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Mobile money: the savior for developing countries?

A RESEARCH INTO THE IMPACT OF MOBILE MONEY ON FINANCIAL AND MONETARY STABILITY IN KENYA.

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Abstract

Mobile money is a widely used financial service in Kenya. Nowhere else does mobile money have such an impact in a country. However, the impact of mobile money on key economic indicators is still an underexplored topic. This study tries to find out if mobile money affects monetary and financial stability in Kenya. To answer this question, two regression analyses were performed. A multiple OLS-regression was used to answer the question of the effect on financial stability. The results of this research indicate that mobile money has no effect on financial stability in Kenya. On the other hand, an OLS- and VEC model answered the question of the effect on monetary stability. The results of this regression analyses indicate that mobile money has a positive relationship with real money demand in Kenya. This modifies the functioning of the monetary policy, which has a negative impact on monetary stability. It will therefore be reasonable for countries where mobile money is already widely represented, to include these effects of mobile money in their future policy design. Otherwise, their policies will not achieve their desired goals. A possible follow-up study could focus on another country or on the influence of the time period.

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1.0 Introduction

Financial services delivered via mobile, it is one of the largest and most promising application in the developing economy. Mobile money allows people with a mobile phone to transfer, deposit and withdraw money. A bank account is not required for this, but it is possible in some cases. The system works via a SIM card and is only linked to a telephone number, this makes mobile money outside the formal banking sector (GSMA, 2019). In the future, mobile money payment can ensure that it becomes a general platform that can keep the economy running smoothly. This is because it can be used in any sector, but also in any household. In addition, also because the adoption of mobile phones can still grow considerably in certain regions of the world, especially in Africa.

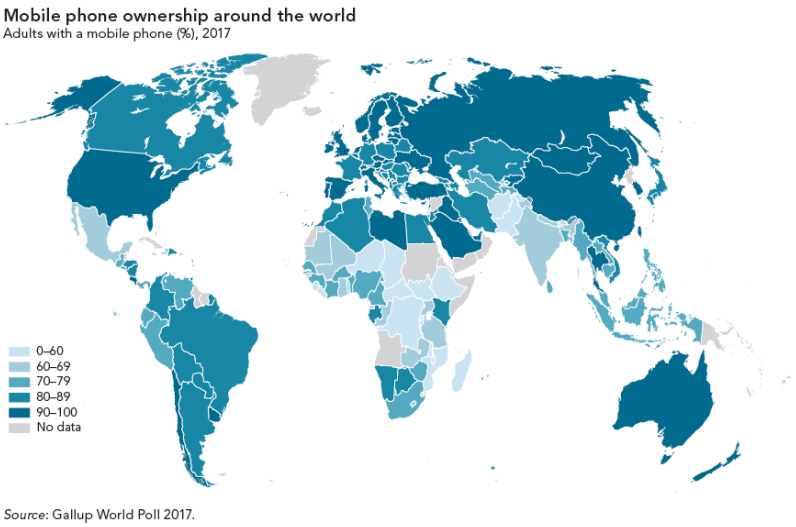


Figure 1: Mobile phone ownership around the world (adults with a mobile phone in 2017).

The technology has a great future ahead of it and has been used for several years, mostly in Africa. A country in which this technology has played an important role in the economy for a long time is Kenya. The largest mobile payment system is developed in Kenya, it is called M-Pesa. The system started in Kenya and has the largest share in the mobile payment system in the country. In 2011, 500 million dollars per month was transferred via M-Pesa and it had 20 million users (Donovan, 2012). These numbers have grown to 12.2 billion transactions in 2020, this in on average 1.017 billion transactions per month. The number of users of M-Pesa in 2020 has increased to 41.5 million users.[1] If you look at the global transaction value per day, mobile money has touched a value of more than 2 billion per day in 2020. This is expected to grow to approximately 3 billion per day by 2022. This value growth is partly because new policy measures allowed higher transaction values and people could have higher balance limits.[2]

[1] Mobile Money in Africa - Statistics & Facts. (2020, 21 October). Statista. https://www.statista.com/topics/6770/mobile-money-in-africa/

[2] Andersson-Manjang, S.K. & Naghavi, N., 2021, State of the Industry Report on Mobile Money, Retrieved from https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2021/03/GSMA_State-of-the-Industry-Report-on-Mobile-Money-2021_Full-report.pdf

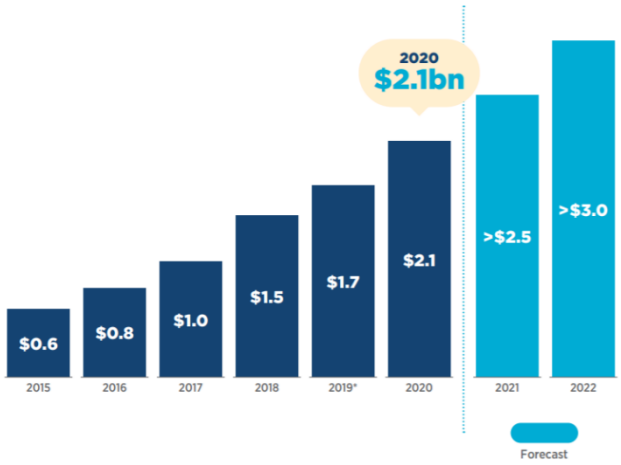


Figure 2: Total mobile money processed worldwide by day in billions[3]

However, the growth of users and transfers shows that there is confidence in the technology.

A big advantage of the mobile money system is that it increases the financial inclusion. Like M-Pesa in Kenya has ensured that the financial inclusion has grown in the country. More people in Kenya can use financial resources since the introduction of the mobile money payment system. In 2019, 82.9 percent had access to financial services. Compared to 2016, this was only 75.3 percent (FSD Kenya, 2019). Mobile money ensures that the 'unbanked poor' have access to financial resources and give them more opportunities to participate in the economy. But there are also skeptics who have doubts about the potential of this system. The profits and funds generated by, for example, M-Pesa have not been redistributed among the population. These profits are mainly due to the poorer of the population, but this money has not been invested in free access to water, electricity, and education. This can lead in the future to more social inequality (Natile, 2020).

How will this affect the country's economy? Since more households can be part of the (financial) economy, this also changes the state of the economy. An extra factor has been added in the ten recent years. This new technology brings new possibilities and new challenges. One of the challenges in the future is that mobile banking is mainly aimed at the unbanked poor, but this group is getting smaller, and a new target group will have to emerge. Another challenge is that mobile money operates between two different business models. On the one hand as a telecommunications company and on the other, as a financial services provider. As a result, the regulation of the system always remains an issue as it is between two industries, each with their own restrictions (Donovan, 2012). Can mobile money bridge these challenges? A more recent development in the technology of the mobile money system is the possibility to request a loan via the mobile money system or to create a digital bank account. A digital bank account is a collaboration between the telecom company and the commercial bank[4]. The system

[3] Andersson-Manjang, S.K. & Naghavi, N., 2021, State of the Industry Report on Mobile Money, Retrieved from https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2021/03/GSMA_State-of-the-Industry-Report-on-Mobile-Money-2021_Full-report.pdf

[4] More about the digital banking accounts in the literature review.

continues to develop, and the many possibilities of the system is therefore one of the advantages of this technology (Asongu, & Asongu, 2018).

2.0 Literature overview

2.1 Mobile Money payment system

The mobile money payment system is the next, evolving, Person-to-Person (P2P) payment. New technology makes it possible that financial services take place via mobile devices. It is a distinction product of mobile banking and is most of the time provided by telecommunication companies. The mobile money system is outside the regulation of the formal banking sector. It is less regulated than the formal banking sector but has become more regulated over the years (Bernanke, 2012). More on this in section 2.4.

The purpose of mobile money was to enable person-to-person payments without the need for a bank account or a bank transfer. Over the years, the possibilities of mobile money have expanded considerably, and it is often used for: people paying their bills with the mobile money system, they can store and hold money (like a savings account), wages can be paid by the system, they can make person-to-business payments (P2B) and receive government-to-person payments (G2P).

The mobile money system is very user-friendly. It is easy to understand and can be used within minutes. As a consumer, one must first register with a mobile money agent to create an account. The information that must be provided is based on the Know you Customer rules that are also used in the formal banking sector. One must register with an ID, this process only takes some minutes. To make transactions with the system, the consumer must first deposit money in his account. This process looks as follows:

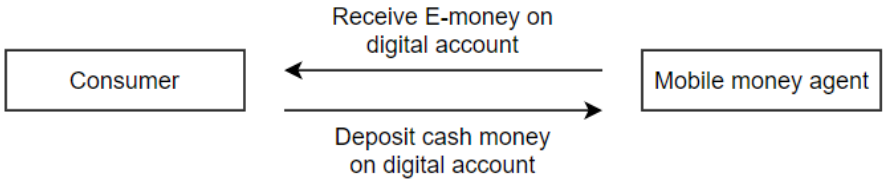


Figure 3: Overview of how a consumer receives the mobile money on their account.[5]

When the money is in the mobile account, one can transfer the money through the country via his phone, provided he has the recipient's phone number. A transaction from consumer to consumer looks like this:

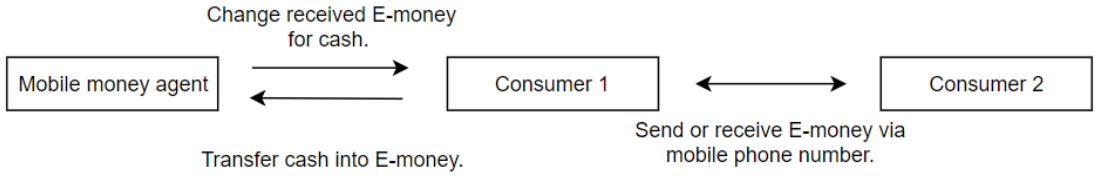


Figure 4: transaction from customer-to-customer with mobile money.[6]

[5] Flowchart based on (Suri, 2017).
[6] Based on (Suri, 2017).

Every transaction via the system often entails transaction costs, deposits are often an exception. Banks are also increasingly starting to cooperate with the telecommunication companies. This allows people to open a bank account, which is called a digital bank account and works on the rails of mobile money. These accounts allow mobile money to be transferred from the mobile money wallet to the digital bank account and vice versa free of charge. The bank account is completely digital and does not fall under mobile banking because it is completely dependent on mobile money and the product would otherwise not exist. To withdraw the money from the digital bank account, one must first get the mobile money to his mobile wallet (for free). After this, one can exchange the mobile money into cash from the mobile money wallet at a mobile money agent. The digital bank account is therefore not a savings account but a digital account where mobile money users can deposit their mobile money instead of leaving it in their mobile money wallet. One can also apply for loans via these digital banking accounts (Suri, 2017).

2.2 Mobile money in Kenya

In March 2007, Safaricom, the leading cell phone company in Kenya, came with a new form of mobile money payment which became a success story in this developing country. The name of this mobile money payment system is M-Pesa[7]. M-Pesa works almost the same as all previous mobile payment systems discussed in the previous section. The big difference with other mobile monetary systems is that M-Pesa has spread successfully and very quickly all over Kenya (Mas & Morawczynski, 2009). M-Pesa is still very popular in Kenya, the number of active monthly users is increasing every year (See figure 2).

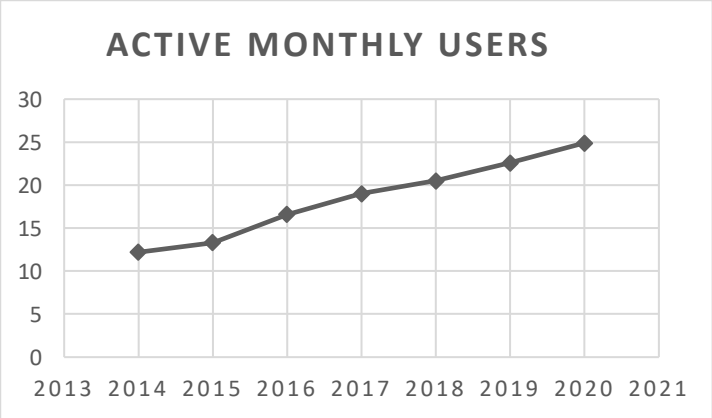


Figure 6: Active monthly users of M-Pesa in Kenya in million users.[8]

Nowhere else was this technology more needed than in Africa. In Africa, physical transportation and fixed line communication is often inadequate and scarce. But because of the mobile money payment technology, more people in Africa can participate in the 21st century economy. At the beginning of the technological development, cell phone users could transfer money over long distances. People could

[7] Pesa is Kiswahili for money. M-Pesa is therefore called M(obile)-Money.
[8] Safaricom Annual Reports, Full Annual Reports - Safaricom. (2021). Safaricom. https://www.safaricom.co.ke/investor-relations/financials/reports/annual-reports

buy 'air-time' (which is known as prepaid) from the telephone companies and use it to send credit to other users. It was very easy for the recipient to sell the received air-time to a local broker for cash. It was also possible to purchase goods or services. This brought part of the sender's purchasing power to the recipient. This technology ensured that the purchasing power of the poorer could increase. What has mainly contributed to the development and adoption of M-Pesa is the extent to which mobile technology has been incorporated. No other technology such as the mobile phones has been adopted so quickly (see figure 5) (Eijkman & Kendall & Mas, 2010).

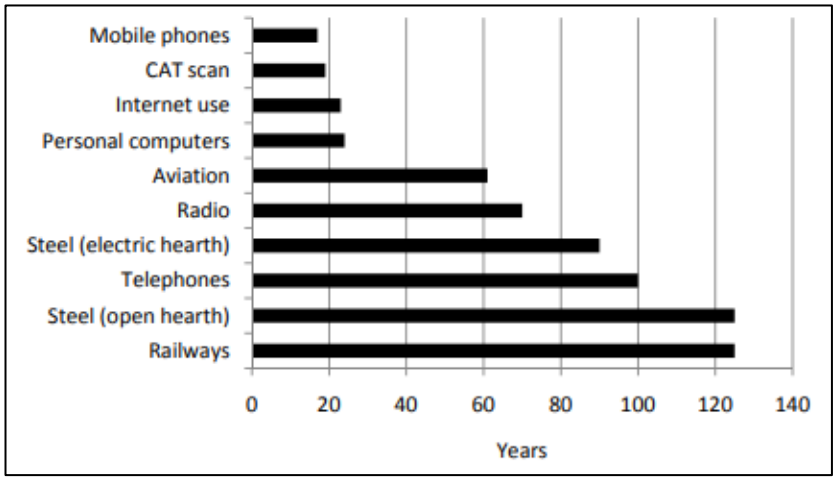


Figure 5: How many years does technology need to be adopted for 80% coverage.[9]

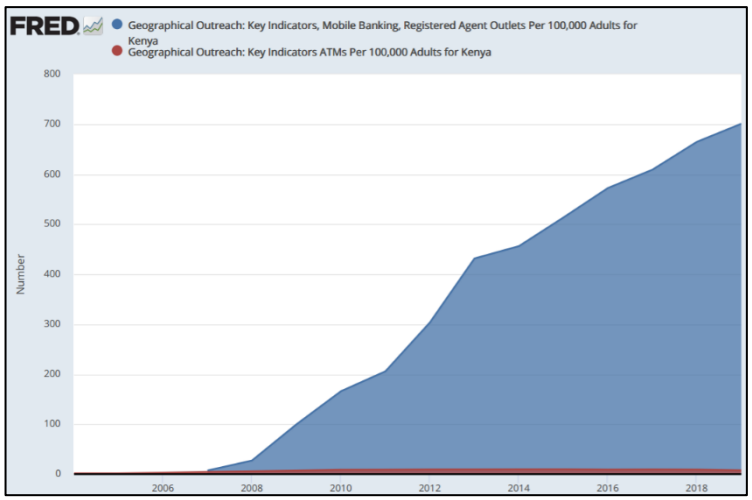
2.3 How M-Pesa works

M-Pesa mobile money wallets are valued in e-float, called M-Pesa, and are 100% backed by liquidity deposits. These liquidity deposits are held by Safaricom and are regulated by two commercial banks in Kenya, The Commercial Bank of Kenya, and the Standard Chartered Bank. The interest earned on these liquidity balances does not go to Safaricom or to the users of M-Pesa. The interest that is earned is paid to charities. Safaricom earns money in a different way through M-Pesa. Most of the revenue comes from the transaction fees that customers have to pay when they make a money transfer with M-Pesa. All transactions via M-Pesa are authorized via a secure SMS and this transaction can have a maximum value of 150.000 KSH.[10]

[9] Eijkman, F., Kendall, J. & Mas, I. (2010). "Bridges to Cash: The Retail End of M-PESA." Savings and Development 34 (2). 219–52.

[10] M-PESA Rates, M-PESA Tariffs, M-PESA Withdrawal Charges, M-PESA Transaction Fees - Safaricom. (2021). Safaricom. https://www.safaricom.co.ke/m-pesa/getting-started/m-pesa-rates

A big advantage of M-Pesa is that per 100,000 adults there are more mobile money agents present in Kenya than ATMs. This makes mobile money more accessible than cash from an ATM (Park, 2020).



Source: International Monetary fund

Figure 3: Number of ATMs or Mobile agent per 100,000 adults in Kenya[11]

The consumer side of the mobile money system is very similar to that of the formal banking system. The way it operates, and the back-end of the mobile money system is different. Mobile money is used instead of cash or currency. The mobile money is traded one-for-one with cash. When a consumer request money in his mobile bank account, he buys mobile money with cash. You buy the amount of mobile money that is equal to the amount of cash. The main role of the mobile money agents is to keep the inventory and float of the mobile money running. Many of these agents are already existing companies that sell airtime or telephones on the side. The conditions for operating as a mobile agent differ per country. In Kenya, one must first register with a mobile money operator to become an agent. One of the requirements is that the agent has a stable internet connection and a bank account. In Kenya the minimal capital requirement for a mobile money agent is 100.000KSh per outlet. When the mobile money agent no longer have mobile money in their mobile money account, they can buy it again from the mobile money operator (In Kenya this is Safaricom). The mobile money account is the account on which the mobile agents' mobile money is deposited. When they need cash, they can sell mobile money from their account to the mobile money operator. The mobile agents are an important part of the mobile money system. (Jack, Suri & Townsend, 2010).

In addition to consumers and mobile money agents, there is a third important factor in the system. What happens to the money itself, or in other words, the operation of mobile money? The money deposited in mobile money accounts is held in so-called trust accounts. These trust accounts are managed by the commercial banks. The mobile money account holders own these trust accounts. The owners of the trust accounts can only withdraw or deposit from another agent. It is not possible to

[11] FRED Economic Data. (2020, 9 November). FRED. https://fred.stlouisfed.org/series/KENFCMORANUM#0

withdraw or deposit money at the commercial bank which holds a trust account. Unlike the mobile money accounts, trust accounts can receive interest. This is because the trust account is subject to the same regulations as the formal bank sector. But unlike the mobile money operators, who are not covered by these regulations as they do not keep the cash, the trust accounts are covered by these regulations (Greenacre & Buckley, 2014).

These trust accounts play an important role in confidence in the mobile money system. The trust accounts reduce the loss of value risk. The Central Bank of Kenya approved business model enabled Safaricom (the founder of M-Pesa together with Vodafone) to spend mobile money in trade for cash held in a trust account which is held by a trustee (the bank). These funds cannot be used by the service provider because they are held separated from the funds of the telecommunication providers. In case of an insolvency, this money is safe from creditor's claims. The customers can be paid through these trust accounts and that money is not given to other creditors. Since M-Pesa has grown enormously, the CBK has decided to divide this trust account among several banks to reduce the risk in the event of a bank failure. This system also ensures that customers are less likely to panic at rumors about the bankruptcy of the service provider, as their (mobile) money is safe in these trust accounts (Muthiora, 2015). The mobile money issuers must ensure that all customer funds are held in a trust account. At no time may the amount of the trust account be less than the amount owed by the issuer to the customer. The trust accounts can only be held with commercial banks. These banks must be covered by the Banking Act or Government of Kenya Securities. As mentioned above, the trust accounts are divided among several commercial banks. This is the case when the amount held in trust exceeds 100 million KES. The total amount must then be divided among four or more banks. However, no bank may hold more than 25% of the total costumer funds in trust. If the amount in trust is less than 100 million KES, this can be placed in one commercial bank. This bank must then be labeled as strong rated by the CBK (Oliveros & Pacheco, 2016).

2.4 Regulation of M-Pesa

At the start of the development and rollout of M-Pesa, they were under almost no regulation and therefore had no regulatory issues. After long discussions between- and with Kenyan and English lawyers, a legal structure for M-Pesa was established in Kenya (Hughes & Lonie, 2007). Because the CBK was in a learning process during the development of M-Pesa, how to handle such financial services, certain laws have been created. The Anti-money Laundering/Combating the Financing of Terrorism and the National Payment System are two examples of this. After many discussions between the CCK and CBK, they also had an agreement about who would regulate M-Pesa. The CBK took on the financial aspects of M-Pesa. They deal with liquidity, deposits, and fraud prevention. The CCK on the other hand, has the regulation over the technical structure. This overcomes the policy void (Onsongo, 2019).

Due to the growth of mobile money in Kenya, regulations became increasingly important. That is why the CKB issued the National Payment Systems (NPS) Regulations in 2014. These new regulations had many more obligations than was the case before. The NPS Regulations contain 60 provisions that mainly concern: governance, reporting, capital, and interoperability.
The CBK did not want to change the business models of the mobile money providers with the new regulation. The NPS regulation did require the mobile money providers to establish sufficient governance arrangements. These governance arrangements need to be effective and transparent so that the integrity of the service is not compromised. The regulation also prohibits the mobile money companies from transferring money from funds to themselves or mixing these funds with the trust funds. There is a lot of emphasis on the governance and management of the trust funds to maintain the trust and money of customers (Greenacre, 2018).
Mobile money agents must have the capacity to handle all transactions. This means that these agents must have a certain minimum liquidity, which differs per mobile money provider. In the NPS regulation, the CBK has no requirements for interoperable arrangements between different mobile money providers. They leave this to the market.
Consumer protection is an important part of this regulation. The companies must have a clear description of the product and provide customer service. They should also notify the CBK or customers 7 days in advance that the terms of condition, charges or material will change. Advertisements about the product are not allowed to be misleading for the consumer but must clearly indicate the functions of the product. There is a fine of 1 million KES, which is US $ 11,600 for non-compliance with these consumer protection rules. As mentioned above, the CBK came up with AML / CFT legislation. However, banks were first only linked to this because mobile money providers do not fall under the Banking act. That is why Safaricom first came up with a voluntary AML / CFT program. In 2009 Kenya came with the AML act, whereby all institutions were required to verify all customer identities, record all transactions, and report all suspicious activities to the Financial Reporting Center. In 2013, the AML Regulations were added, which stated that every institution must undertake a risk assessment before introducing a new product. Since 2014, a lot of regulation has been added that is mainly aimed at protecting consumers (Muthiora, 2015).

2.5 Confidence in the system

A very important part of mobile money is trust in the system. Consumers should have confidence that their money is safe with the mobile money providers. The protection of the customers funds, which is the money of the customers for which they have received mobile money is the most important. These funds with the customers' money are stored on the Provider's server (Safaricom). The provider can store this money on a bank account. Consumers can face three key risks when using mobile money: illiquidity, insolvency, and operational risk. Below, the three different risks are listed and possible approaches that can reduce these risks.

The first one is insolvency; as with a bank, there is a chance that the provider may become insolvent. The provider can therefore use the customers funds to repay its debts. However, this is not their property. In that case, the customer loses his own money to the creditors. The second risk is illiquidity; there should be a 1:1 relationship between the amount of mobile money and customer funds. But if the provider spends the money for its own interests, such as paying fees, they may become illiquid. When the customers want to exchange their mobile money for cash, the provider can no longer pay them. Finally, there is the chance of operational risk; this type of risk arises from internal processes of the provider. These include theft, fraud, poor administration, negligence, and misuse (Tarazi & Breloff, 2011).

There are several ways to reduce these forms of risk. The first is fund isolation, which solves the problem of providers being the legal owners of the bank account. Fund isolation ensures that the provider has to put the customers' funds in a separate bank account, a trust account[12]. The benefits of this are for the customers since the providers can no longer use the customer accounts for other purposes. The trust accounts in Kenya are equal to the size of the customer accounts (World Bank, 2011).

Secondly, the risk can be reduced by fund safeguarding. The rules of fund safeguarding seek to ensure that the loss of mobile money agents and customer funds and illiquidity risk is reduced through a 1:1 relationship between the mobile money issued and the customer funds. Because of this 1:1 relationship, the provider has enough liquidity to pay its customers. This relationship can be achieved through liquidity rules and rules on the use of customer funds. An example of a liquidity rule is that the provider must place 100% of customer funds in a deposit account (not a trust account). In Kenya, there is a similar rule as the trust account must be 100% covered. Another option is that providers must have 100% of customer funds in safe, liquid assets, these assets they can easily convert to cash when customers want their money. There may also be rules on the use of customer funds, for example, providers may not use them to pay loans or expenses. The liquidity rules often stipulate that customer funds must be stored in a deposit account. Here again, there is the risk that the bank becomes insolvent. This risk can be reduced by dividing the total customer funds among several commercial banks. In Kenya, this is also done with the trust accounts. The trust accounts are not stored by one commercial bank but are divided among several banks. Trust laws can be used to realise these liquidity rules, these are also known as trust duties. The trust deed determines in that case what the provider can do with the customer funds (Greenacre & Buckley, 2014).

Thirdly, minimising operational risk. As outlined above, there are many different types of operational risk. Again, trust laws can reduce this form of risk in two ways. First, by auditing, the trust deed can determine when a provider should audit its trust accounts. It also describes how this should be done. The auditing process can help to improve the integrity of the mobile money system. Secondly, the risk

[12] The trust accounts are already explained in section 2.3.

can be reduced by monitoring and appointing the regulator as a 'protector'. A person can passively monitor a provider. This person checks whether the provider complies with the trust deeds and audits the funds properly. However, this creates a problem as most mobile money customers are encountering a financial service for the first time. They have minimal understanding of it and certainly do not understand the trust deeds. The provider can still abuse this, which increases the operational risk. A solution to this is an active approach whereby an entity is appointed as protector. The entity is given the authority to control the provider and work on behalf of the customers. The entity takes an active approach in checking the provider whether they follow the trust deeds. In Kenya, this is arranged by the CBK. They take care of the financial aspects of M-Pesa. This includes the prevention of money laundering and fraud, but also rules on reporting. By doing so, they try to reduce the operational risk (Klein & Mayer, 2011).

All these measures are taken to maintain confidence in mobile money, especially in the customer funds. Kenya does this in various ways that reduce all three types of risk. It is important that these consumer funds do not collapse because otherwise this could weaken the financial integrity and stability in the country (Maina, 2018).

2.6 Potential influence on financial and monetary stability

There are concerns that mobile money carries systematic risk in the payment systems because they are less supervised by the central bank than commercial banks. However, mobile money carries the same solvency and liquidity risks as other forms of money. This is due to the fact that the customer funds in Kenya are also covered 100% by trust funds, just as a bank account. Mobile money is a mobile payment system and the current deposits, the customer funds, are in a trust account. This ensures that a shock in the system is not transferred to another payment system (Mas & Klein, 2012). In some countries, there are concerns that mobile money is putting commercial banks at a disadvantage as it is changing the landscape of the banking sector. Mobile money can cause the role of commercial banks to change because it becomes a substitute for deposits in commercial banks. This can reduce a bank's lending capacity and liquidity position. This worsens the bank's financial performance and health which affects the financial stability in the country. However, mobile money can also cause that customers increase savings and ensure that more people have access to the formal financial services of commercial banks. This would be positive for the banking sector as it increases the depositor base but also diversifies it at the same time. Mobile money is in these two scenarios either a complement or a substitute for the commercial banking sector (Kipkemboi & Bahia, 2019).

Mobile money can make businesses more likely to make a productive investment. The use of mobile money increased the likelihood of investments by 16% in Kenya, Uganda, and Tanzania[13]. This positive relationship may be partly because companies with mobile money have more access to

[13] Islam, A., S. Muzi and J. Meza (2016). 'Does Mobile Money Use Increase Firms' Investment? Evidence from Enterprise Surveys in Kenya, Uganda, and Tanzania', Small Business Economics 51(3), 687–708

financial services. Even if the company uses mobile money to pay suppliers and to receive payments, there is a significant, positive relationship with investments. The companies then buy significantly more fixed assets. More investments can increase efficiency and lower prices (Islam, Muzi & Meza, 2016). Mobile money can also bring new money in the system by increasing the global remittance transfers. Money that was first outside the country, is now in the country. These remittances can have different effects on a country's GDP growth. For example, GDP growth can increase because they have a positive impact on consumption, investments and savings. However, remittances can also have a negative impact on GDP growth as they can reduce the motivation to work (Dridi, *et al.* 2019). Furthermore, mobile money can increase the possibility for the unbanked to access credit and saving facilities. In some countries this is already the case. Like in Kenya, because one can link his mobile money account to a bank account. The increase in the money supply can lead to more productive investments, lowers prices, and can even increase GDP growth and employment (Levine, 2005).
But inflation is also influenced by the consumer demand for money. Mobile money can increase the savings because money can be stored at a safe place. This lowers the consumer demand for money and therefore also inflation (Kipkemboi & Bahia, 2019). On the other hand, mobile money can also increase people's consumption. A study in Kenya showed that consumption levels increased when using mobile money. This was especially among poor women in Kenya. Mobile money mainly contributes to this because it can increase returns on saving and therefore also future consumption. Mobile money provides more access to credit and can smoothing the consumption over time. An increase in the consumption level (and the increase in investments) increases the aggregate demand for money (Suri & William, 2016).

3.0 Research problem

What is particularly striking in the literature on mobile money system, and in this case also on M-Pesa, is that it mainly concerns the technology behind it. It is often about the potential of the technology and what benefits it brings. One of the biggest advantages is: financial inclusion. The mobile money system gives the 'unbanked poor' more access to financial resources. This is often the subject of research (Donavan, Suri, and Jack). But mobile money has an influence on more aspects. It has been a growing 'new' factor in the economy since 2007. It is interesting to study what kind of influence mobile money has on the economy because it is still an underexposed topic in research. As mentioned in section 2.6, there is a discussion about how mobile money impacts the financial and monetary stability in a country. It is theoretically ambiguous and needs further empirical analysis. The evidence that mobile money affects financial stability is rather mixed. A study in Uganda showed that mobile money was negatively correlated with a bank's liquidity position. As a result, commercial banks may have problems with the ability to mobilize savings and deposits (Kamukama & Tumwine, 2012). However, a study in Ghana refutes this and showed that mobile money has a positive relationship with private sector credit and with the payments ecosystem. It also increases the chance that consumers will

become banked (Bank of Ghana, 2017). In Kenya, there was little or no positive impact on the financial performance of the commercial banks (Mohamed, 2019). Why is it important to study the risks of mobile banking on financial stability? Because financial stability shows that the financial system works well, and consumers have confidence in the system. This prevents, for example, bank runs that destabilize the economy. And when there is a shock in the economy, the financial system can absorb it. It also shows consumers that their money can be safely saved and that their money does not disappear[14]. Because previous studies have mixed results on the effect of mobile money, it is important to know what impact mobile money has on financial stability.

Research into the influence of mobile money on monetary stability has mainly been conducted into the influence on inflation. In general, mobile money had almost no impact on inflation. In Uganda, there was no link between inflation and mobile money (Aron, *et al*, 2015). Also, in Kenya, there was no or minimal evidence that mobile money brings monetary implications (Weil, *et al*, 2012). The study from Adam and Walker found that the use of mobile money improves the macroeconomic stability in the country (Adam & Walker, 2015). As also mentioned in section 2.6, mobile money can have two conflicting effects on consumer demand. It can increase aggregates saving or consumer consumption and can therefore influence inflation. It has become an empirical question. Why is price stability so important, because it ensures a higher standard of living because it lowers the uncertainty of price change. It also makes it easier for consumers to perceive relative price changes.[15]

As mentioned in the literature review, M-Pesa is a great success in Kenya. In no other country or another organisation has replicated the success of M-Pesa (Omigie, *et al*, 2017). The research will therefore focus on M-Pesa in Kenya because the technological adoption of mobile money and mobile money transactions are the most developed here. The influence of mobile banking will therefore be the most significant in Kenya and the easiest to observe (Njoki & Fu, 2020). For other countries that also use mobile money, this study can be a good example of what the risks are if mobile money also becomes a great success there.

In short, insufficient research has yet been conducted into the impact of mobile money on financial and monetary stability. And if research has already been conducted, the results of other studies often contradict each other (such as the impact on financial stability). Since financial and monetary stability affects both the economy and the consumer, it is important to study the risks of mobile money.

The research will therefore focus on the impact of mobile money on financial and monetary stability in Kenya with the research question: *What is the impact of mobile money on the financial and monetary stability in Kenya?*

[14] Definition of Financial Stability of The World Bank.

[15] Frankfurt, K. & Main, L. (2009). Price stability: Why is it important for you? The European Central bank.

4.0 Hypothesis

Based on the above literature, two hypotheses will be formulated. This research examines the effect of mobile money on financial and monetary stability in Kenya. A hypothesis will be formulated for both aspects, which is based on the literature described in this paper.

4.1 Hypothesis Financial Stability

As described in section 2.6, mobile money can be a complement or substitute for the commercial banking sector. Research in Ghana did show a positive effect of mobile money. However, there was little or no effect to be found in Kenya. However, a clear, strong, and significant effect has not yet really been demonstrated in the existing literature. A study in Uganda from Kamukama, and Tumwine (2012) showed a negative effect of mobile money on the liquidity position of banks.

But if a significant effect is found, it is often positive (as in Kenya and Ghana). But the results differ per study. Because this research looks at the effect of mobile money in Kenya, the results of these studies are mainly looked at to formulate the hypothesis. Because the study from Mohamed (2019) showed that there was a small significant effect of mobile money on the financial performance of banks, the alternative- and null hypothesis are as follows:

- Null hypothesis (H0) = There is no impact of mobile money on financial stability in Kenya.
- Alternative hypothesis (H1) = There is a positive impact of mobile money on financial stability in Kenya.

4.2 Hypothesis Monetary Stability

As in the studies into the effect of mobile money on financial stability, the results in research on the effects of mobile money on monetary stability are mixed or not proved. However, there are several studies from Kenya that did show an effect of mobile money, especially on inflation. A positive effect was also found on productive investments and price level. However, Aron et al. (2015) found no influence on inflation in Uganda. Weil et al. (2012) also found no effect in Kenya. Nevertheless, the research by Adam and Walker (2015) showed that mobile money improved macroeconomic stability in Kenya. This suggests that mobile money has a positive influence on several aspects of monetary stability (inflation, investments, and prices). Other studies, mentioned in section 2.6, also showed a positive effect of mobile money. Because the multiple part of the studies into the effect of mobile money on monetary stability show a positive effect instead of a negative effect, the alternative- and null hypotheses are as follows:

- Null hypothesis (H0): There is no impact of mobile money on monetary stability in Kenya.
- Alternative hypothesis (H1): There is a positive impact of mobile money on monetary stability in Kenya.

5.0 Methodological approach & method

To study the effect of mobile money on financial and monetary stability, a distinction must be made between the effect on financial stability and on monetary stability. Financial and monetary stability are in fact expressed through a different factor and influenced by other factors. It is therefore important to differentiate between these two dependent variables.

5.1 Financial stability

To study the effect of mobile money on financial stability, the influence on the banking sector stability will be examined. Banking stability is a good indicator of financial stability for Kenya because the financial sector in Kenya is mainly bank dominated[16]. Banking stability has been described by the IMF as Asset Quality. Asset quality is also mentioned as an indicator of banking stability in the report on the state of the banking industry in Kenya. When the Asset Quality is sufficient, the banking system in Kenya is adequately capitalized. This gives the bank system enough loss-absorption capacity to absorb a shock. The banking sector is therefore less likely to be a trigger for instability. Asset Quality is captured by; the ratio of non-performing loans to total gross loans (Koskei, 2020).

A multiple regression model will be used to study the effect of mobile money, along with some key indicators according to the IMF, on the banking stability in Kenya. Banking stability is the dependent variable, which is expressed in: the ratio of non-performing loans to total gross loans (Asset Quality). The ratio is calculated by dividing the value of non-performing loans in Kenya by the total value of loans in Kenya and is often used as an indication of Asset Quality.[17] Banking stability mainly has to do with two important aspects, namely solvency- and liquidity (risk). Solvency risk is defined as the risk that the bank cannot meet maturing liabilities. The bank has in that case a negative net worth, which means that the amount of liabilities is higher than the value of the assets of the bank. The bank can no longer meet their obligations. A sufficient capital buffer can counter this risk. On the other hand, there is liquidity risk. This means that the bank cannot fulfill its obligations in the short term. This may be because the bank does not get enough funding on the market, or because investments and securities cannot be sold quickly enough on the market. Both risks can have a significant impact on banking stability, which is why various solvency and liquidity indicators are included in the regression analysis (Almarzoqi, Naceur, & Scopelliti, 2015).

The key indicators that come from the financial soundness indicator core set are: Return on Assets (ROA), Return on Equity (ROE) and Capital to Risk-Weighted Assets. These indicators are used because these variables are seen as a good monitor of the health and soundness of financial

[16] Kenya Bankers Association, 2020, State Of The Banking Industry Report, https://kba.co.ke/downloads/State%20of%20the%20Banking%20Industry%20Report%20-%202020.pdf

[17] In Financial Soundness Indicators (FSIs), what is the nonperforming loans to total gross loans ratio? – IMF DATA Help. (2017). IMF. https://datahelp.imf.org/knowledgebase/articles/484369-in-financial-soundness-indicators-fsis-what-is#:%7E:text=Nonperforming%20loans%20to%20total%20gross%20loans%20ratio%20is%20calculated%20by,loss%20provisions)%20as%20the%20denominator

institutions. A macroprudential variable will also be used to monitor the vulnerabilities of the financial system. The macroprudential variable used in this research is the Credit to GDP ratio. This indicator captures the systematic risk towards the financial system[18]. The study will therefore include, according to the IMF, the most important indicators that reflect financial/banking stability. The variable stock prices is included as a business cycle indicator. Stock prices are one of the leading business cycle indicators according to the Conference Board. A shift of the leading business cycle indicator can predict the onset of the business cycle. A shift in the stock price can reflect investor sentiment and the fluctuation of interest rates. This is often a good reflection of future economic activity (Ozyildirim, 2019). The study by Koskei (2020) also included the variable inflation rate and found out that it has a significant effect on Asset Quality. A study from Romania also showed that the inflation rate is one of the four main determinants of banking stability, this variable will therefore also be included in the regression equation (Raluca-Ioana & Oaneab, 2014).

To study the effect of mobile money on banking stability in Kenya, indicators of mobile money will also have to be included. One independent variable is the adoption of mobile money in Kenya. The literature review showed that mobile money adoption could entail systematic risk. Because mobile money is not under the same regulation as the commercial banks. The mobile money adoption indicator will be referred as registered mobile money accounts in this research as this shows how many consumers use and have adopted mobile money in Kenya. Because it was also mentioned in the literature review that mobile money can be a substitute for commercial banks, the variable; number of mobile money transfers is included. Because the transactions via mobile money are not via the financial banking system and can therefore be influential (Kipkemboi & Bahia, 2019).

To ensure that this question can be answered statistically, a regression equation will have to be made. As mentioned above, Banking Stability (BS_t) is the dependent variable. This is expressed in terms of; the ratio of non-performing loans to total gross loans (Asset Quality) because the CBK and the IMF indicate that this is the best indicator for banking stability. The influence of various solvency and liquidity variables together with the mobile money variables are included as independent variables. The regression equation is derived from the research of Koskei (2020), where several key variables were included in the regression equation. The multiple model regression equation in this research will look as follows:

(1) $BS_t = \beta_0 + \beta_1 ROA_t + \beta_2 ROE_t + \beta_3 CRA_t + \beta_4 CTG_t + \beta_5 INF_t + \beta_6 MOA_t + \beta_7 MMT_t + \beta_8 StockPrices_t + \epsilon_t$

To clarify the regression equation, the named variable will be explained below:

$\beta_0 = The\ intercept$

$BS_t = banking\ stability;\ the\ ratio\ of\ non-performing\ loans\ to\ total\ gross\ loans$

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8 = The\ beta\ coefficients$

[18] International Monetary Fund. 2019. Financial Soundness Indicators Compilation Guide. file:///C:/Users/luukf/Downloads/2019-fsi-guide%20(1).pdf

$ROA_t = return\ on\ assets\ over\ time$

$ROE_t = return\ on\ equity\ over\ time$

$INF_t = inflation\ rate\ in\ Kenya\ over\ time$

$CRA_t = regulatory\ capital\ to\ risk - weighted\ assets\ over\ time$

$CTG_t = credit - GDP\ ratio\ overtime$

$MOA_t = registered\ mobile\ money\ account\ in\ Kenya\ over\ time$

$MMT_t = number\ of\ mobile\ money\ transaction\ in\ Kenya\ over\ time$

$StockPrices_t = stock\ price\ of\ the\ NSE20\ in\ Kenya\ over\ time$

The variables are measured quarterly. The time period in which the variables are measured is from the first quarter of 2007 to the last quarter of 2020, because M-Pesa has been active in Kenya since 2007.[19] As mentioned above, a multiple regression model will be performed by means of the statistical program STATA. Through this statistical research, the effect of mobile banking, along with other important indicators, will become clear. Further regressions required, such as a robustness check or multicollinearity check, will be performed as needed.

5.2 Monetary stability

Kenya implements a monetary aggregate targeting framework to achieve its inflation target. The framework of the CBK of Kenya operates on the assumption that money demand is stable in the country. The growth of the GDP and the pursuit of a certain inflation target are consistent with determining the money demand in Kenya. To determine the influence of mobile money on the functioning of monetary policy, the stability of the money demand will be tested. If mobile money affects the stability of money demand, it negatively affects the monetary aggregates framework. A negative influence of mobile money on the monetary aggregates framework will therefore have a negative effect on the monetary stability in the country as it modifies the functioning of the monetary policy (Ndirangu & Nyamongo, 2015).

To explain money demand instability, we will look at the instability of the velocity of money. Money demand instability can be caused according to 3 sources. 1, the velocity of circulation changes because the interest change and other parts of the money demand change. 2, the demand for money itself changes. 3, over a shorter period of time, the money stocks held may not match the desired money balances (Anderson, 1985). In this study there is an additional cause, the influence of mobile money. The typical equation to display the money demand is:

$$M^* = F(X) = e^k * e^{-at} * R^{-b} * Y^C \quad (2)$$

The real, desired, money balances are determined by the real income of the country (Y) and the nominal interest rate (R). Where k is a constant and *at* is the trend rate (Hetzel, 1984).

To test the stability of the demand by means of a regression equation, the following function was used:

[19] See section 2.2 Mobile money in Kenya.

$$Ln\left(\frac{M}{P}\right)_t = \beta_1 + \beta_2 LnY_t + \beta_3 LnR_t + e_t \quad (3)$$

However, things have changed over the years and the real income, interest rate, expected inflation rate and the nominal exchange rate will be included in the regression equation. To consider the expected interest rate, a lagged value of the inflation is included (Al-Sowaidi & Darrat, 2006).

To study the stability of the money demand, the following regression equation is used:

$$(RM2)_t = \beta_1 + \beta_2 Y_t + \beta_3 E_t + \beta_4 R_t + \beta_5 \pi_{t-1} + e_t \quad (4)$$

RM2 are the real money balances, the real money balances show the purchasing power of the M2 stock. Y is the real GDP growth and has a positive relationship with the real money demand. When the real GDP grows, the number of transactions that people make will increase, this will rise the real money demand (RM2). E is the price of the foreign currency (in this case the US Dollar) in terms of the KES. A decrease in exchange rate appreciates the KES. In that case, you pay less KES for the same amount of US Dollars. An appreciation of the KES will decrease the international reserve component of the domestic supply of money. This causes the excess demand for money to rise and inflation to fall (Deme & Fayissa, 1995). R is the 3-month interest rate, this variable is negative related with the real money demand. When the 3-month interest rate increases, the real money demand will fall because the opportunity costs to hold money are higher. Variable π_{t-1} is the lagged inflation rate, or in other words, the expected inflation rate. In order to use lagged inflation as expected inflation, it is assumed that expectations are static[20]. The expected inflation rate in negatively correlated with the real money demand because when the expected interest rate rises, people expect higher asset prices. The real money demand will therefore decrease (Awad, 2010).

To include the influence of mobile money, two variables are added to the equation. Mobile money can increase the demand for money because it leads to more consumption. As stated in section 2.6, the money demand increases because mobile money; can increase returns on saving and therefore also future consumption, provides more access to credit and can smoothing the consumption over time. This increases the demand for money but also brings 'new' money into the system. Mobile money increases the global remittance transfers. Money that was first outside Kenya, is now in Kenya. Therefore the variable value of mobile money transfers is included. The value of the transfer of mobile money reflects how much mobile money has been used, especially for consumption. The use of mobile money by consumers can also increase access to credit. This allows productive investments to go up. This ensures greater efficiency. This can reduce prices because products can be produced cheaper and more efficiently (Islam, Muzi & Meza, 2016). The more people have access to mobile money, the more people have access to credit. The number of users is for this reason also included in this study because this can influence the money demand.[21] In order to study the effect of mobile

[20] This is called the adaptive expectation hypothesis. The expected inflation has the following form: $\pi_t^* = \pi_{t-1}^* + y(\pi_t - \pi_t^*)$. Y is the expectations factor and is equal to 1, or similarly the expectations are instantaneous.

[21] Both effects are explained in Section 2.0 Literature overview.

money (M-Pesa) on monetary stability, the variables; the value of mobile money transfers and the number of mobile money users will be included.

The final regression equation will look as follows:

$$(RM2)_t = \beta_1 + \beta_2 Y_t + \beta_3 E_t + \beta_4 R_t + \beta_5 \pi_{t-1} + \beta_6 MOA_t + \beta_7 VMT_t + e_t \quad (5)$$

RM2 is the real money balances, this is calculated by the CPI and M2. Y is the real GDP growth in Kenya, E is the exchange rate in comparison with the US Dollar, R is the three-month deposit rate in Kenya and π_{t-1} is the lagged inflation rate. The mobile money variables are MOA, which is the registered mobile money accounts in Kenya and VMT, which stands for the value of mobile money transfers in Kenya per user. The time period in which the variables are measured is from 2007Q1 to 2020Q4, because M-Pesa has been active in Kenya since 2007.

To study the impact of mobile money on the stability of the money demand, two steps are taken. First, a time series OLS regression using the regression equation above (5). Secondly, it is examined what influence the variables have in the short- and long-term.

First, regression equation (5) will be estimated by using a least squares regression. A Durbin-Watson- and Breusch-Godfrey LM-test will be performed to see if there is autocorrelation. The Breusch-Godfrey test to test whether there is autocorrelation and the Durbin-Watson test to check whether the autocorrelation is positive or negative. If autocorrelation is involved, an autoregressive term will have to be added to the regression equation. The next step is to check if the variables are stationary trough an Augmented Dickey-Fuller test. An Augmented Dickey-Fuller test is used to correct for (possible) autocorrelation. If there is no autocorrelation and all variables are stationarity, then a multiple OLS regression will suffice to measure the effect of the independent variables on the dependent variable. If this is not the case, an Augmented Dickey-Fuller test will be performed on the residuals. If the residuals are stationary, this indicates that the force with which the residuals are pulled back is strong enough. In this case, two regressions will be performed: the OLS- and VEC-model. The OLS model estimates the long-run equation with least squares, and the VEC model estimates the short-run error correction model (Awad, 2010).

5.3 Data sources

This section will discuss where the data will be obtained from. There are many different factors, so multiple data sources will be used to collect all the data. The following data sources are used for the factors that influence banking stability in Kenya: for the number of mobile money transactions and registered mobile money accounts the IMF Financial Access Survey[22] is used. Return on Assets (ROA), Return on Equity (ROE), Regulatory Capital to Risk-Weighted Assets and Credit to GDP ratio are also collected from the IMF database, but from the IMF Financial Soundness Indicators database.[23]

[22] IMF Financial Access Survey. (2020). IMF. https://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C

[23] IMF Soundness Indicators. (2021). IMF. https://data.imf.org/?sk=51B096FA-2CD2-40C2-8D09-0699CC1764DA

The variable inflation rate is achieved from the Kenya National Bureau of Statistics[24] and the stock prices came from Investing.com.[25]

The factors that influence the monetary stability/mobile money demand are also collected from the following databases. The variables: registered mobile money accounts and the value of mobile money transfers in Kenya are retrieved from the CBK database[26].

The variable CPI is achieved from the Kenya National Bureau of Statistics, as is the variable inflation[27]. M2 comes from the global economy site.[28] The exchange rate is retrieved from Investing.com[29]. Finally, the real GDP growth[30] and the 3-month deposit rate are also coming from the CBK database[31].

6.0 Results

This section will discuss the results of the statistical analysis. The section is divided into 2 main aspects, the regression analysis to (i) financial stability and to (ii) monetary stability. For both analyses, the role of multicollinearity will first be examined. Thereafter, the regressions will be performed as described in section 5.0. The critical values of the p-value, t-value and F-value are the most important here. Based on these critical values, the null hypothesis can be rejected or not.

6.1 Results Financial Stability

Multicollinearity

First, the role of multicollinearity will be examined. Multicollinearity is a real problem when the VIF (variance inflation factor) is higher than 5. The VIF shows how much the variance of the coefficient is increased by collinearity. With a VIF value higher than 5, the variables are affected by the strength of the correlation and multicollinearity. In that case the variable will have to be deleted or adjusted (Alin, 2010). When looking at the role of multicollinearity in equation (1), some of the VIF-values are above the critical value of 5 (See Table 1). This means that multicollinearity plays a role in the original regression equation (1). The VIF-values of the variables; MMT, MOA, ROE, ROE and CTG are above 5. If we look at the correlation matrix (See Table 2), MMT and MOA are highly correlated, just like the variables ROE and ROA. These variables do indeed involve multicollinearity. To solve this problem, the variable ROE will be left out of the regression equation. The variable number of mobile

[24] Kenya National Bureau of Statistics. (2021). Statistical Releases. https://www.knbs.or.ke/?page_id=1591

[25] Kenya NSE 20 Historical Rates (NSE20). (2021). Investing.Com. https://www.investing.com/indices/kenya-nse-20-historical-data

[26] Mobile Payments | CBK. (2021). Central Bank Kenya. https://www.centralbank.go.ke/national-payments-system/mobile-payments/

[27] See footnote 23.

[28] Kenya Money supply, billion currency units, February, 2021 - data, chart. (2021). TheGlobalEconomy.Com. https://www.theglobaleconomy.com/Kenya/money_supply/

[29] USD KES Historical Data. (2021). Investing.Com. https://in.investing.com/currencies/usd-kes-historical-data?end_date=1609455600&interval_sec=monthly&st_date=1167606000

[30] Annual GDP | CBK. (2021). Central Bank Kenya. https://www.centralbank.go.ke/annual-gdp/

[31] Interest Rates | CBK. (2021). Central Bank Kenya. https://www.centralbank.go.ke/statistics/interest-rates/

money transfers in Kenya (MMT) will be transferred in number of mobile money transfers per user in Kenya (MMTPU).

With these adjustments, the regression equation will look as follow.

$$BS_t = \beta_0 + \beta_1 ROA_t + \beta_2 CRA_t + \beta_3 CTG_t + B_4 INF + \beta_5 MOA_t + \beta_6 MMTPU_T + \beta_7 StockPrices_t + \epsilon_t \quad (6)$$

This regression equation will also be tested for multicollinearity[32]. Table 3 shows that there is no more multicollinearity. All the VIF-values are below the critical value of 5.

Regression analysis

Regression equation (6) is used for the empirical analysis. In table 4 the results of the OLS regression are shown. The variable Return on Assets (ROA) is highly significant (p-value < 0.001). In this case, ROA has a negative relationship with the ratio of non-performing loans to total gross loans in Kenya. When the Return on Assets increases with 1%, the ratio of non-performing loans to total gross loans decreases with 2.643%. This improves Asset Quality, or in other words the banking stability in Kenya because banks have fewer non-performing loans on their balance sheets. The same applies to the variables Regulatory Capital to Risk-Weighted Assets (CRA), Credit to GDP (CTG) and inflation rate (INF). All three variables have a significant, negative relationship with the ratio of non-performing loans to total gross loans. Regulatory Capital to Risk-Weighted Assets and the Credit to GDP ratio are significant on a 0.1% significance level. The variable inflation rate, is significant on a 5% significance level. When the variables increase, the ratio of non-performing loans to total gross loans will decrease and therefore the financial stability in Kenya will increase. The negative relationship between the credit to GDP ratio and the non-performing loans to total gross loans is contrary to expectations. It means that when the total credit increases (or de GDP decreases), the ratio of non-performing loans to total gross loans decreases; on the contrary, you would expect that with more credit, the number of non-performing loans would also increase. However, it can also be argued that when the credit to GDP ratio increases, the non-performing loans to total gross loans ratio decreases because the total gross loans increases relatively more than the number of non-performing loans in that case. In contrast, the negative relationships of the other three independent variables with the dependent variable are not surprising. The negative relationship between ROA and dependent variable is logical. When ROA rises in Kenya, firms are more efficient and profitable. They make more money with fewer assets (investments). This money can be used, for example, the repayment of loans. The negative relationship between the inflation rate and the dependent variable can be explained by the fact that when inflation rises, more people can meet their payment obligation by eroding the real value of repayment. In

[32] All the variables in the regression equation (6) are also tested for normal distribution. Some values have changed slightly due to the adjustments, but this regression has 56 observations. This probably means that the variables are normally distributed due to the many observations. This is also called the central limit theorem (Lumley, T., Diehr, P., Emerson, S., & Chen, L. 2002).

addition, most people who have loans outstanding are business people. They can pass on the cost of inflation to consumers and therefore continue to pay off their loans (Touny & Shehab, 2015). And finally, the negative relationship between and non-performing loans can be explained by the growing capital adequacy of deposit takers. As a result, they are better able to repay loans and the ratio of non-performing loans will decrease (Sundararajan, V., *et al*. 2002). These results are not surprising because they were expected to have a negative relationship with the dependent variable, and they have therefore a positive influence on the banking/financial stability in Kenya. Also, the IMF uses these variables because they are seen as a good monitor of the health and soundness of financial institutions.
The business cycle indicator, stock prices, is insignificant on a 5% significance level. The stock price index of the NSE20 in Kenya has no effect on the banking stability in Kenya. Table 2 does present that the business cycle indicator has a high correlation with some independent variables. As a result, the business cycle indicator can influence the other variable and therefore also the dependent variable. But since the variable is not significant, there is no direct effect of the stock prices in Kenya on banking stability.
Both indicators of mobile money are insignificant. The number of mobile money transactions per user and the amount of registered mobile money accounts in Kenya are insignificant on a 5% significance level. The T-value of both mobile money indicators is below the critical T-value and the p-value is above the critical p-value of 5%. This means that the null-hypothesis cannot be rejected, and that the alternative hypothesis cannot be accepted. It can be concluded that mobile money has no impact on the financial stability in Kenya. The results do not indicate a significant relationship between mobile money and the dependent variable. This answers the main purpose of this research. In section 3.0 it has already been mentioned that many studies have found little effect of mobile money on financial stability, these results confirm this.
The adjusted R-squared is quite high, namely 0.735. 73.5% of the variance in the dependent variable is explained by the independent variables. It should be noted that the regression includes many independent variables that increase the adjusted R-squared.

6.2 Results Monetary Stability

In this section the results of the regression analysis on the impact of mobile money on monetary stability in Kenya are discussed. The main object of these results is to find out whether mobile money influences money demand in Kenya.

Multicollinearity

As with the regression analysis to Banking Stability, it will first be examined whether there is multicollinearity. There is some multicollinearity in the original regression equation (5). There is one VIF-value above the critical value of 5 (See table 5). This means that one of the explanatory variables has a linear relationship with one of the other explanatory variables. The VIF-value of the exchange

rate indicator, E, is higher as 5. As a result, this variable may be strongly correlated with another variable. Table 6 shows that the exchange rate is indeed highly, negatively, correlated with the dependent variable. The exchange rate is also highly correlated with the mobile money variables. Just like the exchange rate, MOA has a high correlation with the dependent variable and as mentioned, with the exchange rate. But since this variable has a VIF-value less than 5, it will not be changed.
To see if the multicollinearity could be decreased in the original regression equation (5), the exchange rate volatility was included instead of the level of exchange rate. The exchange rate volatility has been calculated by taking the standard deviation of the first difference of logarithms of the USD/KES exchange rate, which is a widely used measure to calculate exchange rate volatility. Because the exchange rate is a floating exchange rate, it is also likely to be more volatile (Clark, *et al.* 2004). This adjustment changed the regression equation to:

$$(RM2)_t = \beta_1 + \beta_2 Y_t + \beta_3 R_t + \beta_4 \pi_{t-1} + \beta_5 MOA_t + \beta_6 VMT_t + \beta_7 ExchangeVolatility + e_t \quad (7)$$

This transformation ensures that multicollinearity plays a much smaller role in this regression analysis. Table 7 shows that every VIF-value is below 2. This means that multicollinearity plays no significant role in equation (7).[33]

Regression analysis

In table 8, the results of the time series regression analysis are shown. The explanatory variable real GDP growth is significant. There is a significant, negatively, relationship between the real money demand and the real GDP growth in Kenya. The same applies to the variable interest, only this variable is significant on a 5% significance level instead of a 0.1% significance level. The T-values are both below the negative critical T-value. There is a negative, significant, relationship between the 3-month interest rate and the real money demand in Kenya. The lagged inflation rate is insignificant, as well as the exchange rate volatility. Not like the other two variables mentioned, there is no significant relationship between these explanatory variables and the dependent variable. These first results are not in line with the results of Awad's (2010) research.
The variable Registered Mobile money accounts in Kenya is highly significant on a 0.1% significant level. The T-value is quite high, namely 10.21. This could be due to autocorrelation, which will be sorted out in the next section. The significance of the variable MOA means that there is a positive relationship between the real money demand and the registered mobile money accounts in Kenya. When the amount of registered mobile money accounts goes up, the real money demand also rises. A possible explanation for this is financial inclusion. With more mobile money users, there is a chance that more of the unbanked poor will have access to financial resources and will participate more in the

[33] All the variables in the regression equation (6) are also tested for normal distribution. Some values have changed slightly due to the adjustments, but this regression has 56 observations. This probably means that the variables are normally distributed due to the many observations. This is also called the central limit theorem (Lumley, T., Diehr, P., Emerson, S., & Chen, L. 2002).

economy. This may increase the wealth of this group, leading to more demand for money. The variable value of mobile money transfers in Kenya per user is insignificant on a 5% significance level. In Kenya, there is a no relationship between the value of mobile money transfers in Kenya per user and the real money demand. The adjusted R-squared is relatively high, 80.03% of the variance in de dependent variable is explained by the independent variables.

Test for Autocorrelation and Stationarity

To test for autocorrelation in the regression equation (7), a Durbin-Watson test and a Breusch-Godfrey LM-test were performed. In table 9, the results of the Breusch-Godfrey LM-test are demonstrated. The table shows that there is serial autocorrelation. The probability is below the 5% significance level; therefore, the null-hypothesis can be rejected. The alternative hypothesis can be accepted in this case, there is autocorrelation in the regression equation (7). In table 10, the results of the Durbin-Watson test are shown. The Durbin-Watson statistics is 1.06528. According to the Durbin Watson table at a 5% significance level the dL and dU values are 1.374 and 1.768. The given Durbin-Watson value is below the dL-value (1.06528<1.374). This concludes that there is positive autocorrelation.

To solve the problem of autocorrelation, a Prais-Winsten treatment has been performed (See table 11). In the original equation (7) the coefficients are correct, only some of the T-values are too high. But as can be seen in the results, the coefficients change after the treatment. Therefore, the Prais-Winsten Treatment will not be used as a solution for the autocorrelation, the original OLS regression is in this case better.

However, autocorrelation is not the only problem. The other problem is that almost all variables are non-stationarity, they are integrated with an order of (1). All variables were tested for non-stationarity by using the Augmented Dickey-Fuller test.[34] The Augmented Dickey-Fuller test is used because there is also the problem of autocorrelation. This variant of the test adds lagged differences to treat the autocorrelation problem. The variables that are stationary are the variables interest and exchange rate volatility. The variables real GDP-growth and VTM are non-stationarity with a constant. The variables MOA and RM2 are non-stationarity with no constant and towards no trend. The variable expected inflation rate is non-stationarity with a constant and towards a trend. In table 12, the results of the augmented Dickey-Fuller test of the residuals are shown. The residuals are stationarity without a constant, which means that the residuals are stationarity towards a constant of 0. The test statistics is below the 5% critical value (-3.660 < -2.623), indicating that the force with which the residuals are pulled back is strong enough. Because the residuals are stationary, indicating that the variables are cointegrated, two different models are used: the OLS- and VEC-model. The OLS model estimates the long-run equation with least squares, and the VEC model estimates the short-run error correction model.

[34] Results of the Augmented Dickey-Fuller test are available on request.

In table 13, the results of the OLS model are presented. In the long-run the variables; registered mobile money accounts, the value of mobile money transfers per user, lagged inflation rate and the exchange rate volatility are significant. The registered mobile money accounts and exchange rate volatility are significant on an 0.1% significance level, the lagged inflation rate is significant on an 1% significance level and the value of mobile money transfers per user is significant on a 5% significance level. They all have a positive relationship with the real money demand in Kenya. These results of the mobile money indicators are not in line with the expectations. It was expected that mobile money would have a positive effect on real money demand, this would mean that mobile money would not affect real money demand. The monetary aggregate targeting framework in Kenya is based on a stable money demand to meet the inflation target. The positive relationship between the mobile money variables and real money demand therefore means that mobile money affects the stability of real money demand, which can have negative effects on monetary stability in Kenya. A possible explanation for the rise in the demand for money is that the demand for more liquid assets (M1) moves to more demand for less liquid assets (M2) when the use of mobile money goes up. This causes a decrease in money demand. However, in this study M2 is used to calculate the real money demand so this effect will be relatively small. On the other hand, the rise in the use of mobile money is giving more unbanked poor people access to financial services. This increases the demand for money demand as they now have another form of money at their disposal and not just cash (Dunne & Kasekende, 2016). The results show that the positive effects on money demand in Kenya are stronger than the negative effects on money demand. The variables lagged inflation and exchange rate have a significant, positive, relationship with the real money demand. This is somewhat counterintuitive. It was expected that these independent variables and the real money demand were inversely related. This conclusion cannot be drawn from the results.

The 3-month interest rate and the real GDP growth are insignificant. There is no relationship between these variables and the real money demand in Kenya in the long run. Both coefficients are negative, this was expected. The adjusted R-squared is relatively high, 95.90% of the variance in the dependent variable can be explained by the independent variables.

Table 14 shows the results of the VEC-model. The model determines whether the variables return to the long-term relationship as estimated by the OLS-regression after a certain shock. Three variables are significant, these are the variables: GDP-growth, MOA and VMT. However, the coefficients of all three variables are positive. This means that they will not return to their long-term stability after a shock. These variables have an explosive character. After a shock in the short-term, these variables will not return to the coefficients shown in table 13. It is worth noting that the coefficients are almost zero. This means that in the event of a shock in the short-term, the variables will not differ much from the coefficients in the long-term. The rest of the variables are not significant and thus will not respond to a shock in the short-term.

Briefly, in the long run, the value of mobile money transfers per user, the number of registered mobile money accounts, lagged inflation rate and exchange rate volatility will have a significant positive effect on real money demand in Kenya. These variables have a positive impact on monetary stability in Kenya. As mentioned earlier, a positive influence of these variables increases the real money demand but this cause monetary instability because the targeting framework in Kenya assumes a stable real money demand. This does not improve the monetary stability in Kenya as it modifies the functioning of the monetary policy. Based on the results, the alternative hypothesis can therefore not be accepted. Mobile money has a negative effect on the monetary stability in Kenya.

7.0 Conclusion

This research aimed to identify the impact of mobile money on the monetary and financial stability in Kenya. Based on quantitative analysis of the monetary and financial stability in response to various economic and mobile money indicators, it can be concluded that mobile money in Kenya has no significant effect on the financial stability. On the other hand, it has a positive significant effect on the real money demand in the country. The results indicate that the number of registered mobile money accounts and the value of mobile money transfers in Kenya per user have a positive influence on the real money demand in Kenya and therefore a negative impact on the monetary stability. The number of mobile money transfers per user and registered mobile money accounts in Kenya have no effect on the financial stability in Kenya.

As mentioned in section 3.0, not much research had been done on the effects of mobile money on financial and monetary stability. And when this was studied, the results were often contradictory. This research has contributed to answer this question. Some studies found a positive effect of mobile money on various financial aspects. This study shows that mobile money does not affect the financial stability in Kenya. The two variables for mobile money were insignificant. This means that mobile money has no effect on the ratio of non-performing loans to total gross loans. As the financial sector in Kenya is mainly bank dominated, mobile money has no effect on financial stability in Kenya. The return on assets, regulatory capital to risk-weighted assets, credit to GDP and inflation rate do have a negative, significant, effect on the ratio of non-performing loans to total gross loans. When these variables increase, the ratio non-performing loans to total gross loans will decrease, and the financial stability will improve.

The same applies to the effect on monetary stability. Much research has been done on the effect on inflation but little actually on the effect on monetary stability. This study examined the effect of mobile money on real money demand. This is because real money demand is an important component in the monetary aggregates framework in Kenya. The mobile money variables were significant in the regression analysis. In the long run, mobile money has a positive effect on real money demand in Kenya. This has a negative effect on the monetary aggregate targeting framework. A negative influence of mobile money on the monetary aggregates framework will therefore have a negative

effect on the monetary stability in the country as it modifies the functioning of the monetary policy. This result is contrary to expectations since previous research found positive influences of mobile money on monetary aggregates. The lagged inflation rate and exchange rate volatility were the only included variables that were significant and had a positive effect on the real money demand.
For countries where mobile money is not yet such a success, these results are alarming since mobile money negatively affects the monetary stability in Kenya. Especially in Africa, where mobile money is widely used, these results can be surprising. Countries where mobile money is already widely used should include these effects of mobile money in their future policy design. Not taking into account the effect of mobile money, especially on real money demand, will otherwise ensure that monetary policy does not achieve its desired goals.

8.0 Discussion

In this study, two regression analyses were conducted to study the influence of mobile money on monetary and financial stability in Kenya. The regressions were based on studies by Awad (2010) and Koskei (2020). All possible biases were removed from the regressions and there were enough observations to draw a conclusion. The dataset used for the regression analyses is representative for the period 2007-2020. Based on this, it can be said that the same results will be obtained in a repeat study. This makes the results of the study valid.
The results showed that mobile money had no impact on financial stability but had a negative impact on monetary stability in Kenya. These results were not in line with expectations. It was expected that mobile money would have a positive effect on both indicators. Especially the results on monetary stability were against expectations. The positive relationship between the variables expected inflation rate (and exchange rate volatility) and real money demand was also not expected.
A possible explanation for this is that some studies already showed that mobile money had little effect on financial stability in Kenya (Mohamed, 2019). The results of the regression to monetary stability, on the other hand, are surprising and difficult to explain. A possible explanation is that mobile money increases the demand for money by increasing the financial inclusion in Kenya. In fact, two crises are taking place in the time period of 2007-2020. This may have caused several outliers to influence the results. However, the study used data that reflects the reality of this period. An assumption was also made to be able to use the lagged inflation rate as the expected inflation rate. Another assumption, such as the rational expectations theory, may give a different result.
The current research complements the already existing theory on the effect of mobile money on monetary and financial stability because the research provides clarity on the impact of mobile money. Earlier studies had not investigated the effect of mobile money on monetary and financial stability. Based on this research, countries, especially developing countries, should think carefully about how far they integrate mobile money into the financial sector.

A recommendation for a follow-up study is to focus on the regression to monetary stability. For example, a different assumption could be made to include the expected inflation rate. It could also be examined whether the crises during the time period 2007 – 2020 have affected the results and whether the results not only relate to Kenya but also to other countries in Africa.

9.0 Bibliography

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10.0 Appendix

Table 1, Test for multicollinearity Financial Stability

Variable	VIF	1/VIF
roe	32.97	0.030333
moa	20.16	0.049615
roa	19.89	0.050268
mmt	18.55	0.053904
ctg	6.03	0.165915
stockprices	4.07	0.245699
cra	2.21	0.452606
inflation	1.69	0.591547
Mean VIF	13.20	

Table 2, Correlation Financial Stability

	bankin~y	mmt	moa	roa	roe	cra	ctg	inflat~n	stockp~s
bankingsta~y	1.0000								
mmt	0.3777	1.0000							
moa	0.3340	0.9565	1.0000						
roa	-0.7502	-0.5255	-0.5268	1.0000					
roe	-0.4481	-0.8415	-0.8460	0.8190	1.0000				
cra	-0.5960	-0.2955	-0.2186	0.4925	0.3209	1.0000			
ctg	-0.2923	0.5288	0.4351	0.1215	-0.3581	-0.0546	1.0000		
inflation	-0.3022	-0.3604	-0.3321	0.1864	0.2815	-0.0251	-0.1660	1.0000	
stockprices	-0.3468	-0.5912	-0.6559	0.6559	0.7088	0.1335	0.0488	-0.0638	1.0000

Table 3, Multicollinearity Financial Stability without Return on Equity and with MMTPU.

Variable	VIF	1/VIF
stockprices	4.23	0.236145
moa	4.09	0.244480
ctg	3.49	0.286890
roa	3.11	0.321348
mmtpu	3.01	0.332469
inflation	1.75	0.572147
cra	1.66	0.602839
Mean VIF	3.05	

Table 4, OLS regression Financial Stability

Financial Stability	
	(1)
	OLS regres~i
Number of mobile m~s	0.158
	(0.83)
Registered mobile ~s	4.13e-08
	(1.48)
ROA	-2.643***
	(-3.92)
Regulatory Capital~h	-0.768***
	(-3.92)
Credit/GDP ratio	-0.304***
	(-3.52)
Inflation rate	-0.154*
	(-2.04)
Stock prices	0.000669
	(1.31)
Constant	40.13***
	(9.61)
Observations	56
Adjusted R-squared	0.735

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 5, test for multicollinearity Monetary Stability indicators

Variable	VIF	1/VIF
E	6.28	0.159187
moa	4.89	0.204353
vmt	2.13	0.469666
lag_infla~on	1.30	0.772083
interest	1.27	0.787706
gdpgrowth	1.16	0.859942
Mean VIF	2.84	

Table 6, Correlation matrix monetary stability indicators

	rm2	moa	vmt	gdpgro~h	E	interest	lag_i~on
rm2	1.0000						
moa	0.8627	1.0000					
vmt	0.3847	0.5477	1.0000				
gdpgrowth	-0.3631	-0.1464	0.0874	1.0000			
E	-0.6651	-0.8670	-0.7103	0.0013	1.0000		
interest	-0.0034	0.1133	0.2038	-0.1721	-0.1976	1.0000	
lag_infla~on	-0.2572	-0.3035	-0.0769	-0.0482	0.2092	0.3248	1.0000

Table 7, Multicollinearity check after adjustment

Variable	VIF	1/VIF
moa	2.10	0.475615
exchangevo~y	1.90	0.527524
vmt	1.75	0.571348
lag_infla~on	1.70	0.588808
interest	1.31	0.764474
gdpgrowth	1.15	0.868884
Mean VIF	1.65	

Table 8, OLS regression Monetary Stability

Monetary Stability	
	(1)
	OLS regres~t
Registered Mobile ~s	262.8***
	(10.21)
Value of Mobile Mo~	-31446.9
	(-0.40)
Real GDP growth	-497192591.6***
	(-3.93)
Exchange rate vola~y	3.46380e+09
	(0.27)
3-Month Interest R~e	-270163743.0*
	(-2.29)
lag_inflation	66439839.5
	(0.69)
Constant	1.01825e+10***
	(4.59)
Observations	56
Adjusted R-squared	0.803

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 9, Breusch-Godfrey LM-test

Breusch-Godfrey LM test for autocorrelation

lags(*p*)	chi2	df	Prob > chi2
1	12.059	1	0.0005

H0: no serial correlation

Table 10, Durbin-Watson Test

Durbin-Watson d-statistic(7, 56) = 1.06528

Table 11, Prais-Winsten Treatment

Prais-Winsten AR(1) regression -- iterated estimates

Source	SS	df	MS		
Model	1.0243e+20	6	1.7071e+19	Number of obs	= 56
Residual	1.6692e+20	49	3.4065e+18	F(6, 49)	= 5.01
				Prob > F	= 0.0004
Total	2.6935e+20	55	4.8972e+18	R-squared	= 0.3803
				Adj R-squared	= 0.3044
				Root MSE	= 1.8e+09

rm2	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
moa	270.8786	49.23728	5.50	0.000	171.9326	369.8247
vmt	17752.3	72673.58	0.24	0.808	-128290.7	163795.3
gdpgrowth	-7.40e+07	1.22e+08	-0.61	0.547	-3.19e+08	1.71e+08
exchangevolatility	-1.15e+09	1.45e+10	-0.08	0.937	-3.03e+10	2.80e+10
interest	-7.22e+07	9.57e+07	-0.75	0.454	-2.64e+08	1.20e+08
lag_inflation	5.65e+07	1.08e+08	0.52	0.604	-1.61e+08	2.74e+08
_cons	6.01e+09	2.39e+09	2.51	0.015	1.21e+09	1.08e+10
rho	.7616546					

Durbin-Watson statistic (original) 1.065280
Durbin-Watson statistic (transformed) 1.960494

Table 12, Augmented Dickey-Fuller test residuals

Augmented Dickey-Fuller test for unit root — Number of obs = 48

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.660	-2.623	-1.950	-1.609

D.r	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r						
L1.	-.5584398	.1525657	-3.66	0.001	-.8661179	-.2507618
LD.	.2661042	.1335557	1.99	0.053	-.0032365	.5354449
L2D.	.2410084	.1323593	1.82	0.076	-.0259197	.5079364
L3D.	.1986745	.1317907	1.51	0.139	-.0671068	.4644558
L4D.	-.1953222	.1284176	-1.52	0.136	-.4543009	.0636566

Table 13, OLS Regression – long term stability

Monetary Stability

	(1) OLS regres~i
Registered Mobile ~s	301.6***
	(10.48)
Value of Mobile Mo~	180686.6*
	(2.41)
Real GDP growth	-273705870.8
	(-1.98)
3-Month Interest R~e	-250631285.4
	(-1.80)
lag_inflation	303168649.2**
	(3.13)
Exchange rate vola~y	4.53066e+10***
	(4.19)
Observations	56
Adjusted R-squared	0.959

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 14, VEC short term correction model

VARIABLES	(1) D_rm2	(2) D_moa	(3) D_vmt	(4) D_gdpgrowth	(5) D_interest	(6) D_lag_inflation	(7) D_exchangevolatility
L._ce1	**0.0554**	**0.000106*** **	**9.32e-08** **	**8.52e-11** **	**1.02e-12**	**-4.99e-11**	**4.53e-13**
	(0.0409)	(3.97e-05)	(3.81e-08)	(3.72e-11)	(6.37e-11)	(-4.99e-11)	(3.57e-13)
LD.rm2	**-0.163**	**-0.000254**	**-2.72e-07***	**-9.62e-10*** **	**-7.56e-11**	**5.63e-11**	**-6.01e-13**
	(0.173)	(0.000168)	(1.61e-07)	(1.58e-10)	(2.70e-10)	(2.11e-10)	(1.51e-12)
LD.moa	**54.03**	**-0.431*** **	**0.000147**	**4.12e-08**	**-1.82e-08**	**2.51e-07**	**-1.20e-09**
	(162.5)	(0.158)	(0.000151)	(1.48e-07)	(2.53e-07)	(1.98e-07)	(1.42e-09)
LD.vmt	**3,987**	**-1.755**	**-0.0515**	**0.000151** **	**4.78e-05**	**0.000181***	**-3.91e-07**
	(80,141)	(77.84)	(0.0747)	(7.30e-05)	(0.000125)	(9.78e-05)	(7.00e-07)
LD.gdpgrowth	**-5.776e+07**	**122,704**	**-208.7***	**-0.117**	**-0.0290**	**-0.404** **	**0.00290** **
	(1.308e+08)	(126,997)	(121.8)	(0.119)	(0.204)	(0.160)	(0.00114)
LD.interest	**-3.552e+07**	**50,795**	**-16.33**	**-0.0596**	**-0.352** **	**0.148**	**0.000418**
	(9.339e+07)	(90,707)	(87.02)	(0.0851)	(0.145)	(0.114)	(0.000816)
LD.lag_inflation	**1.681e+06**	**-43,462**	**95.17**	**0.0525**	**0.0426**	**0.224***	**-0.00148**
	(1.106e+08)	(107,435)	(103.1)	(0.101)	(0.172)	(0.135)	(0.000966)
LD.exchangevolatility	**-1.258e+09**	**8.627e+06**	**-32,289** **	**-17.70**	**-1.532**	**-45.32** **	**0.190**
	(1.574e+10)	(1.529e+07)	(14,670)	(14.34)	(24.53)	(19.22)	(0.138)
Constant	**-2,023**	**1.06e+06*** **	**-745.0** **	**-0.408**	**0.0957**	**-0.0917**	**-0.00224**
	(3.748e+08)	(364,079)	(349.3)	(0.342)	(0.584)	(0.458)	(0.00327)
Observations	**54**	**54**	**54**	**54**	**54**	**54**	**54**

Standard errors in parentheses
***** p<0.01, ** p<0.05, * p<0.1**