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The Role of Governance in Mobile Phones for Inclusive Human Development in Sub-Saharan Africa

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Abstract

This study assesses the synergy effects of governance in mobile phone penetration for inclusive human development in Sub-Saharan Africa with data for the period 2000-2012. It employs a battery of interactive estimation techniques, namely: Fixed effects, Generalised Method of Moments and Tobit regressions. Concepts of political (voice and accountability and political stability/no violence), economic (government effectiveness and regulation quality) and institutional (corruption-control and rule of law) governance are employed. The following findings are established. The previously apparent positive correlation between mobile phones and inclusive development can be extended to a positive effect. Although political governance is overwhelmingly not significant across estimated models, the average effects from economic governance are higher relative to institutional governance. On the interactions between mobile phones and governance variables, while none are apparent in Fixed effects regressions, there are significant synergy effects in Generalised Method of Moments and Tobit estimations, notably, from: regulation quality in the former and political stability, voice and accountability and rule of law in the latter. There is consistent evidence of convergence in inclusive human development. Policy implications are discussed.

JEL Classification: G20; I10; I32; O40; P37

Keywords: Mobile phones; governance; inclusive human development

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1. Introduction

There are at least four reasons for investigating the synergy effects of governance in mobile phone penetration for inclusive human development in Sub-Saharan Africa (SSA). The terms, ‘mobile phone penetration’, ‘mobile telephony’, ‘mobile’ and ‘mobile phones’ are used interchangeably throughout the paper.

The April 2015 World Bank report on attainment of the Millennium Development Goal extreme poverty target has revealed that poverty has been decreasing in all regions of the world with the exception of Sub-Saharan Africa (World Bank, 2015; Asongu & Kodila-Tedika, 2015).

Whereas high-end markets in North America, Europe and Asia are experiencing some degree of stabilization in the growth of mobile phones, there are still substantial business opportunities in developing African markets (Asongu, 2015a). Moreover, according to Penard et al. (2012), Africa has been experiencing an uneven development in mobile phone versus internet penetration. Consistent with this account, as of 2010, mobile and internet penetrations had reached saturation points in developed countries, whereas in Africa the phenomena has been characterised by an asymmetric development, notably with 41 percent of mobile phone penetration and 9.6 percent of internet penetration.

Government quality has been substantially documented to be associated with higher living standards, especially in the: improvement of the quality of life by more efficient allocation of economic resources (Fosu, 2013a, 2013b; Anyanwu & Erhijakpor 2014), principally for the deprived elderly (Fonchingong 2014) and consolidation of a solid foundation for societal change (Efobi, 2015). In essence, the role of institutions in Africa’s economic recovery has motivated a recent book by Fosu (2015a, 2015b) that is focused on assessing whether the recent growth resurgence experienced in the continent from the mid-1990s (Fosu, 2015c, p. 44) is a myth. The notion of myth in the book fundamentally builds on the fact that economic prosperity has not been trickling down to the poor. We aim to extend this strand of the literature by examining the synergy effects of governance in mobile phones for inclusive development in Sub-Saharan Africa: a sub-region with 45 percent of countries off-track from the MDG extreme poverty target.

Mobile phones in Africa have been shown to be more associated with the informal economic sector, as opposed to its formal component (Asongu, 2013a) and mitigate income-inequality (Asongu, 2015b). This is consistent with the growing literature on inclusive development benefits from mobile phones, *inter alia*, for the: empowerment of women (Ojo et al., 2012; Maurer, 2008); promotion of financial inclusion (Singh, 2012, p. 466; Kirui et al.

2013); improvement of health services for the poor (Kliner et al., 2013); bridging of the rural-urban divide (Chan & Jia, 2011, pp. 3-5; Qiang et al., 2011, pp. 14-26); elimination of agricultural waste through the mitigation of supply- and demand-side constraints as well as demand-supply mismatches (Muto & Yamano, 2009; Aker & Fafchamps, 2010); efficiency in the management of households (Al Surikhi, 2012; Asongu, 2014a, 2015c) and the enhancing of business opportunities (Ondiege, 2010, p. 11; Mishra & Bisht, 2013, p. 505).

The above justifications are linked to the present inquiry in that, with good governance, the growth potential of mobile phones can be harnessed to address the policy syndrome of inclusive human development in Sub-Saharan Africa. Moreover, there has been growing requests in scholarly circles for more research on the development outcomes of mobile phones in the recent past. This is partly because the phenomenon has been cautioned not to be considered as a silver bullet for development (Mpogole et al., 2008, p. 71; Asongu & De Moor, 2015). In order to investigate the synergy effects of governance in mobile phones for inclusive development, we articulate the three main governance categories (represented by six indicators), namely: political governance (comprising political stability/no violence and voice & accountability); economic governance (involving government effectiveness and regulation quality) and institutional governance (covering corruption-control and the rule of law). Political governance is defined as the election and replacement of political leaders. Economic governance is the formulation and implementation of rules that enable the delivery of public goods and services. Institutional governance is the respect of the state and citizens of institutions that govern interactions between them. Whereas the evolving literature substantiating the need to unbundle governance indicators is discussed in Section 2; the relevance of such separation is to provide room for more policy implications.

In the light of the above, the main contribution of this investigation is to extend the existing literature by assessing the role of governance in the inclusive human development benefits of mobile phone penetration. By contributing to the macroeconomic literature on managing technology for inclusive human development, the positioning of the inquiry deviates from mainstream corporate or microeconomic technovation literature on managing technology for entrepreneurial opportunities. Some recent narratives in the mainstream strand have included: focus on a set of entrepreneurial innovators who are continuously innovating because of growing skills and financial resources (Best, 2015); opportunity creation and opportunity discovery within the framework of disruptive innovation (Hang et al., 2015; Wan et al., 2015); technological innovation offering new avenues as a result of patent road-mapping (Jeong & Yoon, 2015); entrepreneurial opportunities from ageing population

(Kohlbacher et al., 2015) and emerging ecosystems (Overholm, 2015); opportunity identification by scientific entrepreneurs (Maine et al., 2015) and research collaborators (McKelvey et al., 2015).

Therefore, the inquiry instead extends the strand of literature on the distributional consequences of emerging technologies (Cozzens, 2011). Within the strand, this study is closest to an evolving stream of technology management literature on the importance of mobile phones in development outcomes and social change (Islama & Meadeb, 2012; Brouwer & Brito, 2012; Mira & Dangersfield, 2012). This stream of literature has been documented on both developed (Thakar, 2012) and developing countries (Sonne, 2012; Gupta & Jain, 2012). Therefore, we extend this literature which articulates the use of ICT for inclusive and sustainable development (Alkemade & Surrs, 2012) by assessing the role of governance in mobile phones for inclusive development in sub-Saharan Africa.

The remainder of the paper is presented as follows. The literature on governance, mobile phones and inclusive development is covered in Section 2. The data and methodology are discussed in Section 3. Section 4 presents the empirical results. Section 5 concludes with implications.

2. Governance, mobile phones and inclusive development

2.1 Controversial views and debates on the conception of governance

This section comprises three main parts, namely: definitions of the concept of governance, controversial views on governance measurements in mainstream literature and the imperative of unbundling the concept of governance in the development literature.

In accordance with Asongu (2016), various definitions of the concept of governance have been documented. For brevity, we limit the discourse to four main definitions from recent literature. Economic governance has been defined by Dixit (2009) as the ‘...*structure and functioning of the legal and social institutions that support economic activity and economic transactions by protecting property rights, enforcing contracts, and taking collective action to provide physical and organizational infrastructure*’ (p.5). Tusalem (2015) conceives governance as an embodiment of corruption, rule of law, political stability, bureaucratic effectiveness and regulatory quality. According to Fukuyama (2013), the concept of governance can be improved by adopting four principal approaches through which ‘state quality’ can be understood. They are: procedural measures, output measures, bureaucratic autonomy measures and indicators of capacity which are an embodiment of both resources and the degree of professionalism involved. To the best of our knowledge, the most widely

employed governance indicators from Kaufmann et al. (2010) can be classified into three main categories (see Andrés et al., 2015). They consist of: Political governance which measures the election and replacement of political leaders and is approximated by voice and accountability and political stability/non-violence. Economic governance is defined as the formulation and implementation of policies that deliver public goods and services and is proxied by regulation quality and government effectiveness and Institutional governance is reflected in the quality of institutions that govern interactions between the State and citizens. This is measured by the rule of law and corruption-control.

We devote space to briefly engaging several criticisms in academic circles that have arisen from the use of governance indicators from Kaufmann et al. (2010). As far as we have reviewed, the most notable of these criticisms is the debate between the underlying authors on the one hand and ‘Andrew Schrank and Marcus Kurtz’ on the other. The argument is discussed in four streams, namely: ‘models, measures and mechanisms’, ‘a reply’, ‘a defense’ and ‘a rejoinder’.

Kurtz and Schrank (2007a) have raised doubts about the consensus that good governance is positively associated with economic development by presenting a case for rethinking the mainstream confidence enjoyed by the mainstream governance indicators in the empirical literature on the governance-growth nexus. The authors have concluded that the underlying governance measurements are problematic because they are clouded with a number of issues, *inter alia*: sampling adverse selection, perceptual biases and conceptual conflation with choices of policy.

Kaufmann et al. (2007a) have replied with a three point argument to demonstrate that the claims are unsubstantiated. They have shown that claims on ‘perception-base measurement biases’ in the widely used governance indicators are falsifiable, speculative and short of withstanding empirical scrutiny. They also provide empirical backing to support the argument that the short-term relationship is statistically fragile and conceptually flawed. They have dismissed the empirical study of the contenders of the effect of governance on growth.

In defense of their position, Kurtz and Schrank (2007b) have responded by further articulating that the underpinning concerns about conceptual clarity and corresponding measurement are deeply seated in the debate surrounding the governance-growth relationship. Kaufmann et al. (2007b) have also responded in a brief rejoinder by reiterating the lack of empirical justification for the criticisms. They have further claimed that concerns about ‘potential respondent bias’ also apply to other variables because, they are not exclusively

limited to the measurement of government effectiveness. In light of the above, our line of inquiry will adopt the governance concepts of Kaufmann et al. (2010). Consistent with recent literature on the need to unravel governance measurements for more development outcomes and greater subtlety in policy implication, we employ the six main governance indicators cited earlier.

As emphasised by Asongu (2016), the motivation for employing all governance indicators builds on a recent stream of literature on unbundling institutions in African development, notably: regulation quality and government effectiveness being the most important indicators in stimulating innovation (Oluwatobi et al., 2015); corruption-control being the most effective weapon in the fight against software piracy (Andrés & Asongu, 2013) and conflicts/crimes (Asongu & Kodila-Tedika, 2016a); the role of formal institutions in the promotion of a knowledge economy (Andrés et al., 2015) and the deterioration of governance in the prediction and timing of the Arab Spring (Asongu & Nwachukwu, 2015).

2.2 Mobile phone penetration and inclusive development

In addition to easing the doing of business (Kumar & Zahn, 2003; Kuo & Yub, 2006; Jin & von Zedtwitz, 2008; Lee et al., 2010), the mobile revolution has generated a plethora of inclusive development benefits to developing countries. According to recent African development literature (Asongu & De Moor, 2015), the revolution of the mobile phone has improved both household and corporate management by constantly consolidating networks of interaction which include, *inter alia*: improved payment facilities for Small and Medium Size Enterprises; enhanced business-to-business interactions; better mechanisms for health-care monitoring; upgraded household-to-household as well as household-to-business interactions; reduction of development gaps between rural and urban areas and improved household and corporate management through continuous upgrade of networks of interaction.

We briefly discuss the inclusive benefits of mobile phone penetration in three main themes, notably, in: enhancement of health services, reduction of the gender gap and mitigation of the rural/urban divide.

In the theme on health services, there is growing evidence that mobile phones are being used for the delivery of health services. In essence, the device has been instrumental in providing more affordable medical services (West, 2013). Therefore, income and geography constraints, formerly inhibiting 'health care delivery' are being increasingly mitigated with mobile services. Some mechanisms through which medical services have been improved include: laboratory tests, medical recording and access to the material of reference.

Accordingly, medical devices are progressively being adapted for better treatment and observation of tuberculosis patients (Hoffman et al., 2010); improved tailored feedback due to enhanced self-monitoring (Bauer et al., 2010) and efficient management of clinical appointments (Da Costa et al., 2010). According to Kliner et al. (2013), communities in rural areas are benefiting most from health-oriented mobile applications. This position is confirmed by a study of the same year supporting the negative poverty externalities of mobile phone applications 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’* (Kirui et al., 2013, p. 141). This theme fundamentally builds on the notion that targeted spending on health services is critical for bridging the rural-urban gap (Ssozi & Amlani, 2015).

The theme on rural-urban gap documents evidence of mechanisms by which the rural-urban divide can be reduced, notably via: tackling issues of unemployment, food production and distribution in rural areas; supporting small and medium size enterprises and cooperatives and reducing supply- and demand-side constraints in agricultural productivity. Mobile phones are increasingly being employed to tackle challenges to employment, production and distribution of supplies in food. For instance, in Ghana, a study established that reduction of information asymmetry with the help of the mobile phone augments the income of traders by about 10 percent (E-agriculture, 2012, pp. 6-9). Mobile phones are being complemented with agricultural finance to support SMEs and cooperatives. A notable example from Perez et al. (2011) is the Community Credit Enterprises in Costa Rica through support to financially-sustainable groups and enhancement of the sustainability of business models. In accordance with the engaged literature, the mobile phone is increasingly being employed to improve living standards in rural areas by reducing demand- and supply-side constraints in agricultural productivity (Muto & Yamano, 2009; Aker & Fafchamps, 2010). Consistent with Asongu and De Moor (2015), this mitigation of restrictions with better networking and ‘matching practice’ mechanisms have improved agricultural returns for farmers in rural areas.

In the theme on gender gap, we briefly discuss some recent evidence on the reduction of the gender-divide. Accordingly, there is growing evidence that mobile phones empower women via enhanced channels of financial inclusion. These mechanisms entail improved coordination of female-managed small and medium size enterprises as well as household activities (Asongu, 2014a). Other documented activities on gender inclusion have been cost reduction, education and multi-tasking (Al Surikhi, 2012; Jonathan & Camilo, 2008; Ondiege, 2010, 2013; Asongu, 2014a, 2015b). According to Asongu and De Moor (2015), government

intervention is imperative for females to enjoy the financial inclusive rewards of mobile phones. Other studies consistent with this argument have included: Ojo et al. (2012) showing the usage of mobile phones to enhance the livelihood of women in Ghana and Maurer (2008) sustaining the relevant role of policy in consolidating the gender inclusive benefits of mobile phones. We invite the interested reader to consult Ondiege (2010, p. 11) and Bisht (2013, p. 505) for country-specific strategies/approaches.

The three themes above are in line with the stance of the World Bank that mobile phones are imperative for agricultural and rural development (Qiang et al., 2011). Chan and Jia (2011) have supported this view of the benefits of mobile phones in easing financial access, *'mobile banking is an ideal choice for meeting the rural financial needs'* (pp. 3) partly because of increasing *'rates for bank transfers through mobile cell phones at commercial banks'* (p. 5). The positive gains from mobile telephony are more skewed towards underprivileged citizens in rural areas (Warren, 2007), probably because it helps to uplift further barriers to the purchase of goods and information acquisition. For instance, in India, the mobile phone is increasing financial inclusion (Singh, 2012) in rural areas because *'Telecommunication infrastructure growth especially mobile phone penetration has created an opportunity for providing financial inclusion'* (Mishra & Bisht, 2013, p. 503).

In the light of the above, to the best of our knowledge the available literature has not focused on the complementary role of governance in mobile phone penetration for inclusive development.

3. Data and methodology

3.1 Data

We assess a panel of 49 sub-Saharan African countries with data from the African Development Indicators of the World Bank for the period 2000-2012. Consistent with recent African inclusive development literature (Asongu et al., 2015), the dependent variable is the inequality-adjusted human development index while the mobile telephony variable is measured by the mobile phone penetration rate (per 100 people) in line with recent African knowledge economy literature (Tchamyou, 2015). The human development index denotes a national average of achievements in three fundamental dimensions: health and long life, decent living standards and knowledge. The inequality-adjusted human development index does not only account for average achievements in terms of income, health and education, but it also controls for the distribution of those attainments among the population by discounting the average value of each dimension according to its inequality level.

In accordance with the explanations provided in Section 2, we use the six governance indicators. They are: voice & accountability and political stability/no violence for political governance, government effectiveness and regulation quality for economic governance and corruption-control and the rule of law for institutional governance. These indicators have also been used in recent governance literature (see Gani, 2011; Andrés et al., 2015; Yerrabit & Hawkes, 2015; Asongu & Nwachukwu, 2016a).

Selected control variables are Gross Domestic Product per capita growth, private domestic credit, foreign direct investment and remittances. We expect a positive relationship between these covariates and inclusive human development in line with recent inclusive growth literature (see Anand et al., 2012; Mishra et al., 2011; Seneviratne & Sun, 2013; Mlachila et al., 2014). In principle, per capita economic growth, foreign direct investment and credit facilities are needed for ‘social spending’ with consequent improvement in human development (Mlachila et al., 2014) while remittances which are used for consumption purposes for the most part are also very likely to enhance human development (Mlachila et al., 2014; Ssozi & Asongu, 2015).

The definition and sources of variables are provided in Appendix 1 and the summary statistics in Appendix 2 whereas Appendix 3 discloses the correlation matrix. From the summary statistics: the means of the variables are comparable and in light of corresponding variations, we can be confident that reasonable estimated linkages would emerge. The purpose of the correlation matrix is to avoid concerns of multicollinearity. We notice that concerns about degrees of substitution among variables are apparent among governance variables. However, consistent with the exposition in Section 2 on the need to unbundle governance indicators, conceptual priority takes precedence over degrees of substitution. To this end, we do not bundle the variables by means of principal component analysis and employ the six governance variables independently in distinct specifications to avoid concerns of multicollinearity.

3.2 Methodology

In accordance with recent inclusive development literature (Asongu & Nwachukwu, 2016b, 2016c), we adopt three main empirical strategies which control for: the unobserved heterogeneity with Fixed Effects regression, persistence in the dependent variable with the Generalised Method of Moments and the limited range of the dependent variable with the Tobit model.

The panel FE model is presented as follows:

$$IHD_{i,t} = \partial_0 + \partial_1 M_{i,t} + \partial_2 G_{i,t} + \partial_3 MG_{i,t} + \sum_{h=1}^4 \omega_h W_{h,i,t-\tau} + \eta_i + \varepsilon_{i,t} \quad (1)$$

Where: $IHD_{i,t}$ is inclusive human development of country i at period t ; ∂ is a constant; M is mobile phone penetration; G is Governance (*Voice & accountability, political stability/ no violence, government effectiveness, regulation quality, corruption-control and rule of law*); MG , interaction between mobile phone penetration (M) and Governance (G); W is the vector of control variables (*GDP per capita growth, Private domestic credit, Remittances and Foreign direct investment*); η_i is the country-specific effect and $\varepsilon_{i,t}$ the error term.

Since, the estimation strategy involves interactive regressions; it is important to engage some pitfalls associated with these types of regressions documented by Brambor et al. (2006). Accordingly, all constitutive variables should enter into the specifications. Moreover, for the estimations to have economic meaning, corresponding estimated parameters from interactive terms should be interpreted as conditional marginal impacts.

Consistent with Asongu (2013b), there are at least three reasons for adopting the GMM approach. Accordingly it: controls for potential endogeneity in all regressors; reduces potential biases of the difference estimator in small samples and does not eliminate cross-country differences. Whereas the system Generalised Method of Moments estimation (Arellano & Bover, 1995; Blundell & Bond, 1998) has been preferred to the difference estimator (Arellano & Bond, 1991) as justified by Bond et al. (2001), we adopt the recent approach that employs forward orthogonal deviations. This is an extension of Arellano and Bover (1995) by Roodman (2009a, 2009b) and has been documented to account for cross-sectional independence and limit over-identification or instrument proliferation (Love & Zicchino, 2006; Baltagi, 2008). In the specification, we employ a *two-step* Generalised Method of Moments with forward orthogonal deviations instead of differencing. The *two-step* approach is preferred to the *one-step* because it is consistent with heteroscedasticity,

The following equations in levels (2) and difference (3) summarize the standard system GMM estimation procedure.

$$IHD_{i,t} = \sigma_0 + \sigma_1 IHD_{i,t-\tau} + \sigma_2 M_{i,t} + \sigma_3 G_{i,t} + \sigma_4 MG_{i,t} + \sum_{h=1}^4 \delta_h W_{h,i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (2)$$

$$IHD_{i,t} - IHD_{i,t-\tau} = \sigma_0 + \sigma_1 (IHD_{i,t-\tau} - IHD_{i,t-2\tau}) + \sigma_2 (M_{i,t} - M_{i,t-\tau}) + \sigma_3 (G_{i,t} - G_{i,t-\tau}) + \sigma_4 (MG_{i,t} - MG_{i,t-\tau}) + \sum_{h=1}^4 \delta_h (W_{h,i,t-\tau} - W_{h,i,t-2\tau}) + (\xi_t - \xi_{t-\tau}) + \varepsilon_{i,t-\tau} \quad (3)$$

Where: τ represents tau and ξ_t is the time-specific constant.

Given that the inequality-adjusted human development index theoretically falls between 0 and 1, Ordinary Least Squares may be inappropriate. To this end, many authors have employed double-censored Tobit models to control for the limited range of the dependent variable (Kumbhakar & Lovell, 2000; Koetter et al., 2008; Ariss, 2010; Coccoresse & Pellecchia, 2010). In accordance with recent literature (McDonald, 2009; Coccoresse & Pellecchia, 2010), if there are no observations of either 0 or 1 for the inequality-adjusted human development index (which is the case here), estimating by a double-censored Tobit model is the same as estimating by a linear regression model since the two likelihood functions coincide. Therefore, the logistic regression associated with the Tobit model is as follows:

$$IHD_{it} = \frac{\exp(x_{it}'\beta)}{1 + \exp(x_{it}'\beta)} + \phi_{it} \quad (4)$$

where x_{it} is the same vector of regressors used in the Tobit model, β is the vector of parameters and ϕ_{it} is independently and identically distributed (iid) with mean zero and variance σ_{ϕ}^2 variance.

4. Empirical results

4.1 Presentation of results

Table 1 below presents the Fixed Effects findings for which we have controlled for the unobserved heterogeneity in terms of country-specific effects. The following findings can be established. Mobile phones consistently increase inclusive human development in sub-Saharan Africa. Economic governance increases inclusive human development, albeit with the government effectiveness tool exerting a higher magnitude relative to regulation quality. Only the rule of law dimension of institutional governance significantly increases inclusive development. The effect of political governance is not significant. Significant synergy effects are not apparent. The significant control variables have expected signs. Accordingly, we expect Gross Domestic Product per capita growth, remittances and foreign direct investment to positively affect inclusive human development.

Table 1: Inclusive development and mobile phones (Fixed Effects)

Dependent Variable: Inequality Adjusted Human Development (IHDI)						
	Political Governance		Economic Governance		Institutional Governance	
	Political Stability (PolS)	Voice & Accountability(VA)	Government Effectiveness (GE)	Regulation Quality(RQ)	Corruption-Control (CC)	Rule of Law (RL)
Constant	0.428***	0.429***	0.444***	0.438***	0.429***	0.449***

Mobile phones (Mob)	(0.000) 0.0006*** (0.000)	(0.000) 0.0007*** (0.000)	(0.000) 0.0006*** (0.000)	(0.000) 0.0006*** (0.000)	(0.000) 0.0006*** (0.000)	(0.000) 0.0006*** (0.000)
Political Stability	-0.001 (0.805)	---	---	---	---	---
Voice & Accountability	---	0.001 (0.887)	---	---	---	---
Government Effectiveness	---	---	0.024** (0.012)	---	---	---
Regulation Quality	---	---	---	0.015* (0.094)	---	---
Corruption Control	---	---	---	---	0.002 (0.770)	---
Rule of Law	---	---	---	---	---	0.030*** (0.001)
'Political Stability'×Mob	-0.00004 (0.410)	---	---	---	---	---
'Voice & Accountability' ×Mob	---	0.00009 (0.225)	---	---	---	---
'Government Effectiveness'×Mob	---	---	-0.00009 (0.237)	---	---	---
'Regulation Quality'×Mob	---	---	---	-0.00001 (0.870)	---	---
'Corruption Control' ×Mob	---	---	---	---	-0.00008 (0.240)	---
'Rule of Law'×Mob	---	---	---	---	---	0.00009 (0.899)
GDP per capita growth	0.001*** (0.001)	0.001*** (0.002)	0.001*** (0.002)	0.001*** (0.001)	0.001*** (0.001)	0.001*** (0.002)
Private Domestic Credit	-0.00001 (0.958)	-0.00002 (0.933)	0.000008 (0.981)	-0.00008 (0.822)	-0.000009 (0.978)	-0.0001 (0.769)
Remittances	0.0007* (0.064)	0.0007** (0.040)	.0006* (0.071)	0.0006* (0.071)	0.0007* (0.057)	0.0005 (0.123)
Foreign Direct Investment	0.0004** (0.029)	0.0004** (0.020)	0.0004* (0.054)	0.0004* (0.065)	0.0004** (0.048)	0.0003* (0.073)
Adjusted R ² (within)	0.439	0.441	0.452	0.444	0.440	0.462
Fisher	29.62***	29.77***	31.13***	30.11***	29.74***	32.50***
Countries	39	39	39	39	39	39
Observations	310	310	310	310	310	310

*, **, ***: significance levels of 10%, 5% and 1% respectively. GDP: Gross Domestic Product.

We have observed from Fixed Effects regressions that synergy effects appreciating the interaction between governance and mobile phones variables are not consistently significant. It is important to note that the system Generalised Method of Moments equation is tailored such that its difference equation eliminates country Fixed Effects (see Eq. 3). However, the Generalised Method of Moments approach controls for time-invariant omitted variables which represent some bite on endogeneity. Moreover, at least two conditions are necessary for the application of the Generalised Method of Moments, most importantly: (i) the dependent variable should be persistent and (ii) the number of cross-sections should exceed the number of years in each time series ($N > T$). The latter is respected since we have 49 countries (N) and 13 years (T). The former also holds because the correlation between the inequality-adjusted human development index and its lag is 0.999, which is higher than the rule of thumb threshold of 0.800 needed to ascertain the persistence of the dependent variable (Asongu & De Moor, 2016).

In accordance with Asongu and De Moor (2016), we employ four main information criteria to assess the validity of corresponding models. First, the null hypothesis of the second-order Arellano and Bond autocorrelation test (AR [2]) in difference for the absence of autocorrelation in the residuals should not be rejected. Second, the Sargan and Hansen over-identification restrictions (OIR) tests should also not be significant because their null hypotheses are the positions that instruments are not correlated with the error terms, implying that they are valid. Accordingly, whereas the Sargan OIR test is not weakened by instruments and not robust, the Hansen OIR is weakened by instruments but robust. Third, we complement the Sargan OIR and Hansen OIR tests with the Difference in Hansen Test for exogeneity of instruments. Fourth, a Fischer test for the joint validity of estimated coefficients is also provided.

The following findings are established. There is some evidence of catch-up in inclusive human development because the absolute values of the lagged endogenous variables are consistently between 0 and 1. We invite the interested reader to refer to Fung (2009, p. 58) and Asongu (2013b, p. 49) for more insights into the convergence criterion. Mobile phone penetration consistently increases human development. With the exception of political stability, all governance variables have positive impacts on inclusive development. Only the synergy effect from regulation quality is positive. All the significant control variables have the expected positive signs.

Table 2: Inclusive development and mobile phones (GMM)

	Dependent Variable: Inequality Adjusted Human Development (IHDI)					
	Political Governance		Economic Governance		Institutional Governance	
	Political Stability (PoS)	Voice & Accountability(VA)	Government Effectiveness (GE)	Regulation Quality(RQ)	Corruption-Control (CC)	Rule of Law (RL)
Constant	0.043*** (0.000)	0.052*** (0.000)	0.053*** (0.000)	0.084*** (0.000)	0.055*** (0.000)	0.0731*** (0.000)
IHDI(-1)	0.843*** (0.000)	0.826*** (0.000)	0.829*** (0.000)	0.814*** (0.000)	0.794*** (0.000)	0.758*** (0.000)
Mobile phones (Mob)	0.0004*** (0.000)	0.0005*** (0.000)	0.0005*** (0.000)	0.0004*** (0.000)	0.0005*** (0.000)	0.0005*** (0.000)
Political Stability	-0.001 (0.638)	---	---	---	---	---
Voice & Accountability	---	0.003* (0.054)	---	---	---	---
Government Effectiveness	---	---	0.009*** (0.008)	---	---	---
Regulation Quality	---	---	---	0.015*** (0.000)	---	---
Corruption Control	---	---	---	---	0.007*** (0.004)	---
Rule of Law	---	---	---	---	---	0.009*** (0.000)
'Political Stability'×Mob	-0.000005 (0.895)	---	---	---	---	---
'Voice & Accountability' ×Mob	---	0.00002 (0.468)	---	---	---	---
'Government Effectiveness'×Mob	---	---	0.000009	---	---	---

			(0.842)			
'Regulation Quality'×Mob	---	---	---	0.00004* (0.050)	---	---
'Corruption Control' ×Mob	---	---	---	---	-0.00006 (0.161)	---
'Rule of Law'×Mob	---	---	---	---	---	-0.00002 (0.472)
GDP per capita growth	0.0005*** (0.000)	0.0004*** (0.000)	0.0005*** (0.000)	0.0005*** (0.000)	0.0004*** (0.000)	0.0003*** (0.000)
Private Domestic Credit	0.0002 (0.315)	0.0002 (0.160)	0.000001 (0.990)	-0.0001 (0.374)	0.0005*** (0.005)	0.0005*** (0.000)
Remittances	0.0001 (0.277)	0.0003* (0.088)	0.000009 (0.955)	0.0004*** (0.002)	0.0002* (0.088)	0.0004*** (0.003)
Foreign Direct Investment	0.0002*** (0.003)	0.0002*** (0.003)	0.0003*** (0.000)	0.0002*** (0.000)	0.0002*** (0.001)	0.0002*** (0.001)
AR(1)	(0.090)	(0.087)	(0.075)	(0.026)	(0.289)	(0.352)
AR(2)	(0.621)	(0.743)	(0.915)	(0.641)	(0.973)	(0.461)
Sargan OIR	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hansen OIR	(0.692)	(0.626)	(0.387)	(0.231)	(0.521)	(0.550)
DHT for instruments						
(a)Instruments in levels	(0.637)	(0.575)	(0.603)	(0.645)	(0.601)	(0.876)
H excluding group	(0.599)	(0.556)	(0.274)	(0.126)	(0.415)	(0.293)
Dif(null, H=exogenous)						
(b) IV (years, eq(diff))						
H excluding group	(0.471)	(0.297)	(0.198)	(0.474)	(0.347)	(0.122)
Dif(null, H=exogenous)	(0.787)	(0.902)	(0.717)	(0.129)	(0.678)	(0.997)
Fisher	358750.35***	93951.21***	159000***	134730.84***	101114.55***	37327.28***
Instruments	40	40	40	40	40	40
Countries	38	38	38	38	38	38
Observations	261	261	261	261	261	261

*, **, ***: significance levels of 10%, 5% and 1% respectively. GDP: Gross Domestic Product.. *DHT*: Difference in Hansen Test for Exogeneity of Instruments' Subsets. Dif: Difference. *OIR*: Over-identifying Restrictions Test. The significance of bold values is twofold. 1) The significance of estimated coefficients, Hausman test and the Fisher statistics. 2) The failure to reject the null hypotheses of: a) no autocorrelation in the *AR(1)* and *AR(2)* tests and; b) the validity of the instruments in the Sargan *OIR* test.

As discussed in Section 3.2, the Tobit model is appropriate when the dependent variable is limited. Since the inequality-adjusted human development index varies between 0 and 1, we control for the limited range of the dependent variable by employing a double censored Tobit model to establish the following findings. Mobile phones consistently increase inclusive human development. With the exception of political governance from which effects are insignificant, the impacts from constituents of economic governance and institutional governance are positive. Positive synergy effects are observed from political governance (political stability and voice & accountability) and the rule of law. The significant control variable has the expected sign.

Table 3: Inclusive development and mobile phones (Tobit)

	Dependent Variable: Inequality Adjusted Human Development (IHDI)					
	Political Governance		Economic Governance		Institutional Governance	
	Political Stability (PoS)	Voice & Accountability(VA)	Government Effectiveness (GE)	Regulation Quality(RQ)	Corruption-Control (CC)	Rule of Law (RL)
Constant	0.391*** (0.000)	0.385*** (0.000)	0.437*** (0.000)	0.417*** (0.000)	0.414*** (0.000)	0.412*** (0.000)
Mobile phones (Mob)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
Political Stability	0.009 (0.168)	---	---	---	---	---
Voice & Accountability	---	0.001	---	---	---	---

		(0.850)				
Government Effectiveness	---	---	0.059*** (0.000)	---	---	---
Regulation Quality	---	---	---	0.057*** (0.000)	---	---
Corruption Control	---	---	---	---	0.042*** (0.001)	---
Rule of Law	---	---	---	---	---	0.030*** (0.009)
'Political Stability'×Mob	0.0005*** (0.001)	---	---	---	---	---
'Voice & Accountability' ×Mob	---	0.0005* (0.051)	---	---	---	---
'Government Effectiveness'×Mob	---	---	0.0002 (0.257)	---	---	---
'Regulation Quality'×Mob	---	---	---	-0.00009 (0.748)	---	---
'Corruption Control' ×Mob	---	---	---	---	0.0003 (0.196)	---
'Rule of Law'×Mob	---	---	---	---	---	0.0005** (0.022)
GDP per capita growth	0.001 (0.360)	0.0009 (0.436)	0.0002 (0.816)	0.001 (0.168)	0.001 (0.389)	0.0008 (0.478)
Private Domestic Credit	0.001*** (0.000)	0.001*** (0.001)	0.0005* (0.054)	0.0009*** (0.003)	0.0009*** (0.000)	0.0008*** (0.005)
Remittances	0.0001 (0.700)	0.0002 (0.665)	-0.0001 (0.823)	0.0002 (0.682)	0.0006 (0.183)	-0.00006 (0.891)
Foreign Direct Investment	-0.0005 (0.325)	-0.0007 (0.224)	0.00007 (0.902)	-0.0001 (0.805)	-0.0003 (0.518)	-0.0003 (0.545)
LR Chi-Square	227.89***	202.98***	246.03***	222.80***	230.61***	232.68***
Log Likelihood	360.390	347.934	369.457	357.844	361.746	362.783
Observations	310	310	310	310	310	310

*, **, ***: significance levels of 10%, 5% and 1% respectively. GDP: Gross Domestic Product.

4.2 Further discussion of results and policy implications

This section is engaged with two main themes, namely: the effect of mobile phones, the impact of governance (implications for policy) and convergence in inclusive development (implications for theory).

4.2.1 Further discussion of results and implications for policy

We have confirmed the positive correlation between mobile phones and inclusive human development in Africa previously established by Asongu (2014a, 2015b). It is important to note that the underlying studies have been based on cross-sectional data. Hence, the requirement of a positive effect for sound policy implications has been established by the present inquiry. As a policy implication, the mobile revolution remains a source of inclusive development and pro-poor growth in sub Saharan Africa. Hence, given that more than 45 percent of countries in the sub-region are off-track from achieving the Millennium Development Goals extreme poverty target, the mobile phone can play a crucial role in the post-2015 development agenda if good policies are put in place by the governments of sampled countries in order to maximise the established inclusive benefits. This leads us to another dimension on the role of governance in these projected benefits.

The literature reviewed in Section 2 has shown the need for better governance policies in view of maximising the potential inclusive development benefits of mobile phones (e.g. see Maurer, 2008). Two main trends draw our attention from the findings on the effect of governance: whereas political governance is overwhelmingly not significant across estimated models, average effects from economic governance on inclusive development are higher relative to institutional governance. We devote space to providing more insights into these trends. *First*, the fact that economic governance has the highest effect on inclusive development can be justified from conceptual and empirical standpoints. From a conceptual perspective, compared to institutional and political governances, economic governance is by definition the most closely related governance concept to human development because it entails, the formulation and implementation of policies that deliver public goods. These public goods embody facilities that are conceptually very close to the inclusive human development index. More specifically, they are: health, educational and social amenities. Oluwatobi et al. (2015) have assessed the role of governance components in stimulating innovative development in Africa and found economic governance to be the most effective governance mechanism. *Second*, the insignificant effect of political governance (compared to economic governance) may be traceable to the fact that priorities in political governance as opposed to economic governance engender less development rewards at the early stages of industrialisation. It is important to clarify the sequence of governance in the development process. According to recent literature, economic institutions should be prioritised over political institutions at the initial stages of economic development in order for governance to deliver better public goods and services. The interested reader can find country-specific and continental evidence in Kramon (2009) and Anyanwu and Erhijakpor (2014) respectively. As a main policy implication, in increasing order, political governance, institutional governance and economic governance are positively associated with inclusive human development. Moreover, governance can consolidate the gains of inclusive development from mobile phones. However, the corresponding low net effects imply that governance standards need to be improved in order to accelerate the underlying inclusive gains in the post-2015 development agenda. More specifically, the effect of mobile phones on inclusive human development is very clear. Hence, policies to promote the diffusion of mobile phones are useful. Better governance guidelines, especially for economic governance, are also important for two reasons: they are effective by themselves and have synergy effects with mobile phones.

Our findings have clearly shown that the mobile phone can be used as a tool to improve governance for inclusive development in sub-Saharan Africa in the post-2015 development agenda. Therefore policy would have to tailor mobile phones such that they facilitate on the one hand, *inter alia*: transparency, openness and free flow of information between layers, departments and institutions within the government. On the other hand, mobile-governance services and applications would need to be strengthened in order to: open-up more avenues for citizens to actively participate in decisions that influence their livelihoods and enhance the free-flow of information between the citizens and government. Therefore, the mobile phone can act as an inclusive interface between citizens and government if policies on mobiles are designed to increase, *inter alia*: reach, access, interaction, adoption, efficiency and cost-effectiveness. First, on 'increasing reach', because of concerns in network infrastructure, mobile phones ownership can be increased in areas that lack information and communication technology infrastructure like fixed lines and internet. Second, the penetration rate of mobiles can be enhanced by improving access such that anytime and anywhere, it can be used to leverage on the positive relationship between governance and inclusive human development. Third, contrary to public speeches, brochures, radios and posters, the appeals of mobiles in offering multilateral dialogues in real time should be enhanced. Fourth, policy favouring the adoption of mobile phones should be favoured so that they become part and parcel of mobile governance and peoples' lives. Fifth, the efficiency of government communications with citizens would be improved if mobiles services are tailored to enhance citizenry feedbacks and suggestions on development projects that affect their livelihoods. Sixth, mobile phone affordability is still an issue in many parts of Africa due to cost. Hence, policies towards subsidising mobile infrastructure and community ownership for collective purposes could address communications issues between the government (local and central) and forgotten communities in very remote areas.

4.2.2 Further discussion of results and implications for theory

It is important to highlight the policy relevance of convergence that is apparent from the Generalised Method of Moments findings. Accordingly, we have consistently observed that the information criterion for convergence holds because the absolute value of the lagged endogenous variable is between 0 and 1. This finding is consistent with recent findings by Asongu (2014b) who has established evidence of convergence in the inclusive human development index with data from 38 African countries for the period 1981 to 2009, albeit that the inclusive human development index converges more slowly than some of its

constituent components. The implication of the established evidence of convergence is that countries with lower levels of inclusive human development in sub-Saharan Africa are catching-up their counterparts with higher levels of inclusive development. This line of interpretation extends the theoretical underpinnings of income convergence to other fields of economic and human development. It is important to note that this form of convergence is ‘conditional catch-up’ because decreasing cross-country differences in inclusive human development index depend on the selected set of control variables. Hence, when countries differ structurally and institutionally in the conditioning information set, conditional convergence is likely to occur. As a caveat, this form of convergence depends on selected variables in the conditioning information set, which may not represent all cross-country institutional and structural differences that determine catch-up.

Overall the established role of mobile phones on inclusive development is consistent with the engaged literature. The positive inclusive human development benefits may be traceable to several factors documented in the underlying literature, *inter alia*: efficiency in household management (Al Surikhi, 2012); enhancement of health services (Kliner et al., 2013); women empowerment (Maurer, 2008; Ojo et al., 2012); promotion of financial inclusion (Singh, 2012, p. 466; Kirui et al. 2013, p. 141); improvement of household business opportunities (Ondiege, 2010, p. 11; Mishra & Bisht, 2013, p. 505); elimination of demand- and supply-side constraints as well as agricultural waste (Muto & Yamano, 2009; Aker & Fafchamps, 2010) and bridging of the rural-urban divide (Qiang et al., 2011, pp. 14-26; Chan & Jia, 2011, pp. 3-5). The present inquiry has complemented this strand of literature by establishing that enhanced governance standards would potentially improve the inclusive human development benefits of mobile phones currently being enjoyed by the sampled countries in sub-Saharan Africa.

5. Concluding implications

Innovation contributes to economic development by addressing social problems and enhancing the diffusion of new commodities is also fundamental in innovation policy. Investigating the social impacts of the diffusion of a new product like the mobile phone could simultaneously contribute to innovation policy and the growing literature on inclusive development by means of new technologies. This study has assessed the synergy effects of governance in mobile phone penetration for inclusive human development in Sub-Saharan Africa with data for the period 2000-2012 by employing a battery of interactive estimation techniques, namely: Fixed effects, Generalised Method of Moments and Tobit regressions.

Concepts of political (voice & accountability and political stability/no violence), economic (government effectiveness and regulation quality) and institutional (corruption-control and rule of law) governance have been employed. The following findings have been established.

The previously apparent positive correlation between mobile phones and inclusive development in Africa can be extended to a positive effect in sub Saharan Africa. As a policy implication, in the post-2015 development agenda, the mobile revolution remains a relevant means to inclusive development and pro-poor growth in the sub-region. Whereas political governance is overwhelmingly not significant across estimated models, average effects from economic governance on inclusive development are higher relative to institutional governance. As a policy implication, in increasing order, political governance, institutional governance and economic governance are positively associated with inclusive human development.

On the synergy effects from interactions between the mobile phone and governance variables, whereas none are apparent in Fixed Effects regressions, there are significant synergy effects in the Generalised Method of Moments and Tobit estimations, notably from regulation quality in the former and political stability, voice & accountability and rule of law in the latter. As a policy implication, governance can consolidate the gains of inclusive development from mobile phones. However, the corresponding low net effects further imply that governance standards need to be improved in order to accelerate the underlying inclusive gains for the post-2015 development agenda.

There is consistent evidence of convergence in inclusive human development. The implication for this convergence is that countries with lower levels of inclusive human development in sub Saharan Africa are catching-up their counterparts with higher levels of inclusive development. Future studies within the scope of this inquiry would improve the extant literature by decomposing the: sub-region into fundamental characteristics of African development and inclusive human development index into its constituents in order to assess how the established findings are reflected in the fundamentals and constituents respectively.

Appendix 1: Definition and sources of variables

Variables	Signs	Definitions	Sources
Inclusive development	IHDI	Inequality Adjusted Human Development Index	UNDP
Mobile Phone	Mobile	Mobile phone subscriptions (per 100 people)	WDI
Political Stability	PolS	“Political stability/no violence (estimate): measured as the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional and violent means, including domestic violence and terrorism”.	WDI
Voice & Accountability	VA	“Voice and accountability (estimate): measures the extent to which a country’s citizens are able to participate in selecting their government and to enjoy freedom of expression, freedom of association and a free media”	WDI
Government Effectiveness	GE	“Government effectiveness (estimate): measures the quality of public services, the quality and degree of independence from political pressures of the civil service, the quality of policy formulation and implementation, and the credibility of governments’ commitments to such policies”.	WDI
Regulation Quality	RQ	“Regulation quality (estimate): measured as the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development”.	WDI
Corruption-Control	CC	“Control of corruption (estimate): captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as ‘capture’ of the state by elites and private interests”	WDI
Rule of Law	RL	“Rule of law (estimate): captures perceptions of the extent to which agents have confidence in and abide by the rules of society and in particular the quality of contract enforcement, property rights, the police, the courts, as well as the likelihood of crime and violence”	WDI
GDP per capita	GDPpcg	GDP per Capita growth rate	
Private Credit	Credit	Private credit by deposit banks and other financial institutions (% of GDP)	WDI
Remittance	Remit	Remittance inflows (% of GDP)	WDI
Foreign investment	FDI	Foreign Direct Investment net inflows (% of GDP)	WDI

UNDP: United Nations Development Program. WDI: World Development Indicators. GDP: Gross Domestic Product.

Appendix 2: Summary statistics

	Mean	SD	Min	Max	Obs
Inequality Adj. Human Development	0.721	3.505	0.129	0.768	485
Mobile Phone Penetration	23.379	28.004	0.000	147.202	572
Political Stability	-0.543	0.956	-3.323	1.192	578
Voice & Accountability	-0.646	0.737	-2.233	0.990	578
Government Effectiveness	-0.771	0.620	-2.450	0.934	577
Regulation Quality	-0.715	0.644	-2.665	0.983	578
Corruption-Control	-0.642	0.591	-1.924	1.249	579
Rule of Law	-0.741	0.662	-2.668	1.056	578
GDP per Capita growth	2.198	5.987	-49.761	58.363	608
Private Domestic Credit	18.551	22.472	0.550	149.78	507
Remittances	3.977	8.031	0.000	64.100	434
Net Foreign Direct Investment Inflows	5.332	8.737	-6.043	91.007	603

SD: Standard deviation. Min: Minimum. Max: Maximum. Obs: Observations. Adj: Adjusted.

Appendix 3: Correlation Matrix (Uniform sample size: 330)

Governance Variables						Control Variables				Ind. Vble	Dep. Vble	
PolS	VA	GE	RQ	CC	RL	GDPpcg	Credit	Remit	FDI	Mobile	IHDI	
1.000	0.688	0.653	0.625	0.692	0.777	-0.011	0.279	0.032	-0.018	0.310	0.411	PolS
	1.000	0.774	0.734	0.683	0.810	0.113	0.452	0.042	-0.010	0.318	0.361	VA
		1.000	0.877	0.836	0.897	0.118	0.543	0.020	-0.152	0.389	0.584	GE
			1.000	0.799	0.856	-0.0001	0.532	-0.076	-0.192	0.363	0.512	RQ
				1.000	0.851	0.053	0.469	-0.196	-0.104	0.373	0.519	CC
					1.000	0.070	0.471	0.079	-0.084	0.345	0.507	RL
						1.000	0.029	0.026	0.172	0.043	0.077	GDPpcg
							1.000	-0.095	-0.082	0.511	0.536	Credit
								1.000	0.122	-0.056	-0.043	Remit
									1.000	0.075	-0.026	FDI
										1.000	0.634	Mobile
											1.000	IHDI

PolS: Political Stability. VA: Voice & Accountability. GE: Government Effectiveness. RQ: Regulation Quality. CC: Corruption-Control. RL: Rule of Law. GDPpcg : GDP per capita growth rate. Credit: Private domestic credit. Remit: Remittances. FDI: Foreign Direct Investment. Mobile: Mobile Phone Penetration. IHDI: Inequality Adjusted Human Development Index. Ind. Vble: Independent Variable. Dep. Vble: Dependent Variable.

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