MOBILE MONEY AND MACROECONOMIC OUTCOMES IN EAST AFRICA

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DECLARATION

I declare that this work has not previously been submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the Research Project contains no material previously published or written by another person except where due reference is made in the Research Project itself.

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ABSTRACT

This study examined the outcomes of mobile money use on money supply, inflation and national output. Data was taken from East African countries that have adopted mobile money services, namely Kenya, Tanzania, Uganda and Rwanda. A Panel Vector Autoregression was fitted to the data, and subsequently a Forecast Error Variance Decomposition and Orthogonalized Impulse Response Function were generated to examine the dynamics between the variables. The findings indicate that mobile money transactions have modest negative effects on inflation and money supply in the medium-term. Indicating that mobile money substitutes for the transactional function of money to some extent, and enhances output and efficiency of production.

TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

According to the United Nations Conference on Trade on Development (UNCTAD), mobile money is defined as money stored using the SIM (Subscriber Identity Module) card of a mobile phone. An account is created on the SIM into which subscribers deposit money through agents. Their Mobile Network Operator (MNO) then issues the notational equivalent which is stored in the account. The corresponding cash value is stored elsewhere, usually in a bank account. The SIM card can then be used to transmit instructions to transfer amounts or make payments from the account balance.

Mobile money services can be classified into three groups: M-transfers, where money is transferred between users, usually without an exchange of goods or services; M-payments where money is exchanged between users for a good or service; and M-financial services where one's mobile money is linked to a bank account allowing them to undertake transactions normally conducted at bank branches via their mobile phone (UNCTAD, n.d.).

Mobile money emerged in the East African market by the launch of Safaricom's M-Pesa product in 2007. This service allowed subscribers of the MNO to use their SIM cards for "money transfer and financing" services. Since then the product has had a notable impact on the Kenyan economy. For instance, between 2006 and 2019 formal financial inclusion increased from 26.7% to 82.9%, and those excluded from use of both formal and informal financial services decreased from 41.3% to 11%. This has been linked to the establishment of mobile financial services which helped induct more people into formal financial inclusion (Financial Sector Deepening, 2019).

The establishment of mobile money services in other East African countries has had similar effects. In Uganda for instance, mobile money services were introduced in 2009. Subsequently, the level of exclusion from use of financial services then decreased from 30% in 2009 to around 15% in 2013. This is mainly attributed to the introduction of mobile money services (Economic Policy Research Centre, 2013). Similarly, in Tanzania when mobile money services were introduced in 2007 about 11% of the population used formal financial services; in 2017 the total population with a financial account had increased to 62%. Most of these being accounts held with MNOs. Thus by 2014, Tanzania had reached its 50% financial inclusion target which had originally been set for 2016 (World Bank Group, 2017).

As a result, there has been considerable interest in the impact of mobile money on different economic factors across East Africa. The impact on household conditions and economic welfare has been closely examined. Mobile money has been found to allow households to leverage on wider networks, thus smoothing consumption (Jack & Suri, 2011). Blumenstock, Eagle and Fafchamps (2011) found that Rwandese households used mobile money to help friends and family afflicted by crisis. Jack and Suri (2016) found further, that mobile money has alleviated the number of households facing extreme poverty and allowed female-led households to allocate their labor and consumption more efficiently.

Less clear, are the macroeconomic outcomes of mobile money. Kipkemboi and Bahia (2019), Kamukama and Tumwine (2012), Nampewo and Opolot (2016), Aron et al. (2015), and Ndirangu and Nyamongo (2015) examined the impact mobile money has on monetary and financial stability, but some of their findings were contradictory. Where Ndirangu and Nyamongo (2015) found no effect of financial innovations on the Kenyan money demand function, Nampewo and Opolot (2016) found that financial innovations increased money velocity in the long-run for Uganda. Contrarily, Kipkemboi and Bahia (2019) found that mobile money does not increase the velocity of money, and should have no inflationary effect. So where the macroeconomic outcomes are examined, the conclusions are varied. This is despite the importance of understanding these relationships for policy purposes.

1.2 PROBLEM STATEMENT

Mobile money has had substantial effects across East African economies: it has raised levels of financial inclusion in Kenya, enhanced private sector credit in Uganda (Financial Sector Deepening, 2019; Nampewo et al., 2016), and been shown to alleviate poverty (Jack & Suri, 2016). As financial inclusion increases, policymakers can see their decisions have wider reaching effects, for instance, households that previously were unaffected by policy rates are now involved in the banking sector, and have their consumption and saving patterns altered by any changes - as intended. This also opens up more possibilities for policy, by allowing policymakers to target different variables: where before they had to ensure their targets' effects reached beyond the financial sector to the unbanked population, as this segment decreases, a larger proportion of the population has their consumption and saving patterns altered by policy rates, so policy can become more innovative, focusing on different targets, such as headline inflation rather than core inflation (Adam & Walker, 2015).

However, with the large impact this technology has had in these countries, its effect on macroeconomic variables is not well understood. Several authors have analyzed its effect on microeconomic issues (Jack and Suri, 2011; Jack and Suri, 2016; Blumenstock, Eagle and Fafchamps, 2011; Adam & Walker, 2015), and further still, these studies have focused on these effects in Kenya and Uganda, where mobile money is used more widely. Where authors do examine its macroeconomic outcomes, the literature has focused on

monetary aggregates and monetary policy, and findings are contradictory (Kasekende & Nikolaidou, 2018; Nampewo & Opolot, 2016; Ndirangu & Nyamongo, 2015; Sichei & Kamau, 2012; Weil, Mbiti & Mwega, 2012). Mobile money can affect credit creation, as bank balances are created and must match the amount of mobile money created; users essentially create debt between themselves, which is subsequently transformed and circulated; its use transmits shocks across space and time (Jack, Suri & Townsend, 2010). All these factors must be examined for, and if found significant, accounted for by policy.

If the outcomes of mobile money on other macroeconomic variables are not studied or well understood, it is possible that intended policy outcomes will be distorted; as mobile money could play an unseen role in the economy, causing these macroeconomic variables targeted by policy to shift and interact, leading to unintended outcomes. Existence of private credit due to mobile money for example, can cause price movements and output volatility when money supply is increased; and the credit issued when cash is exchanged for mobile money also needs to remain in equilibrium, and its maturity should be well factored for, or this too can result in extreme price movements. (Jack, Suri & Townsend, 2010). As such, this paper hopes to expand the research by widening the countries and variables under examination.

1.3 RESEARCH OBJECTIVE

This study hopes to assess the wider and collective macroeconomic outcomes caused by the use of mobile money. More specifically, how does use of the technology affect monetary and financial stability in terms of money stock, national income, and inflation?

1.4 SIGNIFICANCE OF THE STUDY

The outcomes of this study should be of particular use to policymakers and Central Bankers, as it will inform on the changes, if any, that mobile money causes on the financial system, and on monetary policy target variables.

Stakeholders in the financial system, such as commercial banks concerned about the effects the technology may have on financial services and products, will also find the outcomes of the study informative for their operational decisions.

Further, as East Africa continues on towards formation of the East African Monetary Union (EAMU) integration of monetary policy and payment systems remains important. Understanding how mobile money affects these systems in the partner states is important for informing the decisions taken towards harmonization.

CHAPTER TWO

LITERATURE REVIEW

2.1 THEORETICAL AND EMPIRICAL LITERATURE REVIEW

The ubiquity in use of mobile money raises questions on its economic implications. A review of the literature informs the theoretical and empirical approach taken to tackle this question.

2.1.1 THEORETICAL REVIEW

Several models of money have been built to assess optimal monetary policy under different economic and household conditions. Jack, Suri and Townsend (2010) discussed some of these models, how they are related to mobile money operations, the relevant economic outcomes and how policy should respond to these outcomes.

The first model discussed was a model on Financial Deepening and Growth (Townsend, 1980). With the use of a Walrasian centralized exchange regime, paired households that would otherwise be spatially separated, exchange products between themselves, using electronic debits and credits. These balances are settled at the end of the trading period. Having such a regime in place encourages labor supply to increase, output and consumption to rise, as well as trade volume. This centralized regime alongside a decentralized fiat money regime encourages financial interconnection, resulting in the increase of debt per capita, a decrease in the level of fiat money relative to income, and an increase in the level of credit relative to income.

In much the same way, mobile money can be seen as having increased financial interconnection, allowing agents to transfer debits and credits while being spatially separated. This model suggests implications for credit creation: households that purchase goods from other households cause the balances of electronic money to increase, which is matched by a deposit of physical money.

The second model of money they examined is the Manuelli and Sargent (2009) Turnpike model. This model features both private credit and fiat money. Agents trade for two out of the four subintervals in a year, and in each subinterval, only one of the agents at a time possesses a good for consumption; the other agent does not possess the good in the same subinterval, but will possess the good in the next subinterval. They trade using private credit, but as the two agents are only in contact for two periods, there is no long term debt, fiat money performs the role of this debt. This model can be viewed alternately, where the agents are not in physical contact for the two periods as stated, but instead are connected electronically, through mobile money. As such, agents can issue longer-term debt as this technology evolves.

The earlier Townsend model was inefficient in that agents held money without interest, the Manuelli and Sargent model eliminates the inefficiency by introducing monetary policy actions. The impact that these actions have depends on the existence of mobile money. Where private credit i.e. mobile money is absent, for example, increasing the supply of money generally decreases the level of output, without affecting its volatility, but where private credit exists, increasing the supply of money increases prices and makes output more volatile. In this way, it is clear that mobile money can affect the target variables for monetary policy. The manner of these effects depends on the specifics of the mobile money operations, so policy should reflect the changes that mobile money has had on the financial system. In this way, monetary policy will be seen to be redistributive, because optimal policy in a system with mobile money will differ from policy in a system with no mobile money.

The Townsend model can be modified to highlight money as a means of communicating important information between agents that are on different 'islands' i.e. are spatially separated, and so, receive different kinds of preference shocks due to this separation. Communication of these shocks determines how inflation is allowed to influence purchasing power of agents. Mobile money can be used as the tool for communication, but distinctions must be made when this is the case. Fiat money and mobile money are not the same, as the latter allows for insurance from shocks that occur across time and space, in theory. This is compromised by the introduction of transaction costs which distort what ideally should be a one to one trade between cash and mobile money. The decision on whether to maintain this one to one trade affects the functioning of mobile money: is it simply a means of payment, or can it be used to compensate for missing credit and insurance markets?

In the Townsend and Wallace (1982) model, the previous Townsend model is modified, such that the agents lend to each other. An agent 'b' can lend in one period and then travel to another island in the next period, where they are removed from the agent/bank 'a' that they lent to. In this period the lender 'b' can transfer their debt-holding to the other inhabitant of this new island 'a*'. 'b' and a fourth agent, 'b*' travel once more in the next period and the new holder of the debt 'a*' transfers the debt once again to agent 'b*', who will meet the original issuer 'a' in the next and last period, and extinguish this debt. In this way, mobile money can facilitate the transformation of debt and its circulation.

In the case of mobile money, 'a' is an M-Pesa agent, who issues debt and 'b' goes on to trade with this debt, 'b*' who extinguishes this debt at the end of the time horizon is simply withdrawing the amount 'b' originally put into the system. As 'a' and 'a*' can both be M-Pesa agents (and issue debt), coordination is required to ensure the money dispensed remains in equilibrium. Keeping with the M-Pesa analogy, mobile money has been seen to have high transfer velocity. This raises questions on the issue of coordination, as agents are issuing credit. The matter of the rate at which cash is exchanged for mobile money is also of

importance. A balance must be achieved, such that the credit issued is in equilibrium with not too little, or too much credit issued. Further, the maturity of the total credit issued should also be well calculated. Failure in these aspects could result in extreme price movements. Such a situation would then call into question the ability of the agents, and by extension, the mobile money system to allocate purchasing power as needed for purposes of liquidity and debt redemption.

2.1.2 EMPIRICAL REVIEW

Seeing how important money is within an economy, several authors have undertaken the task of examining the impact mobile money has had within Africa.

One of the most widely examined relationships is the effect of mobile money on financial inclusion. Jack and Suri (2011) found that households that began to use mobile money were able to leverage on larger networks for remittances, allowing for consumption smoothing and risk sharing behavior. Further, they found that mobile money users were more likely than their counterparts who had never used mobile money to have bank accounts. Like Adam and Walker (2015) they found that mobile money encourages financial inclusion.

The question of financial inclusion is pertinent, especially in East African countries which are slowly transitioning from traditional monetary policy regimes - Kenya for example adopted a forward-looking monetary policy framework in 2011 (IMF, 2016). Financial inclusion plays a major role in determining what kind of regime is suitable within an economy, as more households become directly affected by interest rate changes, policymakers are free to change the sort of indicator that they target.

Adam and Walker (2015) further, used a Dynamic General Equilibrium Model featuring rural and urban households that sent remittances between themselves. The authors found that mobile money not only encourages economic stability but encourages financial inclusion too. This led them to conclude that as more households were included in formal financial services, having their saving and consumption decisions affected by policy rates, then policymakers could begin to target core inflation rather than headline inflation.

Weil, Mbiti and Mwega (2012) assessed the implications that mobile money and financial innovations could have on monetary policy in East Africa. Specifically, they estimated the transfer velocity of M-Pesa in Kenya, and found that its velocity was not as large as that of other monetary aggregates. However, there are other factors to consider when it comes to the relationship between mobile money and monetary policy, such as the effect on the demand for money.

Kasekende and Nikolaidou (2018) estimated the relationship between mobile money and demand for money using ARDL methods. They found that mobile money is significant in determining demand for money in

Kenya, but it does not affect the stability of money demand. Ndirangu and Nyamongo (2015) and Sichei and Kamau (2012) examined this relationship too, but had contradictory findings. They concluded that financial innovations did not affect money demand. Further research into this topic, with different techniques may shed light on this point of contention.

Aside from this, Islam, Muzi and Meza (2016) examined the relationship between firms' investment and mobile money in Kenya. They found that firms that use mobile money are 16% more likely to invest than their counterparts. Use of mobile money to pay employees, suppliers and utility bills, likely frees up cash flows for investments. This has important implications for an economy, and raises the question of availability of private sector credit to allow for such investments in the first place. Especially in East Africa where a significant number of households and businesses still lack access to formal financial services.

Some authors have examined the relationship between private sector credit and mobile money. Nampewo, Ainomugisha and Ssonko (2016) assessed the role mobile money plays in determining access to private sector credit in Uganda. They used Vector Error Correction methods and found that there was a significant relationship between use of mobile money and private sector credit. They concluded that the uptake of these services in Uganda meant the unbanked population of Uganda gained access to formal financial services. As such, their resources made their way into the banking system and this translated into creation of credit.

However, few authors have examined the combined effects of mobile money across an economy, most authors focus on specific macroeconomic factors. However, authors like Kipkemboi and Bahia (2019) and Mawejje and Lukama (2019) took this approach. Kipkemboi and Bahia (2019) examined the effects of mobile money on monetary and financial stability across Sub-Saharan Africa. Regarding monetary stability, they concluded that mobile money assists households in transferring non-cash assets into the financial system, because of this monetary policy is bolstered. Further, use of mobile money decreased the currency in circulation and increased the money multiplier. Supporting an idea similar to that of Ndirangu and Nyamongo (2015) that mobile money increases bank deposits, while decreasing the transaction demand for mobile money. Regarding financial stability, Kipkemboi and Bahia (2019) did not find any evidence that mobile money threatened the banking sector. More bank accounts were created, and retail banks saw higher Returns on Equity (ROE) when mobile money was adopted. Their study however was correlation in nature, econometric analysis may allow for deeper insight into the relationships presented and their causality.

Mawejje and Lukama (2019) however, conducted such an econometric analysis. They employed a Vector Error Correction model and a Structural Vector Autoregression to perform an analysis like Kipkemboi and Bahia (2019) only they examined more economic variables. They examined the relationship between mobile money and money demand, money stock, inflation, interest rates, private sector credit, and economic

output. Finding that the relationship between mobile money and money demand is not statistically significant. Regarding the other variables, they concluded that mobile money has moderate effects on macroeconomic variables. Although shocks in mobile money did have short run effects on inflation and private sector credit. They also found that mobile money balances were more significant for the transmission of monetary policy than mobile money transactions.

2.2 RESEARCH GAP

The research on the macroeconomic effects of mobile money is still very limited. Most of the literature focuses on issues at the household level, such as consumption smoothing, risk sharing and the gender effects of mobile money (Jack & Suri, 2014; Jack & Suri, 2016; Kikulwe, Fischer & Qaim, 2014). The studies that do analyze macroeconomic factors have tended to focus on a narrow range of topics, the effects on monetary policy and stability for example, are very popular. Additionally, despite its use across Africa, researchers tend to focus their analyses on Kenya and Uganda, where mobile money use is more widespread.

This study hopes to expand the literature by extending the economic factors under consideration, examining how these factors are affected by each other and mobile money. Further, this analysis will extend across East Africa considering other economies that are not as widely examined in the literature.

2.3 CONCEPTUAL FRAMEWORK

Mobile money might affect each of the independent variables under study differently. The probable relationships are highlighted herein.

Mobile Money and Money Stock

As mentioned by Mawejje and Lukama (2019), Mehrotra and Yetman (2015) and Kipkemboi and Bahia (2019) the introduction of mobile money allows non-banked households access to formal financial services, they can convert non-cash items into cash. This should then increase the demand for money, as well as the supply of money. On the other hand, the transactional function of mobile money might reduce the demand for money for the same. Ndirangu and Nyamongo (2015) were of this opinion.

Mobile Money and Output

As mobile money reduces the frequency of transactions and time spent on their completion, managers and employees may find that they have more free time with which to pursue other productive activities. (Frederick, 2014). This makes them more profitable and productive. The combination of lower transaction costs, and increased productivity and investment should translate to improved economic output.

Mobile Money and Inflation

As Mawejje and Lukama (2019) highlighted, mobile money might be inflationary if it causes the velocity

of circulation to increase, without a similar increase in economic output. On the other hand, if it enhances productivity and increases economic output it might have the opposite effect.

CHAPTER THREE

METHODOLOGY

3.1 RESEARCH DESIGN

The study examined the effects of mobile money on different macroeconomic variables in East Africa. As such, this involved quantitative analysis by estimating a Panel Vector Autoregression (PVAR). As this study extended across East Africa, the analysis involved panel estimation which is longitudinal and cross-sectional in nature.

3.2 POPULATION AND SAMPLING

The study's population was made up of the economies of East Africa. The sample in this way, was composed of the countries with mobile money infrastructure in place. This however, was restricted by the availability of such data for these countries. As such, the sample in the end was composed of Kenya, Tanzania, Uganda, and Rwanda -- Burundi and South Sudan were not included as their data series on mobile money is too short. The data spanned between the years of 2009 and 2019.

3.3 DATA COLLECTION

The study made use of data on GDP (to capture national income) mobile money transactions, money stock and, CPI indices (to capture inflation) for each country specified. These were sourced from the World Bank Economic Indicators database, the Bank of Uganda, the Central Bank of Kenya, the Bank of Tanzania, and the National Bank of Rwanda. These data sources are online and readily available.

3.4 DATA ANALYSIS

The analysis involved panel estimation techniques, i.e. a PVAR model.

3.4.1 PANEL VECTOR AUTOREGRESSION

The study adopted the PVAR developed by Abrigo and Love (2015). The PVAR is similar to a Vector Autoregression (VAR) all variables are assumed to be endogenous. In addition, it accounts for the cross-sectional nature of the data (Dees and Guntner, 2014).

A PVAR of order p with n variables would be expressed as:

$$Z_{it} = Z_{it-1}A_1 + Z_{it-2}A_2 + \cdots + Z_{it-p}A_p + Y_{it}B + u_{it} + e_{it} \quad (1)$$

Where Z_{it} is a $(1 \times n)$ vector of dependent variables, Y_{it} is a $(1 \times k)$ vector of exogenous variables, u_{it} is a $(1 \times n)$ vector of fixed effects and e_{it} is a $(1 \times n)$ vector of errors. The $(n \times n)$ A_i and $(k \times n)$ B matrices are parameters to be estimated.

So, a PVAR can account for dynamic interdependencies because lagged values of all variables can be included in the model, and cross-sectional heterogeneity because the intercepts, u_{it} and e_{it} are specific to the different units.

The model in this study was thus specified as:

$$MMT_{it} = \beta_{10} + \beta_{11}MMT_{it-1} + \beta_{12}M2_{it-1} + \beta_{13}CPI_{it-1} + \beta_{14}GDP_{it-1} + u_{1t}$$

$$M2_{it} = \beta_{20} + \beta_{21}MMT_{it-1} + \beta_{22}M2_{it-1} + \beta_{23}CPI_{it-1} + \beta_{24}GDP_{it-1} + u_{2t}$$

$$CPI_{it=}\beta_{30} + \beta_{31}MMT_{it-1} + \beta_{32}M2_{it-1} + \beta_{33}CPI_{it-1} + \beta_{34}GDP_{it-1} + u_{3t}$$

$$GDP_{it} = \beta_{40} + \beta_{41}MMT_{it-1} + \beta_{42}M2_{it-1} + \beta_{43}CPI_{it-1} + \beta_{44}GDP_{it-1} + u_{4t} \quad (2)$$

Where MMT is the value of mobile money transactions, M2 is the level of broad money, CPI is the Consumer Price Index, GDP is the Gross Domestic Product, β_{10} .... β_{44} are parameters to be estimated and the u_{it} are idiosyncratic errors.

All variables were expressed in logarithmic form and the PVAR was estimated at one lag due to the short length of the panel.

To estimate the PVAR, first the variables were tested for stationarity using the Fisher Augmented Dickey Fuller unit root test for panel data. The test highlights whether any variables contain a unit root, which can result in spurious regressions. Following this, a Granger causality test was run, this test shows which variables, if any, are useful for predicting the other variables. Next, an Orthogonalized Impulse Response Function (OIRF) was generated. This function shows how a particular variable responds to a standard deviation shock in another variable, holding other variables constant. The results of the Granger Causality test were used to inform the ordering of the OIRF. Lastly, a Forecast Error Variance Decomposition was performed. Such a decomposition shows the proportion of the variables' forecasted errors that can be explained by shocks to the other variables.

CHAPTER FOUR:

EMPIRICAL RESULTS AND DISCUSSION

4.1 PANEL VAR

After testing the variables for stationarity using a Fisher-type test utilizing the Augmented Dicky Fuller test, it was found that all the variables were non-stationary and had to be differenced once.

Once stationarity was achieved, a PVAR was estimated at one lag, as stated in the methodology. After estimating the PVAR an Eigenvalue stability test was conducted to ensure the model was well specified, and the test showed that all the eigenvalues lay within the unit root, allowing for the conclusion that the model is stable (**Appendix A**). From this, the results of the model can be interpreted with the assurance that the model is well-specified.

The results from the estimation are shown in Table 1 below.

Panel Vector Autoregression Results

VARIABLES	(1) MMT	(2) M2	(3) CPI	(4) GDP
L.MMT	0.180	-0.0229**	0.110	0.0260
	(0.431)	(0.0101)	(0.146)	(0.0253)
L.M2	1.523	-0.138	2.675	-0.703
	(2.624)	(0.222)	(1.890)	(0.482)
L.CPI	0.0134	0.0165	-0.294	-0.0145
	(0.307)	(0.0199)	(0.209)	(0.0719)
L.GDP	-1.822	0.227***	-1.460	-0.0547
	(1.251)	(0.0822)	(1.022)	(0.216)

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

Table 1

The results suggested only two variables were significant in explaining the others, these were the lags of M2 and mobile money. The results indicated that a 1% change in the value of MMT, 1 period in the past, causes the value of M2 to decrease by 2.3% today; while a 1% change in GDP 1 period in the past causes M2 to increase by 22.7%. Note that a period here is one year.

4.2 FORECAST ERROR VARIANCE DECOMPOSITION

To gain a deeper understanding of how these variables affect each other, a Forecast Error Variance Decomposition (FEVD) was conducted. The results of which are highlighted in Table 2 below.

Forecast Error Variance Decomposition Results

Response Variable	Forecast Horizon	Impulse Variable			
		MMT	M2	CPI	GDP
MMT	1	1	0	0	0
	2	0.94311	0.11282	0.011361	0.034247
	3	0.938818	0.015414	0.011605	0.034163
	4	0.937423	0.01562	0.011804	0.035154
	5	0.937297	0.015736	0.011817	0.03515
M2	1	0.009938	0.990062	0	0
	2	0.081633	0.754752	0.007311	0.156304
	3	0.082676	0.751042	0.01063	0.155653
	4	0.083906	0.747628	0.011774	0.156692
	5	0.083897	0.747693	0.011778	0.156632
CPI	1	0.216506	0.00388	0.779614	0
	2	0.183107	0.090048	0.658182	0.068663
	3	0.186434	0.087647	0.633886	0.092034
	4	0.185943	0.088299	0.633852	0.091907
	5	0.186016	0.088271	0.633794	0.09198
GDP	1	0.103734	0.021561	0.220323	0.747735
	2	0.028929	0.092238	0.200211	0.678623
	3	0.03997	0.094596	0.194784	0.670651
	4	0.040294	0.096159	0.194549	0.668998
	5	0.040572	0.096174	0.194511	0.668744

Table 2

The decomposition highlighted that in both the short-term and medium-term, forecast errors in MMT can

be almost entirely explained by itself. GDP explains the largest proportion of the forecasted errors, at 3% in both the short and medium-term.

Meanwhile, forecast errors in M2 similarly, are largely explained by M2 itself, but MMT explains between 10 to 8% of the forecast errors in the short and medium term respectively; CPI explains 7% of the forecast errors in the short-term and this increases to 12% in the medium term; and lastly GDP can explain 16% of the forecast errors in M2 throughout the short and medium term.

For CPI, again much of the forecast errors are explained by itself, ranging from 78% in the short-term to 64% in the medium-term. Also, MMT can explain a significant proportion of the forecast errors: going from 22% in the first forecast period to 19% in the forecasted medium-term. M2 explains up to 9% of the forecast errors in the short-term and medium-term, and GDP explains 7% of the short-term forecasted errors, and 9% of the medium-term forecasted errors.

Lastly, for GDP, most of its forecasted errors are explained by itself, peaking at 75% in the short-term, CPI explains a significant proportion of its forecasted errors, peaking at 22% in the short-term and 19% in the medium-term; MMT can only explain up to 3% of the forecasted errors in the short-term, but this increases to 4% in the medium term.

The results suggested that shocks in MMT determine a notable proportion of the variance in CPI and M2.

4.3 ORTHOGONALIZED IMPULSE RESPONSE FUNCTION

A Granger Causality test was performed to analyze the extent to which the different variables can be used to forecast the other(s). The results of this suggested that MMT and GDP Granger cause M2 i.e. they are useful for forecasting M2. Further, the combined variables (MMT, CPI, and GDP) Granger cause both M2 and CPI (**Appendix B**). This, combined with theoretical work informed the ordering of the Orthogonalized Impulse Response Function (OIRF), such that GDP was ordered first, then MMT and M2, and lastly, CPI. The results are highlighted in Figure 1 below.

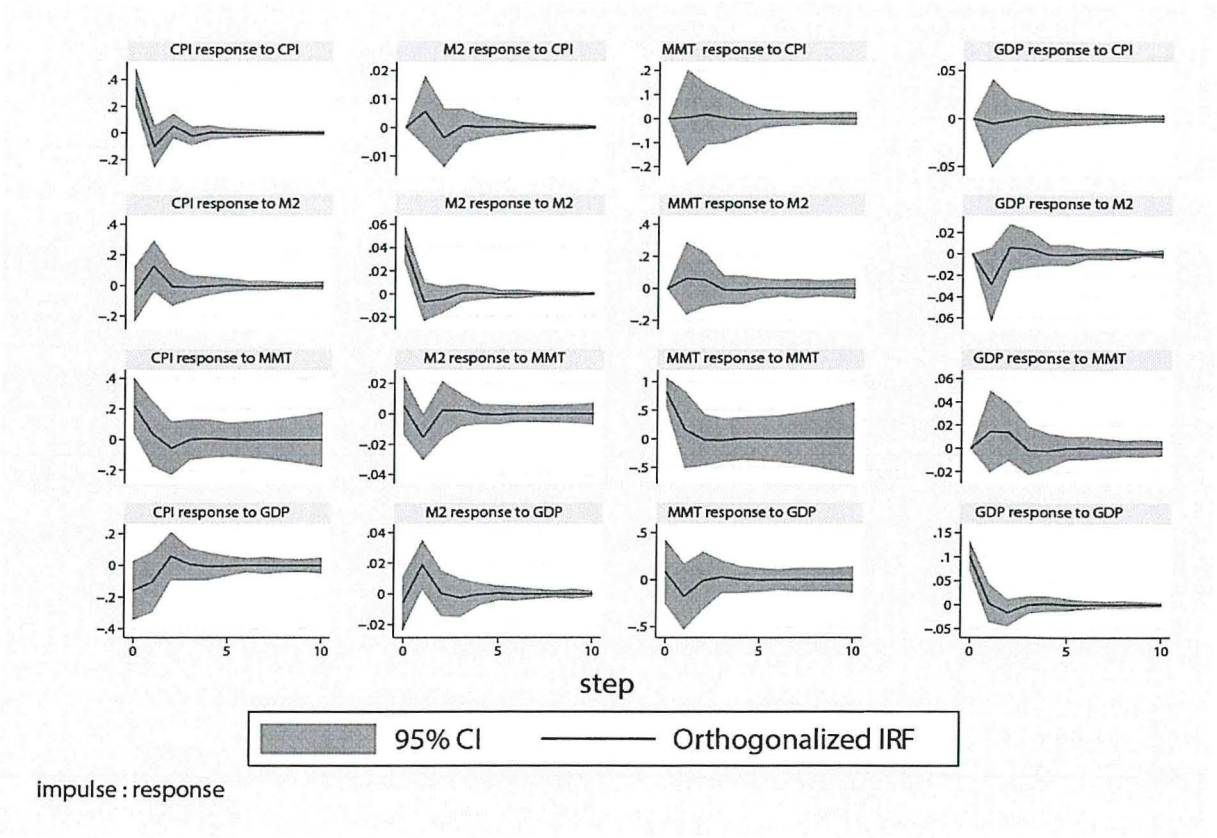

Figure 1

From this, it was implied that a shock in MMT decreases the level of inflation for up to 6 months afterwards, thereafter the effect levels off and ceases to be significant. This is in line with the findings of Aron et al. (2015), who found that the ratio of MMT to M3 has an insignificant, but negative effect on non-food inflation. The authors note that should mobile money increase efficiency and output, this should be the expected effect, which Mawejje and Lukama (2019) similarly hypothesized.

In the case of M2, a shock in MMT can be seen to decrease the level of M2 for a period of 1.5 years, however this is not significant. This contradicts the findings of Mawejje and Lukama (2019) and Mehrotra and Yetman (2015). However, it does follow the proposition of Ndirangu and Nyamongo (2015), that should mobile money be used for transactional purposes it might replace the demand for money for the same purposes.

Lastly, a shock to MMT is seen to increase GDP for 2 years, before decreasing for the next 2 years and finally levelling off -- although this is again insignificant. This is in line with the hypothesis of Frederick (2014) who proposed that mobile money use should increase productivity, and reduce transaction costs, leading to higher economic output.

These results were in line with other authors who have found mobile money to have modest macroeconomic effects.

CHAPTER FIVE:

CONCLUSION AND IMPLICATIONS

5.1 CONCLUSION

Mobile money has undoubtedly revolutionized financial systems across East Africa, giving the unbanked population access to financial services previously out of their reach, and offering the associated solutions such as consumption smoothing and risk sharing. Nonetheless, there has been concern from different sectors on the effects of the new product. In the banking sector, apprehension concerns whether mobile money is a threat to the safety of the existing payment systems; and whether commercial banks will lose business if mobile money does indeed turn out to function as a store of value.

This study aimed to assess the impact that mobile money transactions have on monetary policy, and economic performance and stability, by estimating a PVAR that draws on macroeconomic variables touching on each of these factors. Namely, money supply (M2), inflation (CPI) and GDP.

The results showed that CPI is affected by shocks to MMT in the short-run, although the response is not very large. This response would favor the hypothesis that mobile money increases efficiency of production as well as economic output, which causes the level of inflation to decrease (Mawejje & Lukama, 2019). Additionally, the FEVD suggested that mobile money can explain variation in both M2 and CPI. Combining this with the results of the OIRF and the PVAR, it would appear that MMT causes M2 to decrease; replacing its transactional function as hypothesized (Ndirangu & Nyamongo, 2015). These results however, were not quite economically significant, in fact where it comes to M2 and MMT they were not statistically significant either. So, much as other authors have found, mobile money does not have a significant effect on macroeconomic variables.

5.2 IMPLICATIONS FOR POLICY

Mobile money can still be of interest to policymakers for its dampening effect on inflationary processes. This link should be more closely examined, controlling for other potential inflationary factors, to isolate the role of mobile money. If this relationship can be better understood and proves to be significant, it can be utilized in controlling for inflation.

Further, the relationship between M2 and MMT is also of interest, as MMT causes the value of M2 to decrease. So, it would be of interest to policymakers to ensure mobile money is well regulated and monitored. The relationship should also be more closely examined, as intended monetary policy outcomes may be distorted by this relationship if it is not accounted for. It also holds potential for East African

countries to revolutionize their monetary policy, as more and more households enter the formal banking sector, and become financially included, interest rate changes directly affect their consumption and saving. Further, if mobile money substitutes M2 for transactional purposes, this could open up a new channel for policy that should be considered.

5.3 LIMITATIONS

However, given the fairly short period under examination, these results may not be conclusive, and may even change as the technology evolves and MNOs introduce new features to mobile money services.

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APPENDIX

APPENDIX A: STABILITY TEST

The Eigenvalue PVAR test for stability tests whether the eigenvalues lie within the unit root, showing whether the model is well-specified. The results are given below.

Eigenvalue stability condition		
Eigenvalue		
Real	Imaginary	Modulus
.0146455	-.4055053	.4057697
.0146455	.4055053	.4057697
-.3460613	0	.3460613
.0101665	0	.0101665

All the eigenvalues lie inside the unit circle.

PVAR satisfies stability condition.

APPENXIX B: GRANGER CAUSALITY TEST

The Granger test for causality analyses whether different time series can be used to forecast each other. The results of this test are shown below.

Granger Causality Test

Equation \ Excluded	chi2	df	Prob > chi2
dlogmminusd			
dlogm2	0.337	1	0.562
dlogCPI	0.002	1	0.965
dlogGDPusd	2.120	1	0.145
ALL	2.279	3	0.517
dlogm2			
dlogmminusd	5.153	1	0.023
dlogCPI	0.689	1	0.407
dlogGDPusd	7.632	1	0.006
ALL	13.635	3	0.003
dlogCPI			
dlogmminusd	0.564	1	0.453
dlogm2	2.003	1	0.157
dlogGDPusd	2.041	1	0.153
ALL	11.829	3	0.008
dlogGDPusd			
dlogmminusd	1.054	1	0.305
dlogm2	2.122	1	0.145
dlogCPI	0.041	1	0.840
ALL	6.046	3	0.109