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Bank accounts, bank concentration and mobile money innovations

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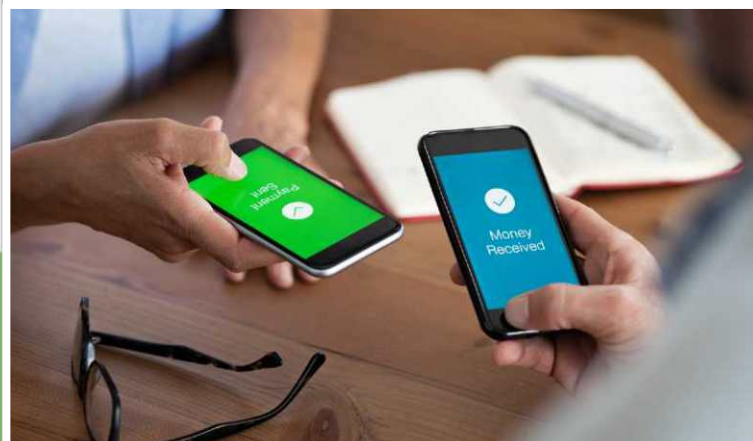P. O. Box 392, UNISA, 0003, Pretoria, South Africa.
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Abstract

The present study investigates how increasing bank accounts and bank concentration affect mobile money innovations in 148 countries. It builds on scholarly and policy concerns in the literature that increasing bank accounts may not be having the desired effects on financial inclusion on the one hand and on the other, that bank concentration which is a proxy for market power is a relevant mobile money innovation demand factor. The empirical evidence is based on Tobit regressions. From the findings, it is apparent that boosting bank accounts is positively related to the three mobile money innovations (i.e. mobile bank accounts and the mobile phone used to send money). Moreover, some critical levels of bank account penetration require complementary policies in order to maintain the positive relationship between boosting bank accountsand positive outcomes in terms of money mobile innovations. Conversely, financial inclusion in terms of the three mobile money innovations is not significantly apparent upon enhancing bank concentration. Policy implications are discussed in the light of the provided thresholds for complementary policies.

Keywords: Mobile money; technology; diffusion; financial inclusion; inclusive innovation, information asymmetry.
JEL Classification: D10; D14; D31; D60; O30

1. Introduction

The foundational elements of this research arecentred on three main critical perspectives in the scholarly and policy literature pertaining to the relevance of bank accounts, market power and financial inclusion in socio-economic development. These perspectives are articulated in the subsequent paragraphs along the lines of: (i) the importance of financial inclusion in the post-2015 sustainable development agendaor Sustainable Development Goals (SDGs); and (ii) concerns in the literature on the relevance of bank accounts and market power in financial inclusion[1]The underlying perspectives are engaged in the same chronology as highlighted.

First, financial inclusion, especially in developing countries is of crucial relevance in the human and economic development prospects of developing countries, especially for the achievement of most inequality- and poverty-related SDGs (Gosavi, 2018; Uduji and Okolo-Obasi, 2018a, 2018b; Tchamyou, Erregers and Cassimon, 2019; Tchamyou, Asongu and Odhiambo, 2019; Asongu, Biekpe and Cassimon, 2020, 2021). In essence, as documented by Klapper, El-Zoghbi and Hess (2016), there is a steady progress in getting more people in low-income countries to possess bank accounts in the formal financial institutions. According to the narrative, many accounts are still dormant, and a plethora of transactions in developing countries are cash-outs or person-in-person transfers. This has led the authors to question whether the improvement of bank accounts in the attendant countries engenders more inclusion. The focus of this study takes this consideration on board by assessing whether the expansion of financial services in the perspective of more bank accounts across developing countries has led to more financial inclusion within the framework of mobile money innovations[2].

Second, while the contending positions of the importance of bank accounts in developing countries has been articulated by Klapper, El-Zoghbi and Hess (2016), another demand factor of financial inclusion recently documented by Lashitew, van Tulder and Liasse (2019) that merits critical examination is bank concentration in the light of the debate on the importance of market power in financial inclusion. Given that the attendant literature considers bank concentration asa measure of market power (Ryan, O'Toole and McCann, 2014; De Guevara, Maudos and Pérez, 2005), the present study is concerned about whether improvements in market power can engender financial inclusion. The premise of the underlying study is motivated by the fact that, simply defined, market power is the ability of banks to price

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[1]Financial inclusion within the context of the study is understood as how improving demand-side mobile money drivers can increase mobile money innovations in terms of mobile money accounts, the mobile phone used to send money and the mobile phone used to receive money. There is no claim in the study that bank accounts are a pre-requisite to financial inclusion, which is why this study is limited to enhancing demand-side factors. As clarified in the data section, there are also supply and macroeconomic factors.

[2]"The mobile" and "the mobile phone" are used interchangeably throughout the study. "Bank concentration" and "bank sector concentration" are used interchangeably throughout the study. "Bank concentration" and "Bank sector concentration" are also used interchangeably throughout the study. Mobile money within the context of the study entails the use of the mobile phone to pay bills, receive money and send money (Asongu and Boateng, 2018; Lashitew, van Tulder and Liasse, 2019).

loans above their corresponding marginal costs (Ariss, 2010; Coccorese and Pellecchia, 2010; Asongu and Biekpe, 2018; Dai and Li, 2019; Asongu, Nting and Nnanna, 2020)[3] and banks have been documented to use their market power to limit financial access (Asongu, Nwachukwu and Tchamyou, 2016), which could also restrict the development of financial inclusion through mobile money innovations. It follows that the closest study in the literature to the present investigation is Lashitew, van Tulder and Liasse (2019) from which, we leverage on demand factors for financial inclusion documented in the attendant study in order to assess whether enhancing these demand factors improves financial inclusion in the perspective of mobile money innovations.

Employing the same dataset(i.e. of 148 countries with data mostly consisting of 2010-2014 averages) and estimation technique (i.e. Tobit regressions) as in Lashitew, van Tulder and Liasse (2019)the present study attempts to answer the following research question: how does improving demand-side mobile money drivers increase mobile money innovations in terms of mobile money accounts, the mobile phone used to send money and the mobile phone used to receive money?[4]The findings of the study show that while enhancing bank accounts do engender net positive relationships with two of the three mobile money innovations (i.e. mobile bank accounts and the mobile phone used to send money) there are thresholds of bank accounts at which complementary policies are required in order to maintain the positive relevance of bank accounts in improving the corresponding mobile money innovations. The finding partly confirms the concern of Klapper, El-Zoghbi and Hess (2016) that the improvement of bank accounts in developing countries may not be having the desired effect on financial inclusion because the present study shows that some complementary policies at certain thresholds of financial inclusion are also worthwhile. Conversely enhancing bank sector concentration does not significantly influence financial inclusion within the framework of all the considered mobile money innovation proxies (i.e. mobile bank accounts, the mobile used to send money and the mobile used to receive money). This finding, therefore, confirms the scholarly positions on the abuse of bank concentration or market power notably that banks leverage on such market power to improve their profit margins instead of enhancing financial inclusion and financial access (Asongu, Nwachukwu and Tchamyou, 2016).

The positioning of the study departs from contemporary telematics and informatics literature which has largely focused oninter alia: assessing whether biometric and mobile

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[3]According to the attendant literature, market power in the banking industry translates a "quiet life" which reflects the perspective that big banks would allocate less investment towards enhancing financial access but instead leverage on their market power to increase their profit margins.

[4] The problem statement, findings and implications of the two studies are different. (i)The problem statement of Lashitew, van Tulder and Liasse (2019) focuses on correlates of mobile money innovations while this study is concerned with how enhancing demand-side mobile money drivers influence money innovations. (ii) The findings of Lashitew, van Tulder and Liasse (2019) are interpreted as linear additive models while the findings in the present study are interpreted as non-linear models because the corresponding specifications involve quadratic estimations. (iii) Blanket policies are provided by Lashitew, van Tulder and Liasse (2019) while in this study, thresholds for complementary policies are provided based on the findings from the quadratic estimations.

payments can replace cards in the offline payments market of Korea (Kim, Kim and Kim, 2019); examining if perceptions in mobile banking are influenced by country culture (Hassan and Wood, 2020); providing a descriptive analysis of social characteristics in platforms for mobile payments (Acker and Murthy, 2020) and preferences of consumers in attributes of South Korea mobile payment services (Choi et al., 2020).The rest of the study is structured as follows. The theoretical underpinnings are covered in Section 2, while Section 3 discusses the data and methodology. The empirical results are provided in Section 4, while Section 5 concludes with policy implications and future research directions.

2. Theoretical underpinnings andthe nexus between ICT and financial development

2.1 Theoretical underpinnings

This section on theoretical underpinnings is discussed in three main strands, notably: (i) on the nexus between mobile money innovation and bank accounts (which is aligned with bank accounts used in this study as an independent variable of interest); (ii) the Free Market Model (which is more consistent with bank concentration used in this study as another independent variable of interest) and (iii) the theory of asymmetric information (which is aligned with both bank accounts and bank concentration used in this study as independent variables of interest). These underlying strands are expanded in the same order as they have been highlighted.

The first strand on the nexus between bank accounts and mobile money innovations is broadly consistent with Ondiege (2013) and Asongu (2013) on the usage of mobile phones in mobile banking. The connection between the theoretical postulations of the underlying policy (Ondiege, 2013) and scholarly studies (Asongu, 2013) and the present study builds on the fact that the notion of mobile banking used in the attendant theoretical studies is consistent with the concept of mobile money innovation used in the present study, notably: mobile money accounts, the mobile used to send money and the mobile used to receive money. According to the attendant literature, four main viewpoints can articulate the nexus between mobile phones and mobile phone innovations within the context of this study. (i) The mobile phone can represent a virtual bank card through which both institutions and customers can leverage upon in order to avoid the banks incurring the costs associated with the distribution and management of traditional bank cards. In essence, the subscriber identity module (SIM) card in mobile phones represents a smartcard such that the underlying SIM card can reflect the same performance as a virtual bank card. (ii) The mobile phone also plays the role of a point of sale (POS) terminal in the perspective that the mobile phone also enables the user to communicate and transact with corresponding financial institutions within the framework of providing banks with a complementary mechanism for soliciting and authorizing transactions. Accordingly, some traditional bank functionalities can be easily duplicated with the mobile phone, which plays the role of POS terminal. (iii) The functions of an automated teller machine (ATM) can also be performed by the mobile phone in the perspective that, the underlying POS characteristics connected to the mobile phone can be leveraged for the payment of bills and receipts of payments, which is consistent with the mobile money innovation proxies used in this study. Considering the premise that access to savings in bank accounts are acknowledged as commodities which customers can store, then some of the functions of an ATM used by banks can be performed by the mobile phone as a POS in the collection and distribution of cash. (iv) Last but not least, the mobile phone can also serve as an internet banking terminal in the perspective that, two main services are offered for the purpose, notably: the making of payments and remote transfers, and the ability to instantly access bank accounts.

Second, the Free Market Model (FMM) documented in Pradeep (2011) is relevant for the framework of this study because it is based on financial exclusion and hence, in order to promote financial inclusion, the consequence of the FMM in terms of financial exclusion should be kept in check. According to the FMM, deregulation that is not properly checked in the banking sector can exacerbate issues of financial exclusion as well as engender catastrophes in the financial spaces of economies. According to Pradeep (2011), two potential outcomes can be apparent with excessive deregulation. On the one hand, a financial system that is deregulated can entrench existing polarisations between the financially-excluded and financially-included in society. On the other, the number of excluded groups in society can also increase with more deregulation. Market power in terms of bank concentration can be a product of deregulation where a few banks used their existing market powers to stifle competition and decrease financial inclusion because such banks are exclusively focusing on increasing their profit margins. It follows that some form of regulation from the government is essential to enhance competition and oriented the banking industry towards services that are fundamentally designed to promote financial inclusion instead of financial exclusion.

In the third strand, the theory of asymmetric information argues for the need of information sharing offices in the banking industry in order to fight information asymmetry in the banking sector, which limits financial access to certain categories of the population, notably, the poor for the most part who are excluded from formal banking institutions. Accordingly, adverse selection (i.e. ex-ante of the lending process) and moral hazard (i.e. ex-post of the leading process) are features of asymmetric information that limit bank accounts and increase bank concentration or market power (Asongu and Biekpe, 2018). Hence, the introduction of information sharing offices such as private credit bureaus and public credit registries are designed to reduce the underlying concerns associated with information asymmetry (Kusi et al., 2017; Asongu and Odhiambo, 2018a; Kusi and Opoku-Mensah, 2018; Tchamyou, 2019; Giri, Mohapatra and Debata, 2023).

2.2 ICT and financial development

This section discusses nexuses between information and communication technologies (ICTs), financial access and inclusive development in two mains strands, notably: (i) the connection between financial access, ICTs and socio-economic inclusion and (ii) linkages between mobile phone innovations and financial inclusion. The two scholarly strands are expanded in the same highlighted order.

First, Sarma and Pais (2011) have assessed the nexus between financial inclusion and economic progress to establish that financial inclusion and socio-economic development are closely connected. Corrado and Corrado (2017) is concerned with how financial inclusion affects inclusive growth and concludes that enhanced financial access provides a plethora of opportunities both for households and corporations, *inter alia*: (i) planning of long term

objectives of consumption and investment for corporations; (ii) protection of businesses and households against shocks and (iii) provision of opportunities the enable the transition from one socio-economic class to another. Meniago and Asongu (2018) conclude that financial access and financial intermediation efficiency mitigate inequality while Abor, Amidu and Issahaku (2018) establish that financial inclusion considerably increases the odds of households escaping from poverty.

In the second strand, on linkages between mobile phone innovations and financial inclusion, Peruta (2017) does not support the scholarly position that financial inclusion is promoted by mobile money usage. Gosavi (2018) shows that the use of mobile money services by companies increases their access to loans and/or credit facilities while Bongominet al. (2018) conclude on a significant moderating impact of social network in the nexus between mobile money usage and financial inclusion. Adaba and Ayoung (2017) find within the context of the Upper East region of Ghana that while a mobile network operator has constructed a growing network of material and composite social stakeholders with the purpose of offering mobile services, significant challenges are still apparent, not least, because mobile money uptake is yet to reach a critical mass. The relevance of mobile money in financial inclusion is contingent on the quality of data used to assess the nexus (Qureshi, 2020). Asamoah, Takieddine andAmedofu (2020), have examined the effect of mobile money transfer capabilities on business development and growth as well as on the well-being of corresponding entrepreneurs to confirm three underlying hypotheses. The findings are broadly consistent with Rahman, Alam and Taghizadeh (2020)who establish that mobile financial services contribute towards the subjective well-being of micro-entrepreneurs. Pal, Herath, De' and Rao (2020) provide contextual features that facilitate (e.g. price benefit, habit, trust and network externalities) and inhibit (e.g. like risk, operational constraints and lack of facilitating conditions) the adoption of mobile payments and by extension, financial inclusion. The discussed two strands are broadly consistent with the extant financial inclusion and mobile money innovations literature (Mas and Morawczynski, 2009; Waverman and Koutroumpis, 2011; Demirguc-Kunt and Klapper, 2012; Gruber and Koutroumpis, 2013; Demirgüç-Kunt and Klapper, 2013; Asongu, 2015; Demirgüç-Kunt, Klapper and Van Oudheusden, 2015; World Bank, 2016; Haldar and Sethi, 2022; Yeyouomo, Asongu and Agyemang-Mintah, 2023).

3. Data and methodology

3.1 Data

Following Lashitew, van Tulder and Liasse (2019) and Asongu, Biekpe and Cassimon (2020, 2021) which are closest to this study, the data consist of 2010-2014 averages of yearsfrom 148 countries. The variables from the underlying studies are obtained from a plethora of sources, notably: (i) the World Bank's World Development Indicators (WDI); (ii) the World Bank's World Governance Indicators (WGI); (iii) the Global Financial Structure Database (GFSD); (iv) the Financial Inclusion Indices (Findex) database; (v) Waverman and Koutroumpis (2011) and (vi) the Global System for Mobile Communications Association (GSMA). As clarified by Lashitew, van Tulder and Liasse (2019), the data correspond to all countriesfor which data were available at the time of the study.

The main dependent variables which are obtained from the Findex database include: mobile money accounts, the mobile used to send money, and the mobile used to receive money. Three main types of factors characterize the independent variables, notably: demand, supply and macro-oriented features. (i) The demand factors which are traceable to the GFSD are as follows: banking sector concentration; the number of automated teller machines (ATMs) and the percentage of adults with a bank account in a formal banking institution. (ii) Supply factors entail: "gross and unique subscription" rates from the GSMA and mobile penetration rate from the WDI; the telecommunications (telecom) sector regulation variable is obtained from Waverman and Koutroumpis (2011), while mobile connectivity and performance dynamics are from the GSMA. (iii) Adopted macro-level indicators are obtained from both the WGI (i.e. the rule of law) and WDI (GDP per capita, GDP growth and the urbanization rate).

The underlying control variables which are largely expected to be positively associated with the outcome variables or mobile money innovation dynamics are informated by the corresponding financial inclusion literature (Asongu and Asongu, 2018; Asongu and Odhiambo, 2018b; Muwanguzi and Musambira, 2009; Van der Boor, Oliveira and Veloso, 2014; GSMA, 2018; Murendo et al., 2018; Asongu and Odhiambo, 2019a).

The sources and definitions of the variables are provided in Appendix 1, the corresponding summary statistics are in Appendix 2, while Appendix 3discloses the correlation matrix. The correlation matrix enables the study to identify concerns of multicollinearity (highlighted in bold), which leads to some variables documented in Lashitew, van Tulder and Liasse (2019) not being used in the regression exercise, namely: ATM penetration, mobile connectivity coverage, GDP per capita and the rule of law. The procedure for eliminating these variables is clarified in the last paragraph of the methodology section that follows.

3.2 Methodology

The estimation technique used in this study follows that employed by the closest study in the literature to the present research (i.e. Lashitew, van Tulder and Liasse, 2019). The corresponding

Tobit regression technique for the empirical analysis is used when the outcome variable is defined within a given range. This justification is consistent with contemporary (AsonguandNwachukwu, 2016; Ajide, Raheem and Asongu, 2019) as well as non-contemporary studies (Kumbhakar and Lovell, 2000; Koetter and Vins, 2008; Ariss, 2010; Coccorese and Pellecchia, 2010) maintaining that when the dependent variable is defined within specified minimum and maximum limits, then a Tobit approach is worthwhile.

Considering the underlying information within the framework of our study, the adopted outcome financial inclusion proxies which are defined in Appendix 2 are theoretically situated between 0% and 100%; motivating the choice of a double censored model because the attendant variables are censored both in the left and in the right. In the light of the censored character of the variables, a standard Ordinary Least Squares (OLS) technique is inappropriate to produce robust estimates because the OLS estimation approach is not designed to consider differences in the conditional probability of restricted observations such as in countries characterised by 0% adoption rate and/or 100% adoption rate (Amemiya, 1984). It follows that the empirical strategy adopted is contingent on specificities of the dependent variable, which require censoring on either side of the conditional distribution of the outcome variable.

Following seminal studies on Tobit regressions (Tobin, 1958; Carson and Sun, 2007), Equations (1) and (2) below denote the main Tobit estimation process.

$$y_{i,t}^* = \alpha_0 + \beta X_{i,t} + \varepsilon_{i,t} , \qquad\qquad (1)$$

where $y_{i,t}^*$ is a latent response variable, $X_{i,t}$ is an observed $1 \times k$ vector of explanatory variables and $\varepsilon_{i,t} \approx$ i.i.d. N(0, σ²) and is independent of $X_{i,t}$. As opposed to observing $y_{i,t}^*$, we observe $y_{i,t}$:

$$y_{i,t} = \begin{cases} y_{i,t}^*, & if \ y_{i,t}^* > \gamma \\ 0, & if \ y_{i,t}^* \le \gamma, \end{cases} \qquad\qquad (2)$$

where γ is a non-stochastic constant. It follows that, the value of $y_{i,t}^*$ is missing when it is less than or equal to γ.

From the discussed Tobit approach, the underlying assumptions are that: (i) residuals in the estimation exercise are normally distributed and (ii) there is evidence of latent dependent indicators that reflect a linear and unbounded function of the independent indicators (Amemiya, 1984). It is also of interest to note that there are two corresponding marginal relationships associated with the main independent variables (i.e. bank accounts and bank sector concentration). One appreciates the marginal relationship of the independent indicators of the unobserved, latent rate of adoption, while the other depicts the censored and observed adoption rate.

Following the contemporary mobile money innovation literature that is closest to the present study (Lashitew, van Tulder and Liasse, 2019; Asongu, Biekpe and Cassimon, 2020, 2021), only marginal relationships pertaining to the observed and censored rates of adoption

are disclosed because according to the attendant literature, they are consistent with a more apparent analytical interpretation. Moreover, the specifications are tailored such that the multicollinearity issues are taken on board. The corresponding multicollinearity issues which are not considered by Lashitew, van Tulder and Liasse (2019) have been engaged in corresponding replication studies (Asongu, Biekpe and Cassimon, 2020, 2021) of Lashitew, van Tulder and Liasse (2019). In essence, a multicollinearity threshold of 0.600 is used in accordance with the underlying literature. It is important to further emphasize that 0.600 is the average of the two contenting strands in the multicollinearity thresholds literature, notably: 0.500 is suggested by Wichers (1975) and Obrien (2007) while 0.700 is posited by Kennedy (2008). The multicollinearity concerns that are avoided in the specifications related to the empirical results below are highlighted in bold in Appendix 3. Hence, in line with the underlying studies (Asongu, Biekpe and Cassimon, 2020, 2021), the following variables are not used in the regression exercise because of concerns related to multicollinearity, namely: ATM penetration, mobile connectivity coverage, GDP per capita and the rule of law.

4. Empirical results

The empirical findings are provided in this section and contrary to Lashitew, van Tulder and Liasse (2019) and Asongu, Biekpe and Cassimon (2020, 2021) which focus on the determinants of mobile money innovations, the present study is exclusively oriented towards understanding how enhancing some demand factors affect the attendant mobile money innovations. In Table 1, the results are presented in seven columns. While the first column presents the variables and corresponding information criteria, the last-six columns are specifications pertaining to the two main independent variables of interest, namely: bank accounts and bank sector concentration. The second to the fourth columns which focus on enhancing bank accounts entail three specifications which correspond to each of the mobile money innovation dynamics (i.e. mobile money accounts, the mobile phone used to send money and the mobile phone used to receive money). In the same vein, the fifth to the seventh columns focus on specifications pertaining to enhancing bank sector concentration, each of which also corresponds to a mobile money innovation outcome variable.

The empirical results show that while enhancing bank accounts does engender net positive relationshipson two of the three mobile money innovations (i.e. mobile money accounts and the mobile phone used to send money), there are thresholds of bank accounts at which complementary policies are required in order to maintain the positive relevance of bank accounts in improving the corresponding money mobile innovations. Conversely, enhancing bank concentration does not significantly influence financial inclusion within the framework of all the considered mobile money innovation proxies (i.e. mobile money accounts, the mobile used to send money and the mobile used to receive money). Most of the significant control variables display the anticipated signs.

Table 1: Promoting bank accounts and bank concentration for financial inclusion

	Dependent variables: Mobile money accounts, Mobile used to send money & Mobile used to receive money					
	Enhancing bank accounts			Enhancing bank concentration		
	Mobile money accounts	Mobile used to send money	Mobile used to receive money	Mobile money accounts	Mobile used to send money	Mobile used to receive money
Demand Factors						
Bank Accounts	0.275**	0.223*	0.277**	---	---	---
	(0.014)	(0.052)	(0.041)			
Bank Accounts × Bank Accounts	-0.003***	-0.002**	-0.003	---	---	---
	(0.006)	(0.021)	(0.011)			
Bank sector Con	---	---	---	0.050	0.086	0.140
				(0.618)	(0.237)	(0.135)
Bank sector × Con Bank sector Con	---	---	---	-0.0006	-0.0007	-0.001
				(0.372)	(0.246)	(0.133)
Supply Factors						
Unique Mobile Subscription. rate	-0.011	0.006	-0.014	0.005	0.017	0.004
	(0.584)	(0.784)	(0.586)	(0.786)	(0.428)	(0.874)
Mobile Connectivity Performance	0.088	-0.188**	-0.223**	-0.029	-0.277***	-0.353***
	(0.187)	(0.021)	(0.020)	(0.463)	(0.001)	(0.000)
Telecom Sector Regulation	2.655	-1.143	-0.527	3.607	-0.133	-0.335
	(0.271)	(0.646)	(0.864)	(0.145)	(0.964)	(0.925)
Macro-level factors						
GDP growth	0.476**	-0.077	-0.235	0.670***	0.113	-0.025
	(0.011)	(0.725)	(0.440)	(0.001)	(0.634)	(0.935)
Urbanization	-0.054*	0.005	0.022	-0.047	0.001	0.016
	(0.075)	(0.907)	(0.678)	(0.103)	(0.969)	(0.754)
Region dummies						
Africa	7.915***	2.858	4.557**	7.398***	1.544	2.872
	(0.000)	(0.122)	(0.048)	(0.000)	(0.384)	(0.197)
Asia	3.936**	0.316	1.176	3.591**	-0.428	0.342
	(0.024)	(0.841)	(0.556)	(0.030)	(0.790)	(0.862)
Americas	4.848***	-2.130	-2.188	4.884***	-2.291	-2.291
	(0.009)	(0.124)	(0.174)	(0.007)	(0.104)	(0.156)
Middle East	4.222**	-3.452*	-3.056	5.001**	-2.920	-1.967
	(0.039)	(0.091)	(0.183)	(0.023)	(0.174)	(0.399)
Net Relationships	0.0006	0.0401	na	na	na	na
Thresholds	45.833	55.750	na	na	na	na
Observations	111	117	117	116	120	120

GDP: Gross Domestic Product. *,**,***: significance levels of 10%, 5% and 1% respectively. The average value of Bank accounts at formal financial institutions 45.72. na: not applicable because at least one estimated coefficient needed for the computation of netrelationshipsis not significant.

It is important to provide more insights into the computation of net relationships and corresponding thresholds for complementary policies. The consideration of these net relationships can be articulated in the second column of Table 1 in which, the net relationship from enhancing bank accounts on financial inclusion is 0.0006 (2×[-0.003 × 45.72] + [0.275]). In this calculation, 0.275 is the unconditional relationship between bank accounts and financial inclusion, 45.75 is the average value of bank accounts, -0.003 is the conditional or marginal relationship of bank accounts while the leading "2" corresponds to the quadractic derivation. The corresponding negative threshold is 45.833=0.275/ (2×0.003). It is qualified as a negative threshold because of the associated negative marginal relationship. Moreover, given the negative marginal nexus, when bank accounts reach a critical mass of 45.833% for adults who have personally used a mobile phone to pay bills, send or receive money in the past 12 months, the overall net relationship on the outcome variable is 0 (2×[-0.003 × 45.833] + [0.275]). Hence, when the corresponding bank account penetration exceeds the computed threshold, corresponding policies are imperative in order to ensure that bank accounts continuously promote mobile money accounts. In the same vein, the net positive relationship of 0.0401 corresponds to enhancing bank accounts for the mobile used to send money, while the corresponding threshold for complementary policies is 55.750 % for adults who have used a mobile phone to send money in the past 12 months.

Is it also worthwhile to emphasis that while positive net effect is apparent from improving bank accounts for mobile money innovations, enhancing bank account beyond specific bank account thresholds engenders effects that are consistent with Potnis, Gaur and Singh (2020) who have shown from an Indian context that the ownership of bank accounts considerably dampens the use of mobile money. It is on the premise of the potential negative effects at certain thresholds of bank accounts that the study recommends complementary policies at specific critical masses of bank accounts in the concluding section. Hence, the study does not exclusively provide a blanket linkage between bank accounts and mobile money innovations because; the relationship is understood and modeled as non-linear.

Before concluding, it is worthwhile to clarify why competition-oriented policies should be enhanced for the sampled countries, in the light of the fact that, as established in the findings, more bank concentration or market power does engender more financial inclusion within the framework of mobile money innovations. Three main perspectives can explain the underlying insignificant relationship between bank market power and the outcome variables. First, large banks in the sampled countries can be using their market power to increase their profit margins (Mitichell and Onvural, 1996; Asongu and Odhiambo, 2019b). Second, some financial institutions can be associated with substantial diseconomies of scale, especially as it relates to coordination, organization and poor management (Clark, 1996; Karray and Chichti, 2013). Third, large banks could be using information sharing offices (which are traditionally designed to increase financial access) for private gain instead of leveraging on such information to financial inclusion (Brown and Zehnder, 2010; Boateng et al., 2018).

5. Concluding implications and future research directions

The present study investigates how increasing bank accounts and bank concentration affect mobile money innovations in 148 countries. It builds on scholarly and policy concerns in the literature that increasing bank accounts may not be having the desired effects on financial inclusion on the one hand and on the other, that bank concentration which is a proxy for market power is a relevant mobile money innovation demand factor. The empirical evidence is based on Tobit regressions. The study finds that while enhancing bank accounts does engender a net positive relationship on two of the three mobile money innovations (i.e. mobile accounts and the mobile phone used to send money) there are thresholds of bank accounts at which complementary policies are required in order to maintain the positive relevance of banking in improving the corresponding mobile money innovations. The thresholds for complementary policies are: (i) 45.833% for adults, who have personally used mobile phonesto pay bills, send or receive money in the past 12 months and (ii) 55.750 % for adults who have used a mobile phone to send money in the past 12 months. The finding partly confirms the concern of Klapper, El-Zoghbi and Hess (2016) that the improvement of bank accounts in developing countries may not be having the desired effect on financial inclusion because findings of the present study have shown that some complementary policies at certain thresholds of financial inclusion are also worthwhile.

Conversely, enhancing bank concentration does not significantly influence financial inclusion within the framework of all the considered mobile money innovation proxies (i.e. mobile money accounts, the mobile used to send money and the mobile used to receive money). This finding, therefore, confirms the scholarly positions on the abuse of banking concentration or market power notably that banks leverage on such market power to improve their profit margins instead of enhancing financial inclusion and financial access (Asongu, Nwachukwu and Tchamyou, 2016). The inference should be understood in the light of: (i) the conception of market power which is used to decrease financial inclusion and access as clarified in the introduction; (ii) bank concentration being a proxy of market power; and (iii) the insignificance of bank concentration in improving financial inclusion by means of mobile money innovations in this study.

In the light of the relevance of financial inclusion in promoting SDGs, especially in relation to inequality and poverty-related goals, complementary policies at the established thresholds could include, *inter alia*: (i) promoting universal access to mobile phones and associated mobile money accounts, (ii) limiting information asymmetry between clients and banks in the banking industry and (ii) fighting market power in terms of bank concentration which can explain why after a certain level of mobile money penetration, banks start leveraging on their market power to increase their profit margins instead of promoting financial inclusion by means of mobile money innovation.

Obviously, this study leaves room for future research, especially as it pertains to assessing policies through which competition in the banking industry can be enhanced and market power limited in the light of mobile money innovations. Moreover, assessing other complementary policies that could be taken on board in order for bank accounts to increase mobile money innovations is worthwhile. In considering these future research directions, updated data should be used. Accordingly, the present study has employed the data of Lashitew, van Tulder and Liasse (2019) because the study is positioned as a direct extension of the corresponding study.

6. Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Acknowledgement

Appendices
Appendix 1: Definitions and sources of variables

Variables	Descriptions	Sources
Dependent variables		
Mobile Accounts	Percentage of adults who have personally used mobile phone to pay bills, send or receive money in the past 12 months using a GSMA recognized mobile money service	Financial Inclusion Indices (Findex) database
Sending Money	Percentage of adults who used a mobile phone to send money in the past 12 months	
Receiving Money	Percentage of adults who used a mobile phone to receive money in the past 12 months	
Demand factors		
Account at formal financial institution	Percentage of adults who have an account at a formal financial institution	Global Financial Structure Database (GFSD)
ATM access	Number of ATMs per 100,000 people	
Banking sector concentration	The percentage share of the three largest commercial banks in total banking assets	
Supply factors		
Mobile phone penetration - Gross & unique subscription rates	Gross mobile subscription rates refer to the percentage of adults in a country with subscriptions to mobile phones based on data from WDI. We used additional data from GSMA (2014) to calculate unique mobile subscription rates by correcting for double SIM-card ownership, which differs between rural and urban areas. This correction is based on survey evidence that urban and rural users own	World Development Indicators (WDI), GSMA

	2.03 & 1.18 active SIM-cards respectively.	
Mobile connectivity quality	Measures the average speed of uploading and downloading data through mobile network in 2014 & 2015.	GSMA
Mobile connectivity coverage	Measures the weighted average of share of populations covered by 2 G, 3 G and 4 G mobile data networks (normalized to range between 0 and 100).	GSMA
Telecom regulation	Measures the regulatory quality of the telecom sector in terms of four major criteria: transparency, independence, resource availability, and enforcement capability of the regulator. The index is based on dozens of indicators taken from the International Telecommunication Union's regulatory database.	Waverman and Koutroumpis (2011)
Macro-level factors		
Rule of Law	A measure of the extent to which agents have confidence in and abide by the rules of society *"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"*	WGI
GDP per capita	GDP per capita in purchasing power parity	WDI
GDP growth	The rate of total GDP growth	WDI
Urbanization rate	Percentage of population living in urban areas	WDI

Notes: Mobile Accounts is based on the second wave of the survey (2014) and Sending Money and Receiving Money are based on the first wave (2011). The variablestelecom regulation is based on data for 2011. The two variables measuring mobile connectivity are based on average values for the years 2014 & 2015. For the remainingvariables, averages are taken over the years 2010–2014 to smooth out potential year-to-year variations.

Appendix 2: Summary Statistics

Variables	Mean	S.D	Min	Max	Obs
Dependent variables					
Mobile accounts (%)	3.30	7.90	0.00	58.39	145
Sending money (%)	3.10	7.58	0.00	60.48	146
Receiving money (%)	4.47	9.58	0.00	66.65	146
Demand factors					
Account at formal fin. Institution (%)	45.72	31.73	0.40	99.74	147
ATM penetration	43.28	45.03	0.33	279.71	148
Banking sector concentration	71.94	20.70	9.49	100.00	143
Supply factors					
Unique mobile subscription rate	61.73	23.29	4.23	133.64	199
Mobile connectivity (performance)	11.92	14.69	0.04	67.19	147
Mobile connectivity (coverage)	62.18	27.29	8.88	99.60	147
Telecom regulation	0.41	0.17	0.00	0.74	128
Macro-level factors					
GDP per capita (PPP)	17,874	19,677	648	132,468	152
GDP growth	3.90	2.82	-4.92	11.10	153
Rule of Law	-0.09	1.01	-2.42	1.98	157
Urbanization (%)	58.22	22.85	8.81	100	155

Notes:- The average values for the dependent variables are calculated across all countries, including those in which mobile money services are not available.

Appendix 3: Correlation matrix

	Mobile inclusion variables			Demand Factors			Supply Factors				Macro-level Factors				Region dummies			
	MMA	Send M	Receiv.M	BankAc	ATM Pen	BankSC	UMSr	MCP	MCC	TSR	GDPpc	GDPg	RL	Urban	Africa	Asia	Americas	Middle East
MMA	1.000																	
Send M	0.640	1.000																
Receiv.M	0.597	0.980	1.000															
Bank Ac	-0.292	-0.227	-0.266	1.000														
ATM Pen	-0.319	-0.248	-0.279	**0.708**	1.000													
BankSC	-0.079	-0.028	-0.026	0.051	-0.171	1.000												
UMSr	-0.237	-0.116	-0.142	0.411	0.305	-0.045	1.000											
MCP	-0.320	-0.272	-0.300	**0.821**	**0.779**	-0.053	0.270	1.000										
MCC	-0.385	-0.300	-0.323	**0.815**	**0.701**	-0.091	0.525	**0.780**	1.000									
TSR	-0.088	-0.070	-0.067	0.549	0.363	-0.008	0.237	0.466	0.473	1.000								
GDPpc	-0.420	-0.209	-0.228	**0.825**	**0.690**	-0.078	**0.644**	**0.729**	**0.872**	0.535	1.000							
GDPg	0.376	0.189	0.176	-0.532	-0.481	-0.058	-0.300	-0.477	-0.527	-0.433	-0.553	1.000						
RL	-0.271	-0.273	-0.308	**0.850**	**0.623**	0.040	0.374	**0.838**	**0.772**	0.605	0.772	-0.457	1.000					
Urban	-0.396	-0.212	-0.220	0.566	0.567	-0.051	0.364	0.598	0.731	0.349	**0.788**	-0.381	0.583	1.000				
Africa	0.533	0.415	0.444	-0.558	-0.519	0.123	-0.462	-0.487	**-0.681**	-0.288	**-0.683**	0.407	-0.418	-0.560	1.000			
Asia	-0.101	-0.076	-0.088	0.087	0.077	-0.009	-0.013	0.153	-0.006	-0.129	0.007	0.244	0.014	-0.075	-0.199	1.000		
Americas	-0.098	-0.116	-0.095	-0.176	-0.016	-0.004	0.092	-0.198	-0.029	0.001	0.045	0.025	-0.221	0.158	-0.268	-0.278	1.000	
Middle East	-0.086	-0.072	-0.082	-0.0001	0.047	0.019	-0.010	0.035	0.124	-0.131	0.140	0.040	0.017	0.237	-0.101	-0.105	-0.141	1.000

MMA: Mobile Money Accounts. Send M: Sending Money. Receiv M: Receiving Money. Bank Ac: Bank Accounts. ATM Pen: ATM Penetration. BankSC: Bank Sector Concentration. UMSr: Unique Mobile Subscription rate. MCP: Mobile Connectivity Performance. MCC: Mobile Connectivity Coverage. TSR: Telecom Sector Regulation. GDPpc: Gross Domestic Product per capita in PPP (in logs). GDPg: GDP growth. RL: Rule of Law. Urban: Urbanization.

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