing, ACLEDA Unity, Cellcard	Aircel ICICI Mobile Money,Airtel Money, Alpha Money, Beam Money, BSNL SBI Mobile Money, Eko, Idea Money, M-Pesa, M-Wallet, MoneyOnMobile, mRupee, Oxigen Wallet, State Bank Mobicash, Suvidhaa Money, Union Bank Money	Airtel Money, M-Pesa, MobiKash, Orange Money, PAYG Platform, Tangaza Pesa Mobile Money Transfer, Yucash	Easypaisa, HBL Express, Mobicash, Mobile Paisa, TimePey, UBL OMNI, Upaisa	GCash, SMART Money	Community Banking, FNB eWallet Solutions, M-Pesa, Mobile Money, Mxit Money, WIZZIT	Airtel Money, ezyPesa, Tigo Pesa, Vodacom M-Pesa	Airtel Money, EzeeMoney, M-Sente, MCash, MTN Mobile Money
Licences/letter of no objection from	Licence to payment	Licence to payment	Permission given to bank	Licence banks. Proposal is to	Authorisation certificate to	Authorisation granted to	Non-banks have to	Approval of the Registrar	Letter of no objection	Letter of no objection letter

	Afghanistan	Brazil	Cambodia	India	Kenya	Pakistan	Philippines	S. Africa	Tanzania	Uganda
central bank	service provider	service provider	to outsource payment transactions services third-party processor/s	grant a licence to 'Payment Banks'	payment service provider (MNO)	bank	secure a quasi-banking licence.	of Banks required (Section 52 of the Banks Act) for a joint venture	letter to licenced bank	to licenced bank
Specific mobile money regulations	Money Service Providers General Regulations and Definitions (2008?) (DAB, central bank)	October, 2013 regulations.	Prakas (Rules and Implementing Regulations) on Third-Party Processors (2010)	Mobile payment operative guidelines (2008), amended 2011. Draft guidelines (July 2014).	National Payment System Regulations (August, 2014)	Branchless banking regulations (2008); amended 2011.	Cicular 649, 2009, BSP (central bank)	Position paper on e-money: National Payment System Dept of the SARB in 2009 (NPS 01/2009).	Draft regulations (2012). Legislation will be enacted in 2015.	Bank of Uganda (interim) Mobile Money Guidelines, October, 2013.
Trust law?	Yes	Yes	No. Civil law.	Yes. Common Law	Yes. Common Law.	Yes.	Yes.	Yes. Roman Dutch Law.	Yes. Common Law.	Yes. Common Law.
Trust or Escrow account to safe-guard customer funds	Pooled funds must be diversified in trust accounts across a minimum of 4 banks once total float exceeds AFN 250 million (~ US$ 4.3 million)	Trust account 100% coverage, ring-fenced. Held on account at the central bank and do not form part of the deposit base of the banks.	Pooled funds in licenced bank	Pooled funds in licenced bank. Draft proposal is to ring-fence, liquid assets.	Trust account with 1 or more banks. Ring-fenced, liquid assets. Above a threshold, have to be placed in at least two banks.	Pooled funds in licenced bank	Must maintain unencumb-ered liquid assets, 100% coverage, in bank deposits, certain government securities, or any other liquid asset permitted by the central bank.	By Banks Act, deposits of e-money held in a separately identifiable e-money account for each holder and comply with the Banks Act and its Regulations.	Trust account with a single licenced Bank, 100% coverage, ring-fenced.	Escrow account in the licenced bank. Ring-fenced, liquid assets. BOU may require diversification over several licensed institutions.
Interest paid on trust/escrow account?	Yes, in guidelines. Providers are prohibited from paying	Unclear	Unclear	No. Aim under new rules to pay interest on the value stored in mobile	Yes. Paid to charity. In principle could be allocated by	Presumably. Not clear what happens to it.	Presumably. Not clear what happens to it.	Yes.	Bank of Tanzania Circular (26 Feb.2014): interest	Unclear. Not in guidelines.

	Afghanistan	Brazil	Cambodia	India	Kenya	Pakistan	Philippines	S. Africa	Tanzania	Uganda
	interest to customers, but may keep any interest themselves.			accounts and on government securities, but they are not required to pay it out to consumers.	Trustees according to Trust legislation to beneficiaries of the Trust.				accrued on trust accounts should benefit mobile money customers and agents	
Bank deposit insurance rules 2015 (*= IADI Members [e.])	Yes. Escrow has to be insured.	Yes*	Under study	Yes*	Yes*	Under study	Yes*	Under study	Yes*	Yes*
AML/CFT regulation & compliance 2015 [f.]	Yes, in progress.	Yes, compliant.	Yes, compliant.	Yes, compliant.	Yes, compliant.	Yes, compliant.	Yes compliant.	Yes, compliant.	Yes, compliant.	Yes, but progress deemed insufficient.
Proportionate KYC requirements	KYC observed – unclear if proportionate.	Yes	No	No. Aim to achieve in Draft rules.	Yes	Yes: low-value accounts, but require national ID card.	Yes: but limited: permit providers to wait up to 90 days before verifying certain informatio n.	Yes: low-value accounts, banks do not need verify residential address, tax number, or keep records of ID.	Yes	Yes
Non-bank agent network	Yes, business or individuals.	Yes, any retail establishment ..	Yes, merchant network.	Yes, only cooperatives, non-profit entities, and postal system within 30km radius of bank branch.	Yes; Agent Banking Guidelines (2011) allow banks to use agency networks.	Yes	Yes	Yes, retail outlets, bank branches, and bill payment counters.	Yes	Yes
Legal responsibility for actions of agents	Mobile money service provider.	Mobile money service provider.	Mobile money service provider.	Bank	Authorized payment service provider.	Bank	Licenced provider.	Bank	Mobile money service provider.	Mobile money service provider.
MFS Consumer protection regulation	Yes	Yes	In progress	Yes, but not MFS-specific	Yes	Yes	Yes	Yes	Yes	Bank of Uganda

	Afghanistan	Brazil	Cambodia	India	Kenya	Pakistan	Philippines	S. Africa	Tanzania	Uganda
										Financial Consumer Protection Guidelines
Interoperability of mobile payments [g.]	No	No	WING is connected to all mobile network operators.	No	Yes (April, 2015)	Yes (2014)	No. In preparation for 2016.	No	Yes (2014)	Yes (April, 2015)
Adoption level	Medium	Low	Medium-low, mainly over the counter.	Low to medium.	High	Mainly over the counter.	High	Medium	Medium to high.	Medium to high.
International mobile transfers allowed	Yes, incoming.	No	Yes, via VISA.	No	Yes, several int'l partners.	Yes	Yes	In progress with MTN.	Yes	Yes

Sources: This table also draws on Bilodeau et al. (2011); Cousins and Varshney (2014); Flaming et al. (2013); Di Castri (2013); di Castri & Gidvani (2014); GSMA website.
Notes:
[a.] Members of Alliance for Financial Inclusion.
[b.] Of the 89 markets where mobile money is live, only 47 markets have an enabling regulatory approach, while in the other 42 markets regulatory barriers still exist: http://www.gsma.com/mobilefordevelopment/is-regulation-holding-back-financial-inclusion-a-look-at-the-evidence
[c.] Additive models: append a channel to existing financial services for users. Transformational models are targeted at the unbanked without financial services. Additive models in developing countries can be found in Cambodia, Vietnam and Indonesia.
[d.] See Mobile Money Tracker: appendix Table A1: http://www.gsma.com/mobilefordevelopment/programmes/mobile-money-for-the-unbanked/insights/tracker
[e.] http://www.iadi.org/iadi_members.html (Not clear if insurance is on a pooled basis for these accounts, see Section 10.2.)
[f.] http://www.fatf-gafi.org/topics/high-riskandnon-cooperativejurisdictions/documents/fatf-compliance-february-2015.html
[g.] Interoperability "The ability for customers to undertake money transfers between two accounts at different mobile money schemes, or to transfer money between accounts at mobile money schemes and accounts at banks. To date, MNOs in four markets have interoperated their mobile money schemes." Scharwatt et al. (2015). See also http://www.businesswire.com/news/home/20150420006824/en/Vodafone-M-Pesa-MTN-Mobile-Money-Agree-Interconnect on 2015 interoperability.

Appendix Table A1: Sources for global micro- and macro-tracking of mobile money, and financial inclusion

Organisation	Website/Publication name	Data collected	Coverage	Web Address
MOBILE MONEY				
GSMA (Association representing global mobile operators using GSM (Groupe Speciale Mobile) technology and associated industrial companies (e.g. software companies)	MMU (Mobile Money for the Unbanked) *Mobile Money Deployment Tracker* ***[Online live Database]***	Live and planned mobile money services (for the unbanked) globally, including the providers, name of the mobile money service, its launch date, the financial products offered, and which partners are involved in delivering each service. In 2014, extended to include information on mobile insurance services and mobile credit and savings services. (Data Sources: members of GSMA.)	Live (continuous), by country/region	http://www.gsma.com/mobilefordevelopment/m4d-tracker/mobile-money-deployment-tracker
GSMA	MMU *Global Adoption Survey of Mobile Financial Services* ***[Data by subscription, see below. Summary in Pénicaud & Katakam (2014), Scharwatt et al. (2015) and GSMA (2016a)]***	Standardised operational metrics about mobile money services, self-reported (confidential) through a global survey of mobile money providers. Where sensible, estimates are made to complete the data set (e.g. in 2013 report, numbers of mobile money accounts (both registered and active) are estimated). (Data Sources: confidential surveys.)	Annual survey conducted for Sep-12, Dec-12, Mar-13, Jun-13 and Jun-14 (ongoing). GSMA estimates that it covers the majority of the industry as larger mobile money providers tend to participate each year; in 2014 (2013): 127 (110) participants from 69 (56) countries, about half of the 255 (219) live mobile money services in the world 115 (98) responded on mobile money, 33 (21) on mobile insurance, and 15 (16) on mobile credit and savings).	http://www.gsma.com/mobilefordevelopment/programmes/mobile-money/industry-data-and-insights
GSMA	Mobile for Development Impact ***[Data by subscription, but can sign up for a public account with partial access]***	Market Statistics for mobile money (and other mobile innovations) including competitive structure. Network coverage globally, by type, map. (Data Sources: IMF FAS, MMU Deployment Tracker, UNDR, World Bank.)	140+ developing world countries	https://gsmaintelligence.com/
ICT STATISTICS-COVERAGE AND MARKET DATA				
Groupe Special Mobile (GSM)	GSM World Coverage Map and GSM Country List	GSM Bands information by country	Global, up to date	http://www.worldtimezone.com/gsm.html
Ericsson	*Ericsson Mobility Report*	In-depth data traffic measurements from the early days of mobile broadband	2010-2020, global, regional	http://www.ericsson.com/er

Organisation	Website/Publication name	Data collected	Coverage	Web Address
	June 2014 ***[Traffic Exploration graphics tool]*** ***[Downloadable data]***	from a large base of live networks: internal forecasts, network coverage, current traffic and market trends. Traffic and subscriptions – regional forecasts by device type.		icsson-mobility-report http://www.ericsson.com/TET/trafficView/loadBasicEditor.ericsson
Wireless Intelligence/ International Telecommunications Union (UN specialized agency for ICTs, ITU is the official source for global ICT statistics)	World Telecommunication/ICT Indicators database December 2014 (18th Edition) ***[Limited downloadable data; can buy data]***	Data for more than 150 telecommunication/ICT statistics covering fixed telephone network, mobile-cellular telephone subscriptions, quality of service, Internet (including fixed- and mobile-broadband subscription data), traffic, staff, prices, revenue, investment and statistics on ICT access and use by households and individuals.	Data for over 200 economies. Time series data for the years 1960, 1965, 1970 and annually from 1975 to 2013 Data collected from annual questionnaire, usually from the regulatory authority or the ministry in charge of telecommunication and ICT. Additional data are obtained from reports provided by telecommunication ministries, regulators and operators and from ITU staff reports. In some cases, estimates are made by ITU staff; these are noted in the database. Household data.	http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx
INTERNATIONAL REMITTANCES FLOWS & COSTS OF TRANSFER				
The World Bank	Migration and Development Briefs, World Bank ***[Downloadable data]***	Migration and international remittances flows: data and costs of transferring remittances	Regional and by country	http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTDECPROSPECTS/0,,contentMDK:21121930~menuPK:3145470~pagePK:64165401~piPK:64165026~theSitePK:476883,00.html
The World Bank	Remittance Prices Worldwide ***[Downloadable data]***	Provides data on the cost of sending remittances globally.	Covers 219 "country corridors", including 32 major remittance sending countries and 89 receiving countries, covering over 60% of total remittances to developing countries.	http://remittanceprices.worldbank.org/en
The World Bank	Send Money Africa ***[Downloadable data]***	Provides data on the cost of sending relatively small amounts of money from selected countries worldwide to a number of African countries, as well as within the African continent.	African corridors	http://www.worldbank.org/en/topic/paymentsystemsremittances/publication/the-cost-of-sending-remittances-december-2015-data

Organisation	Website/Publication name	Data collected	Coverage	Web Address
FINANCIAL INCLUSION INDICATORS				
USER (NATIONAL DEMAND–SIDE DATA)				
The World Bank (Bill and Melinda Gates Foundation commissioned; Gallup)	2011 Global Financial Inclusion (Global Findex) Database ***[Downloadable data; graphics]***	Survey of *users* (demand-side data). Measures how adults in 148 countries save, borrow, make payments and manage risk. Includes two questions on mobile phone payments and transfers. Nielsen (2014) comments: "the definition of formal financial services is based on people's perception of whether their provider is a formal financial institution, which is not necessarily aligned with the regulatory and supervisory framework of a country" and that "the sample is randomized at the individual level, which allows users to aggregate the data by individual characteristics, such as income and gender, but this also makes the data incompatible with household-level surveys".	Covers 148 countries for the 2011 survey. The 506 indicators are disaggregated by gender, age, education, income, rural vs urban. Limited usage data on mobile money is included. A 2014 survey with expanded data on payments will be released in April 2015. The following survey will be done in 2017.	http://datatopics.worldbank.org/financialinclusion/
The Center for Financial Inclusion at Accion (CFI)	Mapping the Invisible Market ***[Graphics]***	Navigational tool for the Global Findex data, showing how demographics, economics, fertility, income growth, urbanization, and technology influence financial inclusion. (Data Sources: United Nations Population Division, World Population Prospects: The 2010 Revision; The World Bank, Global Findex database; The World Bank, World Development Indicators 2012.)	As above – view by country, region, income group, and trends over time.	http://www.centerforfinancialinclusion.org/fi2020/mapping-the-invisible-market
USER (HOUSEHOLD OR INDIVIDUAL DEMAND–SIDE DATA)				
FinMark Trust	FinScope SME surveys (first piloted in 2002 in South Africa) ***[Online reports]***	Nationally representative surveys of how small business owners source their income and how they manage their financial lives. The survey looks at owners of micro, small, and medium enterprises, as well as individual entrepreneurs.	FinScope MSME surveys have been implemented in 6 SADC countries; other surveys are being implemented. They are not fully comparable across countries.	http://www.finmark.org.za/category/publications/focus-areas/financial-inclusion/small-micro-and-medium-enterprises/
FinMark Trust	FinScope consumer surveys ***[Online reports]***	Nationally representative surveys of how individual people source their income and how they manage their financial lives and focuses on adults in a particular country.	Conducted in 18 countries (15 in Africa of which 10 are in the SADC region, 3 in Asia). There is no standard definition of "financial inclusion" across surveys.	http://www.finmark.org.za/category/publications/focus-areas/financial-inclusion/information-and-research/
FinAccess	Access to Financial Services Surveys ***[Online reports]*** ***[Data access with permission]***	Nationally representative surveys of how individual people source their income and how they manage their financial lives and focuses on adults in a particular country. They were not conducted by FinMark Trust. For example, the Kenyan FinAcess surveys, conducted in 2006 and 2009, were collected by Financial Sector Deepening Trust Kenya (FSD Kenya), with financial and technical support from the Central Bank of Kenya, donors and commercial banks in Kenya. The 2006 round consisted of ~4,400 individuals, while the 2009 round consisted of ~ 6,600 individuals.	They are not designed for cross-country comparison; and there may be inconsistencies in data quality and incomparability as different entities conduct these surveys. There is no standard definition of "financial inclusion" across surveys. Subsequent waves for Kenya can be	http://www.fsdkenya.org/finaccess/

Organisation	Website/Publication name	Data collected	Coverage	Web Address
			organised into a locational but not a household panel.	
InterMedia, an independent, global consultancy (Bill and Melinda Gates Foundation commissioned)	The Financial Inclusion Insights (FII) program The Financial Inclusion Tracker Study (FITS) ***[Downloadable data]*** Tanzania Mobile Money Tracker Study (TMMTS)	FII produces original data and practical knowledge on demand-side trends in mobile money and other digital financial services mainly for individuals. FITS are tracking awareness, use, drivers and barriers to use, of mobile financial services for households. TMMTS track market trends, mobile money adoption, awareness and use, and drivers and barriers to mobile money expansion.	FII: Bangladesh, India, Indonesia, Pakistan, Kenya, Nigeria, Tanzania and Uganda (shortly from fall 2013 – Nigeria, Kenya, Tanzania, Uganda, Pakistan, India and Bangladesh) (Indonesia data will be added in fall 2014). These surveys are not panel studies. FITS: Pakistan (5000 HH), Tanzania (3000 HH), Uganda (3000 HH), three year panel survey study tracking the same households. Start in early 2012. TMMTS: individual-level quarterly surveys conducted in 2012. (A similar survey was conducted in Haiti in 2011.)	http://finclusion.org/datacenter/ http://www.m-moneydata.org/ http://www.intermedia.org/mobile-money-is-on-an-upward-trajectory-in-tanzania-2/
Gallup (Bill and Melinda Gates Foundation commissioned)	Gallup ***[Online report]***	Payments and money transfer behaviour of sub-Saharan Africans (domestic money transfers, international remittances, government and wage payments, payments for goods and other bills).	Gallup conducted face-to-face interviews with 1,000 adults, aged 15 and older, June-October 2011 in 11 sub-Saharan African countries. Total sample size of 11,000. The coverage area includes entire countries, including rural areas. A 2012 study included Indonesia and six South Asian countries: Afghanistan, Bangladesh, India, Nepal, Pakistan, and Sri Lanka.	http://www.gallup.com/poll/155693/mobile-money-transfers-popular-kenya-tanzania-uganda.aspx http://www.gallup.com/poll/155132/Payments-Money-Transfer-Behavior-Sub-Saharan-Africans.aspx
PROVIDER (NATIONAL SUPPLY–SIDE DATA)				
The IMF, the IFC	Financial Access Survey ***[Downloadable data by country. The complete FAS dataset is available in Excel format]***	Global supply-side financial data (sourced from *providers*) on financial inclusion, encompassing internationally-comparable basic indicators of financial access and usage.	The FAS database contains annual data for 189 jurisdictions, including all G20 economies, covering an 11-year period (2004-2014), totalling 152 time series and 47 key indicators. From 2014, FAS includes indicators for mobile money. Coverage is of prudentially-regulated financial	http://fas.imf.org/

Organisation	Website/Publication name	Data collected	Coverage	Web Address
			service providers only.	
The World Bank	Global Financial Development Database (GFDD) ***[Downloadable data]***	Measures of (1) depth, (2) access, (3) efficiency, and (4) stability of financial systems. Each of these characteristics captures both (1) financial institutions (such as banks and insurance companies), and (2) financial markets (such as stock markets and bond markets). It also provides other useful indicators, such as measures of concentration and competition in the banking sector. (Data Sources: Uses latest available data from Bankscope, Bank for International Settlements, IMF's International Financial Statistics, and World Bank's World Development Indicators.) See Chapter 1 of the 2013 Global Financial Development Report, and also Cihák et al. (2012).	203 economies. Annual data, 1960-2011. The November2013 version of the dataset includes new data for 2011 and adds 37 new indicators relative to the April dataset.	Global Financial Development Database
The World Bank	The World Bank Global Payments Survey ***[Online report 2011]***	A multi-country comprehensive survey carried out by the World Bank's Payment Systems Development Group. Domestic payments, international remittances and regulatory information are covered, and mobile money is a part of this.	139 countries, 2010. The second iteration is adding a retail payments focus.	http://hdl.handle.net/10986/12813
G20 FINANCIAL INCLUSION INDICATORS (DEMAND AND SUPPLY-SIDE)				
Global Partnership for Financial Inclusion (GPFI)	The G20 Basic Set of Financial Inclusion Indicators (endorsed by G20 in Jun-12) ***[Downloadable data]***	Methodology: G20 Basic Set of Financial Inclusion Indicators.pdf Developed by the GPFI's Data and Measurement Subgroup and its Implementing Partners AFI, CGAP, IFC and the World Bank. The Basic Set includes indicators of access to, and usage of, financial services. No mobile money data. (Data Sources: The Global Findex, the IMF FAS, the World Bank's Global Payment Systems Survey, and the Enterprise Survey.)	Summary statistics use data from the most recent year available. The Global Findex and the IMF FAS indicator averages are from 2011, the Global Payment Systems Survey indicator average is from 2009, and the Enterprise Survey average values are calculated using the most recent data for each country.	http://www.gpfi.org/featured/g20-basic-set-financial-inclusion-indicators
GPFI	The G20 Extended Set of Financial Inclusion Indicators (endorsed Sep-13) ***[Downloadable data]*** Website is powered by the World Bank's Data Group.	Methodology: G20 Set of Financial Inclusion Indicators and core and second tier indicators: http://www.afi-global.org/library/publications/mobile-financial-services-indicators-measuring-access-and-usage-2013 Developed by the GPFI's Data and Measurement Subgroup and its Implementing Partners AFI, CGAP, IFC and the World Bank. The Extended Set includes indicators of access to, and usage of, and quality of service delivery (including financial literacy), financial services. One question on mobile money payments. (Data Sources: World Bank data sources are the Enterprise Surveys, the Global Financial Inclusion database (Global Findex), the Global Payment Systems	Summary statistics use data from the most recent year available.	http://datatopics.worldbank.org/g20fidata/ http://databank.worldbank.org/data/views/variableselection/selectvariables.aspx?source=g20-basic-set-of-financial-inclusion-indicators

Organisation	Website/Publication name	Data collected	Coverage	Web Address
		Survey 2010, the Global Survey on Financial Consumer Protection and Financial Literacy, Financial Capability and Household Surveys; and Doing Business. Other data sources are the Gallup World Poll; International Monetary Fund's (IMF) Financial Access Surveys (FAS) and both the SME Scoreboard 2012 and Measuring Financial Literacy survey of the Organization for Economic Co-operation and Development (OECD).)		
Alliance for Financial Inclusion (AFI) (2008 Bill and Melinda Gates Foundation - funded project; with AusAid)	AFI Core Set of Financial Inclusion Indicators on Access and Usage and Second Tier Indicators. ***[Downloadable reports]***	Core Indicators on Access and Usage. Second Tier Indicators include measurement and tools for barriers to access and usage, and the quality dimension of financial inclusion.	Member countries	http://www.afi-global.org/policy-areas/measuring-financial-inclusion
CREDIT SCORES/RATINGS				
EXPERIAN	EXPERIAN Microanalytics	Calculate credit risk for each individual mobile money user using internal MNO data, combining mobile and mobile money usage, in an algorithm.	Commercial application	http://www.e-microanalytics.com/mobile-money-plus/
The World Bank	Global Financial Development Report ***[Downloadable data]***	Dataset provides information on credit reporting systems (credit registries – state-owned and credit bureaus- privately-owned commercial enterprises), building on the Doing Business Indicators database. Credit registry and credit bureau are dummy variables that take a value of 1 if a registry/bureau exists in a country and zero otherwise. In the sample, approximately 45% of countries have a credit registry and 55 percent have a credit bureau.	Latest date is 2010, for 195 countries around the world.	Credit Reporting Database
NATIONAL CENTRAL BANK DATA ON MOBILE MONEY STATISTICS				
Example Bank of Kenya	Central Bank of Kenya Statistical Bulletin ***[Downloadable report]***	Monthly mobile banking transactions: number of agents, number of users, monthly value moved	Aggregate to 2014. (Per mobile phone operator data available directly from the central bank.)	https://www.centralbank.go.ke/index.php/statistical-bulletin
MAPS				
MIX market (funded by The MIX; & Master-Card, the Gates Foundation & others)	The MIX's Geospatial Maps	Geo-spatial supply-side data for MFIs.	Nine countries: Zambia, Uganda, S Africa, Rwanda, Senegal, Peru, Nigeria, Jenya, India and Ragasthan.	http://maps.mixmarket.org/
Fspmaps.com	Fspmaps.com	Geospatial information on financial access points by provider and distance;	Data for Tanzania, Uganda, Nigeria	Fspmaps.com

Organisation	Website/Publication name	Data collected	Coverage	Web Address
(funded by the Gates Foundation; & Spatial Development International)	***[Exportbable graphics] [Own data-sets can be uploaded]***	mobile network coverage; and high-resolution population data including poverty densities.	and Bangladesh; will be adding Kenya and parts of Indonesia and India.	
Microinsurance Network (funded by several groups incl. World Bank)	The World Map of Microinsurance	Data on insurance coverage: a searchable online platform will be launched in Q1 2015.	In prospect.	http://www.microinsurancenetwork.org/world-map-microinsurance

Notes: All these web addresses were last accessed in 2016Q2.