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CAN MOBILE MONEY MAKE A CHANGE WHERE MICROFINANCE DID NOT? ACCESS TO CREDIT IN UGANDA

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MAKE A CHANGE WHERE MICROFINANCE DID NOT? ACCESS TO CREDIT IN UGANDA.

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To resilient outliers

INDEX

1. Introduction

In recent years, many developing countries saw the diffusion of an innovative technology called mobile money. Mobile money allows users to store digital value on an account linked to a SIM card, send this value to other mobile money users (in some cases even unregistered users) and to exchange it for cash by simply visiting a retail agent that needs only to verify the user's identity.

Retail agents only need a mobile phone and a liquidity disposal to provide their service, thus not requiring complex infrastructures and technologies such as ATMs or bank branches. They are therefore much more extensive and widespread. Registered agents in East Africa, for example, are now 1 million and have been increasing exponentially in the last years (GSMA, 2017a).

The so-called mobile money revolution now counts 690 million registered mobile money accounts worldwide: a fast growing market, considering that in 2017 there was an increase of 25% with respect to 2016. These accounts process an average of 1 billion dollars per day through 276 mobile money deployments in 90 countries, of which over 20 percent in 2017 were offering savings, pensions or investment products, with another 37% intending to do so during 2018 (GSMA, 2017a). One of the areas where these technologies have succeeded the most is East Africa: 66 percent of the combined adult population of Kenya, Rwanda, Tanzania and Uganda actively use mobile money; Eastern Africa now counts almost 200 million registered accounts with a total transactions value of 13.2 billion USD in 2017 (ibidem).

Mobile money platforms are offering more and more complex financial services that go beyond the simple peer-to-peer transfers. Whether this innovation can broaden access to credit to a larger share of the population, especially among the most disadvantaged, remains an open question that has not been addressed yet. This thesis tries to provide empirical evidence to give an answer. I exploit a difference-in-difference strategy to estimate the causal impact of the use of mobile money on access to credit among commercial farmers in Eastern Uganda. The results are positive

and statistically significant: owning a mobile money account increases the probability of having an easy access to credit by 4.02 percentage points, which corresponds approximately to a 9 percent increase with respect to the reference (the average of easiness of access to credit for those who did not have a mobile money account when credit services via mobile money were not available). To account for the potential endogeneity of access to mobile money with respect to access to credit, I employ an instrumental variable strategy. The instrument I use is the 3G network coverage: the exogenous variation is correlated to the use of mobile money. The results of the instrumental variable regression confirm the statistically significant positive impact. The coefficient is slightly higher, corresponding to 4.51 percentage points.

Section 2 provides a general background on mobile money use in developing countries and more specifically on the reasons why it should be considered as an important innovation in the credit market. Section 3 is a literature review of the studies that addressed the impact of mobile money on several dimensions. Section 4 illustrates the mobile money financial services offered in Uganda, describing their characteristics in detail. Section 5 shows the data I am going to employ to assess the impact of mobile money use on access to credit. I afterwards show in Section 6 the results I find by exploiting two different empirical strategies: a difference-in-difference and an instrumental variable approach. I finally provide in Section 7 robustness checks and conclude with several policy implications in Section 8.

2. The mobile money revolution

2.1 Access to finance

Lack of access to finance is considered to be one of the most urgent and relevant impediments to economic growth in developing countries. Although this would suggest an unmet demand for credit, the previous experience with microfinance services in low-income countries has been disappointing in terms of take-up rates (Banerjee, Karlan, and Zinman, 2015).

Many different explanations have been provided to interpret the insufficient outreach of microfinance: high expected project risk and low profitability (Attanasio, Augsburg, and De Haas, forthcoming), lack of information on financial products (Banerjee, Chandrasekhar, Duflo, and Jackson, 2013), high interest rates (Karlan and Zinman, 2008).

Another fundamental barrier that should be taken into account are long, time- consuming and cumbersome procedures required to have access to credit, which can represent both direct and opportunity costs: what we can define as transaction costs (Bencivenga, Smith, and M., 1995). An example, particularly relevant in not-easily reachable geographical areas, is represented by the travel and time costs to reach the nearest bank branch or microcredit institution. The relative expenditure for microfinance transaction costs of rural households has been estimated to be much higher than the one for their urban counterparts (Dehem and Hudon, 2013) - 2.5 per cent of total consumption compared to 1.2 per cent respectively.

Transaction costs, therefore, can substantially hinder access to credit for agricultural households and entrepreneurs in developing countries, which typically represent a very large share of the population. Microfinance institutions today tend to target urban or semi-urban areas, while servicing the clients of rural areas remains an open challenge of the sector (Armendariz and Morduch, 2010).

Another type of transaction cost is corruption: in particular, staff members of subsidized institutions offering below-market credit often require bribes from potential borrowers (Robinson, 2001).

2.2 Mobile money

"Footprint" of households that are normally excluded from the banking and financial services market. This innovative borrower scoring can overcome an important obstacle to credit supply for the poor: the provision of collateral.

Chen and Faz (2015) estimated that using unconventional data to build new credit scoring consistently reduced the cost of providing microloans: for example, in Tanzania a loan of USD 200 costed 30 per cent less thanks to this technology.

Moreover, they can avoid traditional microfinance schemes of joint liability that incentivize repayment of loans but have been shown to have sometimes worrying consequences in generating excessive social pressure and discouraging reliable clients (Gine and Karlan, 2014).

2.3 Advantages to customers

Digitization stimulates the development of more and more innovative financial products that involve ongoing and dynamic interactions between lender and borrower. The recorded financial history, enriched by mobile phone use data, basically allows to reduce asymmetric information and improves transparency.

Loans are disbursed immediately after using specific USSD[1] codes through the personal device which allow to browse the available services via mobile money, choose the credit services, check the

[1] USSD (Unstructured Supplementary Service Data) is a communications protocol GSM cellular telephones use to communicate with computers of the mobile network operator. It is also called Quick codes" or "Feature codes" and it must be simply typed and called like a telephone number.

loan limit (the maximum amount of money that can be borrowed), the fees and interest rates and finally perform the request 1.

The rapidity of the disbursement is also due to the previously mentioned automatisation of the borrower scoring, that avoids in-person interviews and paperworks filling out. The loan limit is automatically computed based on personal data. This rapidity in loan approval and disbursement can be greatly helpful in cases of income shocks. This feature is in vivid contrast with respect to traditional microfinance institutions, that normally use complex procedures to assess the productivity of investments for which the loans are requested.

Mobile money loans are generally microloans. For example, MTN Ghana allows to borrow up to 1,000 GHC, which corresponds to approximately 250 USD; Tala and Branch in Kenya offer loans of 50,000 KES maximum, which can be converted to approximately 500 USD. In Nigeria, it is possible to borrow 200,000 NGN with ALAT, which corresponds to around 550 USD, and up to 1 million NGN with Paylater, approximately 2,750 USD. An exception is the famous KCB M-Pesa service by KCB and Safaricom, which offers loans that can reach 1 million KES, almost 10,000 USD.

Moreover, being protected by the PIN code of the device, mobile money represents a great improvement in terms of safety from thefts when compared to cash (Wright, Tekin, Topalli, McClellan, Dickinson, and Rosenfeld, 2017), especially when relatively large amounts of money are borrowed. The risk of theft is obviously reduced, also thanks to the fact that the value stored in this manner is less visible. This factor incentivizes both the number and value of transactions across different geographical areas.

These elements may lead in the future to uncollateralised credit to play a significant role not only for temporary risk management and private consumption of individuals and households, but also for microcredit to small and medium-sized enterprises.

2.4 Disadvantages

It is worth noticing how the interest rates required by these services nowadays available in the market are typically quite high and the periods of repayment quite short (many of the previously mentioned services impose 30 days of time for repayments). Credit scoring is generally used to put a limit on the maximum amount of money that can be borrowed, rather than to adapt the interest rate.

Another possible pitfall to consider is the effective comprehension and knowledge of mobile money users with regards to the digital credit service and its contractual terms (Banerjee et al., 2013), given the fact that there is basically no human interaction that may address specific doubts of the borrower. Lack of confidence relating to technology and skill in the use of mobile devices may constitute relevant barriers to the diffusion of mobile money schemes especially among the poor and less literate (Liberoff and Horn, 2011).

The absence of human interaction could engender another issue: microfinance institutions typically organize frequent face-to-face meetings with borrowers that exert social pressure and provide useful financial advice that can significantly improve rates of re-payment. If this is true, the disintermediation mobile money technology creates could make the service less viable and prevent its development.

In addition to this, even if mobile money services seem to have an impressive comparative advantage with respect to traditional banking and financial services when it comes to rural areas, it is also true that providers still consider rural markets as relatively untapped commercial opportunities (GSMA, 2017a).

To sum up, while m-transfers and mobile financial solutions may reach more easily the poor when compared to traditional schemes, there are hurdles to be overcome for mass adoption, and valid concerns to be faced for mobile banking to mature as an industry (Liberoff and Horn, 2011).

Whether mobile financial services can broaden access to credit and in particular microcredit in low-income countries, notably in rural areas, thus, remains an open question that needs to be addressed.

3. Literature Review

An increasing and recent body of literature has investigated the impact of mobile money on several economic outcomes of interest for both households or individuals and firms.

3.1 Impact of mobile money on consumption and investments

Some authors have studied the effect of mobile money use on consumption patterns and poverty. In a path breaking study, Jack and Suri (2014), showed how mobile money adoption significantly increases consumption smoothing: this, they argued, has been made possible not due to liquidity effects that the platform may enable, but thanks to improved risk sharing in face of negative shocks through remittances coming from a wider network of sources. As a matter of fact, rural users seem to be the ones enjoying a larger impact on income and a better allocation of consumption, since they usually heavily depend in developing countries from remittances coming from their relatives working in urban areas (Morawczynski and Pickens, 2009).

Suri and Jack (2016) also found that the use of mobile money caused changes in financial behaviour: access to mobile money incentivized savings and financial resilience, improving the efficiency of the allocation of consumption over time. In the meanwhile, adoption of mobile money seems to have had an impact on labour market outcomes as well, in particular for female-headed households: occupational choices have increasingly changed from the agricultural sector to business. Women enjoyed an increased financial autonomy from their husbands thanks to their personal devices. These effects resulted in a meaningful reduction of poverty in Kenya (2 percent of Kenyan households were lifted out of poverty).

The two authors had also previously found evidence of how the famous Kenyan mobile service, M-Pesa, improves the investment

in, and allocation of, human capital by making it easier to send remittances across large distances. Specifically, the young are more likely to invest in skills enabling them to gain high returns thanks to high-paying jobs in distant locations (urban areas), either on a permanent or temporary basis (Jack and Suri, 2011).

Aker, Boumnijel, McClelland, and Tierney (2016) used a randomized experiment to show evidence of the benefits of using mobile money to deliver cash transfers. They estimated large positive effects on diversity and protein and energy richness of recipients' diets. They argued this effect is due to time savings and transaction costs reduction, since m-transfer households spent less time travelling and waiting for their transfers, but also thanks to increased intra-household bargaining power of women, that have gained greater financial autonomy. In addition, the available time was used by recipients to engage in other productive activities: their households were more likely to cultivate crops that are primarily grown by women.

3.2 Impact of mobile money on the credit market

Other researchers addressed the relationship between m-transfer systems and traditional financial systems questioning whether and under what conditions mobile money applications can foster financial inclusion and extend financial services to the poor.

Indeed, thanks to the specific features I mentioned, the m-transfers ecosystem seems to have a comparative advantage in terms of accessibility. Moreover, branchless banking can obviously avoid relevant fixed costs and offer more convenient prices to financially underserved individuals when compared to traditional banking. It is not obvious, how- ever, whether mobile money systems can be considered as substitutes for traditional banking or can instead promote it.

Batista and Vicente (2013) ran a randomized controlled trial in rural villages of Mozambique, where the intervention included the

hiring and training of one mKesh (local mobile money service) agent per each of the treatment areas, community meetings where mobile money tools were explained to the local population, and a set of individual dissemination activities such as registration with mKesh and experimentation of several mKesh functionalities. As a result, they found evidence of increased financial literacy and willingness to send remittances, but there seemed to be no impact on savings. However, they also found that adoption of mobile money substituted the use of traditional methods for both savings and transfers (cash).

Mbiti and Weil (2015) argued that the famous Kenyan mobile money service, M-Pesa, severely challenged not only informal competitors in the money transfer market, but also formal ones like banks or Western Union, rapidly gaining a dominant position within two years of its inception. The increased competition forced money transfer companies to improve their products and services while lowering prices. Therefore, mobile money fostered access to finance not only directly, but also indirectly.

Additionally, the authors found that M-Pesa adoption had a strong positive association with bank use and formal savings. The authors claimed that the relationship is causal: M-Pesa dramatically increased the proportion of banked individuals in the country. This may bring evidence of a sort of complementarity between formal banking and innovative mobile technologies. Their estimates also show a negative and statistically significant impact of M-Pesa on informal saving mechanisms such as ROSCA (rotating saving and credit associations) and the use of secret hiding places for money. Therefore, it seems to be the case that mobile money dominates informal financial tools, probably due especially to the higher security.

3.3 Impact of mobile money on firms

Another research stream focuses not on individual use of mobile money, but rather on its adoption by private firms. Islam, Muzi, and Rodriguez Meza (2018), for example, showed a positive relationship between firm's adoption of mobile money and investments, specifically purchase of fixed assets. The reasons behind this relationship are considered to be the dramatic reduction in transaction costs, increase in liquidity and improvement of credit worthiness thanks to mobile phone financial services. Moreover, they found that the firms enjoying greater benefits are small and medium-sized enterprises.

Mbiti and Weil (2015) found a statistically significant and positive impact of M-Pesa on employment, which is also considered by authors as a proxy for economic activity in general. In particular, the result is driven by farm employment. This may be due to the increased resource flows coming as remittances to the rural areas, thus boosting the demand for labor and increasing employment. As a matter of fact, salary disbursement is claimed to have been a big driver of consumer adoption and transaction volume in mobile money ecosystems such as M-Pesa in Kenya and EasyPaisa in Pakistan, according to Mas and Sullivan (2011).

Blumenstock, Callen, Ghani, and Koepke (2015) implemented a randomized controlled trial in Afghanistan that was designed to increase adoption of mobile money. The intervention was a mobile salary payment program: a large firm had to switch the payments of regular salaries to a random subset of workers in mobile money rather than in cash. The transition had an immediate, positive and statistically significant impact on the employer thanks to the new ability to effectively shift the costs of managing the salary supply chain to the mobile phone operator: the cost savings mostly went to the firm, rather than to employees.

Kikulwe, Fischer, and Qaim (2014) showed how more frequent and generous remittances thanks to mobile money adoption increase incomes of rural households both directly and indirectly. The support they give on the ability to reduce risk and overcome

liquidity constraints promotes agricultural commercialization. They found suggestive evidence that mobile money could foster market access and promote rural development: mobile money users were found to apply more purchased farm inputs, market a larger proportion of their output, and have higher profits than non-users of this technology.

3.4 Impact of mobile money on macroeconomic dimensions

Mawejje and Lakuma (2017), in a pioneering study, gave a contribution to the very scarce macroeconomic literature on the subject by estimating the macroeconomic impacts of mobile money in Uganda by using SVAR - Structural Vector Autoregressive methods. They found moderate positive effects on monetary aggregates, on the sector credit and on the consumer price index. In addition to this, they also argued that deposits on mobile money accounts respond to changes in monetary policy.

The final recommendation they give is for policy makers to design a regulatory framework enabling mobile money balances to become interest-bearing assets: this, they argue, will allow economic agents to directly respond to changes in the policy rate, thus further strengthening the monetary policy transmission mechanism.

3.5 This thesis contribution to the existing literature

Since the early diffusion of M-Pesa in Kenya, a small but active group of scholars from several disciplines has examined the role of mobile money in the lives of its users (Blumenstock et al., 2015). However, despite a general interest and enthusiasm both in the academic and business sector in the potential for mobile money to impact the lives of the poor, there is room for more empirical evidence to substantiate these claims, especially when it comes to

the effect on firms, notably agricultural entrepreneurs in rural areas.

This thesis in particular wants to address a question to which no answer has been provided yet: do rural households owning small activities, like commercial farmers, have easier access to credit when credit services via mobile money are available where they live?

4. Mobile money technology and credit services in the Ugandan context

4.1 Ugandan banking and financial industry

I will focus on the context of a particular developing country in Sub-Saharan Africa: Uganda. According to the Financial Access Survey of the International Monetary Fund (IMF, 2018), in 2017 in Uganda 36.43 per cent of inhabitants owned a deposit account in a commercial bank, while only 3.41 per cent owned a loan account. Moreover, there were only 2.58 commercial bank branches and 4.06 Automated Teller Machines (ATMs) per 100,000 adults, mostly concentrated in the capital Kampala (IMF, 2017).

Although deposits in commercial banks increased in recent years, both in absolute numbers and in terms of percentage over GDP (17.53 per cent in 2017), it is true at the same time that borrowers at commercial banks have decreased from 3.14 per cent in 2016 to 2.99 per cent in 2017; outstanding loans have decreased as well: they corresponded in value to the 13.84 per cent of GDP in 2016 while they were the 13.3 per cent in 2017. The traditional credit market in Uganda, therefore, seems to be experiencing a decline.

4.2 Ugandan mobile money industry

If we consider the mobile money industry, instead, numbers seem much more promising. Registered mobile money agent outlets according to the Financial Access Survey of the IMF were 175.6 times the ATMs in the country (712.95 per 100,000 adults). Mobile money transactions are dramatically increasing in the last years, more than doubling from 2013: in 2017 they were 48,461 per 1,000 adults. According to the Global Findex Database (Demirgu¨ ̧c-Kunt and Hess, 2018), 50 per cent of the adult population in Uganda in 2017 owned a mobile money account: this percentage was considerably higher with respect to the previously cited percentage of adult population owning a traditional bank account.

It is worth mentioning that the share of women owning a mobile money account was found to be not statistically different from the share of men owning it; moreover, there was no particular evidence of a difference with respect to age groups either. The technology, thus, seems to be particularly inclusive.

The report shows as well that 32 per cent of agricultural payments recipients reported receiving them into an account rather than cash, in the vast majority mobile money accounts. 33 per cent of people in Uganda use semiformal methods to save money, such as ROSCAs and savings clubs, and not formally through financial institutions; even in the case of bank account owners, 20 per cent of them save semi formally.

According to the Uganda National Household Survey of 2016-2017, 70 per cent of households living in rural areas know mobile money, and they use mobile money as a saving mechanism more than commercial banks (Ugandan Bureau of Statistics, 2016-17).

Uganda's communications sector is considered to be one of the fastest growing sectors in the country, due to the rapid expansion of mobile telephony. For the mobile industry to emerge, the legal framework does not need to be particularly sophisticated; nevertheless, some features seem to be key for its fruitful development: the regulatory environment should allow (or not explicitly forbid) non-bank financial institutions to issue money, and an electronic signature law should allow the development of retail payment services (Gutierrez and Choi, 2014).

4.3 Mobile money credit services in Uganda

The largest telecom company in Uganda is MTN Uganda, with 11.2 million subscribers, accounting for 55 per cent market share, as of 30 June 2017.

MTN Uganda has released in the late 2016 a micro-savings and loans product called "MoKash", enabling every MTN customer, without requiring any particular prerequisite, to borrow and save money through their mobile money wallet. Customers don't need to

have a bank account, nor to visit any office or to fill any form. The only requirement is to be a registered MTN Mobile Money active customer. In order to have access to the service, an internet connection is not needed: the customer simply has to dial a USSD code on his device, which does not need to be a smartphone. The activation of the account is free.

The minimum a customer can save on their MoKash account is 50 Ugandan shillings - which in the end of 2016, when the service was launched, corresponded approximately to 0.014 USD - up to any amount.

The minimum a customer can borrow, instead, is UGX 3,000 (0.89 USD), while the maximum is UGX 1,000,000 (296.73 USD) depending on a personal loan limit. The credit limit is computed based on a customer's usage and utilization of all MTN services and is also influenced by how long the customer has been on the MTN network. The fee is constant across borrowed amounts and different customers and is equal to 9 per cent. The loans are repayable in 30 days.

A few months later, in March 2017, the second largest telecom company in the country, Airtel Uganda, launched its own micro-credit service. It is called Wewole and has similar features to MoKash. It is accessible to any active customer of Airtel Money from more than 6 months. In this case as well, the loan limit depends on transactions history of the customer on the Airtel Money platform itself. However, Wewole only allows to borrow between UGX 8,000 (2.37 USD) and 500,000 (148.37 USD).

A fundamental aspect to highlight is the fact that both services do not require any type of collateral for borrowing money. They only rely on an algorithm based on trans- actions performed on the platform itself to establish the maximum possible amount the customer can borrow. The interest rate, instead, is fixed and not varying over individual characteristics of the borrower. This is also due to the fact that the additional amount of money that has to be paid back is not officially recognized as an interest rate but as a fixed "facilitation fee".

5. Data

5.1 Survey Data

I employ original data by a team from Stockholm University and Bocconi University, which I was part of, for a research project regarding credit constraints and capital mis-allocation in agriculture. The team conducted two censuses in rural areas in the Eastern part of Uganda - particularly around Mbale and Tororo - collecting detailed information at the household level: one survey round was in the end of 2016 and the other in mid 2017. It is important to underline that these are not the baseline and follow-up of an experiment, and therefore there should not be concerns about any confounding effect of an experiment on our results.

The dataset contains socio-economic data on 10,664 small commercial farmers. The information is organized in four sections. We firstly have individual-level data on the respondent, in most cases the head of the household, such as his or her gender, age, education and occupation. The second section includes questions on the agricultural activity of the household such as the commercial nature of the activity, the amount of land owned by the household, the types of crops cultivated and the revenues from the sales of crops. The third section regards investments in technologies that increase productivity, such as the use of fertilizers, pesticides and so on. The last section concerns financial inclusion and it contains information on the ownership of a mobile money account and of access to credit.

Table 1 shows summary statistics of the main variables from the dataset. The average age of respondents is considerably high relative to the average age of Uganda, which has one of the youngest populations in the world. This is probably due to the fact that we normally interviewed the head of the household or the wife. Considering the dummy for gender, which is equal to 1 if the respondent is a male and 0 if the respondent is a female, we can observe in fact that the observations seem to be equally distributed. The average household size is 5.4, which is larger than the average

household size in the country according to the Uganda National Household Survey of 2016-2017, around 4.7 (Ugandan Bureau of Statistics, 2016-17).

The mean of owned land corresponds to approximately 2.4 acres, meaning that the largest part of our observations is constituted by small commercial farmers. The mean revenues of the last 6 months period are extremely low as well: 405,301.2 UGX corresponded to approximately 120 USD. However, they have a very large variance: the minimum declared is 0 while the maximum reaches 9 million and a half UGX, which can be converted approximately to 2,600 USD.

The following variables give us more information about our topic of interest, mobile money use. First of all, it should be noticed how a very large part of the interviewed farmers own a mobile money account: slightly more than half of them, precisely 52.1 per cent. They perform 3.062 transactions on average, but there are also respondents that perform a very high number of transfers via mobile money, with a maximum of

100. The final two variables will be considered as outcomes of interest in this thesis. A very large proportion of observations declare that it is easy for them to borrow 30.000 UGX, which corresponded to slightly less than 10 USD: 88.7 per cent of them. Less observations, however, find it easy to borrow 300.000 UGX, slightly less than 100 USD: 59.5 per cent of them.

Table 1
Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Gender	23,072	.472	.499	0	1
Household size	23,072	5.412	2.775	1	27
Owned land (acres)	22,991	2.419	2.696	0	80
Revenues of the last 6 months (UGX)	8,137	405,301.2	613,544.5	0	9,500,000
Mobile money account	10,640	.521	.5	0	1
N. of transactions via mobile money	5.491	3.062	2.884	0	100
Easy to borrow 30.000 UGX	10,644	.887	.316	0	1
Easy to borrow 300.000 UGX	10,644	.595	.491	0	1

5.2 Network coverage: the instrumental variable

In order to assess whether mobile money services are available to the whole population taken into consideration, I use restricted access data offered by Collins Bartholomew to map network coverage.

I display in Figure 1 the coordinates of observations in our censuses (the white dots) and the network coverage in 2017. The grey areas are the ones covered by GSM network, while the red areas are also covered by 3G network.

We can observe that GSM network has a universal coverage in the considered area, while 3G network (however, not strictly necessary for the use of mobile money, as already stated) is not available everywhere.

Nevertheless, it is worth mentioning that only half of network operators in Uganda have provided Collins Bartholomew with their network coverage data: therefore, what is shown in Figure 1 is most certainly a partial picture of actual coverage. However, we can

assert that at least 41 per cent of our sample is reached by the 3G network.

These data on network coverage are used not only to check that mobile money services can reach customers residing in the considered area of Eastern Uganda, but also as an instrumental variable for mobile money use in an empirical strategy that will be exploited to address endogeneity issues.

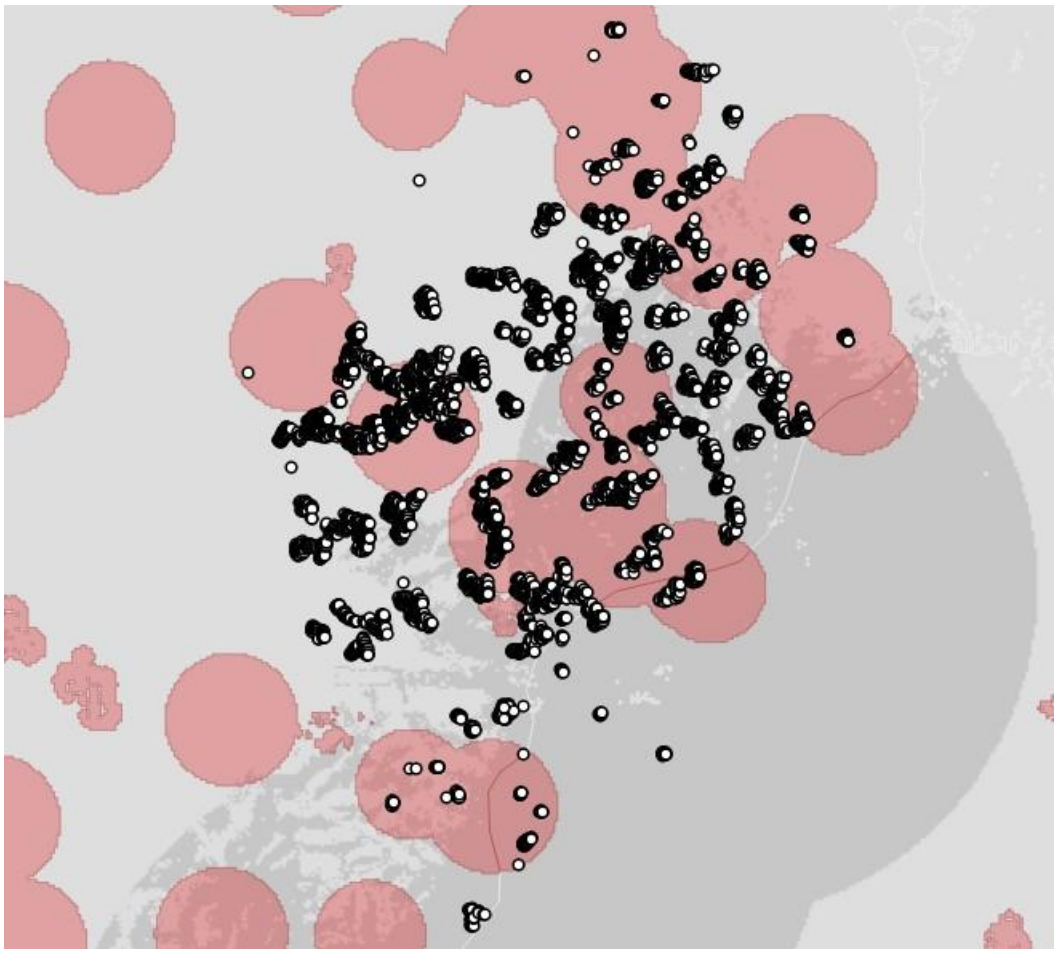

Figure 1

Observations' coordinates (white dots) and network coverage: GSM in shades of grey and 3G in red

6. Results

I aim to study the impact of the introduction of credit supply via mobile money on inclusion in the credit market of underserved or unserved small commercial farmers in a developing country context. Specifically, I am going to assess whether the availability of credit services through e-money wallets increases the perceived access to credit market by farmers themselves. In other words, did ”MoKash” by MTN Uganda and ”Wewole” by Airtel Uganda give a chance to a larger audience to have easy access to credit? In particular, were they able to offer a service capable of reaching the bottom of the pyramid, meaning rural and remote areas of the country?

The outcome of interest is the answer to the question ”How easy would it be for you to borrow 300.000 UGX?”: the value 1 corresponds to possible, while value 0 corresponds to not possible. The amount of money, which corresponded to slightly less than 100 USD, is the average monthly income in rural areas in Uganda during the period 2016-2017 (Ugandan Bureau of Statistics, 2016-17).

Using this variable from the survey as an outcome variable means focusing on perceived access to credit. As a matter of fact, supply-side factors may change in the considered environment, without financial consumers realizing financial services supply improvements, especially in rural areas. With respect to credit rationing, Stiglitz and Weiss (1981) argue that discouragement to access to finance has more important implications. This outcome variable captures the perception rural farmers have of the possibility for them to have access to credit, or in other words their own personal experience of the credit market, without making distinctions based on the formality.

It should be also noticed that 300.000 UGX is an amount of money that can be borrowed through both credit services offered by MTN Uganda and Airtel Uganda, as previously mentioned.

6.1 Difference-in-difference strategy

The detailed data I have from two different points in time - before and after the introduction in Uganda of credit services based on mobile money - allow me to consider a difference-in-difference strategy as a valid candidate to estimate the causal impact of mobile money use on access to credit.

I start by analysing a 2x2 table with average proportions of individuals who state that they have access to credit classified into four groups resulting from the combination of two dummy variables: Treated, that takes value 1 if the individual has a mobile money account and 0 otherwise, and Post, which corresponds to 1 for year 2017, when the credit services through e-transfers were made available to the public, and 0 for year 2016, when they were not yet available. However, as I have also information on the number of transactions performed through the mobile money account, I do not consider those who performed 0 transactions in the last year as users and I simply exclude these observations from our sample.

Table 2

Difference-in-Difference

	Treated=0	Treated=1	Difference 2
Post=0	0.44	0.67	0.23***
	(0.4966)	(0.4702)	(0.0151)
Post=1	0.48	0.75	0.27***
	(0.4997)	(0.4323)	(.0118)
Difference 1	0.04***	0.08***	0.04**
	(.0137)	(.0129)	(0.0191)

In Table 2 we can observe how access to credit has increased in time for both mobile money users and non-users, but for mobile money users it increased more. As a matter of fact, non mobile money users had a probability of having access to credit of 44 per cent in 2016, which increased by 4 percentage points the following year; the probability of having access to credit was already higher in 2016 for mobile money users, corresponding to 67 per cent, but it increased by a greater amount in 2017, reaching 75 per cent. The difference in difference amounts to 4 percentage points and it is statistically significant at the 5 per cent level.

I estimate a difference-in-difference regression that includes controls:

$$Credit = \alpha + \beta_1 Treated_i + \beta_2 Post_t + \beta_3 Treated_i * Post_t + \gamma X_{it} + s_{it} \quad (1)$$

The coefficient of interest is of course the one of the interaction term ”Treated*Post”. I include in the study other specifications that involve other variables to control for which might be correlated with both access to credit and use of mobile money. I control for variables such as age, highest level of completed education and owned land by the respondent’s household, which can be interpreted as the ability to provide a collateral. I also control for a wealth index corresponding to a principal component analysis score that takes into account the ownership of durable goods that can typically be owned by agricultural farmers such as a wheelbarrow, a watering can and a sprayer.

Indeed, they are time-varying factors that could directly or indirectly affect easiness to access to credit over time. As I will discuss more thoroughly later, mobile money users, with respect to non-users, might be able to increase their wealth more rapidly and therefore have easier access to credit, or there might be a self-selection into treatment based on time-varying individual characteristics such as literacy and education that are linked to easiness of access to credit as well. This could create an endogeneity issue that I will address later.

The results from different specifications are hereby shown in Table 3 along with standard errors robust to heteroskedasticity.

Table 3
Multivariate regression: mobile money and access to credit

How easy would it be to borrow 300,000 UGX?

	(1)	(2)	(3)	(4)	(5)
Treated Post	0.0400**	0.0461**	0.0464**	0.0411**	0.0402**
	(0.0191)	(0.0189)	(0.0189)	(0.0187)	(0.0187)
Treated	0.229***	0.174***	0.172***	0.163***	0.158***
	(0.0149)	(0.0152)	(0.0152)	(0.0151)	(0.0151)
Post	0.0408***	0.0396***	0.0371***	0.0322**	0.0325**
	(0.0137)	(0.0136)	(0.0136)	(0.0134)	(0.0134)
Education		0.0209***	0.0223***	0.0185***	0.0171***
		(0.00118)	(0.00120)	(0.00123)	(0.00124)
Age			0.00148***	0.000283	0.0000691
			(0.000303)	(0.000317)	(0.000317)
Owned Land				0.0202***	0.0185***
				(0.00202)	(0.00196)
Wealth Index					0.0335***
					(0.00397)
Constant	0.441***	0.340***	0.273***	0.289***	0.315***
	(0.00979)	(0.0112)	(0.0174)	(0.0174)	(0.0178)
Observations	10661	10661	10657	10653	10634
R-squared	0.0756	0.0995	0.101	0.119	0.123

Dependent variable: 1 if access to credit is possible, 0 otherwise. Robust standard errors in parentheses.

* p<0.1 ** p<0.05 *** p<0.01

First of all, it is worth noticing how considerable in both magnitude and statistical significance is the difference of access to credit for mobile money active users with respect to those who do not use it, ceteris paribus. The coefficient of the interaction term Treated Post is 0.0402 in the specification where more controls are included, significant at the 5 per cent level. This implies that owning a mobile money account increases the probability of having access to credit by 4.02 percentage points, which corresponds approximately to a 9 per cent increase with respect to the constant (the average of easiness of access to credit in 2016 for those who did not have a mobile money account) if we consider the last specification, which controls for more factors.

We can observe, as well, the control variables' coefficients. First of all, highest level of completed education seems to be positively associated with access to credit. When age is included in the specification, there is a statistically significant positive association with the dependent variable; however, the coefficient looses its significance when I include the amount of land owned as an additional control. Therefore, the coefficient of the variable age probably suffered from an omitted variable bias, which is confirmed by the fact that it is positively correlated with acres of land owned.

Comparing Table 2 and Table 3 it can be noticed how the magnitude of the coefficient of interest does not vary significantly across specifications with more controls. This means that the observable variables included seem not to be correlated with the interaction term, which does not result to be inflated by them. This is also confirmed by the fact that the coefficient of interest does not vary substantially across different specifications in Table 3.

The above identification strategy relies on the parallel trend assumption, that is, in absence of the availability of credit services through mobile money wallets, the evolution in time of access to credit for both users and non-users of mobile money would have followed the same trend. However, this is a strong assumption that must be tested: as a matter of fact, different kinds of potential endogeneity might arise.

6.2 Threats to validity

First of all, mobile money use can be interpreted as a more active use of mobile phones that can be both cause and consequence of a richer network of social contacts. Therefore mobile money users might increase their ability to borrow money more than their non-users counterparts, for example thanks to the fact that they strengthen their social networks more rapidly over time.

It should be highlighted, indeed, that the outcome variable, concerning access to credit, does not distinguish the formality of credit itself: it can be the case that their ability to borrow is increased by the availability of friends willing to lend money.

Secondly, the perceptions of access to credit may improve more rapidly with respect to non-users because their revenues might have increased substantially thanks to, say, more clients reached by mobile phone. In addition to this, it might be the case that mobile money allows to improve consumption smoothing and to invest more in durables and technologies that might improve their farms' productivity, resulting in turn in more access to credit thanks to an increased income.

Even though I presented results of the difference-in-difference regressions with time- varying controls such as education, age and owned acres of land, it might be the case that adoption of mobile money is driven by unobservable characteristics: if this self-selection into treatment is due to time-varying characteristics, this might threaten the validity of our impact assessment. One example is the willingness to take up technologies in their commercial activities, which might be correlated with easiness of access to credit through income.

Finally, the presence of retail agents, which is correlated with the adoption of mobile money, might not be random, but instead correspond to a company strategy that is informed on household and village characteristics. However, in the literature on mobile money, several authors have shown how the selection bias of agents density with respect to villages and household characteristics is likely to be very low if not completely absent (e.g. Aron, 2017).

6.3 Instrumental variable strategy

An exogenous variation that can be exploited in order to assess the impact of use of mobile money on access to credit is network coverage. Even if internet access is not necessary to use this technology, it can significantly improve the user experience thanks to dedicated applications on smartphones.

I perform a spatial join between the coordinates of observations recorded in 2017 and the areas covered by the 3G network, allowing us to know which of the households live in an area that is covered by network and which does not, as shown in Figure 1.

Since all observations are located in a very limited buffer around network areas - the longest distance recorded between one observation and covered area is around 10 km - we can easily suggest that living in an area that is covered or not in our sample is basically random and therefore the network can be considered as exogenous.

Table 4

Statistical differences between covered and uncovered areas by 3G Network

	(1)		(2)		(3)	
	Not Covered		Covered		Difference	
	Mean	St. Deviation	Mean	St. Deviation	Difference	St. Error
Male	0.512	(0.500)	0.502	(0.500)	0.010	(0.013)
Age	41.622	(14.951)	42.130	(14.456)	-0.509	(0.379)
Land owners (acres)	3.445	(3.272)	3.583	(3.687)	-0.138	(0.088)
Total revenues of the year (UGX)	990186.094	(1716673.790)	1042661.781	(2228929.163)	-52475.686	(53323.528)
Use of fertilizer	0.094	(0.292)	0.100	(0.299)	-0.005	(0.008)
Use of pesticide	0.375	(0.484)	0.397	(0.489)	-0.023*	(0.012)
Use of watering can	0.105	(0.307)	0.118	(0.323)	-0.013	(0.008)
Use of whealbarrow	0.009	(0.299)	0.111	(0.315)	-0.013	(0.008)
Use of sparyer	0.137	(0.344)	0.151	(0.358)	-0.014	(0.009)
Observations	3803		2532		6335	

Sample Means with Standard Deviations in parentheses and Difference in Means with Standard Errors in parentheses

* p<0.1 **p<0.05 *** p<0.01

In order to support this claim, in Table 4 I show the means of several dimensions by dividing the sample in two subcategories: the units that live in areas covered by 3G network and those that do not. I also show whether the differences between averages across these two groups are significantly different from zero. It can be easily seen how there are no statistically significant differences, except the use of pesticide, at 10 per cent level; however, the difference is very small - 2 percentage points with respect to a baseline of 38.

Both groups are equilibrated with respect to the gender of the respondent: approximately half of them are male and half female in both covered and uncovered areas. The mean of the age of the respondent is around 42 years for both groups; the owned land is very similar too, across groups, around 3 acres and a half. The total revenues of the last six months are around 1 million UGX. Considering the agricultural techniques used by farmers, we can observe how around 10 per cent of the respondents use fertilizers, almost 40 per cent of them use pesticides, around 10 per cent use watering cans and wheelbarrows and slightly more use a sprayer.

The sample considered for this empirical strategy is obviously different from the one considered in the previous one, as it only includes observations recorded in 2017. This is the reason why the summary statistics shown in Table 4 result to be different from the ones shown in Table 1.

We find a positive correlation between 3G network and mobile money use; I will check for underidentification or weakness of the instrument with appropriate tests. We therefore use network coverage as an instrumental variable for mobile money use and we run a regression on our outcome variable of interest, the possibility to borrow 300.000 UGX, with robust standard errors.

In the following table, we show the first stage regression and the second stage regression, along with the Kleibergen-Paap rk LM statistic to test for underidentification and the Kleibergen-Paap rk Wald F statistic to test for weak identification of our instrument. The first test uses a statistic that is built as a generalization of the Anderson canonical correlation rank statistic allowing for heteroskedasticity, autocorrelation and clustering. The same can be said about the second test, which uses a generalization of the Cragg- Donald statistic allowing for errors to be not independent and identically distributed (Kleibergen and Paap, 2006).

Table 5
Use of mobile money instrumented by 3G Network coverage

	Mobile Money Account	Access to Credit
Network 3G	0.0536*** (0.0127)	
Mobile Money Account		0.0451** (0.023)
Constant	0.568*** (0.00813)	0.377*** (0.134)
Observations	6177	6177
R-squared		0.0374
Underidentification test	(Kleibergen-Paap rk LM statistic)	17.75
Weak identification test	(Kleibergen-Paap rk Wald F statistic)	17.80

Dependent variable: How easy would it be for you to borrow 300.000 UGX for 6 months? R

Robust standard errors in parentheses.

* p<0.1 ** p<0.05 *** p<0.01

Not only we find our previous result to be confirmed, both in terms of sign and statistical significance, but we also get a very similar coefficient of slightly higher magnitude. As a matter of fact, when mobile money use is instrumented by network coverage, we find that it increases access to credit by 4.51 percentage points with a 5 per cent significance level.

The Kleibergen-Paap rk LM statistic of 17.75 and the Kleibergen-Paap rk Wald F statistic of 17.80 allow us to reject the null

hypothesis of underidentification and weak identification at maximum level of significance, giving us more elements to support the statement that the instrument is relevant, or in other words that it is correlated with the endogenous explanatory variable.

7. Robustness Checks

Since we only have data from two points in time, we are not able to estimate a placebo regression on previous periods to the ones considered in our Difference-in-Difference strategy in order to test the parallel trends assumption. However, we can provide other placebo regressions to test whether some of the previously mentioned validity threats can actually call into question our results.

7.1 Social Networks

A possible critique to the previously shown results is that mobile money users may develop social networks more rapidly with respect to those who do not use this technology, and this might be linked to a better access to credit: as a matter of fact, the dependent variable I employ to measure perceived access to credit simply measures whether the respondent can be able to borrow money, not specifying the formality of the channel.

However, during the census we asked the same question to respondent with a different amount of money: ”How easy would it be for you to borrow 30.000 UGX?”: this is a very small amount that could be easily asked to friends or relatives, corresponding to approximately 10 USD.

We test whether the coefficient of the interaction term is significant for this different outcome variable, using the same specifications as before. We display results in Table 6 along with robust standard errors.

Table 6
Social networks, mobile money and access to credit

How easy would it be to borrow 30,000 UGX?

	(1)	(2)	(3)	(4)	(5)
Treated Post	-0.00125	0.00105	0.00036	-0.000498	-0.00053
	(0.0133)	(0.0132)	(0.0132)	(0.0132)	(0.0132)
Treated	0.0892*** (0.0114)	0.0682*** (0.0115)	0.0695*** (0.0115)	0.0681*** (0.0115)	0.0673*** (0.0116)
Post	0.101*** (0.0102)	0.100*** (0.0101)	0.102*** (0.0101)	0.102*** (0.0101)	0.102*** (0.0101)
Education		0.00796*** (0.000815)	0.00694*** (0.00079)	0.00634*** (0.000796)	0.00626*** (0.000803)
Age			-0.0011*** (0.00023)	-0.00129*** (0.000244)	-0.00127*** (0.000245)
Owned Land				0.00316*** (0.00113)	0.00304*** (0.00115)
Wealth Index					0.00148
					(0.0026)
Constant	0.783*** (0.00813)	0.744*** (0.00936)	0.793*** (0.0132)	0.796*** (0.0133)	0.797*** (0.0135)
Obs.	10661	10661	10657	10653	10634
R-squared	0.0509	0.0593	0.0619	0.0630	0.0627

Dependent variable: 1 if access to credit is possible, 0 otherwise.

Robust standard errors in parentheses.

* p<0.1 ** p<0.05 *** p<0.01

Table 6 shows that, even if the ability to borrow small amounts of money is positively associated with mobile money use, the interaction term is never statistically significant, suggesting that

this is not changing over time differently across mobile money users and non users. To be precise, not only is the coefficient of the interaction term insignificant, but it is also a precisely estimated zero. Therefore, if a statistically significant result was found in the case of borrowing 300.000 UGX, it is unlikely that our main result is driven by increased ability to borrow money from friends.

Another piece of evidence suggests that results are not driven by social networks. Respondents that declared access to credit to be possible for them were also asked how much they would have to pay back after they had borrowed the money. We therefore build a variable, NoInterest, that is equal to 1 if the amount that has to be paid back is lower or equal to the loan itself, and 0 if it is higher.

We assume that if the amount has to be the same or lower, the channel through which the respondent is able to borrow more money is through informal social networks; otherwise, the channel is formal. In other words, a commercial service would ask a positive interest on the loan while only social networks can provide a zero-interest loan or even a gift as a personal favour. We run again a difference-in-difference estimation with robust standard errors, and we obtain results observable in Table 7.

Table 7
Borrowing at zero interest

Loan of 300,000 UGX without interest

	(1)	(2)	(3)	(4)	(5)
Treated Post	-0.00899	-0.00901	-0.00893	-0.00892	-0.00892
	(0.00930)	(0.00927)	(0.00927)	(0.00929)	(0.00930)
Treated	-0.00621	-0.00609	-0.00597	-0.00594	-0.00570
	(0.00704)	(0.00711)	(0.00711)	(0.00710)	(0.00705)
Post	0.00601	0.00601	0.00619	0.00622	0.00623
	(0.00751)	(0.00751)	(0.00752)	(0.00752)	(0.00753)
Education		-0.00005	-0.000130	-0.0000996	-0.000031
		(0.00057)	(0.000571)	(0.000591)	(0.00059)
Age			-0.000189	-0.000176	-0.000165
			(0.000148)	(0.000159)	(0.00016)
Owned Land				-0.000135	-0.000072
				(0.000489)	(0.00049)
Wealth Index					-0.00144
					(0.00166)
Constant	0.0326*** (0.00527)	0.0328*** (0.00616)	0.0409*** (0.00882)	0.0407*** (0.00891)	0.0396*** (0.00902)
Obs.	6345	6345	6345	6342	6333
R-squared	0.00129	0.00129	0.00154	0.00155	0.00164

Dependent variable: 1 if the loan has no interest, 0 otherwise.

Robust standard errors in parentheses.

* p<0.1 ** p<0.05 *** p<0.01

The ability to borrow money at no interest is not significantly correlated with the use of mobile money, and this is not time-varying. In general, no coefficient of this regression seems to be statistically significant; the coefficient of the interaction term is a precisely estimated zero.

Even by instrumenting mobile money use with network coverage we do not find any statistically significant impact, as it is shown in Table 8.

Table 8
Use of mobile money instrumented by 3G Network coverage

	Mobile Money Account	30.000 UGX Credit
Network 3G	0.0536***	
	(0.0127)	
Mobile Money Account		0.169
		(0.117)
Constant	0.568***	0.836***
	(0.00813)	(0.0693)
Observations	6177	6177
R-squared		0.00372
Underidentification test	(Kleibergen-Paap rk LM statistic)	17.75
Weak identification test	(Kleibergen-Paap rk Wald F statistic)	17.80

Dependent variable: How easy would it be for you to borrow 30.000 UGX for 6 months?

Robust standard errors in parentheses.

* p<0.1 ** p<0.05 *** p<0.01

As a matter of fact, if we include in the sample only those respondents who claim they must bear a positive interest loan, the results we obtain with the usual difference-in- difference specifications are consistent with the previous one found on the total sample, as shown in Table 9.

Table 9
Positive interest, mobile money and access to credit

How easy would it be to borrow 300,000 UGX?

	(1)	(2)	(3)	(4)	(5)
Treated Post	0.0432**	0.0482**	0.0486**	0.0429**	0.0429**
	(0.0193)	(0.0191)	(0.0191)	(0.0189)	(0.0189)
Treated	0.232***	0.177***	0.175***	0.166***	0.166***
	(0.0150)	(0.0153)	(0.0153)	(0.0152)	(0.0152)
Post	0.0391***	0.0383***	0.0356***	0.0309**	0.0310**
	(0.0138)	(0.0137)	(0.0137)	(0.0135)	(0.0135)
Education		0.0209***	0.0224***	0.0186***	0.0186***
		(0.00120)	(0.00121)	(0.00124)	(0.00124)
Age			0.00154***	0.000336	0.000344
			(0.000305)	(0.00032)	(0.00032)
Owned Land				0.0203***	0.0203***
				(0.00206)	(0.00206)
Wealth Index					-0.00790*
					(0.00407)
Constant	0.433***	0.331***	0.261***	0.278***	0.278***
	(0.00984)	(0.0112)	(0.0175)	(0.0175)	(0.0175)
Obs.	10479	10479	10475	10471	10471
R-squared	0.0775	0.101	0.104	0.121	0.121

Dependent variable: 1 if access to credit is possible, 0 otherwise

Robust standard errors in parentheses

Subsample: respondents who bear positive interest loans

* p<0.1 ** p<0.05 *** p<0.01

The results seem to be consistent in terms of sign and statistical significance, also in terms of magnitude. As can be seen in the specification including more controls, the interaction term coefficient corresponds to approximately 4.29 percentage points with 5 per cent significance level.

7.2 Revenues

Another possible interpretation of the results may argue that m-transfers users could be able to boost their revenues more rapidly thanks to the reduction of transaction costs, and this in turn might be correlated with access to credit. This would mean that the actual channel through which mobile money has an impact on access to credit is not through financial services offered by mobile money platforms. I rule out this interpretation by checking total revenues as an outcome variable of our usual difference- in-difference strategy and I display results in Table 10.

Table 10
Revenues, mobile money and access to credit

	(1)	(2)	(3)	(4)	(5)
Treated Post	15373.8	24684.9	30615.9	13359.4	13595.5
	(119134.3)	(117039.8)	(117022.2)	(118602.9)	(118627.8)
Treated	191868.3	121945.2	111955.1	46394.9	45793.6
	(117030.1)	(102078.5)	(102113.5)	(81535.9)	(81659.9)
Post	101305.3	98001.9	83106.8	72816.4	72444.9
	(64609.5)	(64309.6)	(67661.5)	(67955.9)	(68137.0)
Education		25623.8***	31002.1***	8809.0*	8793.7*
		(6110.5)	(6396.9)	(4717.0)	(4722.5)
Age			6267.4***	-994.4	-1008.4
			(1799.5)	(2564.0)	(2562.7)
Owned Land				111601.1**	111570.4**
				(45103.7)	(45099)
Wealth Index					12234.6
					(10691.6)

	(1)	(2)	(3)	(4)	(5)
Constant	278236.4***	153937.2*	-126007.2*	-24768.2	-23407.3
	(62943.5)	(80397.1)	(73178.3)	(41180.9)	(41279.1)
Obs.	8331	8331	8327	8323	8323
R-squared	0.00455	0.00719	0.00978	0.0529	0.0530

Dependent variable: total revenues of last 6 months from commercial farming in UGX.

Robust standard errors in parentheses.

* p<0.1 ** p<0.05 *** p<0.01

We do not find a statistically significant coefficient for the interaction term in any of the specifications. We find, not surprisingly, that education and acres of owned land are positively associated with total revenues, while the coefficient of age looses its statistical significance once we control for the amount of land owned by the household of the respondent.

We perform the same regression after a logarithmic transformation of revenues and we show the results in Table 11. This will allow to weigh less extreme observations in the distribution.

Table 11
Logarithm of revenues, mobile money and access to credit

	(1)	(2)	(3)	(4)	(5)
Treated Post	-0.0515	-0.0362	-0.0301	-0.0430	-0.0434
	(0.0582)	(0.0573)	(0.0569)	(0.0542)	(0.0542)
Treated	0.517***	0.404***	0.393***	0.334***	0.335***
	(0.0517)	(0.0511)	(0.0508)	(0.0488)	(0.0488)
Post	0.640***	0.639***	0.620***	0.618***	0.618***
	(0.0359)	(0.0356)	(0.0357)	(0.0339)	(0.0339)
Education		0.0415***	0.0479***	0.0290***	0.0290***
		(0.00320)	(0.00323)	(0.00320)	(0.00320)
Age			0.00757***	0.00128	0.00129
			(0.000826)	(0.000892)	(0.000892)
Owned Land				0.0954***	0.0955***
				(0.00805)	(0.00805)
Wealth Index					-0.0131
					(0.0206)
Constant	11.72***	11.51***	11.17***	11.26***	11.26***
	(0.0293)	(0.0330)	(0.0480)	(0.0459)	(0.0459)
Obs.	8331	8331	8327		

Dependent variable: total revenues of last 6 months from commercial farming in UGX.

Robust standard errors in parentheses.

* p<0.1 ** p<0.05 *** p<0.01

The coefficients of the interaction term are not statistically significant. The coefficient of education remains significantly positive and the coefficient of age looses its statistical significance as in the previous case when the acres of land owned are taken into account. Although one might think that access to credit should in turn boost revenues, it does not seem to be the case here. We do not find a significantly positive coefficient for the interaction term either for the logistic transformation of revenues. A possible explanation is that for this effect to be observed, a longer period of time should pass from the moment in which the credit services are made available to customers. In other words, since we measure the perception the commercial farmers have about their access to

credit, it could be the case that this perception was not translated into action yet.

Another possible argument is that loans through mobile money were activated not for investments in productivity that can be reflected in increased revenues, but only to buy, for example, consumption goods, or to invest in other types of long-term investments, such as human capital investments - say school fees of the children of the household.

7.2 Investments

I therefore check whether there is an impact on investments. As a matter of fact, another possible channel through which mobile money can affect access to credit in a time- varying fashion is a more rapidly increasing ability of m-transfers users to smooth their consumption and invest more in durables that might improve the productivity of their commercial farming activities, which in turn could affect access to credit. This would be an alternative channel through which mobile money can impact access to credit that is not the availability of new financial services through mobile money platforms.

In order to test whether this is the case, we employ the usual difference-in-difference strategy considering as outcome variable the use of the agricultural technologies for which we have available information in the survey: watering can, wheelbarrow, sprayer, fertilizers and pesticides.

The use of these technologies might also proxy the unobservable ability of the farmer to run his or her commercial activity and willingness to adopt more advanced farming techniques.

I use the specification that includes more controls to test for all the agricultural technologies we mentioned and I show the results in Table 12.

Table 12
Commercial farming investments

	Watering can	Wheelbarrow	Sprayer	Fertilizers	Pesticides
Treated Post	-0.000000159	0.00632	-0.00598	0.00712	0.0249
	(0.00000199)	(0.0111)	(0.0120)	(0.0108)	(0.0183)
Treated	-0.000000192	0.0449***	0.0451***	0.0312***	0.0786***
	(0.00000170)	(0.00865)	(0.00883)	(0.00828)	(0.0145)
Post	0.000000314	-0.00156	0.0421***	0.0144**	0.0466***
	(0.00000145)	(0.00575)	(0.00680)	(0.00613)	(0.0119)
Education	-0.000000125	0.0124***	0.0109***	0.00646***	0.0158***
	(0.000000135)	(0.000938)	(0.000990)	(0.000878)	(0.00131)
Age	1.96e-08	0.00181***	0.00112***	-0.0000741	0.0000357
	(3.31e-08)	(0.000206)	(0.000211)	(0.000178)	(0.000306)
Owned Land	-0.000000332** (0.000000161)	0.0148*** (0.00160)	0.0184*** (0.00164)	0.00660*** (0.00127)	0.0198*** (0.00203)
Wealth Index	3.041***	0.00414*	0.00892**	0.00539*	0.00330
	(0.00000211)	(0.00225)	(0.00400)	(0.00314)	(0.00453)
Constant	0.178***	-0.129***	-0.102***	-0.000482	0.108***
	(0.00000257)	(0.0108)	(0.0110)	(0.01000)	(0.0169)
Obs.	10643	10649	10647	10652	10652
R-squared	1.000	0.0966	0.0913	0.0295	0.0733

(1) Dependent variable: use of watering can.

(2) Dependent variable: use of wheelbarrow.

(3) Dependent variable: use of sprayer.

(4) Dependent variable: use of chemical fertilizers.

(5) Dependent variable: use of pesticide

Robust standard errors in parenthesis

* p<0.1 ** p<0.05 *** p<0.01

Once again, in none of the regressions we find a statistically significant coefficient on the interaction term, even if they all seem to be significantly correlated with use of m-transfers, exception made for the use of watering can, which has a coefficient corresponding to a precisely estimated zero.

Similarly to the case of the impact on revenues, one might think that increased access to credit should in turn increase investments; however, as we do not find a statistically significant coefficient, it might be the case that these are long term impacts that are not captured yet at the point of time in which the survey was taken.

8. Conclusions and policy implications

Mobile money has emerged in the past few years as an innovative and simple solution to complex issues like the lack of banking infrastructures and appropriate financial services for the most disadvantaged areas of the world.

Digitization of monetary value, in settings where the greatest part of transactions and economic exchanges are informal, can have several advantages. The generated data can make a great contribution in designing more efficient financial services, thus reducing asymmetric information and improving transparency. At the same time, digitization overcomes the need for bank branches and ATMs, improving the capillarity and ability to reach rural and remote areas. Moreover, it increases the rapidity of transactions and disbursement of loans, while increasing safety with respect to cash transfers.

Thanks to these characteristics, mobile money platforms in recent years developed financial services with unique and unprecedented features that have revolutionized the credit market in developing countries. Telecommunication companies started supplying new options in the credit market that are completely different from the ones offered by traditional banks or microfinance institutions.

The aim of this thesis was to measure the impact of the availability of credit services running on mobile money platforms on access to credit for rural farmers in Uganda, providing systematic and novel evidence of an effect that has not been assessed by the existing literature.

A difference-in-difference empirical strategy and an instrumental variable approach were exploited to assess the effect, which is found to be positive and statistically significant, corresponding to an increase of approximately 4-4.5 percentage points on the probability of being able to borrow a considerable amount of money.

Several robustness checks were conducted to strengthen the previously shown pieces of evidence, which seem to be quite reassuring on the absence of potential endogeneity threats.

This thesis, though, sheds light on a very specific sample, made of small commercial farmers living in Eastern Uganda. A more extensive study, capable to consider different contexts and various types of credit services, may give a broader picture of the real impact of mobile money on financial inclusion.

Moreover, the next step would be to study whether these financial services, given their improved accessibility with respect to the traditional ones, have positive or negative impact on economic outcomes of interest. As a matter of fact, it could be that unintended consequences may arise because time inconsistent and financially illiterate individuals may borrow money and use it in unproductive manners or not fully understanding the contractual terms, and have to subsequently bear high interest rates they cannot afford. There is certainly scope for further research on the effects of digital credit.

As it seems to be the case that households in rural areas perceive a greater access to credit thanks to mobile money based services, a proper consumer protection should be designed in order to guarantee an informed consent and complete understanding by customers with respect to the new services they are using. However, there are several regulatory challenges given by the fact that not all companies offering digital credit services fall under the jurisdiction of the financial sector regulator.

At the same time, an enabling regulatory environment is fundamental for the industry to develop. A regulation framework that is too cumbersome can raise costs for consumers and limit investments and innovations: according to GSMA (2017a), companies operating in countries without an enabling regulatory environment for mobile money services feature dramatically lower activity rates of customers and less profits.

In low-income countries, where informal economic exchanges are extremely widespread, governments may have the temptation to

tax mobile money transfers, that are easily traceable. Several countries in Sub-Saharan Africa already begun to follow this direction. However, an unfriendly tax system may discourage investors and increase the costs borne by customers, thus hindering the diffusion of mobile money technology and the development of financial services. Since financial inclusion is a a fundamental objective for governments of low income countries, and the contribution of mobile money platforms seems to be relevant, hampering them would be a contradiction. The low cost of mobile money based financial services is key for its diffusion.

As a matter of fact, Uganda recently introduced a tax on mobile money deposits, transfers and withdrawals, which came into effect on the 1st of July in 2018. Not only the transaction fee is taxed, but even the transaction value. The government should instead put in place disincentives to withdraw money, boosting digital transfers and deposits.

Companies and governments, therefore, should engage in active dialogues to strike a balance in policies that can offer a sustainable market growth, protecting the customer while offering new credit options in the market.

For the mobile money industry to develop, infrastructures are needed: the network coverage and the electrification, especially of rural areas. According to the Ugandan Rural-Urban Electrification Survey of 2012 (Ugandan Bureau of Statistics, 2012), the electrification rate, which is a combination of three sources of electricity, meaning grid, solar and generator power, amounted to 19.9 per cent for rural households and 52.5 per cent for rural businesses. Rural households highly rely on grid power to charge their phone (53.4 per cent), but solar power is promising as well (37.5 per cent).

Scale is a critical factor for the mobile money industry to offer more and more efficient services at lower prices, thus in turn broadening the audience. If a larger share of the customer base adopts mobile money based credit services in time, companies offering them will be able to collect more data and build more powerful algorithms to predict default risk, thus reducing losses and allowing for more

customized services at lower prices. This might in turn broaden even more the share of the population that has access to credit, resulting in a virtuous circle. Moreover, more clients mean that more transactions can be performed digitally, without any conversion in cash. This in turn can help addressing the largest operating cost for the business of mobile money: the retail agents network.

Governments might decide to promote the cashless economy by conveying transfers (both inflows and outflows) with citizens through mobile money platforms. Many countries in Sub-Saharan Africa are moving in this direction: a success story is the one of Kenya, where person-to-government and government-to-person transfers via mobile money are extremely common - licenses, business permits, land rates, construction approvals, passport fees and many other services are being paid through the government digital payments platform, called eCitizen (GSMA, 2017b).

Governments agencies might decide to activate public-private partnerships with several stakeholders in order to promote financial literacy, increase uptake of mobile money based financial services, improve transparency and user experience and finally ensure accessibility for larger shares of the population, especially among the most disadvantaged ones, during the design, implementation and marketing processes.

References

Jenny C. Aker, Rachid Boumnijel, Amanda McClelland, and Niall Tierney. Payment mechanisms and antipoverty programs: Evidence from a mobile money cash transfer experiment in niger. *Economic Development and Cultural Change*, 65(1):1–37, 2016.

Beatriz Armendariz and Jonathan Morduch. *The economics of microfinance*. MIT press, 2010.

Orazio Attanasio, Britta Augsburg, and Ralph De Haas. Microcredit contracts, risk diversification and loan take-up. *Journal of the European Economic Association*, forthcoming.

Abhijit Banerjee, Arun G. Chandrasekhar, Esther Duflo, and Matthew O. Jackson. The diffusion of microfinance. *Science*, 341(6144), 2013.

Abhijit Banerjee, Dean Karlan, and Jonathan Zinman. Six randomized evaluations of microcredit: Introduction and further steps. *American Economic Journal: Applied Economics*, 7(1):1–21, 2015.

Catia Batista and Pedro Vicente. Introducing mobile money in rural Mozambique: Evidence from a field experiment. Novafrica working paper series, Universidade Nova de Lisboa, Faculdade de Economia, NOVAFRICA, 2013.

Valerie Bencivenga, Bruce Smith, and Starr Ross M. Transactions costs, technological choice, and endogenous growth. *Journal of Economic Theory*, 67(1):153–177, 1995.

Daniel Bjorkegren and Darrell Grissen. The potential of digital credit to bank the poor.AEA Papers and Proceedings, 108:68–71, 2018.

Joshua E. Blumenstock, Michael Callen, Tarek Ghani, and Lucas Koepke. Promises and pitfalls of mobile money in Afghanistan: Evidence from a randomized control trial. In Proceedings of the Seventh International Conference on Information and

Communication Technologies and Development, ICTD '15, pages 15:1–15:10, New York, NY, USA, 2015. ACM.

Gregory Chen and Xavier Faz. The potential of digital data: How far can it advance financial inclusion? Focus Note 100. Washington, D.C.: CGAP, January, 2015.

Thibaut Dehem and Marek Hudon. Microfinance from the clients' perspective: An empirical enquiry into transaction costs in urban and rural india. Oxford Development Studies, 41(sup1):S117–S132, 2013.

Leora Klapper Dorothe Singer Saniya Ansar Demirgu¨ ¸c-Kunt, Asli and Jake Hess. The global findex database 2017: Measuring financial inclusion and the fintech revolution. 2018.

Xavier Gine and Dean S. Karlan. Group versus individual liability: Short and long term evidence from philippine microcredit lending groups. Journal of Development Economics, 107:65–83, 2014.

GSMA. Mobile money. State of the Industry Report, 2017a.

GSMA. Person-to-government (p2g) payment digitisation: lessons from Kenya. 2017b.

Eva Gutierrez and Tony Choi. Mobile money services development: The cases of the republic of korea and uganda. Policy Research Working Paper; No. 6786. World Bank, Washington, DC, 2014.

IMF. Financial access survey, mobile money note. 2017. IMF. Financial access survey. 2018.

Asif Islam, Silvia Muzi, and Jorge L. Rodriguez Meza. Does mobile money use increase firms' investment? evidence from enterprise surveys in Kenya, Uganda, and Tanzania. Small Business Economics, Springer, 51:678–708, 2018.

William Jack and Tavneet Suri. Mobile money: The economics of m-pesa. (16721), January 2011.

William Jack and Tavneet Suri. Risk sharing and transactions costs: Evidence from Kenya's mobile money revolution. American Economic Review, 104(1):183–223, Jan- uary 2014.

Dean S. Karlan and Jonathan Zinman. Credit elasticities in less-developed economies: Implications for microfinance. American Economic Review, 98:1040–68, 2008.

Enoch M. Kikulwe, Elisabeth Fischer, and Matin Qaim. Mobile money, smallholder farmers, and household welfare in Kenya. PLOS ONE, 9(10):1–13, 10 2014.

Frank Kleibergen and Richard Paap. Generalized reduced rank tests using the singular value decomposition. Journal of Econometrics, 133(1):97–126, 2006.

Ramona Liberoff and Chris Horn. Mobile identity and financial inclusion at the bottom of the pyramid. Innovations: Technology, Governance, Globalization, 6(4):65–72, 2011.

Ignacio Mas and Nicholas Sullivan. Mobile money as an information utility that touches everyone: Refining the vision for financial inclusion. Innovations: Technology, Governance, Globalization, 6(4):17–25, 2011.

Joseph Mawejje and E. C. Paul Lakuma. Macroeconomic effects of mobile money in uganda. 2017.

Isaac Mbiti and David N. Weil. Mobile Banking: The Impact of M-Pesa in Kenya, pages 247–293. University of Chicago Press, September

Olga Morawczynski and Mark Pickens. Poor people using mobile financial services: observations on customer usage and impact from m-pesa. 2009.

Marguerite Robinson. The Microfinance Revolution: Sustainable Finance for the Poor.

World Bank e-library. World Bank Publications, 2001.

Joseph E. Stiglitz and Andrew Weiss. Credit rationing in markets with imperfect information. The American Economic Review, 71(3):393–410, 1981.

Tavneet Suri and William Jack. The long-run poverty and gender impacts of mobile money. Science, 354(6317):1288–1292, 2016.

Richard Wright, Erdal Tekin, Volkan Topalli, Chandler McClellan, Timothy Dickinson, and Richard Rosenfeld. Less cash, less crime: Evidence from the electronic benefit transfer program. The Journal of Law and Economics, 60(2):361–383, 2017.