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How has Mobile Phone Penetration Stimulated Financial Development in Africa?

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How has Mobile Phone Penetration Stimulated Financial Development in Africa?

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Abstract

In the first macroeconomic empirical assessment of the relationship between mobile phones and finance, this paper examines the correlations between mobile phone penetration and financial development using two conflicting definitions of the financial system in the financial development literature. With the traditional IFS (2008) definition, mobile phone penetration has a negative correlation with traditional financial intermediary dynamics of depth, activity and size. However, when a previously missing informal-financial sector component is integrated into the definition, mobile phone penetration has a positive correlation with informal financial development. Three implications result: there is a growing role of informal finance; mobile phone penetration may not be positively assessed at a macroeconomic level by traditional financial development indicators and; it is a wake-up call for scholarly research on informal financial development indicators which will oriented monetary policy.

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1. Introduction

The mobile revolution has transformed the lives of many Africans, providing not just communications but also basic financial access in the forms of phone-based money transfer and storage (Jonathan & Camilo, 2008; Demombynes & Thegeya, 2012). The high growth and penetration rates of mobile telephony that are transforming cell phones into pocket-banks in Africa is providing opportunities for countries on the continent to increase affordable and cost-effective means of bringing on board a large chunk of the population that hitherto has been excluded from formal financial services for decades. Such a transformation is of interest not only to banks and Micro Financial Institutions (MFIs) but also to governments, financial regulators as well as development partners who are providing support to improve the livelihoods of Africans through poverty reduction and sustained economic growth.

At the Connect Africa summit in 2007, Paul Kagame, president of Rwanda asserted: "*in ten short years, what was once an object of luxury and privilege, the mobile phone has become a basic necessity in Africa*" (Aker & Mbiti, 2010, 208). An article in *The Economist* (2008) also reported: "*a device that was a yuppie toy not so long ago has now become a potent for economic development in the world's poorest countries*". This paper seeks to assess if these sentiments and slogans are reflected in the correlation of mobile phone penetration with financial development in Africa?

Beyond, the need to investigate these perceptions, there is a growing body of work pointing to the imperative of more scholarly research on a phenomenon whose time is now: mobile banking. To the best of our knowledge, one of the most exhaustive accounts of the 'mobile phone' development literature concludes: "*Existing empirical evidence on the effect of mobile phone coverage and services suggest that the mobile phone can potentially serve as a tool for economic development in Africa. But this evidence while certainly encouraging remains limited. First, while economic studies have focused on the effects of mobile phones*

for particular countries or markets, there is little evidence showing that this has translated into macroeconomic gains…" (Aker & Mbiti, 2010, 224). Also, as sustained by Maurer (2008) and confirmed in subsequent literature (Jonathan & Camilo, 2008; Thacker & Wright, 2012), scholarly research on the adoption and socioeconomic impacts of mobile (m) banking (payments) systems in the developing world is scarce. From a broad perspective, most studies on mobile banking have been theoretical and qualitative in nature (Maurer, 2008; Jonathan & Camilo, 2008; Merritt, 2010; Thacker & Wright, 2012). The few existing empirical works hinge on country-specific and micro-level data (collected from surveys) for the most part (Demombynes & Thegeya, 2012).

This paper aims to assess the correlations between mobile phones and financial development dynamics. By distinguishing correlations between formal and informal financial intermediary sectors, findings could have substantial policy relevance; especially on the concern of examining which financial sectors are benefiting most from the soaring phenomenon of mobile phone penetration. The seminal character of this work also adds to the literature by proposing some hitherto unexplored dimensions of financial development which could provide the much needed guidance to policy makers on the financial development empirics of mobile phones. The paper is a descriptive study that extends "Mobile Bank in Africa: Taking the Bank to the people" Ondiege (2010). Hence, the study is more informative in nature. In other words, the paper contributes at the same time to the macroeconomic literature on measuring financial development and responds to the growing field of economic development by means of informal financial sector promotion, microfinance and mobile banking. It suggests a practicable way to disentangle the correlations between 'mobile phone penetration' and various financial sectors. Our contribution to the literature is therefore threefold. Firstly, we complement existing theoretical literature on the mobile-finance nexus by providing the first macroeconomic descriptive empirical assessment on the correlations

between the growing phenomenon of mobile phones with financial development[2]. Secondly, owing to the debate over which financial sectors are benefiting most from 'mobile phone penetration', we assess its impact by disentangling financial depth to include a previously missing component. Hence, we are able to capture both formal and informal financial intermediary development effects. Thirdly, based on the findings, we provide relevant measures that could guide future search and macroeconomic policy.

The rest of the paper is organized as follows. Section 2 reviews existing literature. Data and methodology are presented and outlined respectively in Section 3. Empirical analysis is covered in Section 4. Section 5 concludes.

2. Existing literature

There are four main avenues along which the incidence of mobile phone penetration on mobile banking could be discussed. The first strand captures the usefulness of mobile transactions (store of value, conversion of cash and, transfer of stored value). The concepts of savings (basic or partially intergrated) in mobile banking are eludicated in the second strand. The third strand relates mobile banking to GSM phones while the fourth presents some statistics on the proliferation of mobile banking in Africa.

In the first strand, Jonathan & Camilo (2008) stress that, most mobile transactions[3] in the developing world enable users to do three things. (a) Store value (currency) in an account

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[2] "*Relative to the spread of some other technologies that have been introduced in sub-Saharan Africa-improved seeds, solar cook stoves and agricultural technology-mobile phones adoption has occurred at a staggering rate on the continent. Yet few empirical economic studies have examined mobile phone adoption. This could be due to a variety of factors, including unreliable or nonexistent data on individual level adoption (leading to measurement error)…*" Aker & Mbiti (2010, 225).

[3] In order to have a mobile money account and make a deposit, a customer must own a cell phone SIM card with the mobile operator and register for a mobile money account. The customer then makes cash deposits at the physical offices of one of the operator's mobile money agents. These cash deposits create electronic money credit in the account. Customers can make person-to-person transfers of mobile money credit to the accounts of other mobile money users in the same network. They can also use their mobile money credit to pay bills and to buy phone airtime. Withdrawals (conversion to cash) could be made at the offices of the network's mobile money agents. There is also a possibility for a mobile money customer to make a transfer to someone who is not registered with the same network. In this case, when notice of the transfer is received through an SMS text message, the recipient can receive the cash at a mobile money agent (Demombynes, & Thegeya, 2012).

accessible via a handset. When the user already has a bank account, this is generally a question of linking to a bank account. If the user does not have an account, then the process creates a bank account for him/her or creates a pseudo bank account, held by a third party or the user's mobile operator. (b) Convert cash into and out of the store value account. When the account is linked to a bank account, then users can visit banks to cash-in and cash-out. In many instances, users can also visit the GSM providers' retail stores. In most flexible services, a user can visit a corner kiosk or grocery store (maybe the same one where he/she purchases airtime) and transact with an independent retailer working as an agent for the transaction system. (c) Transfer stored value between accounts. Users can generally transfer funds between accounts linked to two mobile phones, by using a set of SMS messages (or menu commands) and PIN codes. The new services offer a way to move money from place to place and present an alternative to the payments system offered by banks, pawn shops, remittance firms…etc. The uptake of m-banking (payments) systems has been particularly strong in the Philippines (where three million customers use systems offered by mobile operators Smart & Globe; Neville, 2006); Kenya (where nearly two million users registered with Safaricom M-PESA system within a year of its nationwide rollout, Vaughan, 2007; Ivatury & Mas, 2008) and South Africa where 450, 000 people use Wizzit ('the bank in your pocket'; Ivatury & Pickens, 2006) or one of two other national systems (Porteous, 2007).

The second strand elucidates the concept of savings. Demombynes & Thegeya (2012) have approached the mobile-finance nexus through this concept. They distinguish two types of mobile savings. (a) *Basic mobile* savings; which is simply the use of a standard mobile money system such as M-PESA to store funds. These basic mobile savings do not earn interest. Bank-integrated mobile savings perspectives have received a great deal of attention as a way to provide banking services to the poor. They have the edge of offering access to basic banking services without requiring proximity to a physical bank branch. Hence, with a

bank-integrated mobile savings account, basic banking services can be accessed through a network of mobile phone agents, which in Kenya outnumber the weight of bank branches significantly (Mas & Radcliffe, 2011). (b) The term *'partially integrated'* mobile savings system is also used to describe situations where bank account access via mobile phones is contingent on the establishment of a traditional account at a physical bank. More so, banks are beginning to build their own agent networks in order to assume a more competitive bargaining position in accessing mobile service platforms. Fully and partially integrated savings present different types of contracts among the partnering bank and mobile service provider. According to Demombynes & Thegeya (2012); on the one hand, a partially integrated product clearly delineates the role of the bank (which provides and owns banking services) from that of the mobile service provider (which provides mobile telephony infrastructure and controls the agent network). Thus, the bank compensates the mobile service provider for access to the network and enjoys the remaining profits. This type of contract more closely looks like a debt contract between parties. On the other hand, a fully integrated solution may not draw the same distinction between bank and mobile service providers. In this case, the distribution of surplus is contingent on the relative bargaining power of the bank and mobile service provider. This sort of contract more closely resembles an equity contract between two parties. Equity-like contracts are more likely to be complex and therefore more difficult to negotiate than debt-like contracts, there-by presenting a potential hurdle towards the goal of increasing access.

In the third strand, mobile banking is linked to GSM phones. Ondiege (2010), Chief Economist of the African Development Bank looks at the mobile-finance nexus from four perspectives. Firstly, the mobile phone can serve as a virtual bank card where customer and institution information can be securely stored, thereby avoiding the cost of distributing cards to customers. In fact he postulates, the subscriber identity module (SIM) card inside most (if

not all) GSM phones is in itself a smartcard (similar to the virtual bank card). Therefore, the banks customer's PIN and account number can be stored on this SIM card to perform the same functions as the bank virtual card. Secondly, the mobile phone may serve as a point of sale (POS) terminal. As such, a mobile phone could be used to transact and communicate with the appropriate financial institution to solicit transaction authorization. These are the same functions of a POS terminal at mails, retail or other stores. A mobile phone can duplicate these functionalities with ease. Thirdly, the mobile phone can also be used as an ATM. A POS is thus used to pay for goods and services at the store. If cash and access to savings were to be considered as 'goods and services', that customers buy and store, then the POS will also serve as a cash collection and distribution point which basically is the function of an automatic teller machine (ATM). Fourthly, the mobile phone may be used as an Internet banking terminal. Implying, it offers two fundamental customer services: a) ability to make payments and transfers remotely and; b) instant access to any account. Hence, the mobile phone device and wireless connectivity bring the internet terminal into the hands of otherwise unbanked customers.

A clearer picture of the proliferation of mobile banking is presented in the fourth strand with some statistics. Borrowing from Mbiti & Weil (2011), the story of the growth of mobile phones in Africa is one of a tectonic and unexpected change in communications technology. From virtually unconnected in the 1990s, over 60% of Africa now has mobile phone coverage and there are now over ten times as many mobiles as landline phones in use (Aker & Mbiti, 2010). In line with Aker & Mbiti (2010), mobile phone coverage in Africa has progressed at staggering rates over the past decade. In 1999, only 11% of the African population had mobile phone coverage, primarily in Northern (Egypt, Algeria, Libya, Morocco and Tunisia) and Sothern (Kenya and South Africa) Africa. By 2008, 60% of the population (477 million) could get a signal and an area of 11.2 million square kilometers had

mobile phone coverage: equivalent to the United Sates and Argentina combined. By the turn of 2012, it is projected that most villages in Africa will have coverage with only a handful of countries relatively unconnected. Borrowing from Demombynes & Thegeya (2012), Kenya has undergone a remarkable information and communication technology (ICT) revolution. At the turn of the 1990s, less than 3% of Kenyan households owned a telephone and less than 1 in 1000 Kenyan adults had mobile phone service. However, by the end of 2011, 93 percent of Keynan households owned a mobile phone. This soar is largely credited to the M-PESA mobile-banking network (Demombynes & Thegeya, 2012, 23-25).

3. Data and methodology

3.1 Data

We examine a sample of 52 African countries with data from African Development Indicators (ADI) and the Financial Development and Structure Database (FDSD) of the World Bank (WB). The mobile phone penetration rate is obtained from the African Development Bank (AfDB). In line with existing literature we proxy for 'mobile banking/activities' with the 'mobile penetration' rate (Ondiege, 2010; Aker & Mbiti, 2010). Owing to constraints in the time series properties of the mobile penetration measurement, data structure is cross-sectional and consists of 2003-2009 average growth rates[4]. While formal financial intermediary development indicators are directly extracted from the FDSD, semi-formal and informal financial indicators are computed from the FDSD in line with propositions from Asongu (2011a).

Details about the variables' definitions and data sources, descriptive statistics with presentation of countries and correlation analysis (showing the basic correlations between key variables employed in this paper) are presented in the appendices. The summary statistics

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[4] Data on 'mobile phone penetration' is thesame as in Ondiege (2010).

(Appendix 1) of the variables used in the cross-country regressions show that, there is quite a degree of variation in the data utilized so that one should be confident that reasonable estimated relationships should emerge. The purpose of the correlation matrix (Appendix 2) is to manage issues resulting from overparametization and multicolinearity. Based on the correlation coefficients, there do not appear to be any serious concerns in terms of the relationships to be estimated. Source and definition of the variables are reported in Appendix 3.

In a bid for clarity in presentation, we classify selected variables into two main strands below.

3.1.1 Financial intermediary development dependent variables

a) Financial depth

Borrowing from the FDSD and recent African finance literature (Asongu, 2011bcd), this paper measures financial depth from two standpoints: overall-economic and financial system perspectives with indicators of broad money supply (*M2/GDP*) and financial system deposits (*Fdgdp*) respectively. While the former denotes the monetary base plus demand, saving and time deposits, the later indicates liquid liabilities. Since we are dealing exclusively with developing countries, we distinguish liquid liabilities from money supply because a substantial chunk of the monetary base does not transit through the banking sector (Asongu, 2011bcd). The two indicators are in ratios of GDP (see Appendix 3) and both can robustly cross-check each other as either accounts for over 97% of information in the other (see Appendix 2).

b) Financial efficiency

By financial intermediation efficiency here, this study neither refers to a profitability-oriented concept nor to the production efficiency of decision making units in the financial

sector (through Data Envelopment Analysis: DEA). What we seek to highlight is the ability of banks to effectively fulfill their fundamental role of transforming mobilized deposits into credit for economic operators (agents). We adopt proxies for banking-system-efficiency and financial-system-efficiency (respectively 'bank credit on bank deposits: *Bcbd*' and 'financial system credit on financial system deposits: *Fcfd*'). Like with financial depth, these two financial allocation efficiency proxies can cross-check each other as they represent more than 83% of variability in one another (see Appendix 2).

c) Financial size

With respect to the FDSD, we measure financial intermediary size as the ratio of "deposit bank assets" to "total assets" (deposit bank assets on central bank assets plus deposit bank assets: *Dbacba*).

d) Financial activity

By financial intermediary activity here, the work highlights the ability of banks to grant credit to economic operators. We proxy for both banking system intermediary activity and financial system intermediary activity with "private domestic credit by deposit banks: *Pcrb*" and "private credit by domestic banks and other financial institutions: *Pcrbof*" respectively. The later measure cross-checks the former as it represents more than 92% of information in the former (see Appendix 2).

e) Formal, informal and semi-formal financial developments

In line with Asongu (2011a): *formal* financial development is the ratio of bank deposits (liabilities)[5] on GDP (or M2) in absolute (or relative) terms; *absolute* informal financial development (*Informal 1*) is measured as the difference between money supply (M2)

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[5] Bank deposits here refer to demand, time and saving deposits in deposit money banks. See Lines 24 and 25 of International Financial Statistics (IFS, October 2008) for the definition of *formal* financial intermediary development.

and financial system deposits[6] in percentage of GDP; *relative* informal financial development (*Informal 2*)[7] is measured as the difference between money supply and financial system deposits in percentage of M2; informal and semi-formal financial development[8] is the difference between M2 and bank deposits in percentage of M2.

3.1.2 Control variables

In the regressions, we shall control for the macro economic environment (inflation, government expenditure and domestic savings), financial openness (foreign direct investment: FDI) and the quality of institutions (regulation quality). The following discussion is relevant to their expected signs in relation to financial development dynamics. (1) While low and stable inflation rates generally provide a conducive environment for financial development, high inflation on the other hand, does quite the opposite. In addition, recent African finance literature has established a negative association between inflation and financial intermediary allocation efficiency (Asongu, 2011e). (2) Government expenditure could decrease financial depth if the budget allocated for investment is misallocated through corrupt practices (Ndikumana, 2000). (3) Savings improve financial depth (liquid liabilities). (4) While capital account openness in terms of FDI increases financial depth, it decreases financial efficiency. It is logical that FDI increases the use of currency. However, recent African openness-finance literature has found FDI to significantly deteriorate financial intermediary allocation efficiency because, the domestic financial sector has a less competitive advantage in the financial service industry (Asongu, 2010). (5) Though microfinance (and other forms of informal finance) at least in its (their) initial stages can strive without relying heavily on

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[6] Financial deposits are demand, time and saving deposits in deposit money banks and other financial institutions. See Lines 24, 25 and 45 of IFS (October, 2008).
[7] This is a measure of sector importance in financial development. That is, from *formal* and *semi-formal* to '*informal'* financial development: (Informalization). This proposition appreciates the deterioration of the f*ormal* and *semi-formal* banking sectors to the benefit of the *informal* sector. See Asongu (2011a).
[8] This is also a measure of sector importance in financial development. That is, from *formal* to '*semi-formal and informal'* financial development: (Semi-informalisation and informalization). This proposition appreciates the deterioration of the *formal* banking sector to the benefit of other sectors (informal and semi-formal). See Asongu (2011a).

government regulation, too much regulation and strong legal institutions that permit the poor to borrow against their assets could significantly affect the smooth growth of this (these) sector (s). This explanation is consistent with Batuo et al. (2010).

3.2 Methodology

Due to the cross-sectional structure of our data, we follow the empirical specification employed in the literature for this datastructure (Andrés, 2006)[9]. The model to be estimated is as follows:

$$Finance = \sigma_0 + \sigma_1 Mobile + \sigma_2 Inflation + \sigma_3 GovExp + \sigma_4 FDI + \sigma_5 RQ + \sigma_6 Savings + \varepsilon \quad (1)$$

where, *Finance* denotes financial development indicators, *Mobile* is the mobile phone penetration rate, *GovExp* refers to government expenditure, *FDI* is foreign direct investment, *RQ* stands for regulation quality, *Savings* represent gross domestic savings and, ε is the error term. Robustness of the analysis will be ensured by: (1) use of alternative financial development indicators; (2) modeling with Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors and; (3) RAMSEY's Regression Equation Specification Error Test (RESET) for validity of model specifications. Apart from using alternative financial development indicators, the four basic concerns of Ordinary Least Squares (OLS) regression are ensured. That is, while autocorrelation in residuals and heteroscedasticity are tackled with HAC standard errors, the assumption of linearity is verified with the RESET. As we have already discussed, the correlation analysis in Appendix 2 has guided us to avoid issues of multicolinearity and overparametization.

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[9]A referee has also suggested an OLS approach with a lot of controls for the omitted variable bias problems. This suggestion is premised on the lack of good instruments at a macro level necessary for an Instrumental Variabe empirical strategy.

4. Empirical analysis

This empirical section addresses two main issues: (1) the ability of 'mobile phone penetration' to be correlated with financial intermediary development dynamics conditional on other covariates (control variables) and; (2) the possibility of non-linear combinations of the fitted values explaining the response variable. While the first issue is addressed by the significance and signs of estimated coefficients, the second depends on the outcome of RAMSEY's RESET. The intuition behind the RESET is that, if non-linear combinations of the explanatory variables have any power in explaining the response variable, then the model is mis-specified. Hence, the RESET is a general specification test for a the linear regression model. The null hypothesis of this test is the position that, non-linear combinations of the fitted values have no explanatory power on financial development dynamics. Hence, failure to reject the null hypothesis lends credit to the linear model specification. While Table 1 reports regressions of traditional financial intermediary dynamics of depth, activity, efficiency and size on the mobile phone penetration (mobile) channel, Table 2 reflects the mobile-finance nexus with measures of financial sector importance. The imperative here is to examine how the phenomenon of mobile phone penetration is playing-out in the development of formal, semi-formal and informal financial intermediary sectors. Discussion of results hinge on the assumption that, mobile phone penetration affects financial development only through mobile banking activities. Hence, we might use mobile phone penetration and mobile banking interchangeably.

The first issue in Table 1 which is addressed by the significance of estimated coefficients is valid for financial intermediary dynamics of depth, activity and size. The negative mobile banking elasticities of finance point to the deterioration of the traditional financial intermediary dynamics owing to the phenomenon of mobile penetration. This negative incidence is more pronounced in financial system activity than in banking system

activity and also, more witnessed in financial system deposits than in economic financial depth. Two facts explain these disparities in weight of elasticities. (1) Mobile banking has a greater negative correlation with 'financial system activity' than with 'banking system activity' because the former entails a semi-formal banking activity which should also be negatively correlated with the phenomenon. The interpretation is valid on the condition that, the phenomenon also negatively affects semi-formal financial intermediation activity (the difference between financial system activity and banking system activity). This is only logical because semi-formal finance according to the IFS (2008) definition of the financial system entails, specialized non-bank and other financial institutions like rural banks, post banks, credit unions…etc. From intuition and common-sense, mobile banking should therefore be negatively correlated with semi-formal banking activities because of their quasi-formal settings. In plainer terms, credit (financial activity) allocated by the semi-formal financial sector also has a negative correlation with mobile banking. (2) Financial system depth is more negatively correlated with mobile banking than does economic financial depth. This is only logical from common-sense and theoretical postulations elucidated at the first phase of this paper. Economic financial depth is overall money supply (M2) and is made-up of the financial system's depth (formal and semi-formal deposits) as well as, the informal financial sector depth (which is a great chunk of the monetary base: M0, in developing countries) that does not transit through formal banks and other financial institutions recognized by the financial system (IFS, 2008). Hence, it is only logical that, mobile-penetration has a less negative correlation with overall economic financial depth. Another supposition resulting from this interpretation is the fact that, the less negative incidence on overall economic financial depth attests to a hypothetical positive correlation between mobile banking and the informal financial sector (which is still not a component of the financial system according to the IFS, 2008 definition).

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The second issue is addressed by the RESET. Overwhelming failure to reject the null hypothesis of this test points to the validity of the specification and suggests that non-linear combinations of the fitted values do not have any explanatory power on traditional financial development dynamics.

Three points retain our attention on the significance of the control variables. (1) Inflation is negatively correlated with financial development, consistent with recent African finance literature on the positive association between inflation (inflation- uncertainty) and banking inefficiency (Asongu, 2011e). (2) Government expenditure could decrease financial depth if budget allocated for investment is misallocated through corrupt practices (Ndikumana, 2000). Hence, if budget intended for a particular domestic investment is deposited in a foreign bank account by corrupt officials, it is a loss in domestic money supply. (3) While capital account openness in terms of FDI increases financial depth, it decreases financial efficiency. It is logical that FDI increases the use of currency. However, recent African openness-finance literature has found FDI to significantly deteriorate financial intermediary allocating efficiency because, the domestic financial sector has a less competitive advantage in the financial service industry (Asongu, 2010). Therefore, it could be concluded that the significant control variables have the right signs.

Note should be taken of the fact that, Table 1 is based on the IFS (2008) definition of the financial system which is comprised of only, the formal banking system and other financial institutions (semi-formal banking sector). Regressions in Table 2 however, relax the IFS (2008) assumption and integrate a previously missing component of the financial system (informal sector) into the conception and definition of the financial system; in line with Asongu, (2011a). This redefinition of the financial system is premised on two counts: (1) theoretically, the growing phenomenon of mobile banking is escaping the grasp of the formal and semi-formal financial sectors; (2) empirically our findings in Table 1 fail to demonstrate a

positive mobile-finance nexus, which logically implies, the phenomenon may be positively captured by a missing component in the IFS (2008) conception and definition of the financial system.

Table 2 below is based on the Asongu (2011a) definition of the financial system which integrates the previously missing informal financial sector component into the IFS (2008) definition. Instead of using traditional indicators of financial development based on dynamics of depth, efficiency, activity and size as captured by Table 1, we employ measures of sector importance. Hence, we distinguish between the formal, semi-formal and informal sectors. We use two indicators of informal finance (absolute and relative measures) to distinguish between the growth in absolute terms of the informal sector (*Informal 1*), conditional on GDP and; relative growth of the informal sector (*Informal 2*), contingent on M2. Hence, the latter measures the relative importance of the informal sector with respect to the two other sectors, encapsulated in the IFS (2008) definition. In other words, *Informal 2* appreciates how the informal financial sector evolves at the expense of the formal and semi-formal financial sectors. The last indicator (*Informal & Semiformal*) appreciates the extent to which informal and semi-informal finance progress to the detriment of the formal banking sector.

Like in the previous table, two main issues outlined in the introduction of this section are assessed. Looking at the first concern, the following could be noticed. (1) Mobile banking is positively correlated with informal financial development. Its positive correlation with respect to the absolute measure (*Informal 1*) is insignificant while that in respect of the relative indicator (*Informal 2*) is significant at the 5% level. A logical deduction is that, mobile banking is positively correlated with the growth of the informal financial sector through improvements in the informal sector's share of money supply (M2) than in its share of GDP growth (on which the absolute measure is based). Hence, with the advent of mobile banking, growth of the informal sector is more pronounced at the expense of the formal and

semi-formal sectors (constituents of M2), than to the detriment of many other macroeconomic variables (constituents of GDP). Plainly put, the share of informal finance is more relevant in M2 growth than in GDP growth. (2) The mobile banking elasticity of 'informal and semi-formal financial development' (0.341) is higher than that of 'informal financial development' (0.340). A logical interpretation follows: financial deposits (depth) of the semi-formal financial institutions increase only by a thin margin owing to their positive correlation with mobile banking. (3) The correlation between mobile banking and formal financial development is significantly negative. This 'banking system depth' finding confirms results of 'economic financial depth' and 'financial system depth' in Table 1.

With regard to the second concern, failure to reject the null hypothesis of the RESET points to the validity of the model specification. Therefore, non-linear combinations of the fitted variables have no explanatory power on the financial sector importance measures.

Three points still capture our attention on the significance of the control variables. (1) Consistent with Ndikumana (2000), the reason government expenditure could be negatively correlated with fiancial development has already been explained above. (2) Though microfinance (and other forms of informal finances) at least in its (their) initial stages can strive without relying heavily on government regulation, too much regulation and strong legal institutions that permit the poor to borrow against their assets could significantly affect the smooth growth of this (these) sector (s). This explanation is consistent with Batuo et al. (2010). (3) While low and stable inflation rates provide a conducive environment for financial development, high inflation on the other hand (as shown in the summary statistics) does quite the opposite.

Before concluding, it is important to highlight a ceveat to this study. A cross-sectional analysis is a descriptive observational study. Hence, results should be interpreted with caution as the estimated coefficients of the exogenous variable of interest do not imply the "effect of

mobile phones" on various financial dynamics. Rather, they should be intepretated as the "correlation of mobile phones" with the financial intermediary development measures under consideration. We report these as "correlations" because the descriptive analytical approach does not provide a good basis for establishing causality.

5. Conclusion, policy recommendations and future directions

In the first empirical assessment of the correlation between "mobile phone penetration" and financial intermediary development in Africa, we have used two definitions of the financial system: the traditional IFS (2008) and Asongu (2011a) measures of financial sector importance. When the financial system is based only on banks and other financial institution (IFS, 2008), mobile banking has a negative correlation with traditional financial intermediary dynamics of depth, activity and size. However, when a previously missing informal-financial sector component is integrated into the definition (Asongu, 2011a), mobile banking has a positive correlation with informal financial intermediary development. Three major implications result from the findings. (1) There is a growing role of informal finance in developing countries. (2) The incidence of a burgeoning phenomenon of mobile banking cannot be positively assessed at a macroeconomic level by traditional financial development indicators. (3) It is a wake-up call for scholarly research on informal financial intermediary development indicators which will oriented monetary policy; since a great chunk of the monetary base (M0) in less developed countries is now captured by mobile banking (informal financial activities). Hence, the study is purely informative in nature. In other words, the paper has contributed at the same time to the macroeconomic literature on measuring financial development and responded to the growing field of economic development by means of informal financial sector promotion, microfinance and mobile banking. It has suggested a

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practicable way to disentangle the correlations between 'mobile phone penetration' and various financial sectors.

Beside rethinking monetary policy transmission mechanisms, other future research directions could include: (1) ascertaining whether and how mobile phones can lead to poverty reduction through growth and financial development; (2) an assessment of short, medium and long-term incidences of mobile phones on financial development is also worthy of note; (3) consequences of regulation on mobile banking and; (4) last but not the least, monetary policy tools that could fight inflation resulting from mobile banking activities.

Table 1: Impact of mobile phone penetration on traditional financial intermediary dynamics

	Dependent variables: Traditonal financial intermediary dynamics						
	Financial Depth		**Financial Efficiency**		**Financial Activity**		**Fin. Size**
	Economic Financial Depth	Financial System Depth	Banking System Efficiency	Financial System Efficiency	Banking System Activity	Financial System Activity	Financial System Size
Constant	**1.216****	**1.268*****	**1.254*****	2.236	**1.009*****	**1.507****	**1.517*****
	(0.015)	**(0.002)**	**(0.002)**	(0.142)	**(0.004)**	**(0.022)**	**(0.000)**
Mobile Phone Penetration	**-0.512***	**-0.579****	-0.205	-0.711	**-0.405****	**-0.675***	**-0.310****
	(0.068)	**(0.015)**	(0.368)	(0.384)	**(0.046)**	**(0.060)**	**(0.030)**
Inflation	0.009	0.010	**-0.017****	-0.008	0.0001	0.005	**-0.015*****
	(0.918)	(0.237)	**(0.019)**	(0.611)	(0.983)	(0.609	**(0.005)**
Government Expenditure	**-0.013****	**-0.009***	0.006	0.004	-0.003	-0.002	0.006
	(0.029)	**(0.053)**	(0.144)	(0.648)	(0.427)	(0.645)	(0.169)
Foreign Direct Investment	**0.021***	0.015	**-0.031****	-0.060	-0.006	-0.017	-0.008
	(0.096)	(0.168)	**(0.012)**	(0.167)	(0.526)	(0.343)	(0.161)
Regulatory Quality	0.095	0.129	0.077	0.205	0.169	0.222	0.085
	(0.381)	(0.186)	(0.554)	(0.337)	(0.105)	(0.142)	(0.132)
Domestic Savings	-0.001	-0.001	0.003	-0.001	-0.0005	-0.001	-0.002
	(0.703)	(0.604)	(0.258)	(0.833)	(0.842)	(0.692)	(0.105)
Adjusted R²	0.383	0.504	0.359	0.189	0.388	0.353	0.521
RAMSEY RESET	**0.616**	**0.436**	**0.466**	**2.097**	**1.834**	**2.371**	**1.639**
	(0.551)	**(0.653)**	**(0.633)**	**(0.159)**	**(0.189)**	**(0.123)**	**(0.219)**
Fisher	**19.038*****	**19.419*****	**5.954*****	2.154	**5.016*****	**2.818****	**4.891*****
	(0.000)	**(0.000)**	**(0.000)**	(0.103)	**(0.003)**	**(0.039)**	**(0.002)**
Observations	52	52	52	52	52	52	52

*,**,***: significance levels of 10%, 5% and 1% respectively. Heteroscedasticity and Autocorrelation Consistent (HAC) p-values in brackets. Fin: Financial.

Table 2: Impact of mobile phone penetration on financial sector importance measures

	Dependent variables: Measures of financial sector importance			
	Informal 1	Formal	Informal 2	Informal & Semiformal
Constant	-0.051	**1.266***	-0.368	-0.364
	(0.743)	**(0.002)**	(0.203)	(0.209)
Mobile Phone Penetration	0.066	**-0.579**	**0.340**	**0.341**
	(0.437)	**(0.015)**	**(0.046)**	**(0.046)**
Inflation	-0.001	0.010	**-0.009**	**-0.008***
	(0.469)	(0.244)	**(0.045)**	**(0.062)**
Government Expenditure	**-0.003***	**-0.009***	**-0.004**	**-0.004**
	(0.004)	**(0.057)**	**(0.026)**	**(0.022)**
Foreign Direct Investment	0.005	0.015	0.004	0.004
	(0.180)	(0.163)	(0.565)	(0.613)
Regulatory Quality	-0.034	0.128	**-0.134**	**-0.132**
	(0.199)	(0.183)	**(0.013)**	**(0.013)**
Domestic Savings	0.0002	-0.001	0.001	0.001
	(0.716)	(0.605)	(0.102)	(0.101)
Adjusted R²	0.108	0.505	0.520	0.510
RAMSEY RESET	**1.654**	**0.474**	**0.097**	**0.165**
	(0.220	**(0.630)**	**(0.907)**	**(0.165)**
Fisher	**4.690***	**19.220***	**5.826***	**6.309***
	(0.004)	**(0.000)**	**(0.001)**	**(0.000)**
Observations	52	52	52	52

*,**,***: significance levels of 10%, 5% and 1% respectively. Heteroscedasticity and Autocorrelation Consistent (HAC) p-values in brackets. Informal 1: Absolute informal financial development. Informal 2: Relative informal financial development. Informal & Semiformal: Relative informal and semi-formal financial development.

Appendices

Appendix 1: Summary statistics and presentation of countries

	Panel A: Summary Statistics	Mean	S.D	Min.	Max.	Obser.
Financial Depth	Economic System Depth (M2)	0.339	0.242	0.079	1.022	44
	Financial System Depth (Fdgdp)	0.273	0.226	0.042	0.895	44
Financial Efficiency	Banking System Efficiency (BcBd)	0.706	0.344	0.252	2.249	51
	Financial System Efficiency (FcFd)	0.712	0.382	0.259	2.458	35
Financial Activity	Banking System Activity (Pcrb)	0.185	0.175	0.027	0.715	44
	Financial System Activity (Pcrbof)	0.208	0.244	0.027	1.423	44
Financial Size	Financial System Size (Dbacba)	0.765	0.210	0.063	1.074	51
Formal F.D	Banking System Deposits (Bdgdp)	0.271	0.225	0.042	0.892	44
Informal F.D 1	Absolute Informal F.D	0.066	0.054	-0.145	0.217	44
Informal F.D 2	Relative Informal F.D	0.239	0.173	-0.336	0.727	44
Informal & Semi-formal	Relative Informal and Semi-formal F.D Development	0.246	0.173	-0.336	0.727	44
	Mobile Phone Penetration	1.674	0.217	1.043	2.242	52
	Inflation	117.95	764.60	1.953	5304.8	44
Control Variables	Government Expenditure	5.488	5.843	-1.325	27.192	33
	Foreign Direct Investment	4.675	4.731	0.062	23.203	41
	Regulation Quality	-0.680	0.617	-2.497	0.623	52
	Domestic Savings	13.296	21.149	-50.018	80.104	48

Panel B: Presentation of Countries

Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Congo Democratic Republic, Congo Republic, Ivory Coast, Djibouti, Egypt, Equatorial Guinea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Mali, Malawi, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome & Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Togo, Tunisia, Uganda, Zambia, Zimbabwe, Tanzania, Comoros.

S.D: Standard Deviation. Min:Minimum. Max: Maximum. Obser.:Observations. F.D: Financial Development.

Appendix 2: Correlation analysis

Formal Financial Development (FD)								Informal & Semi-formal FD			Mobile Phone Penetration	Control Variables					
Financial Depth			Fin. Efficiency		Fin. Activity		Fin. Size	Infor-	Inform-	Informal &		Inflati	Gov.				
M2	Fd	Bd	BcBd	FcFd	Pcrb	Pcrbof	Dbacba	mal 1	al 2	Semi-formal	Penetration	on.	Exp.	FDI	R.Q	Savings	
1.00	0.97	0.97	-0.12	0.04	0.75	0.57	0.28	0.39	-0.36	-0.36	-0.49	-0.09	-0.24	0.35	0.43	-0.06	M2gdp
	1.00	0.99	-0.06	0.16	0.82	0.69	0.36	0.18	-0.53	-0.53	-0.59	-0.05	-0.20	0.33	0.53	-0.04	Fdgdp
		1.00	-0.06	0.16	0.82	0.69	0.36	0.18	-0.53	-0.53	-0.59	-0.05	-0.20	0.33	0.53	-0.04	Bdgdp
			1.00	0.83	0.35	0.34	0.31	-0.28	-0.13	-0.15	-0.23	-0.04	0.05	-0.40	0.30	-0.10	BcBd
				1.00	0.58	0.77	0.37	-0.53	-0.47	-0.46	-0.24	-0.19	-0.15	-0.41	0.43	-0.04	FcFd
					1.00	0.92	0.44	-0.08	-0.59	-0.59	-0.58	-0.15	-0 .17	-0.03	0.65	-0.07	Pcrb
						1.00	0.38	-0.31	-0.65	-0.65	-0.55	-0.12	-0.14	-0.07	0.61	-0.04	Pcrbof
							1.00	-0.23	-0.56	-0.58	-0.35	-0.16	0.23	-0.45	0.56	0.33	Dbacba
								1.00	0.60	0.59	0.23	-0.18	-0.26	0.18	-0.25	-0.12	Informal 1
									1.00	0.98	0.47	-0.21	-0.21	-0.02	-0.60	-0.05	Informal 2
										1.00	0.49	-0.20	-0.22	-0.05	-0.59	-0.06	Inf & Semi
											1.00	-0.03	0.17	-0.23	-0.29	-0.05	Mobile P.
												1.00	0.14	0.04	-0.43	-0.20	Inflation
													1 .00	-0.07	0.04	0.20	Gov. Exp.
														1.00	-0.26	-0.30	FDI
															1.00	0.12	R.Q
																1.00	Savings

M2: Economic financial depth. Fd: Financial system depth. Bd: Banking system depth . BcBd: Banking system efficiency. FcFd: Financial system efficiency. Pcrb: Banking system activity. Pcrb: Financial system activity. Dbacba: Financial system size. Informal 1: Absolute informal financial development. Informal 2: Relative informal financial development. F.D: Financial Development. Fin: Financial. Gov.Exp: Government Expenditure. FDI: Foreign Direct Investment. R.Q: Regulation Quality.

Appendix 3: Variable definitions

Variables	Signs	Variable definitions	Sources
Economic Financial Depth	M2	Money supply (% of GDP)	World Bank (FDSD)
Financial System Depth	Fdgdp	Liquid liabilities (% of GDP)	World Bank (FDSD)
Banking System Depth	Bdgdp	Banking deposits (% of GDP)	World Bank (FDSD)
Banking System Efficiency	BcBd	Bank credit on Bank deposits	World Bank(FDSD)
Financial System Efficiency	FcFd	Financial credit on Financial deposits	World Bank (FDSD)
Banking System Activity	Prcb	Private domestic credit from deposit banks (% of GDP)	World Bank (FDSD)
Financial System Activity	Prcbof	Private domestic credit from deposit banks and other financial institutions (% of GDP)	World Bank (FDSD)
Financial Size	Dbacba	Deposit bank assets on Central bank assets plus Deposit bank assets	World Bank (FDSD)
Absolute Informal FD	Informal 1	M2-Fd (% of GDP)	World Bank (FDSD)
Relative Informal FD	Informal 2	M2-Fd (% of M2)	World Bank (FDSD)
Informal and Semi-formal FD	Informal & Semi-formal	M2-Bd (% of M2)	World Bank (FDSD)
Mobile Phone Penetration	Mobpen	Seven year average growth rate(% of population)	AfDB
Inflation	Infl	Consumer Price Index (annual %)	World Bank (WDI)
Government Expenditure	Gov. Exp.	Government's Final Expenditure (% of GDP)	World Bank (WDI)
Foreign Direct Investment	FDI	Gross Foreign Direct Investment (% of GDP)	World Bank (WDI)
Regulation Quality	RQ	Regulation Quality (estimate): Measured as the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	World Bank (WDI)
Savings	Savings	Gross Domestic Savings (% of GDP	World Bank (WDI)

WDI: World Bank Development Indicators. FDSD: Financial Development and Structure Database. FD: Financial Development. AfDB: African Development Bank. Fd:Financial system deposits. Bd: Banking system deposits. M2: Money supply.

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