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The Mobile Phone, Information Sharing and Financial Sector Development in Africa: A Quantile Regressions Approach [1]

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The Mobile Phone, Information Sharing and Financial Sector Development in Africa: A Quantile Regressions Approach

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Abstract

This study investigates linkages between the mobile phone, information sharing offices (ISO) and financial sector development in 53 African countries for the period 2004-2011. ISO are private credit bureaus and public credit registries. The empirical evidence is based on contemporary and non-contemporary quantile regressions. Two main hypotheses are tested: mobile phones complement ISO to enhance the formal financial sector (*Hypothesis 1*) and mobile phones complement ISO to reduce the informal financial sector (*Hypothesis 2*). The hypotheses are largely confirmed. This research adds to the existing body of literature by engaging hitherto unexplored dimensions of financial sector development and investigating the role of mobile phones in information sharing for financial sector development.

JEL Classification: G20; G29; L96; O40; O55
Keywords: Information sharing; Banking sector development; Africa

1. Introduction

The mobile phone is transforming the lives of many by offering not just a means of quick communication but also enabling a previously unbanked fraction of the population in developing countries to have access to 'mobile banking'-related services. Information and communication technology (ICT) is also being used by information sharing offices (ISO) to enhance financial allocation efficiency and financial sector development in the banking industry.

The literature on the use of ISOs to enhance financial access has revolved around two main themes: the effect of decreasing information asymmetry (IA) and the relevance of creditors' rights in consolidating mechanisms of reducing IA. In essence, one branch of the literature has been oriented fundamentally towards the relevance of better creditors' rights in, *inter alia*: bankruptcy (Claessens & Klapper, 2005; Djankov et al., 2007; Brockman & Unlu, 2009) and bank risk-taking (Houston et al., 2010; Acharya et al., 2011). Another branch of the literature has focused on investigating how enhanced sharing of information by ISO can: affect syndicated bank loans (Ivashina, 2009; Tanjung et al., 2010); influence corrupt lending (Barth et al., 2009) and antitrust intervention (Coccorese, 2012); mitigate the cost of credit (Brown et al., 2009); boost financial access (Asongu et al., 2016a; Triki & Gajigo, 2014; Brown et al., 2009; Djankov et al., 2007) and decrease rates of default (Jappelli & Pagano, 2002).

The literature has substantially focused on developed nations and the emerging economies of Latin America and Asia, while the corresponding scholarship on Africa is sparse. In essence, some studies have focused on nine African countries (see Barth et al., 2009); four (Love & Mylenko, 2003) and none (Galindo & Miller, 2001). More recently, Triki and Gajigo (2014) assessed 42 countries for the period 2006-2009, whereas Asongu et al. (2016a, 2016b) examined 53 countries within the periodic interval of 2004 and 2011.

The engaged literature can be improved in four main ways, notably by: (i) focusing on African countries; (ii) investigating the complementary role of the mobile phone in information sharing to enhance financial sector development; (iii) engaging previously unexplored dimensions of financial sector development in the financial development literature and (iv) accounting for initial levels of financial sector development. We engage the points substantively in the same chronological order.

First, both the broad (Houston et al., 2010; Tanjung et al., 2010; Ivashina, 2009; Galindo & Miller, 2001) and African-centric (Asongu et al., 2016b; Triki & Gajigo, 2014; Singh et al.,

2009; Asongu and Nwachukwu, 2018) literature on information sharing has not substantially explored the role of reducing information asymmetry (IA) in financial development in Africa. The neglect of the IA dimension is not very surprising because data on information sharing were only available from 2004.

In the related literature, Love and Mylenko (2003) have concluded that private registries promote bank lending and reduce constraints to financial access while the corresponding effects from public credit registries are not very significant. Galindo and Miller (2001) maintain that credit registries are better drivers of financial development compared to credit bureaus. Singh et al. (2009) find that African countries with information sharing offices are rewarded with higher levels of financial access. Triki and Gajigo (2014) conclude that relative to public credit registries (PCR), financial access is more positively sensitive to private credit bureaus (PCB)[2]. Asongu et al. (2016b) establish that ISOs have negatively affected financial access for the most part, while Asongu et al. (2016a) have found financial development dynamics to be less positively sensitive to PCR, compared to PCB.

This study is closest to the last three inquiries that have recently employed PCB and PCR as proxies for information sharing. A common gap in the attendant studies is the failure to consider the relevance of information technology in the relationship between information sharing and financial access. This study bridges the identified gaps by involving information technology in the investigated relationship. The intuition and theoretical underpinnings supporting the relevance of information technology are substantiated in Section 2. Moreover, instead of focusing on financial access as in the corresponding literature, this research is concerned with financial sector development. Furthermore, the positioning of the study is also in response to recommendations for more scholarly research on the effects of ISO (Singh et al., 2009, p. 13).

Second, the motivation for investigating the complementary role of the mobile phone in information sharing to enhance financial sector development builds on the high potential for mobile phone penetration in information sharing on the continent[3]. As recently documented by Penard et al. (2012), while mobile phone penetration has reached saturation and stabilization

[2] ISO is used interchangeably with 'PCR and PCB'.

[3] There is a growing strand of literature on the relevance of ICT in development outcomes in Africa(Afutu-Kotey et al., 2017; Asongu & Boateng, 2018; Bongomin et al., 2018 ; Gosavi, 2018; Humbani & Wiese, 2018; Isszhaku et al., 2018; Minkoua Nzie et al., 2018; Muthinja & Chipeta, 2018; Abor et al., 2018).

levels in high-end markets (in Europe, North America and Asia), there is still room for its development in Africa.

Third, introducing the notion of financial sector development is motivated by the fact that, for the most part, the literature on banking development has been skewed towards bank concentration and bank participation (see Asongu, 2015a; O'Toole, 2014). Moreover, as documented by Aryeetey (2005), Adeusi et al. (2012) and Meagher (2013), the role of the informal financial sector has been neglected in financial development literature, partly because studies for the most part have examined the role of financial sector reforms on financial access (see Arestis et al., 2002; Batuo & Kupukile, 2010).

In the light of the above, by introducing the informal financial sector into the mainstream financial system definition, the study unites two branches of research by on the one hand, improving the macroeconomic literature on development within the financial sector and on the other hand, responding to an evolving branch of development studies on channels of microfinance and informal finance. In addition, the proposed approach is a pragmatic means of disentangling the impact of information sharing on various financial sectors in an economy. The propositions for financial sector development (which are discussed in-depth in Section 2), improve the financial development literature in three key areas, notably by: (i) providing a financial system definition that incorporates the previously missing informal financial sector; (ii) disentangling the mainstream definition of the financial system into its semi-formal and formal components and (iii) introducing the concept of financialization within the framework of development in the financial sector.

Fourth, the relevance of a modelling approach that accounts for existing levels of financial sector development builds on the intuition that blanket policies on the complementarity between mobile phones and ISO in financial sector development may not be effective unless such policies are contingent on existing financial sector development levels and tailored differently across countries with high, intermediate and low levels of financial sector development. Hence, the adopted empirical approach is a quantile regressions estimation technique that enables the investigated complementarity to be assessed throughout the conditional distributions of financial sector development. The selected approach deviates from the existing literature that has been based for the most part on mean levels of financial

development, *inter alia*: Triki and Gajigo (2014) and Asongu et al. (2016b), who respectively have employed Probit models and the Generalized Method of Moments (GMM).

In light of the above, this research adds to the existing body of literature by engaging hitherto unexplored dimensions of financial sector development and investigating the role of mobile phones in information sharing for financial sector development. The rest of the study is structured as follows. The theoretical underpinnings, propositions and testable hypotheses are presented in Section 2. Section 3 presents the data and methodology. The empirical results are presented in Section 4, while Section 5 concludes with future research directions.

2. Theoretical underpinnings, propositions and testable hypotheses

2.1 Information sharing offices and financial sector development

From a theoretical standpoint, ISOs are expected to mitigate IA between lenders and borrowers in the financial industry in order to enhance financial sector development and boost financial allocation efficiency. Intuitively, an information and communication technology (ICT), like the mobile phone, can be used by ISO to reduce IA. As recently documented (Triki & Gajigo, 2014; Asongu et al., 2016b; Asongu & Biekpe, 2017), over the past twelve years, ISOs have been introduced in Africa with the ultimate goal of stimulating banking sector development in order to tackle the policy syndrome of surplus liquidity in financial institutions of the continent[4]. Moral hazards and adverse selection in the financial industry can be reduced by tackling concerns of financial access that are related to: physical access, and eligibility to bank lending and affordability. PCR and PCB can limit the underlying sources of IA with the help of a mobile phone.

According to Claus and Grimes (2003) and Asongu et al. (2016b), two main theoretical views have dominated the nexus between information sharing and financial development. The first is focused on the risk features of bank loans whereas the second is oriented towards mechanisms by which liquidity provided by banks can be consolidated. The two streams in the literature are considered from the perspective that the principal goal of financial institutions is to improve the allocation efficiency of mobilised resources which can be consolidated through *inter alia*: increased financial sector development and reduced costs/constraints related to credit access (see Jappelli & Pagano, 2002). The role of information sharing in stimulating financial sector

[4] We invite the interested reader to refer to Saxegaard (2006) and Fouda (2009) for more insights into the substantially documented concerns of surplus liquidity.

development is broadly consistent with the foremost theories, notably: credit rationing models with Jaffee and Russell (1976), Stiglitz and Weiss (1981) and Williamson (1986); Diamond (1984) on diversification within the financial sector; bank communication to investors on future borrowers (Leland & Pyle, 1977) and ex-ante as well as ex-post IA (Diamond & Dybvig, 1983). Triki and Gajigo (2014) and Asongu et al. (2016a) also share the same theoretical perspective in more contemporary literature.

2.2 The connection between the mobile phone and various financial sectors

The connection between the mobile phone and various financial sectors (formal versus informal), can be articulated in three main strands, notably: (i) the usefulness of mobile phone transactions in the storing of value, transfer of stored value and conversion of cash; (ii) the notions of partial- and basic-integrated savings in mobile banking and (iii) banking in the Global system for mobile phones (see Asongu, 2013).

First, with the option of mobile banking, users of mobile phones (or mobiles) in developing countries can accomplish three principal goals[5]. (i) Users are endowed with the possibility of storing currency. Within this perspective, both the formal and informal banking sectors are involved because both real and pseudo bank accounts are used. In essence, whereas a real bank account is used when a user has a formal bank account, a pseudo bank account depends on the user's mobile operator. (ii) The mobile phone enables the conversion of cash out-of and into the stored value. In addition, when such conversion is associated with a formal bank account, users are at liberty to cash-in and cash-out. (iii) The transfer of stored value between accounts can be done both formally (with a real bank account) and informally (using the pseudo account).

Second, according to Demombynes and Thegeya, (2012), two types of mobile savings exist. On the one hand, 'basic savings' which is typical of the informal financial sector (and does not earn interest rate) denotes the use of mobiles for transfers such as in M-PESA (i.e. mobile money) for the purpose of storing money. On the other hand, mobile savings that are 'partially integrated' are connected to the formal banking sector and earn interest rates.

Third, in the light of the first two points, the mobile phone is related to both the formal and informal financial sectors through the following mechanisms. (i) The mobile can be

[5] 'Mobile phone' and 'mobile' are used interchangeably.

employed to store value because the functions of a smartcard (or virtual bank card) can be accomplished by the subscriber identity module (SIM). (ii)The mobile can also play the role of a point of sale (POS) terminal by enabling communications and transactions with the relevant banking establishment and/or mobile user. (iii) The mobile phone can also be employed to play the role of an automated teller machine (ATM).

The above theoretical underpinnings have been confirmed by recent empirical literature on the connection between mobile phones and financial sector development (see Asongu, 2013). The empirical framework builds on propositions that we engage in the section that follows.

2.3 Propositions and testable hypotheses

The proposed financial sector development variables are based on insufficiencies in the International Financial Statistics' (IFS, 2008) definition of the financial system which has not incorporated the informal financial sector (see Asongu, 2014a). Hence, the propositions outlined in Table 1 are fundamentally motivated by drawbacks in the IFS's definition which is restricted to the formal and semi-formal financial sectors. Whereas Panel A shows financial sector indicators that are based on Gross Domestic Product (GDP), those in Panel B are linked to development in the shares of money supply (M2) within the financial sector. In the light of Panel B, previously unexplored concepts of financial non-formalization, semi-formalization, informalization and formalization are articulated. For example, financial informalization represents the improvements in money supply shares of the informal financial sector at the expense of the formal and semi-formal financial sectors. The propositions are increasingly being employed in the financial sector development literature (Asongu, 2015a, 2015b; Meniago & Asongu, 2018; Tchamyou et al., 2019).

Table 1: Summary of propositions

Propositions	Name(s)	Formula	Elucidation
Panel A: GDP-based financial development indicators			
Proposition 1	Formal financial development	Bank deposits/GDP	Bank deposits[6] here refer to demand, time and saving deposits in deposit money banks.
Proposition 2	Semi-formal financial development	(Financial deposits – Bank deposits)/ GDP	Financial deposits[7] are demand, time and saving deposits in deposit money banks and other financial institutions.
Proposition 3	Informal financial development	(Money Supply – Financial deposits)/GDP	
Proposition 4	Informal and semi-formal financial development	(Money Supply – Bank deposits)/GDP	
Panel B: Measures of financial sector importance			
Proposition 5	Financial intermediary formalization	Bank deposits/ Money Supply (M2)	From 'informal and semi-formal' to *formal* financial development (formalization)[8] .
Proposition 6	Financial intermediary 'semi-formalization'	(Financial deposits - Bank deposits)/ Money Supply	From 'informal and formal' to *semi-formal* financial development (Semi-formalization)[9].
Proposition 7	Financial intermediary 'informalization'	(Money Supply – Financial deposits)/ Money Supply	From 'formal and semi-formal' to *informal* financial development (Informalisation)[10].
Proposition 8	Financial intermediary 'semi-formalization and informalization'	(Money Supply – Bank Deposits)/Money Supply	Formal to '*informal and semi-formal'* financial development: (Semi-formalization and informalization) [11]

N.B: Propositions 5, 6, 7 add up to unity (one); arithmetically spelling-out the underlying assumption of sector importance. Hence, when their time series properties are considered in empirical analysis, the evolution of one sector is to the detriment of other sectors and vice-versa.
Source: Asongu (2015a).

In the light of theoretical evidence that ISO are destined to promote the formal financial sector by acting as a disciplining device in discouraging borrowers from resorting to the informal

[6] Lines 24 and 25 of the International Financial Statistics (October 2008).
[7] Lines 24, 25 and 45 of the International Financial Statistics (2008).
[8] "*Accordingly, in undeveloped countries money supply is not equal to liquid liabilities or bank deposits. While in undeveloped countries bank deposits as a ratio of money supply is less than one, in developed countries this ratio is almost equal to 1. This indicator appreciates the degree by which money in circulation is absorbed by the banking system. Here we define 'financial formalization' as the propensity of the formal banking system to absorb money in circulation*" (Asongu, 2015a, p. 432).
[9] "*This indicator measures the rate at which the semi-formal financial sector is evolving at the expense of formal and informal sectors*" (Asongu, 2015a, p. 432).
[10] "*This proposition appreciates the degree by which the informal financial sector is developing to the detriment of formal and semi-formal sectors*" (Asongu, 2015a, p. 432).
[11] "*The proposition measures the deterioration of the formal banking sector in the interest of other financial sectors (informal and semi-formal). From common sense, propositions 5 and 8 should be almost perfectly antagonistic, meaning the former (formal financial development at the cost of other financial sectors) and the latter (formal sector deterioration) should almost display a perfectly negative degree of substitution or correlation*" (Asongu, 2015a, p. 432).

banking sector as a viable alternative to the formal banking sector, the following hypotheses are tested in this study.

Hypothesis 1: Mobile phones complement ISO to enhance the formal financial sector
Hypothesis 2: Mobile phones complement ISO to reduce the informal financial sector

3. Data and Methodology

3.1 Data

The study investigates a panel of 53 African nations with data from African Development Indicators (ADI) and the Financial Development and Structure Database (FDSD) of the World Bank for the period 2004-2011. Of the 54 existing African countries, only South Sudan is excluded because data for the country before 2011 is not available. Information sharing is measured with private credit bureaus (PCB) and public credit registries (PCR). These proxies for information sharing are only available from the year 2004, whereas the latest date in the FDSD is 2011. The positioning of the inquiry in Africa is consistent with the stylized facts provided in the introduction. The choice of the ISO variables is in accordance with recent IA literature (see Triki & Gajigo, 2014; Asongu et al., 2016a; Tchamyou, 2019a; Boateng *et al*., 2018; Kusi *et al*., 2017; Kusi & Opoku- Mensah, 2018; Asongu & Odhiambo, 2018).

The dependent variables of financial sector development that are proposed in Table 1 are computed from the FDSD. Two financial sector variables are used, namely: formal financial development (Propositions 1 and 5) and informal financial development (Propositions 3 and 7). Semi-formal financial development (Propositions 2 and 6) is not used because of issues in degrees of freedom whereas non-formal financial development (Propositions 4 and 8) has a high degree of substitution with informal financial development. The mobile phone variable is the mobile phone penetration rate per 100 people (Tchamyou, 2017; Tchamyou & Asongu, 2019).

Six control variables are employed to account for issues in variable omission bias: foreign aid, public investment, trade, gross domestic product (GDP) growth, inflation, income levels and legal origins. The choice of these variables is consistent with recent financial development literature, notably: Asongu (2014d), Osabuohein and Efobi (2013), Huang (2005), Tchamyou and Asongu (2017a) and Tchamyou (2019b). In what follows, we discuss expected signs.

Whereas development assistance is theoretically expected to boost financial development because its purpose is to mitigate the savings-investment gap poor countries are confronted with

(Easterly, 2005), from a practical angle however, foreign aid may also negatively affect financial development if, *inter alia*, a great bulk of the disbursed foreign aid is: (i) withheld in donor countries and/or siphoned by corrupt officials and (ii) deposited in tax havens that fall within the jurisdictions of developed countries. There is an abundant supply of literature on the positive relationship between economic growth, economic development and financial development (see Greenwood & Jovanovic, 1992; Saint-Paul, 1992; Levine, 1997; Jaffee & Levonian 2001; Odhiambo, 2010, 2013, 2014; Wale & Makina, 2017; Daniel, 2017; Chikalipah, 2017; Bocher et al., 2017; Osah & Kyobe, 2017; Boadi et al., 2017; Oben & Sakyi, 2017; Ofori-Sasu et al., 2017; Iyke & Odhiambo, 2017; Chapoto & Aboagye, 2017). As recently documented by Huang (2011), the positive nexus is traceable to, *inter alia*: greater competition development within the financial sector and consolidated availability of financial resources for investment purposes. Both empirical (Boyd et al., 2001) and theoretical (Huybens & Smith, 1999) literature are consistent with the narrative that chaotic/high inflation is linked to less active and inefficient financial institutions. According to Do and Levchenko (2004) and Huang and Temple (2005), countries with higher levels of trade openness enjoy better levels of financial development.

From empirical and theoretical perspectives, countries with traditions of Common law are associated with higher levels of financial development when compared to their counterparts with French Civil law traditions (2012a). This edge by English Common law is theoretically due to better adaptability and political channels (see Beck et al., 2003). Classification of countries in terms of legal traditions is from La Porta et al. (2008, p. 289). African countries with higher income status have been established to enjoy relatively higher levels of financial development (Asongu, 2012b). This expectation is consistent with Jaffee and Levonian (2001), who maintain that high income status is associated with more efficient banking system structures. The categorisation of nations by income levels is consistent with Asongu (2014c, p. 364)[12] on the World Bank classification. It is relevant to take note of the fact that the control variables may affect the informal and formal financial sectors differently.

The definitions of variables (with corresponding sources), summary statistics and correlation matrix are respectively presented in Appendix 1, Appendix 2 and Appendix 3. It is apparent from the summary statistics that variables are comparable, based on mean observations.

[12] There are four main World Bank income groups: (i) high income, $12,276 or more; (ii) upper middle income, $3,976-$12,275; (iii) lower middle income, $1,006-$3,975 and (iv) low income, $1,005 or less.

From the corresponding standard deviations, we can be confident that reasonable estimated linkages will emerge. The purpose of the correlation matrix is to control for multicollinearity. From a preliminary assessment, the concerns about multicollinearity are apparent in the variables of financial sector development. Fortunately, these concerns are not issues to worry about, because the underlying variables are exclusively employed as dependent variables in distinct specifications.

3.2 Methodology

In accordance with the motivation of this research, in order to account for initial levels in the examination of the complementarity between ISO and mobile phones in financial sector development, we employ an estimation technique that enables us to assess the linkages throughout the conditional distributions of financial sector development. The quantile regression (QR) approach is a strategy that enables us to articulate countries with low, intermediate and high levels of financial sector development. The relevance of this technique in accounting for existing levels of the dependent variable is in accordance with recent development literature (see Keonker & Hallock, 2001; Billger & Goel, 2009; Okada & Samreth, 2012; Asongu & Nwachukwu, 2017; Asongu *et al*., 2018).

By adopting the QR estimation technique, this research departs from existing literature which has investigated the relationship between ISO and financial development using estimation techniques that are based on the conditional mean of financial development (see Asongu et al., 2016b; Triki & Gajigo, 2014). While mean effects are important, this study extends the literature by employing an estimation technique that accounts for initial levels in the dependent variable. The policy relevance of the approach is based on the intuition that mean values provide blanket policy recommendations that could be inefficient unless such policies are contingent on initial levels of financial sector development and tailored differently across countries with low, intermediate and high initial levels of financial sector development.

Moreover, estimation techniques based on mean values like Ordinary Least Squares (OLS) build on a hypothesis that errors are normally distributed. This assumption of normally distributed error terms is not a requirement for the QR strategy (Tchamyou & Asongu, 2017b).

The θ^{th} quantile estimator of a financial sector development variable is obtained by solving for the optimization problem in Eq. (1), which is disclosed without subscripts for ease of presentation and simplicity.

$$\min_{\beta \in R^k} \left[\sum_{i \in \{i: y_i \geq x_{i'}\beta\}} \theta \left| y_i - x_{i'}\beta \right| + \sum_{i \in \{i: y_i < x_{i'}\beta\}} (1-\theta) \left| y_i - x_{i'}\beta \right| \right], \quad (1)$$

where $\theta \in (0,1)$. Contrary to OLS which is based on minimizing the sum of squared residuals, with QR, it is the weighted sum of absolute deviations that is minimised. For instance the 10^{th} or 90^{th} quantiles (with θ=0.10 or 0.90 respectively) by approximately weighing the residuals. The conditional quantile of a financial sector development variable or y_i given x_i is:

$$Q_y(\theta / x_i) = x_{i'}\beta_\theta \quad , \quad (2)$$

where unique slope parameters are estimated for each θ^{th} specific quantile. This formulation is analogous to $E(y / x) = x_{i'}\beta$ in the OLS slope in which parameters are assessed only at the mean of the conditional distribution of financial sector development. For the model in Eq. (2), the dependent variable y_i is a financial sector development variable, whereas x_i contains: a constant term, *ISO*, *Mobile*, *ISO×Mobile*, *foreign aid*, *GDP growth*, *trade*, *inflation, public investment*, *middle income* and *Common law.* The specifications are tailored to control for simultaneity with non-contemporary specifications and the unobserved heterogeneity in terms of fixed effects. Consistent with Brambor et al. (2006) on the pitfalls surrounding interactive regressions: (i) all constitutive variables are included in the specifications, and (ii) the impact of the modifying mobile phone variable is interpreted as a conditional marginal impact. To ascertain that the empirical analysis is not affected by spurious findings because of issues of "non-stationarity", as shown in Appendix 4, unit root tests are performed to establish that the variables are stationary[13]. In the study, robustness is performed by using: (i) different propositions of financial sector development; (ii) both contemporary and non-contemporary regressions, and (iii) different measurements of information sharing.

[13] With the Fisher-type (Choi, 2001) test, the variables are overwhelmingly stationary. These test results are available upon request. Some tests require balanced data and hence could not be performed. They include: The Levin–Lin–Chu (2002), Harris–Tzavalis (1999), Breitung (2000), Breitung and Das (2005) and The Hadri (2000). Moreover, because of insufficient observations, the Im–Pesaran–Shin (2003) test could also not be performed.

4. Empirical results

Table 2, Table 3, Table 4 and Table 5 present findings corresponding to linkages between mobiles and respectively 'formal finance and PCR', 'informal finance and PCR', 'formal finance and PCB' and 'informal finance and PCB'. It should be noted that the right-hand side (RHS) shows non-contemporary estimations and the left-hand side (LHS) of tables discloses contemporary regressions. Irrespective of tables, formal finance regressions consist of formal financial development (Panel A or Prop. 1) and financial sector formalisation (Panel B or Prop. 2) while informal finance estimations entail informal financial development (Panel A or Prop. 3) and financial sector informalization (Panel B or Prop. 7). The interest of lagging the independent variables on the RHS by one period is to have some bite on endogeneity (see Mlachila *et al*., 2017; Asongu et al., 2019a, 2019b). Consistent variations are apparent between QR and OLS estimates. The differences in terms of significance, signs and magnitude of estimated coefficient justify the distinction between an estimation based on mean values and one based on various points on the conditional distribution of financial sector development.

The following findings can be presented for Table 2 on the linkages between formal finance, mobile phones and PCR. First, from Panel A on formal financial development, with the exception of the 90th quantile, net effects of mobiles with PCR are positive. Second, the net effect is also positive on financial formalization in Panel B. The net effects are computed from the unconditional PCR and conditional or marginal PCR impacts which are contingent on the complementary effects of mobile phones. For example, in the second column of Table 2, the marginal effect (from the interaction) is -0.023 while the unconditional impact of PCR is 2.919. The corresponding net effect of PCR with mobile phones is 2.075 ([36.659×-0.023] + 2.919)[14]. This computation is consistent with contemporary interactive regressions literature (Agoba et al., 2019; Asongu & Odhiambo, 2019a, 2019b, 2019c). Third, the significant control variables have the expected signs for the most part.

The following findings can be established for Table 3 on the linkages between informal finance, mobile phones and PCR. From Panel A on informal financial development, the net effect is positive at the 25th quantile. The net effect is also negative on financial informalization in Panel B at the 25th quantile and top quantiles of the distributions. Most of the control variables display expected signs.

[14] 36.659 is the mean value of mobile phones.

In Table 4 on nexuses between formal finance, mobile phones and PCB: (i) the net effect is negative (positive) on the financial development formalization at 90^{th} (25^{th}) quantile of contemporary (non-contemporary) distributions while the effect is positive on financial formalization at the bottom quantiles and the 90^{th} quantile and; (ii) the significant control variables have expected signs for the most part.

The following are apparent in Table 5 on linkages between informal finance, mobile phones and PCB: (i) there are negative net effects on informal financial development at the 25^{th} and 50^{th} quantiles; (ii) there are also negative net impacts on financial informalization at the top quantiles (10^{th} and 90^{th} quantiles) of non-contemporary (contemporary) estimations; and (iii) the significant control variables display expected signs, for the most part.

Table 2: Formal Finance, Mobile Phones and Public Credit Registries (PCR)

Panel A: Formal Financial Development (Prop. 1)

	Contemporary						Non-Contemporary					
	OLS	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**	**OLS**	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**
Constant	**13.205*****	1.893	-0.872	3.106	**16.228*****	**24.923*****	**13.890*****	**2.422***	0.262	3.132	**13.334****	**23.709*****
	(0.002)	(0.275)	(0.717)	(0.442)	**(0.000)**	**(0.000)**	**(0.003)**	**(0.085)**	(0.928)	(0.424)	**(0.012)**	**(0.000)**
PCR	**2.919*****	**1.582*****	**3.406*****	**3.079*****	**2.659*****	0.546	**2.687*****	**1.849*****	**2.463*****	**3.446*****	**2.574*****	**0.281**
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	(0.298)	**(0.001)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.006)**	**(0.594)**
Mobile	**0.227*****	**0.157*****	**0.201*****	**0.227*****	**0.327*****	**0.228*****	**0.255*****	**0.157*****	**0.242*****	**0.261*****	**0.406*****	**0.196*****
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.002)**
PCR×Mobile	**-0.023*****	**-0.015*****	**-0.031*****	**-0.021*****	**-0.019*****	-0.002	**-0.022****	**-0.020*****	**-0.023*****	**-0.026*****	**-0.021****	-0.001
	(0.006)	**(0.000)**	**(0.000)**	**(0.001)**	**(0.000)**	(0.632)	**(0.028)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.049)**	(0.841)
GDP growth	-0.129	-0.131	**-0.277****	-0.265	**0.442****	**0.622*****	-0.078	-0.023	-0.066	-0.306	**0.578****	**0.715*****
	(0.527)	(0.125)	**(0.026)**	(0.225)	**(0.015)**	**(0.004)**	(0.716)	(0.802)	(0.696)	(0.138)	**(0.022)**	**(0.000)**
Inflation	0.004	0.008	0.007	-0.002	0.030	-0.002	-0.012	0.010	0.016	-0.013	0.014	-0.026
	(0.737)	(0.255)	(0.546)	(0.925)	(0.156)	(0.908)	(0.539)	(0.187)	(0.270)	(0.517)	(0.592)	(0.162)
Public Invt.	0.068	-0.137	-0.046	**0.631*****	-0.091	**0.371****	0.054	**-0.179*****	0.004	**0.560*****	0.039	0.217
	(0.772)	(0.121)	(0.770)	**(0.000)**	(0.568)	**(0.047)**	(0.837)	**(0.002)**	(0.984)	**(0.005)**	(0.863)	(0.262)
Foreign Aid	0.019	0.022	**0.259*****	-0.046	0.010	-0.297	-0.015	-0.010	0.184	0.023	-0.010	-0.344
	(0.890)	(0.765)	**(0.006)**	(0.766)	(0.949)	(0.195)	(0.915)	(0.861)	(0.116)	(0.876)	(0.961)	(0.112)
Trade	**-0.061***	0.022	0.025	0.040	**-0.058****	-0.056	-0.051	0.025	0.021	0.050	-0.027	0.030
	(0.083)	(0.173)	(0.219)	(0.239)	**(0.048)**	(0.107)	(0.185)	(0.104)	(0.405)	(0.127)	(0.526)	(0.388)
Middle Income	**9.357*****	-1.656	0.922	-1.121	**12.689*****	**36.773*****	**8.823*****	-1.745	0.283	-2.140	**7.913****	**36.069*****
	(0.001)	(0.144)	(0.544)	(0.669)	**(0.000)**	**(0.000)**	**(0.005)**	(0.138)	(0.882)	(0.415)	**(0.012)**	**(0.000)**
Common Law	**5.963****	**8.446*****	**8.511*****	**7.065*****	0.928	1.414	**6.051****	**9.120*****	**7.747*****	**7.241*****	2.415	0.954
	(0.010)	**(0.000)**	**(0.000)**	**(0.001)**	(0.633)	(0.596)	**(0.015)**	**(0.000)**	**(0.000)**	**(0.000)**	(0.396)	(0.736)
Net effects	2.075	1.032	2.269	2.309	1.962	na	1.880	1.115	1.619	2.492	1.804	na
Pseudo R^2/R^2	0.378	0.210	0.162	0.218	0.318	0.405	0.375	0.208	0.164	0.229	0.314	0.404
Fisher	**23.31*****						**20.22*****					
Observations	294	294	294	294	294	294	258	258	258	258	258	258

Panel B: Financial Development Formalization (Prop. 5)

	Contemporary						Non-Contemporary					
	OLS	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**	**OLS**	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**
Constant	**0.583*****	**0.307*****	**0.511*****	**0.635*****	**0.667*****	**0.722*****	**0.584*****	**0.321*****	**0.499*****	**0.630*****	**0.677*****	**0.687*****
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
PCR	**0.010*****	**0.024*****	**0.011****	0.004	**0.004****	0.0007	**0.010*****	**0.023*****	**0.015***	**0.006****	0.005	-0.0006
	(0.000)	**(0.000)**	**(0.014)**	(0.218)	**(0.023)**	(0.878)	**(0.000)**	**(0.000)**	**(0.071)**	**(0.048)**	(0.159)	(0.928)
Mobile	**0.001*****	**0.002*****	**0.001*****	**0.0005***	**0.0006*****	**0.003*****	**0.001*****	**0.002*****	**0.001****	**0.0005****	0.0004	**0.004*****
	(0.000)	**(0.000)**	**(0.000)**	**(0.059)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.032)**	**(0.047)**	(0.110)	**(0.000)**
PCR×Mobile	**-0.0001*****	**-0.0002*****	**-0.0001****	-0.00004	**-0.00006****	-0.00005	**-0.0001*****	**-0.0002*****	-0.0001	**-0.00006***	**-0.00006***	-0.00006
	(0.000)	**(0.000)**	**(0.028)**	(0.319)	**(0.011)**	(0.295)	**(0.000)**	**(0.000)**	(0.114)	**(0.086)**	**(0.099)**	(0.464)
GDP growth	0.001	0.0004	0.0007	**0.003****	**0.002*****	0.001	0.001	0.0002	-0.0001	**0.003*****	0.001	0.004
	(0.564)	(0.884)	(0.746)	**(0.017)**	**(0.000)**	(0.382)	(0.569)	(0.930)	(0.968)	**(0.008)**	(0.290)	(0.279)
Inflation	**0.0002***	**0.0008*****	0.0002	0.0001	**-0.0001***	-0.00009	0.0003	**0.0008****	0.0002	0.00007	0.0001	-0.00001
	(0.063)	**(0.000)**	(0.112)	(0.481)	**(0.078)**	(0.655)	(0.222)	**(0.017)**	(0.389)	(0.531)	(0.585)	(0.965)
Public Invt.	**0.005*****	**0.008*****	**0.005*****	**0.004*****	**0.004*****	0.001	**0.005*****	**0.007*****	0.005	**0.006*****	**0.005*****	-0.0004
	(0.000)	**(0.000)**	**(0.005)**	**(0.002)**	**(0.0000)**	(0.417)	**(0.000)**	**(0.000)**	(0.164)	**(0.000)**	**(0.000)**	(0.868)
Foreign Aid	0.001	**0.004****	-0.0009	-0.00003	-0.0001	0.003	0.001	0.003	0.001	-0.0001	0.0003	**0.005***
	(0.343)	**(0.022)**	(0.479)	(0.973)	(0.247)	(0.139)	(0.306)	(0.182)	(0.564)	(0.850)	(0.741)	**(0.075)**
Trade	**-0.0005***	-0.0003	0.0001	-0.0001	**0.098*****	-0.0004	**-0.0005***	-0.0001	0.00005	-0.00008	-0.00007	-0.0004
	(0.059)	(0.419)	(0.504)	(0.415)	**(0.000)**	(0.259)	**(0.092)**	(0.751)	(0.923)	(0.658)	(0.724)	(0.497)
Middle Income	**0.096*****	**0.066****	0.024	**0.090*****	**0.133*****	**0.098*****	**0.091*****	**0.083***	0.051	**0.088*****	**0.092*****	**0.096****
	(0.000)	**(0.037)**	(0.288)	**(0.000)**	**(0.000)**	**(0.002)**	**(0.000)**	**(0.060)**	(0.209)	**(0.000)**	**(0.000)**	**(0.045)**
Common Law	**0.150*****	**0.163*****	**0.135*****	**0.106*****	**0.667*****	**0.095*****	**0.151*****	**0.165*****	**0.148*****	**0.104*****	**0.132*****	**0.109*****
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.002)**
Net effects	0.006	0.016	0.007	na	0.001	na	0.006	0.015	na	0.003	na	na
Pseudo R^2/R^2	0.422	0.309	0.212	0.213	0.242	0.254	0.427	0.325	0.214	0.225	0.245	0.243
Fisher	**17.95*****						**15.89*****					
Observations	294	294	294	294	294	294	258	258	258	258	258	258

*,**,***: significance levels of 10%, 5% and 1% respectively. GDPg: GDP growth rate. Public Invt: Public Investment. Mobile: Mobile phone penetration rate. OLS: Ordinary Least Squares. R^2 for OLS and Pseudo R^2 for quantile regression. Lower quantiles (e.g., Q 0.1) signify nations where financial sector development is least.

Table 3: Informal Finance, Mobile Phones and Public Credit Registries (PCR)

Panel A: Informal Financial Development (Prop. 3)

	Contemporary						Non-Contemporary					
	OLS	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**	**OLS**	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**
Constant	**8.183*** **	**4.554** **	**7.559*** **	**8.611*** **	**9.909*** **	**11.892*** **	**8.557*** **	3.763	**7.109*** **	**8.569*** **	**10.047*** **	**12.094*** **
	(0.000)	**(0.026)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	(0.106)	**(0.000)**	**(0..000)**	**(0.000)**	**(0.000)**
PCR	**0.245***	0.394	**0.427*** **	0.201	0.092	-0.127	**0.204***	0.316	**0.458*** **	**0.271***	0.105	-0.109
	(0.071)	(0.439)	**(0.000)**	(0.148)	(0.337)	(0.606)	**(0.053)**	(0.210)	**(0.000)**	**(0.061)**	(0.322)	(0.656)
Mobile	0.006	-0.032	0.003	**0.028*** **	**0.036*** **	**0.044***	0.002	-0.046	-0.001	**0.023** **	**0.040*** **	**0.059*** **
	(0.723)	(0.195)	(0.446)	**(0.003)**	**(0.000)**	**(0.095)**	(0.914)	(0.204)	(0.820)	**(0.038)**	**(0.000)**	**(0.002)**
PCR×Mobile	-0.002	-0.002	**-0.003*** **	-0.002	-0.001	0.0008	-0.001	-0.001	**-0.003*** **	-0.002	-0.001	0.0005
	(0.189)	(0.692)	**(0.001)**	(0.204)	(0.289)	(0.745)	(0.285)	(0.667)	**(0.004)**	(0.103)	(0.269)	(0.849)
GDP growth	**-0.090***	-0.143	**-0.087*** **	-0.042	**-0.075** **	-0.073	-0.064	-0.119	**-0.089** **	-0.071	-0.043	**-0.157** **
	(0.088)	(0.234)	**(0.003)**	(0.397)	**(0.011)**	(0.463)	(0.264)	(0.514)	**(0.015)**	(0.153)	(0.248)	**(0.018)**
Inflation	**-**	-0.00009	**-**	**-**	**-**	**-**	**-**	-0.0001	**-**	**-0.0002**	**-0.0002**	**-**
	0.0002* **		**0.0001*** **	**0.0001*** **	**0.0002*** **	**0.0002*** **	**0.0001*** **		**0.0001*** **	***	***	**0.0002*** **
	(0.000)	(0.126)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.000)**	(0.202)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Public Invt.	**-0.175*** **	-0.023	**-0.084*** **	**-0.135*** **	**-0.080*** **	-0.179	**-0.207*** **	-0.072	**-0.101*** **	**-0.203*** **	**-0.129*** **	**-0.142***
	(0.000)	(0.846)	**(0.000)**	**(0.006)**	**(0.006)**	(0.104)	**(0.000)**	(0.622)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.058)**
Foreign Aid	0.002	-0.021	**-0.064*** **	-0.009	**-0.050** **	0.013	-0.005	-0.005	**-0.060*** **	-0.028	**-0.045***	0.032
	(0.939)	(0.837)	**(0.001)**	(0.805)	**(0.015)**	(0.847)	(0.865)	(0.966)	**(0.007)**	(0.437)	**(0.059)**	(0.396)
Trade	0.012	0.012	**-0.009** **	**-0.013***	-0.007	-0.003	0.010	0.019	0.001	0.001	-0.004	-0.014
	(0.204)	(0.573)	**(0.017)**	**(0.097)**	(0.239)	(0.821)	(0.308)	(0.467)	(0.790)	(0.894)	(0.543)	(0.261)
Middle Income	**-1.015***	**-2.148***	**-2.633*** **	-0.019	-0.336	0.608	-0.790	-0.892	**-2.720*** **	-0.461	-0.289	0.698
	(0.080)	**(0.094)**	**(0.000)**	(0.975)	(0.454)	(0.674)	(0.197)	(0.580)	**(0.000)**	(0.477)	(0.576)	(0.481)
Common Law	**-4.626*** **	**-3.134** **	**-1.910*** **	**-3.501*** **	**-3.896*** **	**-6.098*** **	**-4.938*** **	**-2.677***	**-1.982*** **	**-3.415*** **	**-4.182*** **	**-5.394*** **
	(0.000)	**(0.010)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.050)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Net effects	na	na	0.317	na	na	na	na	na	0.348	na	na	na
Pseudo R^2/R^2	0.229	0.148	0.175	0.191	0.228	0.217	0.246	0.130	0.173	0.194	0.243	0.266
Fisher	**42.26*** **						**40.74*** **					
Observations	309	309	309	309	309	309	275	275	275	275	275	275

Panel B: Financial Development Informalization (Prop. 7)

	Contemporary						Non-Contemporary					
	OLS	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**	**OLS**	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**
Constant	**0.403*** **	**0.198*** **	**0.296*** **	**0.364*** **	**0.499*** **	**0.706*** **	**0.401*** **	**0.193*** **	**0.288*** **	**0.359*** **	**0.532*** **	**0.707*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.003)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
PCR	**-0.009*** **	-0.002	**-0.005** **	**-0.007***	**-0.013** **	**-0.023*** **	**-0.009*** **	-0.001	-0.005	-0.006	**-0.015** **	**-0.022*** **
	(0.001)	(0.650)	**(0.033)**	**(0.088)**	**(0.038)**	**(0.000)**	**(0.001)**	(0.828)	(0.190)	(0.227)	**(0.023)**	**(0.000)**
Mobile	**-0.001*** **	**-0.002*** **	**-**	-0.0005	**-0.001*** **	**-0.002*** **	**-0.001*** **	**-0.002*** **	-0.0004	-0.0005	**-0.001** **	**-0.002*** **
			0.0006* **									
	(0.000)	**(0.000)**	**(0.001)**	(0.114)	**(0.008)**	**(0.000)**	**(0.000)**	**(0.003)**	(0.212)	(0.149)	**(0.020)**	**(0.002)**
PCR×Mobile	**0.0001*** **	0.00006	**0.00006** **	0.00006	**0.0001***	**0.0002*** **	**0.0001*** **	0.00005	0.00007	0.00007	**0.0001***	**0.0002*** **
	(0.001)	(0.266)	**(0.020)**	(0.154)	**(0.060)**	**(0.000)**	**(0.001)**	(0.436)	(0.144)	(0.278)	**(0.051)**	**(0.000)**
GDP growth	-0.0007	-0.00008	-0.001	-0.003	-0.0003	0.0008	-0.0006	-0.001	-0.001	**-0.003***	-0.0003	0.001
	(0.745)	(0.977)	(0.325)	(0.106)	(0.914)	(0.762)	(0.790)	(0.766)	(0.533)	**(0.078)**	(0.919)	(0.751)
Inflation	**-**	-0.0008	-0.0001	**-0.0005** **	**-0.0006**	**-0.001*** **	**-0.0006** **	-0.00007	-0.00008	**-0.0004** **	**-0.0006** **	**-0.001*** **
	0.0005* **				***							
	(0.000)	(0.747)	(0.112)	**(0.036)**	**(0.009)**	**(0.000)**	**(0.019)**	(0.849)	(0.602)	**(0.016)**	**(0.010)**	**(0.003)**
Public Invt.	**-0.005*** **	**-0.003***	**-0.004*** **	**-0.003** **	**-0.006** **	**-0.008*** **	**-0.006*** **	**-0.003***	**-0.005*** **	**-0.005*** **	**-0.007** **	**-0.007*** **
	(0.000)	**(0.067)**	**(0.000)**	**(0.038)**	**(0.024)**	**(0.000)**	**(0.000)**	**(0.091)**	**(0.000)**	**(0.008)**	**(0.027)**	**(0.001)**
Foreign Aid	-0.001	-0.001	-0.0003	-0.0009	-0.001	**-0.005*** **	-0.001	-0.001	0.0002	0.0002	-0.002	**-0.005** **
	(0.356)	(0.644)	(0.712)	(0.470)	(0.427)	**(0.005)**	(0.317)	(0.526)	(0.866)	(0.880)	(0.160)	**(0.035)**
Trade	**0.0005***	**0.0009** **	0.0001	0.0002	0.0001	0.00009	**0.0005***	0.0008	0.0001	0.0001	-0.0001	-0.0001
	(0.053)	**(0.032)**	(0.183)	(0.387)	(0.793)	(0.837)	**(0.084)**	(0.119)	(0.573)	(0.638)	(0.780)	(0.853)
Middle Income	**-0.090*** **	**-0.097*** **	**-0.079*** **	**-0.097*** **	**-0.055***	-0.043	**-0.086*** **	**-0.072** **	**-0.081*** **	**-0.090*** **	-0.048	-0.064
	(0.000)	**(0.002)**	**(0.000)**	**(0.000)**	**(0.083)**	(0.172)	**(0.000)**	**(0.041)**	**(0.000)**	**(0.000)**	(0.161)	(0.175)
Common Law	**-0.159*** **	**-0.106*** **	**-0.129*** **	**0.110*** **	**-0.156*** **	**-0.191*** **	**-0.159*** **	**-0.087*** **	**-0.126*** **	**-0.105*** **	**-0.162*** **	**-0.187*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.005)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Net effects	-0.005	na	-0.002	na	-0.009	-0.015	-0.005	na	na	na	-0.011	-0.014
Pseudo R^2/R^2	0.414	0.226	0.222	0.206	0.221	0.327	0.419	0.212	0.221	0.216	0.227	0.338
Fisher	**18.04*** **						**16.92*** **					
Observations	294	294	294	294	294	294	258	258	258	258	258	258

*,**,***: significance levels of 10%, 5% and 1% respectively. GDPg: GDP growth rate. Public Invt: Public Investment. Mobile: Mobile phone penetration rate. OLS: Ordinary Least Squares. R^2 for OLS and Pseudo R^2 for quantile regression. Lower quantiles (e.g., Q 0.1) signify nations where financial sector development is least.

Table 4: Formal Finance, Mobile Phones and Private Credit Bureaus (PCB)

Panel A: Formal Financial Development (Prop. 1)

	Contemporary						Non-Contemporary					
	OLS	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**	**OLS**	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**
Constant	**12.905*** **	**3.870***	**11.398*** **	**9.529*** **	**10.884*** **	**21.279*** **	**13.467*** **	**4.932****	**12.728*** **	**7.634*** **	**11.670*** **	**15.673*** **
	(0.007)	**(0.070)**	**(0.000)**	**(0.000)**	**(0.001)**	**(0.000)**	**(0.007)**	**(0.018)**	**(0.000)**	**(0.002)**	**(0.001)**	**(0.000)**
PCB	0.117	**0.246*** **	**0.468*** **	**0.235*** **	**0.250****	**-0.704*** **	0.119	**0.304*** **	**0.449*** **	**0.386*** **	**0.274***	**-0.360*** **
	(0.419)	**(0.003)**	**(0.000)**	**(0.002)**	**(0.035)**	**(0.000)**	(0.421)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.051)**	**(0.000)**
Mobile	**0.269*** **	**0.119*** **	**0.164*** **	**0.209*** **	**0.403*** **	**0.252*** **	**0.307*** **	-0.0004	**0.203*** **	**0.261*** **	**0.468*** **	**0.290*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	(0.582)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
PCB×Mobile	-0.0002	-0.0001	-0.001	0.001	0.001	**0.002***	-0.0002	-0.035	**-0.002***	-0.0002	-0.002	-0.0008
	(0.898)	(0.867)	(0.133)	(0.185)	(0.188)	**(0.070-**	(0.915)	(0.745)	**(0.077)**	(0.888)	(0.175)	(0.423)
GDP growth	-0.056	-0.041	-0.084	**-0.358*** **	**0.850*** **	**0.870*** **	-0.001	**0.025*** **	0.004	**-0.359****	**0.475*** **	**1.037*** **
	(0.799)	(0.716)	(0.556)	**(0.002)**	**(0.000)**	**(0.000)**	(0.994)	**(0.007)**	(0.977)	**(0.014)**	**(0.003)**	**(0.000)**
Inflation	0.004	**0.024*** **	**0.025****	-0.003	**0.052*** **	0.0004	-0.014	0.061	**0.028*** **	-0.009	0.015	-0.006
	(0.778)	**(0.005)**	**(0.046)**	(0.821)	**(0.0008)**	(0.975)	(0.596)	(0.617)	**(0.006)**	(0.492)	(0.398)	(0.669)
Public Invt.	0.064	0.058	0.075	**0.549*** **	-0.041	**0.303****	0.024	0.115	0.198	**0.394*** **	0.017	0.210
	(0.785)	(0.678)	(0.629)	**(0.000)**	(0.771)	**(0.033)**	(0.923)	(0.147)	(0.141)	**(0.003)**	(0.912)	(0.139)
Foreign Aid	0.049	0.093	**0.215****	0.039	-0.041	0.242	0.009	-0.021	0.100	0.115	-0.005	-0.194
	(0.753)	(0.310)	**(0.030)**	(0.613)	(0.787)	(0.242)	(0.953)	(0.227)	(0.258)	(0.238)	(0.971)	(0.215)
Trade	-0.020	-0.017	**-0.075*** **	0.016	0.031	-0.029	-0.010	0.381	**-0.088*** **	**0.057*** **	0.040	**0.046***
	(0.577)	(0.385)	**(0.000)**	(0.324)	(0.217)	(0.300)	(0.798)	(0.747)	**(0.000)**	**(0.008)**	(0.143)	**(0.063)**
Middle Income	**8.561*** **	0.434	1.915	-0.493	**6.026*** **	**40.185*** **	**7.386****	**4.196*** **	0.539	-1.350	2.413	**37.582*** **
	(0.002)	(0.746)	(0.223)	(0.707)	**(0.005)**	**(0.000)**	**(0.015)**	**(0.000)**	(0.695)	(0.439)	(0.285)	**(0.000)**
Common Law	1.354	**4.450*** **	-0.137	**1.789***	**-4.539****	**3.780***	1.683	**4.932****	-0.058	1.328	-2.013	3.179
	(0.584)	**(0.000)**	(0.914)	**(0.091)**	**(0.012)**	**(0.079)**	(0.512)	**(0.018)**	(0.959)	(0.345)	(0.304)	(0.120)
Net effects	na	na	na	na	na	-0.630	na	na	0.449	na	na	na
Pseudo R^2/R^2	0.307	0.214	0.172	0.209	0.269	0.431	0.324	0.218	0.170	0.228	0.287	0.431
Fisher	**22.29*** **						**20.91*** **					
Observations	295	295	295	295	295	295	259	259	259	259	259	259

Panel B: Financial Development Formalization (Prop. 5)

	Contemporary						Non-Contemporary					
	OLS	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**	**OLS**	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**
Constant	**0.591*** **	**0.364*** **	**0.557*** **	**0.622*** **	**0.706*** **	**0.743*** **	**0.595*** **	**0.348*** **	**0.558*** **	**0.638*** **	**0.701*** **	**0.745*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
PCB	**0.003****	**0.006*** **	**0.005*** **	**0.003*** **	0.0004	**0.001***	**0.003***	**0.008*** **	**0.005****	**0.002****	-0.001	**0.002****
	(0.012)	**(0.000)**	**(0.002)**	**(0.000)**	(0.671)	**(0.061)**	**(0.064)**	**(0.000)**	**(0.016)**	**(0.044)**	(0.384)	**(0.017)**
Mobile	**0.001*** **	**0.001*** **	**0.001*** **	**0.00006*** **	0.0003	0.0002	**0.001*** **	**0.002*** **	**0.001****	**0.0005****	0.0001	**0.0003***
	(0.000)	**(0.000)**	**(0.001)**	**(0.007)**	(0.198)	(0.302)	**(0.000)**	**(0.006)**	**(0.010)**	**(0.039)**	(0.546)	**(0.063)**
PCB×Mobile	0.000005	**-0.00004*** **	**-0.00003***	-0.00001	**0.00008*** **	**0.00007*** **	0.00001	**-0.00007*** **	**-0.00005***	0.000006	**0.0001*** **	**0.00007*** **
	(0.827)	**(0.001)**	**(0.066)**	(0.293)	**(0.000)**	**(0.000)**	(0.543)	**(0.000)**	**(0.058)**	(0.667)	**(0.000)**	**(0.000)**
GDP growth	0.002	0.00007	0.001	**0.004*** **	0.002	0.0001	0.002	0.0000001	0.004	**0.006*** **	**0.002***	0.0006
	(0.390)	(0.979)	(0.654)	**(0.000)**	(0.102)	(0.804)	(0.396)	(1.000)	(0.302)	**(0.000)**	**(0.055)**	(0.330)
Inflation	**0.0004*** **	**0.0008*** **	0.0002	0.0002	-0.00002	**-0.0002*** **	**0.0004***	**0.001*** **	0.0004	0.0002	-0.0001	**0.0005*** **
	(0.005)	**(0.000)**	(0.231)	(0.300)	(0.855)	**(0.004)**	**(0.064)**	**(0.006)**	(0.112)	(0.139)	(0.396)	**(0.000)**
Public Invt.	**0.005*** **	**0.005*** **	**0.005****	**0.003*** **	**0.004*** **	**0.007*** **	**0.005*** **	**0.008*** **	0.005	0.002	**0.006*** **	**0.006*** **
	(0.000)	**(0.002)**	**(0.015)**	**(0.005)**	**(0.001)**	**(0.000)**	**(0.000)**	**(0.000)**	(0.114)	(0.102)	**(0.000)**	**(0.000)**
Foreign Aid	**0.002***	**0.003***	-0.002	**0.001***	0.0006	0.0002	0.002	**0.005****	-0.0005	0.0006	0.0003	0.0008
	(0.093)	**(0.065)**	(0.154)	**(0.076)**	(0.540)	(0.800)	(0.110)	**(0.048)**	(0.798)	(0.488)	(0.728)	(0.390)
Trade	-0.0003	-0.0002	0.0001	0.0001	-0.00006	0.0001	-0.0003	-0.0005	-0.0004	0.0001	0.00005	0.0001
	(0.160)	(0.535)	(0.575)	(0.456)	(0.745)	(0.229)	(0.252)	(0.334)	(0.387)	(0.487)	(0.779)	(0.466)
Middle Income	**0.080*** **	**0.100*** **	0.0007	**0.064*** **	**0.061*** **	**0.034****	**0.074*** **	**0.114****	0.049	**0.064*** **	**0.058*** **	**0.040*** **
	(0.000)	**(0.003)**	(0.976)	**(0.000)**	**(0.000)**	**(0.022)**	**(0.001)**	**(0.017)**	(0.220)	**(0.000)**	**(0.001)**	**(0.004)**
Common Law	**0.087*** **	**0.120*** **	**0.109*** **	**0.073*** **	**0.068*** **	**0.065*** **	**0.087*** **	**0.106*** **	**0.090*** **	**0.075*** **	**0.065*** **	**0.058*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.002)**	**(0.007)**	**(0.000)**	**(0.000)**	**(0.000)**
Net effects	na	0.004	0.003	na	na	0.003	na	0.005	0.003	na	na	0.004
Pseudo R^2/R^2	0.525	0.332	0.252	0.270	0.345	0.488	0.533	0.344	0.246	0.275	0.363	0.497
Fisher	**20.81*** **						**18.85*** **					
Observations	295	295	295	295	295	295	259	259	259	259	259	259

*,**,***: significance levels of 10%, 5% and 1% respectively. GDPg: GDP growth rate. Public Invt: Public Investment. Mobile: Mobile phone penetration rate. OLS: Ordinary Least Squares. R^2 for OLS and Pseudo R^2 for quantile regression. Lower quantiles (e.g., Q 0.1) signify nations where financial sector development is least.

Table 5: Informal Finance, Mobile Phones and Private Credit Bureaus (PCB)

Panel A: Informal Financial Development (Prop. 3)

	Contemporary						Non-Contemporary					
	OLS	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**	**OLS**	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**
Constant	**8.143*** **	**3.308*** **	**5.014*** **	**8.682*** **	**10.029*** **	**12.994*** **	**8.292*** **	0.102	**4.765*** **	**8.940*** **	**10.572*** **	**12.560*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	(0.921)	**(0.000)**	**(0.0000)**	**(0.000)**	**(0.000)**
PCB	-0.059	-0.036	**0.074***	**-0.073*** **	**-0.073** **	-0.108	-0.015	0.075	**0.082** **	**-0.065** **	**-0.089*** **	-0.086
	(0.360)	(0.136)	**(0.054)**	**(0.001)**	**(0.047)**	(0.142)	(0.826)	(0.272)	**(0.042)**	**(0.015)**	**(0.004)**	(0.346)
Mobile	**0.045*** **	0.018	**0.048*** **	**0.029*** **	**0.043*** **	**0.047** **	**0.046*** **	**0.033** **	**0.050*** **	**0.028*** **	**0.042*** **	**0.051** **
	(0.000)	(0.145)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.028)**	**(0.000)**	**(0.049)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.010)**
PCB×Mobile	**-0.001***	**-0.003*** **	**-0.004*** **	**-0.0004***	-0.0004	-0.0006	**-0.002** **	**-0.004*** **	**-0.005*** **	**-0.0007***	-0.0003	-0.0005
	(0.072)	**(0.000)**	**(0.000)**	**(0.072)**	(0.262)	(0.384)	**(0.033)**	**(0.000)**	**(0.000)**	**(0.054)**	(0.332)	(0.553)
GDP growth	**-0.112** **	-0.076	-0.068	**-0.110*** **	**-0.072***	0.017	**-0.101***	-0.088	-0.074	**-0.066** **	**-0.073** **	**-0.155** **
	(0.024)	(0.281)	(0.275)	**(0.000)**	**(0.061)**	(0.823)	**(0.077)**	(0.256)	(0.210)	**(0.039)**	**(0.039)**	**(0.038)**
Inflation	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	0.0002* **	**0.0001*** **	**0.0002*** **	**0.0002*** **	**0.0002*** **	**0.0002*** **	**0.0002*** **	**0.0001*** **	**0.0002*** **	**0.0002*** **	**0.0002*** **	**0.0002*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.006)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Public Invt.	**-0.155*** **	**-0.175*** **	**-0.201*** **	**-0.104*** **	-0.057	**-0.139***	**-0.170*** **	-0.100	**-0.208*** **	**-0.161*** **	**-0.064***	-0.124
	(0.001)	**(0.003)**	**(0.000)**	**(0.000)**	(0.107)	**(0.082)**	**(0.002)**	(0.135)	**(0.000)**	**(0.000)**	**(0.055)**	(0.112)
Foreign Aid	-0.040	-0.0004	0.009	**-0.036***	**-0.055** **	**-0.113** **	-0.040	0.060	0.006	**-0.045***	**-0.073*** **	-0.016
	(0.135)	(0.991)	(0.810)	**(0.078)**	**(0.038)**	**(0.047)**	(0.132)	(0.290)	(0.870)	**(0.057)**	**(0..004)**	(0.720)
Trade	0.002	0.012	0.013	**-0.009** **	-0.010	-0.021	0.001	**0.034*** **	**0.019** **	-0.006	**-0.012** **	-0.017
	(0.747)	(0.146)	(0.110)	**(0.029)**	(0.158)	(0.116)	(0.851)	**(0.006)**	**(0.025)**	(0.213)	**(0.040)**	(0.226)
Middle Income	-0.309	-0.646	**-1.642** **	0.416	-0.150	1.934	-0.249	-1.347	**-1.948*** **	0.403	0.095	0.943
	(0.519)	(0.279)	**(0.012)**	(0.245)	(0.774)	(0.126)	(0.635à	(0.114)	**(0.002)**	(0.329)	(0.835)	(0.383)
Common Law	**-2.831*** **	-1.646	**-1.789*** **	**-2.987*** **	**-4.014*** **	**-4.751*** **	**-3.122*** **	-1.202	**-1.823*** **	**-3.234*** **	**-3.995*** **	**-4.793*** **
	(0.000)	(0.279)	**(0.001)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	(0.112)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Net effects	na	na	-0.072	-0.087	na	na	na	na	-0.101	-0.090	na	na
Pseudo R^2/R^2	0.448	0.421	0.287	0.282	0.296	0.257	0.479	0.416	0.297	0.282	0.310	0.308
Fisher	**34.99*** **						**30.12*** **					
Observations	310	310	310	310	310	310	276	276	276	276	276	276

Panel B: Financial Development Informalization (Prop. 7)

	Contemporary						Non-Contemporary					
	OLS	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**	**OLS**	**Q.10**	**Q.25**	**Q.50**	**Q.75**	**Q.90**
Constant	**0.397*** **	**0.214*** **	**0.308*** **	**0.380*** **	**0.474*** **	**0.669*** **	**0.392*** **	**0.223*** **	**0.294*** **	**0.384*** **	**0.465*** **	**0.688*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
PCB	**-0.003** **	**-0.001***	-0.0007	**-0.003*** **	**-0.005*** **	**-0.007*** **	-0.002	-0.001	0.0009	**-0.002*** **	**-0.004** **	**-0.008*** **
	(0.023)	**(0.084)**	(0.414)	**(0.000)**	**(0.003)**	**(0.000)**	(0.100)	(0.173)	(0.503)	**(0.009)**	**(0.011)**	**(0.0000)**
Mobile	**-**	-0.0001	-0.0003	**-**	**-0.001** **	**-0.002*** **	**-0.001*** **	0.0001	**-0.0005***	**-0.0006**	**-0.001***	**-0.002*** **
	0.0008* **			**0.0005*** **						***		
	(0.002)	(0.544)	(0.107)	**(0.007)**	**(0.017)**	**(0.000)**	**(0.001)**	(0.638)	**(0.088)**	**(0.009)**	**(0.071)**	**(0.001)**
PCB×Mobile	-0.000008	**-0.00006**	**-0.00007**	0.000008	0.00003	**0.00006** **	-0.00002	**-0.0008**	**-**	-0.000004	**0.00004***	**0.00008** **
		***	***			*		***	**0.0001*** **			*
	(0.728)	**(0.000)**	**(0.000)**	(0.428)	(0.119)	**(0.000)**	(0.482)	**(0.000)**	**(0.000)**	(0.757)	**(0.094)**	**(0.000)**
GDP growth	-0.001	**-0.001** **	-0.001	**-0.004*** **	-0.001	0.0001	-0.001	0.0008	**-0.002***	**-0.006*** **	-0.001	0.00002
	(0.541)	**(0.014)**	(0.111)	**(0.000)**	(0.627)	(0.974)	(0.563)	(0.338)	**(0.057)**	**(0.000)**	(0.774)	(0.995)
Inflation	**-**	-0.0001	**-**	**-**	**-0.0006**	**-0.001*** **	**-0.0007**	0.0001	**-0.0003***	**-0.0006**	**-0.0006** **	**-0.001*** **
	0.0006* **		**0.0003*** **	**0.0005*** **	***		***			***		
	(0.000)	(0.133)	**(0.009)**	**(0.000)**	**(0.004)**	**(0.000)**	**(0.002)**	(0.133)	**(0.059)**	**(0.000)**	**(0.031)**	**(0.001)**
Public Invt.	**-0.005*** **	**-0.009*** **	**-0.005*** **	**-0.003*** **	**-0.007*** **	**-0.009*** **	**-0.005*** **	**-0.007*** **	**-0.005*** **	**-0.002** **	**-0.010*** **	**-0.009*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.002)**	**(0.005)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.012)**	**(0.005)**	**(0.000)**
Foreign Aid	-0.002	**0.001***	-0.0005	**-0.001** **	-0.001	**-0.005** **	-0.002	0.001	-0.0003	**-0.001***	-0.0006	**-0.006** **
	(0.105)	**(0.076)**	(0.585)	**(0.011)**	(0.363)	**(0.036)**	(0.121)	(0.276)	(0.785)	**(0.060)**	(0.773)	**(0.030)**
Trade	0.0003	0.0002	-0.0002	-0.0001	0.00002	0.0003	0.0003	**-0.0004*** **	-0.00002	-0.0003	0.0001	0.0003
	(0.160)	(0.107)	(0.201)	(0.411)	(0.944)	(0.508)	(0.246)	**(0.004)**	0.920)	(0.328)	(0.766)	(0.592)
Middle Income	**-0.074*** **	**-0.030** **	**-0.056*** **	**-0.064*** **	-0.027	-0.059	**-0.070*** **	-0.009	**-0.048** **	**-0.062*** **	-0.036	-0.077
	(0.000)	**(0.021)**	**(0.000)**	**(0.000)**	(0.357)	(0.140)	**(0.002)**	(0.536)	**(0.013)**	**(0.000)**	(0.334)	(0.150)
Common Law	**-0.098*** **	**-0.070*** **	**-0.061*** **	**-0.074*** **	**-0.118*** **	**-0.159*** **	**-0.097*** **	**-0.061*** **	**-0.068*** **	**-0.076*** **	**-0.124*** **	**-0.143*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Net effects	na	-0.003	na	na	na	-0.004	na	na	na	na	-0.002	-0.005
Pseudo R^2/R^2	0.511	0.459	0.319	0.262	0.261	0.342	0.520	0.465	0.340	0.264	0.253	0.349
Fisher	**20.03*** **						**17.68*** **					
Observations	295	295	295	295	295	295	259	259	259	259	259	259

*,**,***: significance levels of 10%, 5% and 1% respectively. GDPg: GDP growth rate. Public Invt: Public Investment. Mobile: Mobile phone penetration rate. OLS: Ordinary Least Squares. R^2 for OLS and Pseudo R^2 for quantile regression. Lower quantiles (e.g., Q 0.1) signify nations where financial sector development is least.

5. Conclusion and future research directions

We set out to investigate linkages between the mobile phone, information sharing mechanisms and financial sector development in 53 African countries for the period 2004-2011. For this purpose, we have proposed measures of financial sector development based on a rethinking of the mainstream financial system definition that the propositions have challenged by *inter alia*: (i) providing a financial system definition that incorporates the previously missing informal financial sector; (ii) disentangling the mainstream definition of the financial system into its semi-formal and formal components and (iii) introducing the concept of financialization within the framework of development in the financial sector.

Information sharing offices (ISOs) in the financial sector include pubic credit registries (PCR) and private credit bureaus (PCB) while the information and communication technology (ICT) by which the sharing of such information is facilitated is proxied by the mobile phone. The theoretical underpinnings build on the fact that: (i) ISOs are meant to stimulate financial sector development; (ii) ISOs also have to act as a disciplining device in preventing borrowers from defaulting on their debts and resorting to the informal financial sector and (iii) mobile phone banking is related to both the formal and informal financial sectors.

The empirical evidence is based on contemporary and non-contemporary quantile regressions (QR). The policy relevance of the approach is based on the intuition that mean values provide blanket policy recommendations that could be inefficient unless such policies are contingent on initial levels of financial sector development and tailored differently across countries with low, intermediate and high initial levels of financial sector development.

Two main hypotheses have been tested: mobile phones complement ISO to enhance the formal financial sector (*Hypothesis 1*) and mobile phones complement ISO to reduce the informal financial sector (*Hypothesis 2*). The hypotheses are confirmed for the most part with the following findings. First, on the linkages between formal finance, mobile phones and PCR: (i) with the exception of the 90^{th} quantile, net effects of mobiles with PCR are positive on formal financial development and (ii) net effects are also positive on financial formalization. Second, on the linkages between informal finance, mobile phones and PCR, the net effects are: (i) positive on informal financial development at the 25^{th} quantile and (ii) negative on financial informalization at the 25^{th} quantile and top quantiles of the distributions. Third, on nexuses

between formal finance, mobile phones and PCB: (i) the net effect is negative (positive) on the financial development formalization at the 90^{th} (25^{th}) quantile of contemporary (non-contemporary) distributions while the effect is positive on financial formalization at the bottom quantiles and 90^{th} quantile. Fourth, on the linkages between informal finance, mobile phones and PCB: (i) there are negative net effects on informal financial development at the 25^{th} and 50^{th} quantiles and (ii) there are also negative net impacts on financial informalization at the top quantiles (10^{th} and 90^{th} quantile) of non-contemporary (contemporary) estimations.

While the findings cannot be directly compared to the literature on the nexus between information sharing and financial access, if it is assumed that formal financial sector development is synonymous with more possibilities of financial access, then the findings can be compared with the engaged literature in the introduction. Overall the findings are broadly consistent with the attendant literature maintaining that the introduction of information sharing offices improves credit access facilities and limits financial access constraints. The studies with conclusions that are broadly in line with those of this study include: Galindo and Miller (2001), Love and Mylenko (2003), Singh et al. (2009), Triki and Gajigo (2014), Kusi et al. (2017) and Kusi and Opoku- Mensah (2018).

The main policy implication from the study is that the use of information technologies as instruments through which information sharing offices reduce information asymmetry in the banking industry should be encouraged, not least because such complementarity promotes the formal financial sector to the detriment of the informal financial sector and by extension the informal economy. This main implication is worthwhile because the objective of every country is to formalize transactions both in the formal financial and economic sectors.

The main scholarly implication of the study is on a methodological front. Accordingly, by introducing previously unexplored dimensions of financial sector development, the study has contributed to two streams of research, notably by simultaneously contributing to the growing field of economic development by means of informal finance and micro finance on the one hand and on the other hand, the stream of literature on the measurement of financial development. The latter contribution builds on the fact that we have proposed a practicable way of disentangling the impact of information sharing on various financial sectors.

Future inquiries can improve the extant literature by assessing other mechanisms by which ISOs promote financial access and formal financial development. Furthermore,

positioning future research on inclusive financial development could elicit some policy syndromes in the post-2015 sustainable development agenda, notably: ICT and ISO channels for poverty and inequality reduction. An exploratory analysis shows that English Common law countries within the context of the study are performing better than their French Civil law counterparts. However, in order not to deviate too much from the scope of the study, it will be worthwhile for future research to critically engage a comparative study based on colonial legal origins. Muazu and Alagidede (2017) is a relevant starting point in this future direction.

Appendices

Appendix 1: Summary Statistics (2004-2011)

	Variables	Mean	S.D	Min.	Max.	Obs.
Financial Sector Development	Formal Financial Development (Prop.1)	28.037	20.970	2.926	92.325	377
	Semi-formal Financial Development (Prop. 2)	0.199	0.715	0.000	4.478	424
	Informal Financial Development (Prop. 3)	5.350	5.106	-18.89	25.674	424
	Non-formal Financial Development (Prop. 4)	5.550	5.171	-18.89	25.674	424
	Financial Formalization (Prop. 5)	0.773	0.168	0.235	1.469	377
	Financial Semi-formalization (Prop. 6)	0.007	0.029	0.000	0.244	377
	Financial Informalization (Prop. 7)	0.219	0.168	-0.469	0.764	377
	Financia Non-formalization (Prop. 8)	0.226	0.168	-0.469	0.764	377
Information Asymmetry	Public Credit registries (PCR)	2.155	5.812	0.000	49.8	381
	Private Credit Bureaus (PCB)	4.223	13.734	0.000	64.8	380
ICT	Mobile Phone Penetration	36.659	32.848	0.214	171.51	420
Control Variables	Economic Prosperity (GDPg)	4.996	4.556	-17.66	37.998	404
	Inflation	7.801	4.720	0	43.011	357
	Public Investment	74.778	1241.70	-8.974	24411	387
	Development Assistance	10.396	12.958	0.027	147.05	411
	Trade Openness (Trade)	80.861	32.935	24.968	186.15	392

S.D: Standard Deviation. Min: Minimum. Max: Maximum. GDPg: GDP growth. Obs: Observations.

Appendix 2: Correlation Analysis (Uniform sample size : 293)

Financial Sector Development								Info. Asymmetry		Control Variables						
Prop.1	Prop.2	Prop.3	Prop.4	Prop.5	Prop.6	Prop.7	Prop.8	PCR	PCB	GDPg	Inflation	PubIvt	NODA	Trade	Mobile	
1.000	0.110	0.127	0.142	0.565	-0.052	-0.556	-0.565	0.411	0.310	-0.094	-0.071	0.058	-0.311	0.141	0.515	Prop.1
	1.000	-0.013	0.130	-0.031	0.872	-0.128	0.031	-0.023	-0.100	-0.060	0.260	-0.040	0.007	-0.086	-0.087	Prop.2
		1.000	0.989	-0.604	-0.068	0.617	0.604	0.127	-0.569	-0.083	-0.082	-0.054	0.033	-0.006	-0.055	Prop.3
			1.000	-0.604	0.057	0.593	0.604	0.123	-0.579	-0.091	-0.044	-0.059	0.034	-0.018	-0.067	Prop.4
				1.000	-0.092	-0.983	-1.000	0.094	0.613	-0.004	0.008	0.128	-0.246	0.119	0.430	Prop.5
					1.000	-0.091	0.092	-0.059	-0.084	-0.077	0.289	-0.012	0.123	-0.074	-0.133	Prop.6
						1.000	0.983	-0.083	-0.598	0.018	-0.061	-0.125	0.224	-0.105	-0.407	Prop.7
							1.000	-0.094	-0.613	0.004	-0.008	-0.128	0.246	-0.119	-0.403	Prop.8
								1.000	-0.140	-0.026	-0.081	0.068	-0.154	0.207	0.369	PCR
									1.000	-0.101	-0.035	-0.047	-0.329	0.084	0.388	PCB
										1.000	-0.169	0.129	0.122	0.037	-0.178	GDPg
											1.000	-0.081	-0.0004	-0.006	-0.054	Inflation
												1.000	0.059	0.130	0.079	PubIvt
													1.000	-0.309	-0.504	NODA
														1.000	0.198	Trade
															1.000	Mobile

Prop.1: Formal Financial Sector Development. Prop.2: Semi-Formal Financial Sector Development. Prop.3: Informal Financial Sector Development. Prop. 4: Non-Formal Financial Development. Prop.5: Financial Sector Formalization. Prop.6: Financial Sector Semi-Formalization. Prop.7: Financial Sector Informalization. Prop.8: Financial Sector Non-Formalization. Info: Information. PCR: Public Credit Registries. PCB: Private Credit Bureaus. GDPg: GDP growth. PubIvt: Public Investment. NODA: Net Official Development Assistance. Info: Information. ICT: Information and Communication Technology. Mobile: Mobile Phone Penetration.

Appendix 3: Variable Definitions

Variables	Signs	Variable Definitions	Sources
Formal Financial Development	Prop.1	Bank deposits/GDP. Bank deposits here refer to demand, time and saving deposits in deposit money banks (Lines 24 and 25 of International Financial Statistics (IFS); October 2008).	
Semi-formal financial development	Prop.3	(Financial deposits – Bank deposits)/ GDP. Financial deposits are demand, time and saving deposits in deposit money banks and other financial institutions. (Lines 24, 25 and 45 of IFS, October, 2008).	
Informal financial development	Prop.3	(Money Supply – Financial deposits)/GDP	
Informal and semi-formal financial development	Prop.4	(Money Supply – Bank deposits)/GDP	Asongu (2014a; 2015ab)
Financial intermediary formalization	Prop.5	Bank deposits/ Money Supply (M2). From 'informal and semi-formal' to *formal* financial development (formalization)	
Financial intermediary 'semi-formalization'	Prop.6	(Financial deposits - Bank deposits)/ Money Supply. From 'informal and formal' to *semi-formal* financial development (Semi-formalization)	
Financial intermediary 'informalization'	Prop.7	(Money Supply – Financial deposits)/ Money Supply. From 'formal and semi-formal' to *informal* financial development (Informalisation).	
Financial intermediary 'semi-formalization and informalization'	Prop.8	(Money Supply – Bank Deposits)/Money Supply. Formal to '*informal and semi-formal'* financial development: (Semi-formalization and informalization).	
Information Asymmetry	PCR	Public credit registry coverage (% of adults)	World Bank (WDI)
	PCB	Private credit bureau coverage (% of adults)	World Bank (WDI)
Information and Communication Technology	Mobile	Mobile phone subscriptions (per 100 people)	World Bank (WDI)
Economic Prosperity	GDPg	GDP Growth (annual %)	World Bank (WDI)
Inflation	Infl	Consumer Price Index (annual %)	World Bank (WDI)
Public Investment	PubIvt	Gross Public Investment (% of GDP)	World Bank (WDI)
Development Assistance	NODA	Total Net Official Development Assistance (% of GDP)	World Bank (WDI)
Trade openness	Trade	Imports plus Exports in commodities (% of GDP)	World Bank (WDI)

WDI: World Bank Development Indicators. FDSD: Financial Development and Structure Database.

Appendix 4: Fisher-type unit root tests

		ADF	
		Constant	**Constant and trend**
Prop.1	P	**134.261*** **	**435.406*** **
	Z	**-2.378*** **	**-4.011*** **
	L°	**-2.498*** **	**-13.523*** **
	Pm	**3.115*** **	**24.100*** **
Prop. 2	P	**30.936** **	67.843
	Z	**-2.624*** **	**-3.410*** **
	L°	**-2.550*** **	**-5.491*** **
	Pm	**2.640*** **	-2.620
Prop. 3	P	**206.553*** **	**350.638*** **
	Z	**-6.133*** **	**-4.276*** **
	L°	**-6.398*** **	**-9.426*** **
	Pm	**7.753*** **	**16.801*** **
Prop. 4	P	**204.789*** **	**391.109*** **
	Z	**-6.007*** **	**-5.041*** **
	L°	**-6.261*** **	**-11.094*** **
	Pm	**7.627*** **	**19.581*** **
Prop. 5	P	**195.589*** **	**561.285*** **
	Z	**-6.341*** **	**-7.902*** **
	L°	**-6.439*** **	**-19.506*** **
	Pm	**7.636*** **	**33.091*** **
Prop. 6	P	**26.695** **	**33.158*** **
	Z	**-2.620*** **	**-3.434*** **
	L°	**-2.512*** **	**-3.566*** **
	Pm	**2.399*** **	-4.631
Prop. 7	P	**205.534*** **	**648.042*** **
	Z	**-6.932*** **	**-9.537*** **
	L°	**-7.070*** **	**-23.697*** **
	Pm	**8.369*** **	**39.288*** **
Prop. 8	P	**195.589*** **	**561.285*** **
	Z	**-6.341*** **	**-7.902*** **
	L°	**-6.439*** **	**-19.506*** **
	Pm	**7.636*** **	**33.091*** **
PCR	P	**116.238*** **	**303.026*** **
	Z	**-4.696*** **	**-8.206*** **
	L°	**-4.811*** **	**-15.639*** **
	Pm	**6.299*** **	**14.074*** **
PCB	P	**30.896** **	21.052
	Z	-0.979	-1.260
	L°	-0.845	**-1.405***
	Pm	**2.149** **	-5.667
Mobile	P	119.097	**349.552*** **
	Z	0.193	**-3.682*** **
	L°	-0.049	**-8.417*** **
	Pm	1.197	**16.727*** **
GDPg	P	283.468***	526.748***
	Z	-10.054***	-9.272***
	L°	-10.151***	-17.887***
	Pm	12.705***	29.738***
Inflation	P	304.162***	441.705***
	Z	-11.618***	-5.839***
	L°	-11.976***	-13.910***
	Pm	15.327***	24.162***

	P	168.867***	93.475
	Z	-5.254***	2.056
Public Investment	L°	-5.292***	1.629
	Pm	6.095***	-0.038
	P	223.137***	360.832***
	Z	-7.680***	-3.746***
NODA	L°	-7.560***	-8.608***
	Pm	8.481***	17.808***
	P	218.117***	194.365***
	Z	-7.965***	-0.925
Trade	L°	-7.772***	-3.531***
	Pm	8.813***	6.672***

,*: significance levels of 5% and 1% respectively. c:constant. ct : constant and trend. ADF: Augmented Dickey Fuller. The lag difference length is one. P: Inverse chi-squared. Z: Inverse normal. L°: Inverse logit t. Pm: Modified inv. chi-squared. Prop.1: Formal Financial Sector Development. Prop.2: Semi-Formal Financial Sector Development. Prop.3: Informal Financial Sector Development. Prop. 4: Non-Formal Financial Development. Prop.5: Financial Sector Formalization. Prop.6: Financial Sector Semi-Formalization. Prop.7: Financial Sector Informalization. Prop.8: Financial Sector Non-Formalization. PCR: Public Credit Registries. PCB: Private Credit Bureaus. Mobile: Mobile Phone Penetration. GDPg: GDP growth. PubIvt: Public Investment. NODA: Net Official Development Assistance.

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