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## **Mobile banking usage, quality of growth, inequality and poverty in developing countries**

Forthcoming: Information Development

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**Abstract**

The transition from Millennium Development Goals to Sustainable Development Goals has substantially shifted the policy debate from development to inclusive development. Using interactive quantile regressions, we examine the correlations between mobile banking and inclusive development (quality of growth, inequality and poverty) among individuals in 93 developing countries for the year 2011. Mobile banking entails: ‘mobile used to pay bills’ and ‘mobile used to receive/send money’. The findings broadly show that increasing mobile banking dynamics to certain thresholds would increase (decrease) quality of growth (inequality) in quantiles at the high-end of inclusive development distributions for the most part. The study is original in that it explores the relationship between mobile banking and inclusive development using three measurements of inclusive development, namely: quality of growth, inequality and poverty. As a main policy implication, encouraging mobile banking applications would play a substantial role in responding to the challenges of immiserizing growth, inequality and poverty in developing countries.

*JEL Classification:* G20; O40; I10; I20; I32

*Keywords:* Mobile banking; Quality of growth; Poverty; Inequality; Developing countries

## 1. Introduction

The mobile<sup>1</sup> revolution is currently changing many industries by, *inter alia*: improving networks of interaction and providing services to previously unexplored sectors like health care and banking. Accordingly, the development of mobile applications is increasingly being tailored towards the improvement of among others: interaction among businesses; solutions of payment for Small and Medium Size Enterprises (SMEs); consultation with medical doctors and monitoring of staff and improvement of services to the underserved factions of the population. Some of the underlying services have also entailed: (i) the provision of mobile banking facilities to population segments previously not served by formal banking institutions and (ii) improvement of the performance of health workers' through enhanced mobile health applications (Asongu, 2017a, 2017b).

In light of the above, there has been a growing call for more scholarly focus on the impact of mobile phone applications on development outcomes (Mpogole et al, 2008, p. 71; Tchamyou, 2016). In accordance with Kliner et al. (2013), the mobile phone is increasingly being employed to improve health service delivery in peripheral communities. This position is consistent with the stance of Kirui et al. (2013) on the rewards of mobile phones in the fight against poverty in rural areas: '*We conclude that mobile phone-based money transfer services in rural areas help to resolve a market failure that farmers face; access to financial services*' (p. 141).

The development outcomes assessed in the present study articulate inclusive development for a twofold reason. First, with the transition from Millennium Development Goals (MDGs) to Sustainable Development Goals (SDGs), the policy focus has fundamentally shifted from development to inclusive development (Asongu & Rangan, 2016). Second, the relevance of the underlying policy debate has been reignited by the April 15<sup>th</sup> 2015 publication of World Development Indicators by the World Bank which has established that, poverty has not been declining as expected in many countries of the world, especially in Sub-Saharan Africa (SSA) (World Bank, 2015; Caulderwood, 2015; Asongu & Kodila-Tedika, 2017). The recent stylized facts are consistent with the QGI in the perspective that, construction of the QGI has been motivated by the documented evidence on 'immiserizing growth', especially in SSA (Dollar & Kraay, 2002; Dollar et al., 2013; Martinez & Mlachila, 2013; Ola-David & Oyelaran-Oyeyinka, 2014).

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<sup>1</sup> Throughout this study, the terms mobile, cell phones, mobile phones and mobile telephony are used interchangeably.

The positioning of this study steers clear of the available inclusive growth literature which has focused on: poverty correlates (Anyanwu, 2013a, 2014a), nexuses between finance, growth, employment and poverty (Odhiambo, 2009, 2011), the role of financial development in poverty reduction (Odhiambo, 2010a, 2010b, 2013), gender inequality (Elu & Loubert, 2013; Anyanwu, 2013b, 2014b; Balamoune-Lutz & McGillivray, 2009; Balamoune-Lutz, 2007; Elu & Price, 2017); financial inclusion (Bocher et al., 2017; Charles & Mori, 2016; Chapoto & Aboagye, 2017; Chikalipah, 2017; Daniel, 2017; Bongomin et al., 2016; Wale & Makina, 2017); reinventing foreign aid for inclusive and sustainable development (Asongu, 2016), debates between relative pro-poor (Dollar & Kraay, 2003) versus absolute pro-poor (Ravallion & Chen, 2003) growth, recent advances in finance for inclusive development (Asongu & De Moor, 2015) and measurements of inclusive development (Anand et al., 2013; Mlachila et al., 2016). The last-two strands are closest to the present study because we are assessing the role of ‘mobile banking’ on development, using (among others) an unexplored inclusive development measurement.

The rest of the study is organized as follows. The literature review and theoretical underpinnings are covered in Section 2. Section 3 discusses the data and methodology. The empirical analysis, discussion of results and implications are covered in Section 4. Section 5 concludes.

## **2. Literature review and theoretical underpinnings**

### **2.1 Literature review**

Mobile applications have been documented to be associated with many inclusive development benefits. According to Warren (2007), communities in rural areas would benefit more from the mobile technology because it mitigates a plethora of issues that are more acutely felt by these communities, notably: ‘information acquisition’ and ‘commodity purchase’. Moreover, in developing countries, in spite of efforts that have been devoted towards enhancing services by mainstream financial establishments, ‘*Telecommunication infrastructure growth especially mobile phone penetration has created an opportunity for providing financial inclusion*’ (Mishra & Bisht, 2013, p.503). Using the same analytical scope of India, Singh (2012, p. 466) has been more direct in establishing the substantial relevance of ‘mobile banking’ in financial inclusion. In summary, economic opportunities in developing countries are being increasingly improved with the conversion of mobile phones into pocket

financial institutions, which has enabled a great chunk of the population previously unbanked, to have financial access (Demombynes & Thegeya, 2012; Asongu, 2013a).

Though the use of mobiles can be classified into a multitude of perspectives, for brevity we discuss three strands, namely: reducing the rural-urban divide; health-service improvement and female empowerment. The following three points are note worthy in the first strand. (i) On the challenges of employment, production and the distribution of food confronted by communities in rural areas, the information gap narrowed and/or bridged by mobile phone applications has yielded substantial poverty mitigation externalities like job creation and incremental generation of income. An extensive literature consistent with this position include, studies in Ghana which have established that enhanced ‘market information’ engenders a rise of income by about 10% for market participants (E-agriculture, 2012, p. 6-9). (ii) Cooperatives and SMEs are being supported by ‘mobile banking’-fuelled agricultural finance. Some cases in point include: Costa Rica with groups that are financially sustainable (Perez et al., 2011, p. 316) and Community Credit Enterprises (CCE) which are fostering sustainable business models (Asongu & De Moor, 2015). This position is directly consistent with the World Bank’s conclusion that mobile phones have been increasingly contributing to inclusive development in rural and agricultural areas (Qiang et al., 2011, pp. 14-26). The account has also been confirmed by Chan and Jia (2011) on the benefits of mobile technology in easing access to loans in rural areas, notably: increasing ‘*rates for bank transfers through mobile cell phones at commercial banks*’ (Table 2, p. 5), deriving from ‘*mobile banking is an ideal choice for meeting the rural financial needs*’ (p. 3). (iii) Muto and Yamano (2009) and Aker and Fafchamps (2010) have joined the underlying stream of the literature by establishing that demand- and supply-side constraints in rural livelihoods and agricultural productivity are increasingly being stifled with the help of advances in mobile technology. Positive externalities for citizens in agricultural communities culminate in ‘high-growth/return’. In summary, mobile phones can improve livelihoods in rural communities by providing an enabling environment for demand- and supply-matching and/or mitigation of wastages via matching networks (see Asongu, 2017a).

In the second strand, we have studies that have focused on the use of mobile phones for the improvement of health services. Consistent with West (2013), the affordability and availability of health facilities have considerably improved with the advent of mobile phones. Exclusive human development challenges like income and geographic income disparities are growingly being addressed via enhanced mobile phone applications for improved health

delivery. Therefore, by linking patients to healthcare providers, mobile applications enhance the delivery of health services through, among others: access to material of reference, laboratory tests and medical records. Some examples have included enhancing mobile applications for: tailored feedback and self-monitoring (Bauer et al., 2010); observations and treatment of patients with tuberculosis (Hoffman et al., 2010) and clinical appointments (Da Costa et al., 2010).

Consistent with Asongu (2017a), in the third strand on female empowerment, we find evidence of increasing women participation in communities owing to ‘mobile banking’ related financial inclusion. Documented channels by which mobile telephony service would empower women have included: household management and small business consolidation (Asongu & Nwachukwu, 2016a, 2018). Consistent with Jonathan and Camilo (2008), Ondiege (2010, 2013) and Asongu (2015), mobile phones mitigate the gender-finance gap and provide an enabling environment for timely responses to poverty-linked shocks. Some mechanisms by which underlying shocks are mitigated entail: income saving, multi-tasking, reduced travelling cost, education and household budget management (Al Surikhi, 2012; Asongu & Nwachukwu, 2016a). Ondiege (2010, p. 11) and Mishra and Bisht (2013, p. 505) have provided country-specific models and sustained that appropriate government policies are needed to enhance the inclusiveness of mobile banking. The narrative of this third strand is in accordance with the findings of: (i) Ojo et al. (2012) who have assessed how mobile phones have influenced the livelihoods of the female gender in Ghana and (ii) Maurer (2008) who has expressed the relevance for policy-making bodies in promoting/sustaining the gender inclusive rewards of mobile telephony.

In spite of the growing literature on the role of mobile phone penetration in inclusive development, very little is known about the relationship between mobile banking and inclusive development. A reason for this scarce literature is the lack of mobile banking and inclusive development data. We contribute to this scarce literature by exploiting: (i) a new dataset on quality of growth recently published by the International Monetary Fund (IMF) in 2014 (Mlachila et al., 2016)<sup>2</sup> and (ii) the only macroeconomic ‘mobile banking’ data available first published by the World Bank in 2013 (Mosheni-Cheraghrou, 2013). We devote space to discussing these points in substantive detail.

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<sup>2</sup> The interested reader can find the published data on the following link: <http://www.imf.org/external/pubs/cat/longres.aspx?sk=41922.0>

First, with respect to the inclusive growth indicators, Mlachila et al. (2016) have built on former indicators (Anand et al., 2013) as well as a plethora of previous concepts, definitions and measurements of ‘pro-poor growth’ to provide the scientific community with a new indicator called the Quality of Growth Index (QGI). This new indicator is based on previous studies from the Commission on Growth and Development (2008) and Ianchovichina and Gable (2012). The QGI conceives ‘inclusive growth’ to be ‘pro-poor growth’ that is high, durable and socially-friendly. Therefore, some important elements needed for ‘quality of growth’ entail: strength, stability, increasing productivity, sustainability, better standards of living and poverty reduction. The present line of inquiry uses the inclusive growth index of Mlachila et al. (2016) because it has integrated social dimensions to the intrinsic measurement of growth. In order to provide room for more policy implications, we complement the inclusive growth dependent variable with two variables of inclusive development: the poverty rate and inequality index.

Second, to the best of our knowledge, the literature on mobile banking with macroeconomic indicators is scarce owing to data availability constraints. As far as we have reviewed, the first macroeconomic data by the World Bank was published in 2013 (Mosheni-Cheraghrou, 2013). We therefore explore this dataset by responding to growing calls for more research on the effects of mobile phones on development outcomes (Mpogole et al, 2008, p. 71; Osah& Kyobe, 2017).

## **2. 2 Theoretical underpinnings**

We devote space to briefly engaging the theoretical underpinnings of the study. These are broadly in accordance with the adoption of new technology and have been substantially documented by Yousafzai et al. (2010, p. 1172). Some of the most popular include, the: theory of reasoned action (TRA), technology acceptance model (TAM) and theory of planned behavior (TPB). A common element of these theories is that the adoption of mobile phones is a complex and multifaceted process, involving: (i) an approach from system developers and information managers that is centered on the customer’s formation of belief and not on the influence of attitudes and (ii) important characteristics which entail composite considerations like, behavioral, utilitarian, social, behavioral and psychological aspects of customers. First, in accordance with Yousafzai et al., the TRA formulated by Fishbein and Ajzen (1975), Ajzen and Fishbein (1980) and Bagozzi (1982) is essentially founded on the hypothesis that customers are rational agents when it comes to taking into account the implications of their



actions. Second, the TPB which is developed by Ajzen (1991) has extended the TRA by emphasising the absence of differences between customers who consciously control their actions relative to those that do not. Third, the TAM pioneered by Davis (1989) considers that the process of adoption of a particular technology by a customer can be elicited essentially by the customer's voluntary intention to accept and use the mobile technology.

The underlying three theories align with the positioning of this paper in the perspective that customers adopt mobile phones because of potential inclusive development gains from mobile applications like mobile banking. The empirical evidence is based on cross-sectional data from 93 countries. In order to provide more space for policy implications, we use interactive quantile regressions (QR). The motivation for this empirical strategy is twofold. First, on QR, blanket inclusive development policies may not be effective unless they are contingent on initial inclusive development levels and tailored differently across high-inclusiveness and low-inclusiveness countries. Second, we interact the mobile banking independent variables of interest to assess evidence of thresholds that are important in policy making.

### **3. Data and Methodology**

#### **3.1 Data**

We investigate a sample of 93 developing countries with cross sectional data: (i) a 2005-2011 average from Mlachila et al. (2016) and the year 2011 from Mosheni-Cheraghrou (2013). The dataset from the former consists of four non-overlapping intervals (1990-1994; 1995-1999; 2000-2004 and 2005-2011) while that of the latter is only available for the year 2011. The QGI dependent variable is computed with data from a plethora of sources, notably: World Development Indicators of the World Bank, IMF's World Economic Outlook, United Nations (UN) COMTRADE database, Sala-i-Martin (2006) and Barro and Lee (2010). In a quest to provide room for more policy implications, we complement the QGI index with the poverty rate and inequality index.

The mobile phone/banking indicators are from Mosheni-Cheraghrou (2013). The data structure is cross-sectional for the year 2011 because to the best of our knowledge, macroeconomic indicators for mobile banking are only available for this year. The two main mobile banking indicators are the: *'mobile phone usage for the payment of bills (% of adults)'* and *'mobile phone usage for sending/receiving of money (% of adults)'*.

Consistent with recent inclusive growth literature (Anand et al., 2013; Asongu, 2015d; Asongu & Rangan, 2016; Asongu & Nwachukwu, 2016b), the control variables include: *education spending, government stability, credit, inflation, foreign direct investment (FDI)* and *remittances*. A complete definition of the variables is provided in Appendix 1. We expect the control variables to be positively correlated with inclusive development, with the exception of inflation for which the sign cannot be established with certainty. Accordingly, while high inflation reduces inclusive growth, inflation that is stable and low has positive income redistributive effects (Asongu, 2013b), essentially because such conditions are needed to stimulate investment needed for economic growth. This is fundamentally because, high inflation creates uncertainty and investors have been documented to prefer economic strategies that less ambiguous (Le Roux & Kelsey, 2015a, 2015b).

The positive covariates have been substantially documented in the bulk of inclusive growth literature (Dollar & Kraay, 2003; Barro & Lee, 2000; Calderon & Servén, 2004; Levine, 2005; Hausmann et al., 2007; IMF, 2007; Mishra, et al., 2011; Anand et al., 2012; Seneviratne & Sun, 2013; Asongu & Nwachukwu, 2016b). We briefly engage the corresponding literature. According to IMF (2007) and Anand et al. (2013), structural change, macroeconomic stability and human capital are important determinants of pro-poor growth in developing countries. Structural change entails globalisation (e.g. financial globalisation or FDI), human capital and macroeconomic stability (Asongu & Nwachukwu, 2018). Other macroeconomic and structural characteristics needed for growth are stable inflation and low negative output volatility (Dollar & Kraay, 2003; Barro & Lee, 2010), financial access (Levine, 2005), infrastructural development (Calderon & Servén, 2004; Seneviratne & Sun, 2013); improvement of value chains (Hausmann et al., 2007; Anand, et al., 2012) and modernization of production (Mishra et al., 2011).

The summary statistics is presented in Appendix 2 while the correlation matrix in Appendix 3. From the summary statistics we observe that: (i) the means are comparable and (ii) the variables exhibit a substantial degree of variation, therefore we can be confident that reasonable estimated linkages would emerge. The purpose of the correlation matrix is to mitigate potential concerns of multicollinearity and overparameterization. Two issues of multicollinearity are highlighted in bold, notably: (i) 0.898 for education and quality of growth and (ii) 0.865 for the two mobile banking indicators. While the first issue is not really a concern because the two correlated indicators entail a dependent and an independent variable, we account for the second issue by employing two specifications.

### 3.2 Methodology

In order to assess if existing levels of inclusive development matter in the role of mobile banking on inclusive development, we adopt Quantile regression (QR). The QR technique consists of investigating the role of mobile banking throughout the conditional distribution of the inclusive development variables. That is: (i) from low-‘inclusive development’ to ‘high-inclusive development’ countries when the QGI is the dependent variable and (ii) from high-‘inclusive development’ and low-‘inclusive development’ when the ‘inequality index’ or ‘poverty rate’ is used as the dependent variable. The technique yields parameters estimated at various points of the conditional distributions of the dependent variables (Koenket & Hallock, 2001). This is in line with the underlying literature on conditional determinants (Billger & Goel, 2009; Asongu, 2013), which is focused on investigating if initial levels of the dependent variable matter in the effects of underlying determinants.

Previous inclusive development studies have reported parameter estimates at the conditional mean of the dependent variable (e.g. Mlachila et al., 2016). While mean effects are relevant, we extend the underlying literature by employing a QR estimation technique that accounts for initial levels of inclusive development. For example, whereas Ordinary Least Squares (OLS) assumes that the inclusive development indicator and error terms are normally distributed, this assumption does not hold for QR estimations. In essence, with the approach, parameter estimates are derived at multiple points of the conditional distributions of inclusive development (Koenker & Bassett, 1978). The QR estimation strategy is increasingly being employed in development literature, inter alia in: finance, (Asongu, 2014a), health (Asongu, 2014b), corruption (Billger & Goel, 2009; Okada & Samreth, 2012; Asongu, 2013c) and quality of growth (Asongu & Rangan, 2016) studies. In summary, the strategy enables an assessment of the role of mobile banking with particular emphasis on best- and worst-performing developing countries in terms of inclusive development.

The  $\theta^{\text{th}}$  quantile estimator of inclusive development is obtained by solving for the following optimization problem, which is presented without subscripts in Eq. (1) for the purpose of simplicity and readability.

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

Where  $\theta \in (0,1)$ . Contrary to OLS which is fundamentally based on minimizing the sum of squared residuals, with QR, the weighted sum of absolute deviations are minimised. For example the 10<sup>th</sup> decile or 25<sup>th</sup> quartile (with  $\theta=0.10$  or  $0.25$  respectively) by approximately weighing the residuals. The conditional quantile of inclusive development or  $y_i$  given  $x_i$  is:

$$Q_y(\theta / x_i) = x_i \beta_\theta \quad (2)$$

Where unique slope parameters are modelled for each  $\theta^{\text{th}}$  specific quantile. This formulation is analogous to  $E(y / x) = x_i \beta$  in the OLS slope where parameters are assessed only at the mean of the conditional distribution of inclusive development. For Eq. (2), the dependent variable  $y_i$  is an inclusive development indicator (quality of growth, poverty and inequality) while  $x_i$  contains: a constant term, *educational spending*, *government stability*, *credit*, *inflation*, *FDI* and *remittances*.

Given that the empirical strategy we have adopted entails interactive models, it is important to briefly discuss some pitfalls of interactive regressions. Consistent with Brambor et al. (2006), for the estimation output to make economic sense, the corresponding estimated interactive coefficients should be interpreted as conditional marginal correlations. Hence, the modifying mobile banking variable should be within the range provided by the summary statistics for marginal correlations to have economic meaning.

## 4. Empirical results

### 4.1 Presentation of results

Table 1, Table 2 and Table 3 presents findings corresponding respectively to ‘quality of growth’, inequality and poverty. While Panel A of all tables provide findings related to the ‘*mobile phone used to pay bills*’, Panel B is concerned with the ‘*mobile phone used to send/receive money*’. For either table, we consistently notice that the QR estimates are different from the OLS estimates in terms of signs and significance. This further justifies the relevance of the QR strategy. Before we discuss table-specific findings, since we have dependent variables with both positive and negative signals, it is worthwhile to clarify three points in order to improve readability, namely on: signals of the dependent variables, conditional distributions and thresholds for inclusive development. First, while growth quality has a positive signal for inclusive development, inequality and poverty have negative signals. Second, in the distribution of the dependent variable, the conditional distributions range from low-‘inclusive development’ to high-‘inclusive development’ countries for the positive signal

and vice-versa for negative signals. Third, for mobile banking to boost inclusive development, positive thresholds are required of the modifying variable for the dependent variable with a positive signal and vice-versa for dependent variables with negative signals.

The following findings can be established from Table 1 on linkages between ‘mobile banking and growth quality’. First in Panel A, while increased use of the mobile to pay bills increases growth quality at the 90<sup>th</sup> decile, the modifying positive threshold of 15 (0.006/[0.0002×2]) is within the range (0.000 to 25.70) provided by the summary statistics corresponding to the modifying mobile banking variable (or mobile used to pay bills). Second, in Panel B, we also find evidence of modifying positive thresholds at the 10<sup>th</sup> decile and 75<sup>th</sup> quartile. The respective corresponding thresholds are with the range (0.000 to 60.50) of ‘mobile used to send/receive money’ provided by the summary statistics, notably: (i) 40 (0.008/[0.0001×2]) at the 10<sup>th</sup> decile and (ii) 50 (0.003/[0.00003×2]) at the 75<sup>th</sup> quartile. Third, most of the significant control variables display the expected signs: (i) educational spending, government stability and private domestic credit are positively related to growth quality whereas (ii) inflation is negatively correlated with the dependent variable.

**Table 1: Mobile banking and Quality of growth**

Panel A: Mobile for Payment of Bills (Mobile.Pay)						
	OLS	Q.10	Q.25	Q.50	Q.75	Q.90
Constant	<b>0.308***</b> (0.000)	<b>0.234*</b> (0.055)	<b>0.265***</b> (0.000)	<b>0.277***</b> (0.000)	<b>0.355***</b> (0.000)	<b>0.376***</b> (0.000)
Mobile.Pay	<b>-0.005*</b> (0.090)	-0.022 (0.145)	-0.001 (0.789)	-0.001 (0.731)	-0.007 (0.176)	<b>-0.006***</b> (0.000)
Mobile.Pay × Mobile.Pay	0.0001 (0.283)	0.0007 (0.241)	-0.00002 (0.932)	-0.0003 (0.861)	0.0003 (0.164)	<b>0.0002***</b> (0.000)
Educational Spending	<b>0.480***</b> (0.000)	<b>0.546***</b> (0.000)	<b>0.491***</b> (0.000)	<b>0.491***</b> (0.000)	<b>0.464***</b> (0.000)	<b>0.434***</b> (0.000)
Government Stability	<b>0.011***</b> (0.000)	0.012 (0.187)	<b>0.014***</b> (0.000)	0.011 (0.310)	<b>0.008***</b> (0.006)	<b>0.010***</b> (0.000)
Inflation	<b>-0.002***</b> (0.008)	-0.002 (0.678)	-0.002 (0.218)	<b>-0.001**</b> (0.024)	-0.002 (0.266)	<b>-0.002***</b> (0.000)
Credit	<b>0.0004*</b> (0.052)	0.0003 (0.819)	0.0005 (0.159)	<b>0.0005**</b> (0.024)	<b>0.0004*</b> (0.067)	<b>0.0006***</b> (0.000)
Foreign Direct Investment	-0.0004 (0.751)	0.0001 (0.973)	-0.001 (0.467)	-0.0003 (0.852)	0.00005 (0.982)	-0.0001 (0.726)
Remittances	-0.0005 (0.387)	0.0004 (0.826)	-0.0002 (0.880)	0.00001 (0.984)	-0.001 (0.217)	<b>-0.001***</b> (0.000)
R <sup>2</sup> / Pseudo R <sup>2</sup>	0.903	0.704	0.726	0.714	0.687	0.712
Fisher	<b>100.88***</b>	---	---	---	---	---
Observations	73	73	73	73	73	73

**Panel B: Mobile for sending and receiving money (Mobile.SR)**

	<b>OLS</b>	<b>Q.10</b>	<b>Q.25</b>	<b>Q.50</b>	<b>Q.75</b>	<b>Q.90</b>
Constant	<b>0.321***</b> (0.000)	<b>0.301***</b> (0.000)	<b>0.284***</b> (0.000)	<b>0.297***</b> (0.000)	<b>0.361**</b> (0.014)	<b>0.367***</b> (0.000)
Mobile.SR	<b>-0.002*</b> (0.068)	<b>-0.008***</b> (0.006)	-0.001 (0.347)	-0.001 (0.386)	<b>-0.003**</b> (0.014)	0.0001 (0.865)
Mobile.SR× Mobile.SR	0.00004 (0.116)	<b>0.0001***</b> (0.008)	0.00002 (0.301)	0.00001 (0.571)	<b>0.00003*</b> (0.088)	-0.00002 (0.241)
Educational Spending	<b>0.467***</b> (0.000)	<b>0.475***</b> (0.000)	<b>0.486***</b> (0.000)	<b>0.478***</b> (0.000)	<b>0.452***</b> (0.000)	<b>0.441***</b> (0.000)
Government Stability	<b>0.0108***</b> (0.000)	0.004 (0.133)	<b>0.014***</b> (0.000)	<b>0.011***</b> (0.000)	<b>0.008***</b> (0.000)	<b>0.007***</b> (0.008)
Inflation	<b>-0.003***</b> (0.005)	<b>-0.004*</b> (0.099)	<b>-0.004***</b> (0.002)	-0.002 (0.219)	<b>-0.002**</b> (0.020)	<b>-0.002*</b> (0.067)
Credit	<b>0.0003*</b> (0.096)	0.0001 (0.457)	<b>0.0004**</b> (0.025)	<b>0.0004*</b> (0.058)	<b>0.0003**</b> (0.016)	<b>0.0006***</b> (0.003)
Foreign Direct Investment	0.00004 (0.964)	<b>0.003*</b> (0.065)	-0.0009 (0.291)	-0.0005 (0.782)	0.0008 (0.493)	-0.00001 (0.987)
Remittances	-0.0007 (0.270)	-0.001 (0.128)	<b>-0.001***</b> (0.000)	0.00001 (0.982)	-0.0009 (0.037)	<b>-0.001*</b> (0.095)
R <sup>2</sup> / Pseudo R <sup>2</sup>	0.905	0.703	0.722	0.718	0.696	0.704
Fisher	<b>84.85***</b>					
Observations	73	73	73	73	73	73

\*\*\*; \*\*, \*: significance levels of 1%, 5% and 10% respectively. Lower quantiles (e.g., Q 0.1) signify nations where Quality of growth is least. OLS: Ordinary Least Squares. R<sup>2</sup> for OLS and Pseudo R<sup>2</sup> for Quantile Regressions. Mobile.Pay: Mobile for payment of bills. Mobile. SR: Mobile of Sending and Receiving money.

The following findings can be established from Table 2 on linkages between ‘mobile banking and inequality’. First in Panel A, while the increased use of the mobile to pay bills is negatively correlated with growth quality at the 90<sup>th</sup> decile, and the modifying negative threshold of 4.071(0.399/[0.049×2]) is within the range (0.000 to 25.70) provided by the summary statistics for the modifying mobile banking variable (or mobile used to pay bills), a constitutive term (0.399) from which the negative threshold is computed is not significant. Second, in Panel B, we also find evidence of modifying negative thresholds at the 75<sup>th</sup> quartile and 90<sup>th</sup> decile with respective thresholds of 32.18 (0.708/[0.011×2]) and 12.91 (0.155/[0.006×2]). While the former is within range, the latter has an insignificant constitutive term (0.155). Third, most of the significant control variables display the expected signs. (i) Government stability is consistently negatively-related to inequality across panels. (ii) While educational spending is negatively linked to inequality in low-inequality countries, it is positively correlated with inequality in high-inequality countries. A possible explanation for this tendency is that, with lower levels of inequality, educational spending potentially leads to appealing income-redistributive effects whereas at the high-end of the inequality distributions, educational spending may also breed further inequality because of concerns like structural

inequality. (iii) Inflation is negatively (positively) correlated with inequality at the low- (high-) end of the inequality distribution. This tendency is consistent with the corresponding relationship with growth quality established in Table 1. Accordingly, while a low and stable inflation is conducive for growth quality, it has a more negative impact on the poor if existing levels of inequality are high. This ultimately results in higher (lower) levels of inequality in countries with higher (lower) initial levels of inequality. (iv) Whereas the evidence of remittances being negatively related with inequality is consistent with expectations, the scanty evidence of the positive relationship between credit, FDI and inequality depends on the inequality dynamics we have alluded to in (iii).

The following findings can be established from Table 3 on linkages between ‘mobile banking and poverty’. First, in Panel A, evidence of threshold in the independent variable of interest is not apparent. Second, in Panel B, we find evidence of modifying positive thresholds at the 10<sup>th</sup> decile, 25<sup>th</sup> and 50<sup>th</sup> quartiles with respective thresholds of 12.5 (0.0005/[0.00002×2]), 17.50 (0.0007/[0.00002×2]) and 16.66 (0.001/[0.00003×2]). While all positive thresholds are within the range (0.000 to 60.50) of the modifying variable, the 50<sup>th</sup> quartile threshold has an insignificant constitutive term (0.001). Third, the overwhelmingly significant control variable has the expected sign, notably: educational spending decreases poverty.

**Table 2: Mobile banking and Inequality**

Panel A: Mobile for Payment of Bills (Mobile.Pay)						
	OLS	Q.10	Q.25	Q.50	Q.75	Q.90
Constant	<b>39.574***</b> (0.000)	<b>39.999***</b> (0.000)	<b>36.913***</b> (0.000)	<b>38.347***</b> (0.000)	<b>42.071***</b> (0.0001)	<b>39.181***</b> (0.000)
Mobile.Pay	0.550 (0.437)	0.125 (0.780)	0.667 (0.614)	0.669 (0.631)	0.605 (0.789)	0.399 (0.526)
Mobile.Pay× Mobile.Pay	-0.030 (0.305)	-0.003 (0.848)	-0.032 (0.565)	-0.031 (0.611)	-0.043 (0.649)	<b>-0.049**</b> (0.044)
Educational Spending	<b>9.068*</b> (0.098)	<b>-7.528*</b> (0.071)	5.044 (0.646)	10.746 (0.346)	16.410 (0.339)	10.582 (0.107)
Government Stability	<b>-1.231***</b> (0.001)	<b>-0.761***</b> (0.000)	-0.928 (0.155)	-1.198 (0.150)	-1.177 (0.311)	<b>-1.046***</b> (0.002)
Inflation	-0.111 (0.613)	<b>-0.313*</b> (0.068)	-0.329 (0.506)	-0.002 (0.995)	-0.188 (0.759)	<b>0.856***</b> (0.000)
Credit	0.013 (0.756)	0.007 (0.703)	0.011 (0.862)	-0.0009 (0.989)	-0.052 (0.667)	<b>0.072***</b> (0.000)
Foreign Direct Investment	-0.174 (0.465)	<b>0.331***</b> (0.003)	-0.094 (0.821)	-0.354 (0.524)	-0.217 (0.707)	-0.074 (0.632)
Remittances	-0.138 (0.399)	0.034 (0.616)	-0.013 (0.964)	-0.206 (0.478)	-0.121 (0.804)	0.141 (0.289)
R <sup>2</sup> / Pseudo R <sup>2</sup>	0.199	0.113	0.114	0.136	0.146	0.229
Fisher	<b>7.73***</b>					
Observations	67	67	67	67	67	67

**Panel B: Mobile for sending and receiving money (Mobile.SR)**

	<b>OLS</b>	<b>Q.10</b>	<b>Q.25</b>	<b>Q.50</b>	<b>Q.75</b>	<b>Q.90</b>
Constant	<b>38.409***</b> (0.000)	<b>40.112***</b> (0.000)	<b>36.886***</b> (0.000)	<b>39.364***</b> (0.000)	<b>39.539***</b> (0.000)	<b>39.076***</b> (0.000)
Mobile.SR	0.327 (0.187)	-0.125 (0.129)	-0.014 (0.963)	0.306 (0.549)	<b>0.708*</b> (0.075)	0.155 (0.349)
Mobile.SR× Mobile.SR	-0.005 (0.221)	<b>0.006***</b> (0.000)	0.001 (0.848)	-0.004 (0.622)	<b>-0.011*</b> (0.093)	<b>-0.006**</b> (0.035)
Educational Spending	<b>10.508**</b> (0.045)	-6.258 (0.102)	5.887 (0.563)	9.033 (0.428)	<b>17.680**</b> (0.046)	<b>10.206*</b> (0.093)
Government Stability	<b>-1.253***</b> (0.001)	<b>-0.402**</b> (0.011)	-0.925 (0.121)	<b>-1.366*</b> (0.086)	<b>-1.173*</b> (0.068)	<b>-1.005***</b> (0.001)
Inflation	-0.055 (0.813)	<b>-0.379***</b> (0.006)	-0.135 (0.800)	0.008 (0.988)	-0.199 (0.589)	<b>0.883***</b> (0.000)
Credit	0.020 (0.629)	0.026 (0.111)	-0.013 (0.804)	0.028 (0.668)	0.036 (0.573)	<b>0.074***</b> (0.000)
Foreign Direct Investment	-0.266 (0.239)	-0.057 (0.540)	-0.063 (0.876)	-0.279 (0.609)	-0.487 (0.190)	-0.063 (0.751)
Remittances	<b>-0.221*</b> (0.086)	-0.068 (0.193)	-0.152 (0.456)	-0.313 (0.199)	<b>-0.427**</b> (0.049)	0.120 (0.470)
R <sup>2</sup> / Pseudo R <sup>2</sup> Fisher	0.207 <b>2.89***</b>	0.135	0.109	0.135	0.161	0.211
Observations	67	67	67	67	67	67

\*\*\*, \*\*, \*: significance levels of 1%, 5% and 10% respectively. Lower quantiles (e.g., Q 0.1) signify nations where Inequality is least. OLS: Ordinary Least Squares. R<sup>2</sup> for OLS and Pseudo R<sup>2</sup> for Quantile Regressions. Mobile.Pay: Mobile for payment of bills. Mobile. SR: Mobile of Sending and Receiving money.

**Table 3: Mobile banking and Poverty****Panel A: Mobile for Payment of Bills (Mobile.Pay)**

	<b>OLS</b>	<b>Q.10</b>	<b>Q.25</b>	<b>Q.50</b>	<b>Q.75</b>	<b>Q.90</b>
Constant	<b>0.160***</b> (0.005)	<b>0.003***</b> (0.006)	<b>0.028***</b> (0.000)	<b>0.106***</b> (0.000)	<b>0.323***</b> (0.000)	0.271 (0.363)
Mobile.Pay	0.006 (0.441)	0.000 (0.943)	-0.0005 (0.466)	0.001 (0.598)	0.005 (0.608)	0.002 (0.951)
Mobile.Pay× Mobile.Pay	-0.0002 (0.370)	-0.000 (0.827)	0.00001 (0.653)	-0.00004 (0.701)	-0.0003 (0.389)	-0.0001 (0.890)
Educational Spending	<b>-0.210***</b> (0.002)	<b>-0.003**</b> (0.026)	<b>-0.027***</b> (0.000)	<b>-0.119***</b> (0.000)	<b>-0.346***</b> (0.000)	-0.343 (0.213)
Government Stability	-0.002 (0.586)	-0.00001 (0.890)	0.00007 (0.827)	-0.00008 (0.967)	-0.002 (0.667)	-0.009 (0.737)
Inflation	0.005 (0.160)	-0.00001 (0.857)	-0.0002 (0.478)	0.00003 (0.974)	0.0004 (0.888)	0.015 (0.485)
Credit	-0.0002 (0.321)	-0.000 (0.661)	-0.00003 (0.300)	-0.00006 (0.661)	-0.0001 (0.734)	-0.00002 (0.992)
Foreign Direct Investment	0.001 (0.482)	0.00002 (0.676)	-0.0001 (0.715)	0.0007 (0.525)	-0.0009 (0.724)	0.003 (0.743)
Remittances	0.001 (0.533)	0.00001 (0.637)	0.00005 (0.661)	-0.0002 (0.671)	0.002 (0.189)	0.001 (0.765)
R <sup>2</sup> / Pseudo R <sup>2</sup> Fisher	0.260 <b>2.77**</b>	0.005	0.018	0.116	0.255	0.346
Observations	73	73	73	73	73	73



**Panel B: Mobile for sending and receiving money (Mobile.SR)**

	<b>OLS</b>	<b>Q.10</b>	<b>Q.25</b>	<b>Q.50</b>	<b>Q.75</b>	<b>Q.90</b>
Constant	<b>0.171***</b> ( <b>0.004</b> )	<b>0.009***</b> ( <b>0.000</b> )	<b>0.020***</b> ( <b>0.000</b> )	<b>0.107***</b> ( <b>0.000</b> )	<b>0.371***</b> ( <b>0.000</b> )	0.274 (0.275)
Mobile.SR	-0.001 (0.465)	<b>-0.0005***</b> ( <b>0.000</b> )	<b>-0.0007***</b> ( <b>0.000</b> )	0.001 (0.168)	-0.002 (0.532)	-0.003 (0.716)
Mobile.SR× Mobile.SR	0.00005 (0.136)	<b>0.00002***</b> ( <b>0.000</b> )	<b>0.00002***</b> ( <b>0.000</b> )	<b>0.00003***</b> ( <b>0.007</b> )	0.00007 (0.176)	0.00005 (0.702)
Educational Spending	<b>-0.208***</b> ( <b>0.002</b> )	<b>-0.007***</b> ( <b>0.005</b> )	<b>-0.018***</b> ( <b>0.000</b> )	<b>-0.117***</b> ( <b>0.000</b> )	<b>-0.412***</b> ( <b>0.000</b> )	-0.3497 (0.130)
Government Stability	-0.001 (0.788)	0.00003 (0.778)	0.0001 (0.694)	0.00007 (0.962)	0.0001 (0.973)	0.006 (0.731)
Inflation	0.004 (0.213)	-0.0001 (0.407)	-0.0003 (0.165)	-0.0001 (0.808)	-0.0004 (0.893)	0.014 (0.386)
Credit	-0.0002 (0.283)	<b>-0.00003***</b> ( <b>0.008</b> )	-0.00002 (0.246)	-0.00004 (0.640)	0.00004 (0.907)	-0.0002 (0.795)
Foreign Direct Investment	0.002 (0.406)	0.000 (0.890)	-0.0001 (0.388)	0.0003 (0.676)	0.002 (0.411)	0.004 (0.591)
Remittances	0.0006 (0.669)	-0.00002 (0.490)	0.00009 (0.212)	-0.0003 (0.363)	0.001 (0.373)	0.001 (0.741)
R <sup>2</sup> / Pseudo R <sup>2</sup> Fisher	0.274 <b>4.85***</b>	0.012	0.026	0.154	0.2727	0.357
Observations	73	73	73	73	73	73

\*\*\*, \*\*, \*: significance levels of 1%, 5% and 10% respectively. Lower quantiles (e.g., Q 0.1) signify nations where Poverty is least. OLS: Ordinary Least Squares. R<sup>2</sup> for OLS and Pseudo R<sup>2</sup> for Quantile Regressions. Mobile.Pay: Mobile for payment of bills. Mobile. SR: Mobile of Sending and Receiving in Money.

## 4. 2 Discussion and implications

The findings broadly show that increasing mobile banking dynamics to certain thresholds would increase (decrease) quality of growth (inequality) in quantiles at the high-end of inclusive development distributions for the most part. The main contribution of the study is that it explores the relationship between mobile banking and inclusive development using three measurements of inclusive development, namely: quality of growth, inequality and poverty. Hence, this contribution relates to the positioning of the inquiry in the light of extant literature on the one hand and findings on the other hand.

While we can only infer correlations and not causality owing to constraints in data structure, findings on the positive role of mobile banking applications in inclusive development are broadly consistent with the stream of engaged literature on the positive benefits of mobile phones and mobile banking for inclusive development (Ondiege, 2010; Al Surikhi, 2012; Ojo et al., 2012; Mishra & Bisht, 2013; Asongu & Nwachukwu, 2016a; Asongu, 2015). Therefore policy encouraging mobile banking applications would play a substantial role in responding to the challenges of immiserizing growth, inequality and poverty in developing countries.

In the light of the main policy implication above, two practical measures can be implemented, notably, the: (i) creation of conducive conditions for the enhancement of mobile phone penetration and (ii) improvement of conditions for the development of mobile applications with which, mobile banking can be effectively exploited for inclusive development. First, it is relevant for policy to leverage on the considerable potential for mobile penetration in Africa by engaging reforms that will consolidate the infrastructure essential for stifling mobile phone access constraints. For instance, the liberalization and privatization of the information and communication technology sector, the promotion of universal mobile phone access schemes and low pricing, are important steps towards limiting access constraints.

Second, in the light of recent evidence on the positive complementarity between information sharing offices (private credit bureaus and public credit registries) and formal financial development in financial access (Asongu & Nwachukwu, 2017), the following are importance policy considerations for improving formal financial development, financial access and mobile banking. (i) The mobile phone can be tailored to be an important medium in storing value within the formal financial system because its subscriber identity module (SIM) can simultaneously be used as a virtual bank card. (ii) If properly complemented with mobile applications, the mobile phone can act as an automated teller machine (ATM) because it will enable instant access to bank accounts and hence, swift bank transactions. (iii) Mobile banking can be leveraged to enhance communications and transactions between individuals and financial institutions and hence, can serve as a point of sale (POS).

Building on the above practical suggestions, the mobile phone has a relevant role in acting as an interface between banks and individuals (from corporations and households). Given that the sharing of information is critical to this interface, informational rents previously paid to intermediaries can be substantially reduced if policies surrounding the usage of mobile phones are tailored to enhance, *inter alia*: outreach, efficiency, cost-effectiveness, access and adoption. The essence of reducing informational rents (due to information asymmetry) is central to the theoretical contribution of this study.

Under the logical hypothesis that the mobile phone is instrumental in reducing information asymmetry between the bank and individuals (especially those previously unbanked and needing access to finance), the results of this paper can be extended to infer the following: the relevance of the mobile phone is broadly in accordance with the theoretical basis of banking intermediation efficiency for financial access through information sharing

offices (Triki & Gajigo, 2014; Tchamyou & Asongu, 2017). Hence within the framework of mobile banking efficiency, the results established in this study on efficient or inclusive human development are largely in line with the theoretical framework of consolidating banking efficiency via information sharing mechanisms.

In spite of the crucial role of mobile phones/banking in inclusive development, this relationship does not feature prominently in the SDGs agenda. This has motivated a number of ongoing reports like the ‘Vodafone SIM project’ (Asongu & De Moor, 2015). Perhaps this missing element is due to scarce macroeconomic evidence on the established nexus.

## **5. Conclusion and future research directions**

The transition from Millennium Development Goals to Sustainable Development Goals has substantially shifted the policy debate from development to inclusive development. Using interactive quantile regressions, we have examined the correlations between mobile banking and inclusive development (quality of growth, inequality and poverty) among individuals in 93 developing countries for the year 2011. Mobile banking entails: ‘mobile used to pay bills’ and ‘mobile used to receive/send money’.

The findings of this study however, remain exploratory because of the scarcity of macroeconomic mobile banking data. Future research could be tailored towards: (i) employing richer data to establish causality in the relationships and (ii) engaging comparative studies for regional specific implications.

Despite the correlations established by this study, we have resisted the temptation of shelving in or consigning the finding to the file drawer, in respect of publication bias in social sciences: of strong results against less strong findings (Rosenberg, 2005). What is granted to us is that we have engaged a timely and relevant line of inquiry and established a potentially very crucial role of mobile banking the post-2015 development agenda.

## Appendices

### Appendix 1: Definition of variables

Variable(s)	Definition(s)	Source(s)
Quality of Growth Index (QGI)	<i>“Composite index ranging between 0 and 1, resulting from the aggregation of components capturing growth fundamentals and from components capturing the socially-friendly nature of growth. The higher the index, the greater is the quality of growth”</i> (p. 25).	Mlachila et al. (2016)
Poverty	Poverty rate: Proportion (per cent) of the population living on one USD a day	Mlachila et al. (2016)
Inequality	GINI index of Inequality	
Mobiles for bills	Mobile phone used to pay bills (% of Adults)	Mosheni-Cheraghloou (2013)
Mobiles to receiving/sending	Mobile phone used to send/receive money (% of Adults)	
Educational Spending	<i>“Public resources allocated to education spending, as percent of GDP”</i> (p. 25)	Mlachila et al. (2016)
Government Stability	<i>“Index ranging from 0 to 12 and measuring the ability of government to stay in office and to carry out its declared program(s). The higher the index, the more stable the government is”</i> (p. 25).	Mlachila et al. (2016)
Inflation	Inflation rate based on the Consumer Price Index (CPI)	Mlachila et al. (2016)
Credit to private sector	<i>“Domestic credit to private sector, namely credit offered by the banks to the private sector, as percent of GDP”</i> (p. 25).	Mlachila et al. (2016)
Foreign Direct Investment	<i>“Net Inflows of Foreign Direct Investments, as percent of GDP”</i> (p. 25)	Mlachila et al. (2016)
Remittances	<i>“Workers' remittances and compensation of employees (Percent of GDP), calculated as the sum of workers' remittances, compensation of employees and migrants' transfers”</i> (p. 25).	Mlachila et al. (2016)

### Appendix 2: Summary Statistics

	Mean	S. D	Minimum	Maximum	Obs
Quality of Growth Index (QGI)	0.656	0.122	0.333	0.842	93
Poverty rate	0.062	0.113	0.000	28.127	93
Inequality	41.844	8.339	28.127	65.27	78
Mobile for Bills payment	2.601	4.125	0.000	25.70	80
Mobile for Sending/Receiving money	4.802	9.615	0.000	60.50	80
Educational Spending	0.701	0.211	0.202	1.000	93
Government Stability	2.626	2.242	-0.379	11.278	93
Inflation (log)	7.909	4.106	2.202	21.669	90
Domestic Credit (log)	39.730	34.036	-14.660	169.251	90
Foreign Direct Investment	4.488	3.720	0.0007	20.869	92
Remittances	5.445	7.612	0.003	38.590	84

S.D: Standard Deviation. Obs: Observations.

### Appendix 3: Correlation Matrix

Educ	Control variables					Mobile banking		Inclusive development			
	GovStab	Infl	Credit	FDI	Remit	MBills	MSR	Pov.	GINI	QGI	
1.000	0.235	0.263	0.392	0.005	0.143	0.207	-0.006	-0.267	0.312	<b>0.898</b>	Educ
	1.000	0.277	0.324	-0.125	-0.063	0.080	-0.182	-0.171	-0.188	0.437	GovStab
		1.000	0.199	0.171	-0.059	0.300	0.130	0.129	-0.019	0.231	Infl
			1.000	-0.202	0.530	0.082	-0.183	-0.367	-0.185	0.576	Credit
				1.000	-0.159	-0.082	0.012	0.203	0.065	-0.117	FDI
					1.000	-0.080	-0.172	-0.130	0.145	0.230	Remit
						1.000	<b>0.865</b>	0.142	0.039	0.121	MBills
							1.000	0.185	0.062	-0.154	MSR
								1.000	0.223	-0.402	Pov.
									1.000	0.135	GINI
										1.000	QGI

Educ: Educational Spending. GovStab: Government Stability. Infl: Inflation. Credit: Domestic Credit. FDI: Foreign Direct Investment. Remit: Remittances. MBill: Mobile used for Paying Bills. MSR: Mobile used for Sending/Receiving Money. Pov: Poverty rate. GINI: Inequality Index. QGI: Quality of Growth Index.

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