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Do migrant remittances matter for financial development in Kenya?



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Abstract

The paper analyzes the relationship between remittances and financial development using Kenyan quarterly data from 2006 to 2016. Five different indicators of financial development are used: credit to the private sector as a share of GDP, the number of mobile transactions, the value of these mobile transactions, the number of mobile agents, and the number of bank accounts. The results from using an autoregressive distributed lag demonstrate a strong, positive relationship between remittances and financial development in long-run equations. This suggests that higher levels of remittances provide opportunities for recipients to open bank accounts, enhance their savings, and access financial systems, in addition to exposing the previously unbanked to both new and existing financial products. The results also confirm the potential advantage of embracing modern and advanced technology to facilitate international mobile transfers. Using international remittance transfers through mobile technology reduces costs by eliminating the need for physical branches and personnel to attend to walk-in customers. Aside from offering convenience and safety for remittance actors, this method also dominates traditional remittance business models. Therefore, a policy window exists for the government to leverage on remittances as a tool of financial inclusion and depth, and particularly through the continued expansion of regulatory space to accommodate the wider use of international mobile remittance transfer channels. Moreover, given the strong, positive relationship between remittances and credit to the private sector as indicated by its share of GDP and number of bank accounts, commercial banks and other players in the remittance market may also find it useful to develop customized products for migrants to access their remittances. For example, financial intermediaries can consider providing better deposit interest rates for diaspora deposits compared to deposits made in the local currency. Further, these institutions can allow regular remittance flows to act as collateral for the allocation of credit, among other incentives to tap into the significant potential of money remitted by migrants to Kenya. The study also recommends that the government consider expanding exploitation of diaspora bonds and diaspora savings and credit cooperative societies while drawing lessons from other countries' previous attempts.

Keywords: Remittances, Financial inclusion, Technology

Introduction

For decades, economic policymakers have experimented with many development mantras, with various objectives ranging from increasing economic growth and reducing inequality to alleviating poverty, and especially for the “bottom billion.”¹ However,

economic approaches in developing countries have historically revealed no compelling evidence of any particular suitable model that has worked perfectly in the developing world, and in Africa in particular (Ascher et al. 2016; Olu and Afeikhena 2014). For instance, various models on financial development—such as micro-credit and digital payment systems meant to increase access to finance for the poor—are still being promoted in African countries, but Africa's level of poverty is increasing while declining in other regions worldwide (Asongu and Sara 2018; Santos and Kvangraven 2017; Bate-man 2017; World Bank, 2015; Hulme and Maitrot 2014).²

Moreover, a recent analysis of financial development indicators in Africa revealed that fewer than one-quarter of adults have an account with a formal financial institution, many adults use informal methods to save and borrow, and a majority of small and medium-sized enterprises are unbanked, with access to financing as their greatest challenge (Demirguc-Kunt and Klapper 2012). Among other reasons, the study also found that the low penetration of bank accounts in Africa is partially attributed to the low income levels that hinder savings, limited physical access points, and the high costs of maintaining bank accounts.

While acknowledging the low income across African communities as a possible constraint to financial inclusion through traditional banking systems, financial inclusion for the “bottom billion” is clearly possible through technology.³ For instance, Ndung'u (2017, 2018) noted that digitalization has driven the accelerated provision of financial services through retail payments, virtual savings, and credit supply. This has been demonstrated in Kenya, where the country's M-Pesa services have contributed to the growth of bank account-holders, from 26.7% in 2006 to over 75% in 2016.⁴ Although the debate regarding the finance-growth nexus is far from concluded, evidence exists based on endogenous growth theories to suggest that a well-developed, inclusive financial system will support higher levels of growth and lower levels of poverty (Terfa 2018; Terfa and Fonta 2018; Mauzu and Alagidede 2018; Zulfiqar et al. 2016; Andrianaivo and Kpodar 2012).

Therefore, focus has intensified following a steady increase in remittance flows to Africa, toward leveraging remittances to enhance financial inclusion and promote financial development. Additionally, research activity has intensified in this area, although these studies present mixed findings. Some studies have confirmed that families receiving migrant remittances can access better health facilities, obtain a better education, and have better financial access and lower poverty levels than those that do not receive such remittances (Uzochukwu and Chukwunonso 2014; Dilip 2013; Reanne et al. 2009). Moreover, remittance flows through formal channels provide opportunities for encouraging savings, increasing deposits, and deepening financial inclusion (Al-Tarawneh 2016; Meyer and Shera 2016; Shera and Meyer 2013). However, other studies have demonstrated that remittances lead to the relaxation of borrowing constraints, which subsequently decreases the marginal utility of wealth and increases the consumption of all normal goods, including leisure. In this case, migrant remittances cause reduction of labor supply among the non-migrants who substitute income for leisure. This may adversely impact investments and the accumulation of capital (Berrak et al. 2018; Guha 2013).⁵

This debate on the remittance-finance link has not escaped policy circles in Kenya; approximately three million Kenyans constituting around 7.0% of the total population live abroad (Ministry of Foreign Affairs 2014). Remittances have steadily increased in

Kenya, at an average annual rate of 15.8% in the past decade and increasing from US\$934 million in 2011 to an estimated US\$2.7 billion in 2018, or 3.0% of Gross Domestic Product -GDP (World Bank 2019). Kenya is one of the top five highest remittance-recipient countries in Africa, after Egypt, Nigeria, Morocco and Ghana, as per the World Bank estimates in 2018. Remittances to Kenya have consistently increased, with higher levels recorded than foreign direct investments and portfolio equity flows. However, these statistics only reflect remittance flows through formal channels and are believed to be grossly underestimated, as migrants send money through informal channels and in-kind transfers, and these are often unrecorded.

As summarized by Filippo et al. (2014), money transferred through financial institutions paves the way for recipients to demand and access other financial products and services. Moreover, providing remittance transfer services allows banks and financial institutions to gather recipients' information, which is important for mitigating adverse selection problems. The same paper also noted that remittance channels can be used to sell financial service packages geared toward low-income individuals. This debate takes on special importance in the case of Kenya, where cross-border remittance transactions have been extensively revolutionized using mobile phone technology. Kenya is one country used as a worldwide example of what adopting technology can accomplish, as with its well-known M-Pesa products.⁶ An international remittance transfer service is one such product with substantial potential to reach millions of people, including low-income and unbanked populations in rural areas.

However, in spite of these remittances' potential impacts on financial development, few country-specific studies have empirically examined the remittance-financial development linkages in the African region. Moreover, no consensus exists regarding the impact or direction of the causality between remittances and financial development (Coulibaly 2015; Nyamongo et al. 2012; Gupta et al. 2009). Previous studies on migration and remittances have concentrated on remittances and growth and have ignored the channels through which migration and remittances affect economic growth (Fayissa and Nsiah 2010). The few studies that have considered these channels have primarily focused on investment and consumption channels, ignoring those that could promote financial development (Makori et al. 2015; Aboulez 2015; Mwangi and Mwenda 2015; Ocharo 2014; Kii et al. 2014).

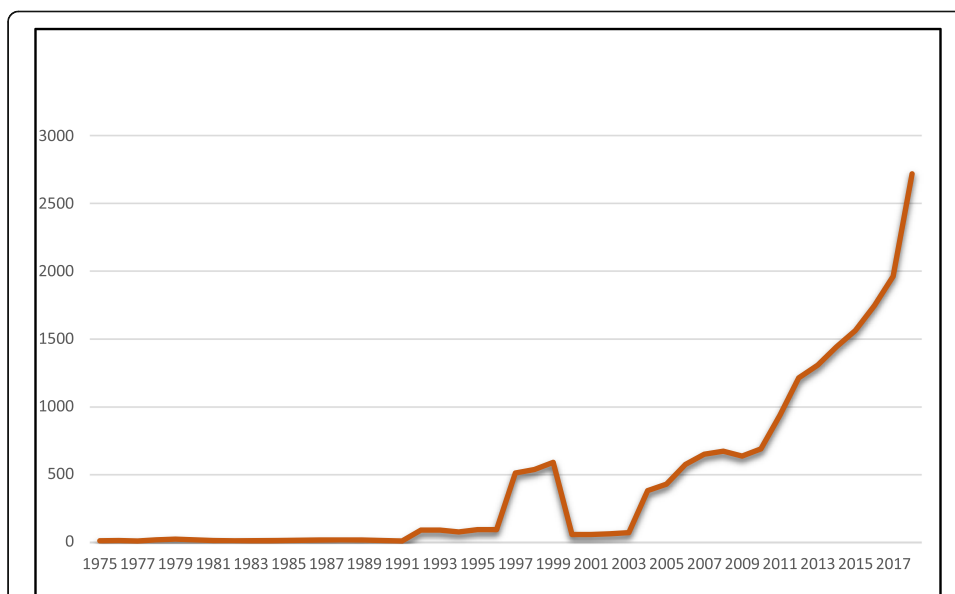
This study attempts to fill this gap by analyzing the relationship between remittances and financial development as it contributes to existing knowledge in at least four respects. First, no study to the best of our knowledge has examined the remittance-financial development nexus using Kenyan data. Second, this paper uses multiple indicators of financial development, including such indicators of financial inclusion as the numbers of bank accounts and mobile transactions that have not been used in previous studies based on Kenyan data. Third, the paper's data set also incorporates the bound co-integration technique or the autoregressive distributive lag model (ARDL), which previous studies have not utilized. Fourth, this study also examines whether any reverse causality exists between remittances flows and financial development, as existing literature indicates the possibility of such a relationship. This study's results are critical for policymakers keen to leverage technology to facilitate enhanced remittances and improved financial inclusion. The study is also beneficial to private sector actors—primarily banks, but also governments—that can benefit by developing customized products for the diaspora.

Remittance flows in Kenya

This section presents an overview of trends in Kenya’s remittance flows. Figure 1 illustrates that remittance flows to Kenya increased in 2003 and has been steadily growing over the last decade. Such flows were stable even during the global financial crisis, when other capital flows were volatile. Figure 2 provides trends on remittances flows and other capital flows.

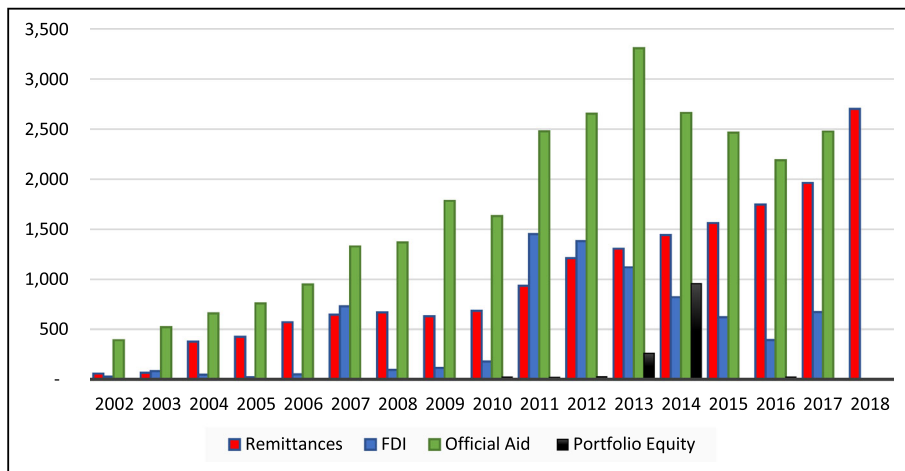
Remittances to Kenya have consistently increased, with higher levels recorded than foreign direct investment and portfolio equity flows. Although official development assistance flows have increased, their developmental impact is not directly tangible compared to remittances that flow directly to their beneficiaries, with potential impacts on health, education, small-scale businesses, and the real sector. Moreover, several previous studies note that official development assistance does not necessarily translate to high economic growth rates (Yiew and Lau 2018; Phiri 2017; Murshed and Khanaum 2014). Historically, official development assistance has been misappropriated at both state and non-governmental levels (Elayah 2016; Kono and Montinola 2013; Bodomo 2013; Doucouliagos and Paldam 2011; Maipose 2000).⁷ Further, remittance flows through formal channels to African countries—including Kenya—are believed to be grossly underestimated, as migrants often send unrecorded funds through informal channels and in-kind transfers.

Kenya receives the highest remittance flows from the United States, Asia, United Kingdom and African countries, or approximately 47%, 15% and 11% of total flows, respectively as illustrated in Fig 3. These numbers indicate not only areas of focus in terms of bilateral agreements to ease and enhance remittance flows, but also where the private sector—and especially commercial banks, mobile companies, and online remittance platforms—should concentrate their attention to attract more remittance flows and expand their market territory. The government could also focus on these corridors in terms of incentives and policies that are conducive to harnessing these flows.



Source: World Bank Migration and Remittances Data; Central Bank of Kenya

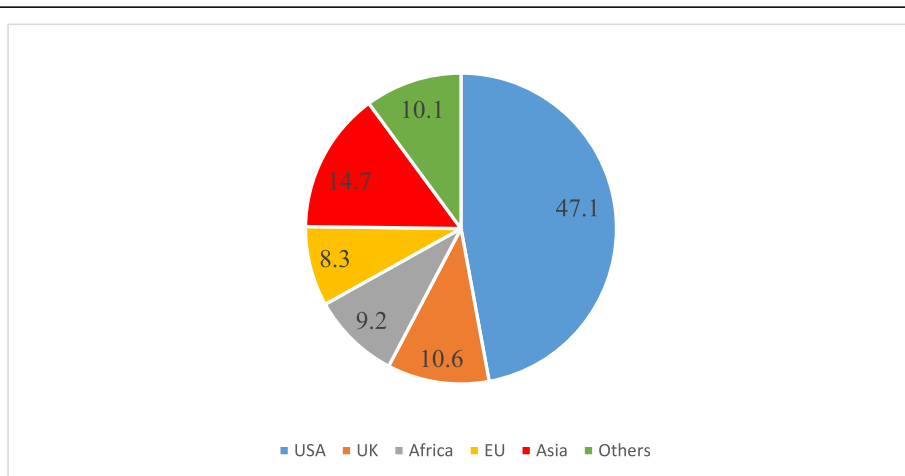
Fig. 1 inflows to Kenya (1975–2018) in Million US\$. Source: World Bank Migration and Remittances data, Central Bank of Kenya



Source: World Development Indicators, World Bank Migration and Remittances data

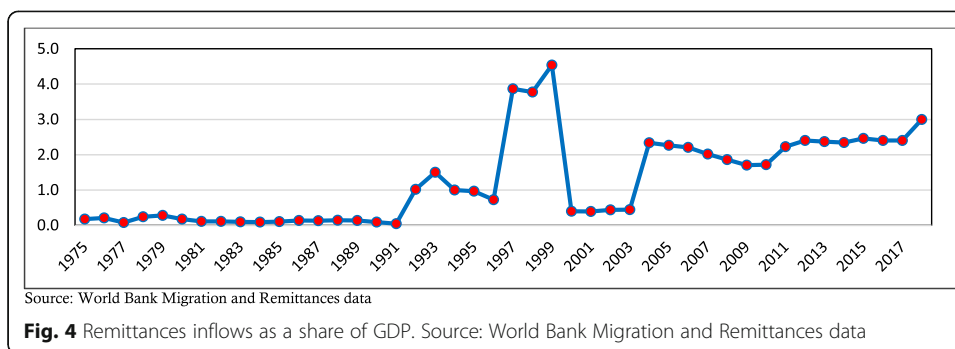
Fig. 2 Capital inflows (in Millions US\$). Source: World Development Indicators, World Bank Migration and Remittances data

Remittance flows to Kenya constitute about 3.0% of the nation’s GDP based on 2018 estimates. Figure 4 displays these trends over time (World Bank, April 2019). In spite of remittance flows’ potential importance, Kenya’s remittance market—and indeed, markets elsewhere on the African continent—is not devoid of challenges. Aside from the inaccuracy of data due to remittance flows through informal channels, it is incredibly expensive to send funds to Sub Saharan Africa, with an average cost of approximately 9.3%, versus a global average of 7.0% (World Bank 2019).⁸ This is 6.3% above target 10c of the sustainable development goals.⁹ The high cost to send funds to Africa are due to an exclusive regulatory framework leading to limited competition, compliance with the Anti-Money Laundering/Counteracting Financing of Terrorism (AML/CFT) international standard, few rural payout stations,



Source: Commercial Banks in Kenya

Fig. 3 Sources of remittance inflows to Kenya in 2017. Source: World Bank Migration and Remittances data

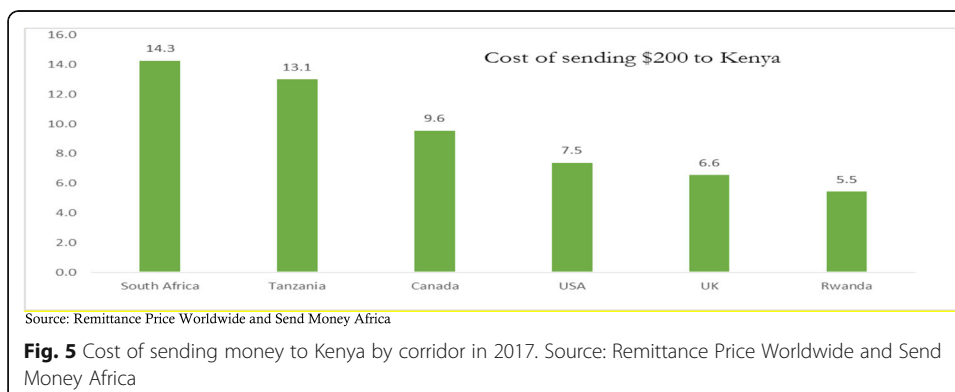


financial illiteracy, and the low utilization of cheaper, more modern technology, among other factors.

We illustrate the magnitude of these costs with Fig. 5, which presents the cost of sending money to Kenya for selected corridors. The figure reveals that it is more expensive to send funds from within the continent than externally. For example, the costs of sending US\$200 from South Africa and Tanzania to Kenya are 14.3% and 13.1%, respectively, while sending the same amount costs 6.6% from the United Kingdom. Substantial variations also exist across corridors, as indicated by the cost of sending similar amounts of money from Rwanda, recorded at 5.5%, yet those in neighboring Tanzania can send the same amount at double the cost. High remittance-transfer costs not only encourage the use of informal channels, with negative implications for the financial sector, but also de-incentivize migrants from sending higher remittance flows.

Review of literature

Literature includes diverse arguments linking remittances to financial development, although most lean toward their potential to enhance financial inclusion, and especially for the unbanked lowest income earners in developing countries. One theory linking remittances and financial development is anchored in the financial literacy hypothesis. Proponents of this hypothesis argue that both remittance senders and recipients create a demand for the financial systems involved in international remittances, which can incentivize either or both parties to seek and interact with the financial institutions involved in other financial products beyond remittances. This will subsequently increase



financial awareness both for the sender and recipient and can lead to the recipients' demand for other financial products, such as savings, insurance, and mortgage services, among others. Increasing the possibilities for formal money transfer services as such could be one response to existing demand. The financial literacy perspective assumes that the exposure to—and knowledge of—financial services induces remittance recipients' use of formal banking services (Brown et al. 2013; Toxopeus and Lensink 2008).

Karikari et al. (2016) further supports the positive relationship between remittances and financial intermediation by arguing that migrant transfers in excess of consumption expenditures are likely to be placed in savings, thus introducing recipient individuals to financial products and services, which could lead to enhanced financial development. Related to these arguments are postulations on how remittances provide an alternative option for financing entrepreneurs who do not qualify for credit in mainstream commercial banks. Over time, these entrepreneurs may become “bankable,” and influence commercial banks to compete for them. Similarly, Ambrosius and Cuecuecha (2016) summarize the connections between remittances and financial access. They posit that remittances function as a substitute for credit; in this case, remittance-receiving households' different spending behavior is explained within a theoretical framework involving imperfect credit markets, in which remittances help poor households overcome the liquidity constraints that restrict investments in human or physical capital.

Considerable arguments on the supply side contend that regular remittance flows facilitate the creation of a credit history and connections that establish recipients' creditworthiness; these current and potential remittance flows could possibly be considered as collateral in allocating credit (Giuliano and Ruiz-Arranz 2009; Toxopeus and Lensink 2008). Further, Anzoategui et al. (2014) corroborate this reasoning to argue that remittances might increase a household's likelihood of obtaining a loan, as processing remittance flows provides financial institutions with information on the recipient households' income. In this case, remittances potentially lower a client's risk profile, as banks can obtain information on remittance recipients who are prospective loan clients. The bank can use this knowledge to further emphasize soft data, such as the client's reliability and character. When remittances go through banks, clients can use both current and future inflows as “collateral” to access credit. If these banks accept such inflows as explained, loans could be covered—at least partially—by remittance inflows, thus lowering the bank's risk and motivating payback and optimal project management. Moreover, remittance receipts' deposited in banks increases these banks' loanable funds, and consequently their ability to extend credit to both remittance- and non-remittance-receiving households (Brown et al. 2013; Motelle 2011).

Further arguments based on policy considerations contend that the government can encourage transfers through formal channels by removing income remittance taxes, relaxing exchange and capital controls, allowing domestic banks to operate overseas, providing identity cards for migrants, and providing financial products targeting the diaspora, among other incentives.¹⁰ In cases in which the use of formal financial institutions are constrained by a lack of migrant documentation, governments can consider entering into bilateral agreements to facilitate the opening of bank accounts and using formal financial institutions. For example, Mexico's Matrícula Consular de Alta Seguridad is an alternative form of identification issued to Mexicans that is also acceptable in US consulates (Toxopeus and Lensink 2008).

In contrast, some arguments indicate negative connections between remittances and financial development. For example, Brown et al. (2013) note that migrants could possibly distrust formal banking services due to reasons other than financial illiteracy, such as the avoidance of formal records of income flows occasioned by required AML/CFT compliance.¹¹ In this case, remittances may not be associated with the opening of bank accounts. Muktadir-Al-Mukit and Islam (2016) also discuss other negative views on the remittance-financial development nexus.

More recent theories have also focused on leveraging technology for financial inclusion, and especially in developing countries. Proponents of this assertion contend that adopting electronic payments can generate important cost reductions in the managing and safeguarding of cash, as well as in such money transmission services as remittances (Santos and Kvangraven 2017).

Many empirical studies have been conducted using both primary and secondary data. For example, Li et al. (2014) use primary data to indicate that remittance-receiving households are more likely to have savings accounts and use bank accounts than households that do not receive remittances. The Table 1 below summarizes some of these empirical findings, including the methods used and countries covered.

Data, variables and methodology

The study uses quarterly data obtained from the Central Bank of Kenya and the Kenya Bureau of Statistics from 2006 to 2016. This data was selected based on its availability in our estimation frequency and based on standard variables as identified in literature (Beck et al. 2018; IMF 2005). Consistent with previous studies, we use the ratios of bank deposits to GDP and credit to the private sector to GDP, the number of bank accounts and mobile transactions, value of mobile transactions, number of mobile agents, and the number of bank branches as proxies for financial development and financial inclusion, and as dependent variables (Ito and Kawai 2018; Camara and Tuesta 2014; Ayadi et al. 2013; Afi 2013; World Bank 2006). The remittance variable is separately regressed against each of the dependent variables. Our control variables include inflation, real GDP, the exchange and interest rates, and trade openness-TOPEN, (Al-Tarawneh 2016).¹²

Following from previous studies, the basic general model is specified below:

$$FIND_t = \alpha_0 + \beta_1 Rem_t + \beta_2 X_t + \varepsilon_t \tag{1}$$

where *FinD* represents financial development variables, *Rem* represents remittance variables, and *X* represents all control variables in all models. Eq. 1 is then reformulated into a long-run relationship, as represented in Eq. 2:

$$\gamma_t = LFinD_t - \alpha_0 - \beta_1 L Rem_t - \beta_2 X_t + \varepsilon_t \tag{2}$$

$$\Delta LFinD_t = \delta_0 + \sum_{i=1}^p \rho_i \Delta LFinD_{t-i} + \sum_{i=0}^q \delta_i \Delta L Rem_{t-i} + \sum_{i=0}^m \tau_i \Delta LX_{t-i} + Z\gamma_{t-1} + \varepsilon_t \tag{3}$$

The reformulation of Eqs. 2 and 3 results in an ARDL specification, as noted in Eq. 4 (Tung 2015; Karamelikli and Bayar 2015):

Table 1 Summary of International Empirical Evidence on remittances-financial development relationship

Year	Author/s	Country/ies	Data	Methodology	Findings
2016	Karikari et al.	50 Developing countries in Africa	1990–2011	Fixed Effects; Random Effects and Vector Error Correction Model	Remittances have a positive effect on financial development in the short run but a negative effect in the long run.
2016	Muktadir-Al-Mukit and Islam	Bangladesh	1976–2012	VAR and VECM	There is a positive relationship between remittances and credit disbursement in the long run. Bi-directional causality is also established
2016	Ambrosius and Cuecuecha	Mexico	Household survey data (2002; 2005)	Fixed effects and instrumental variables	There are positive effects of remittances on the ownership of savings account, existence of debts and borrowing.
2016	Williams	Sub-Saharan Africa	1970–2013	Panel data	Remittances positively influence financial development
2015	Mbaye	Senegal	Household survey data (May–July 2009; April–June 2011)	Household fixed effects model	Receipt of remittances increases likelihood of having a loan in a household.
2015	Coulibaly	Sub-Saharan Africa	1980–2010	Panel granger causality	No strong evidence supporting the view that remittances affect financial development or vice versa.
2014	Anzoategai et al.	El Salvador	1995–2001, four wave rural household level survey data	Fixed effects	Households that receive remittances are more likely to have a deposit account at a financial institution.
2014	Ojapinwa and Oladipo	32 SSA countries	1996–2010	Dynamic panel GMM	Remittances affect financial development in a positive and significant way implying that remittances complement financial intermediation in SSA countries.
2013	Brown et al.	Developing countries	1970–2005	Panel Least Squares, 2SLS and Probit approaches	Remittances flows do not induce opening of bank accounts or increase in credit to the private sector.
2012	Nyamongo et al.	Africa	1980–2009	Panel data approaches	Remittances are complementary to financial development and are an important source of economic growth.
2011	Motelle	Lesotho		Vector Error Correction Model and Causality tests	Remittances have a long-run effect on financial development. Causality is established from financial development to remittances but not vice versa
2009	Giuliano and Ruiz-Arranz	100 developing countries	1975–2002	System GMM; OLS and Fixed Effects	Remittances provide an alternative way to finance investment and help overcome liquidity constraints.
2009	Gupta et al.	Sub Saharan Africa	1975–2004	Three stage least squares	Remittances have a direct poverty mitigating effect and promotes financial development.
2009	Beine et al.	66 developing countries	1980–2005	Dynamic generalized ordered logit model	A strong positive effect of remittances on financial openness.
2008	Toxopeus and Lensink	Developing countries	2003	OLS	Remittance flows have a significant positive effect on financial inclusion in

Table 1 Summary of International Empirical Evidence on remittances-financial development relationship (*Continued*)

Year	Author/s	Country/ies	Data	Methodology	Findings
2011	Aggarwal et al.	99 Developing countries	1975–2003	GMM	developing countries. Impact of remittances on financial development is positive though marginal.

$$\Delta LFinD_t = \alpha_0 + \beta_1 LFinD_{t-1} + \beta_2 LRem_{t-1} + \beta_n LX_{t-1} + \sum_{i=1}^p \rho_i \Delta LFinD_{t-i} + \sum_{i=0}^q \delta_i \Delta LRem_{t-i} + \sum_{i=0}^m \tau_i \Delta LX_{t-i} + \varepsilon_t \tag{4}$$

where *LFinD* represents the log of financial development variables, *LRem* is the log of remittances, and *LX* represents the log of the control variables in the model, as previously described. Further,

p, *q* and *m* are optimal lag lengths;

ρ_i , δ_i , and τ_i are the ARDL model’s short-term dynamics;

β_1 , β_2 ,..., and β_n are long-run multipliers;

Δ is the first difference operator;

α_0 , is a constant term; and

ε_t is the white noise error term

In line with previous studies, other factors affecting financial development include: real GDP, trade openness, the consumer price index (CPI), exchange rate and interest rate (Polat 2018; Karikari et al. 2016; Ayadi et al. 2013; Chinn and Ito 2006). We include trade openness as many previous studies have identified its importance in fostering financial development, (Antonio et al. 2014; Kim et al. 2010; Siong 2009).¹³ The increase in trade openness generates a demand for new financial products, including instruments for trade finance and the hedging of risks. Simultaneously, trade openness may cause macro-level uncertainty and unfavorably influence the financial development-economic growth connection (Rehma et al. 2015; Raza 2014; Antonio et al., 2014); therefore, the a priori sign for this variable is ambiguous. Trade openness constitutes the total of exports and imports divided by GDP, (Qamruzzaman and Jianguo 2017).

We also include the CPI, which measures the average price of the consumer goods and services a household purchases. Several studies indicate that high inflation erodes savings returns, leading to reduced incentives to save, and hence, fewer savers and savings amounts, (Dash and Kumar 2018; Gashe 2017; Muradoglu and Taskin 1996). Consequently, the borrowing pool and credit allocation shrinks with negative implications for the financial sector. This challenge is aggravated in financial markets where collateral is required for efficient borrowing and lending, as too few savings can inhibit the accumulation of collateral and impede growth-enhancing financial intermediation. Moreover, periods of high inflation are often followed by tight monetary policy, which implies high interest rates with potentially inefficient financial markets. High inflation also hampers long-term contracting, and subsequently induces financial intermediaries to maintain incredibly liquid portfolios (Akosah 2013; Manoel, 2011). Thus, we expect a negative relationship between inflation and financial development.

Works by McKinnon (1973) and Shaw (1973) encompass the relationship between interest rate (*INT*) and financial development. The two authors argue that financial

repression—in the form of interest rate ceilings, high reserve ratios, and directed credit—lead to low savings and credit rationing, and hence, low financial depth in most developing countries. The subsequent liberalization theory is hinged on the premise of a real rate of interest adjusting to equilibrium levels, thereby enabling expanded savings and a real supply of credit with positive implications on financial deepening. We used the deposit rate to capture the effect of interest rate liberalization with an anticipated positive sign, as the interest rate’s deregulation was meant to increase yields in deposit rates and result in increased savings—and hence, increased financial depth.

The relationship between economic growth and financial development based on demand-following theories is positive. According to these theories, increased demand for financial services induces growth in the financial sector as the real sector develops. Economic growth generates both additional and new demands for financing, which causes a supply response in the financial system’s growth. Therefore, a lack of financial institutions indicates a lack of demand for their services, (Sahoo 2013; Huang 2011; Al-Naif 2012; Ghosh and Banerjee 1998; Stammer 1972; Patrick 1966).

Equation 4 represents a standard way of specifying an unrestricted error-correction model, which captures both the short- and long-run relationships among this study’s variables. We then test the null hypothesis regarding the relationships among variables.

$H_0: \beta_1 = \beta_2 = \dots = \beta_n = 0$ (In that the long-run relationship does not exist) against the alternative $H_1: \beta_1 \neq 0, \beta_2 \neq 0, \dots, \beta_n \neq 0$ (In that the long-run relationship exists). A rejection of the null hypothesis implies that such a long-run relationship exists. We test this hypothesis by comparing the F-statistics obtained from Wald’s test with the critical values for small samples, or between 30 to 80 observations, as provided by Narayan (2005).

Discussion of results

This section presents unit root test results, as displayed in Table 2.¹⁴ We then estimate the ARDL model as well as the long-run model with different dependent variables in each equation.¹⁵ We consider five dependent variables representing financial development, and correspondingly estimate five different equations. We use credit to the private sector as a share of GDP (*CRED*), bank deposits as a share of GDP, the number of bank accounts and bank branches, and the value of mobile transactions as separate dependent variables in the five separate equations. Tables 3, 4, and 5 reports the co-

Table 2 Augmented Dickey-Fuller test results for unit roots

Variable	At level	At first difference	Order of integration
RGDP	-4.92	-	I(0)
CRED	-3.13	-5.10	I(1)
DEPGDP	-3.20	-7.44	I(1)
TOPEN	-3.59	-	I(0)
ER	-3.48	-5.62	I(1)
Lending	-1.665	-5.884	I(1)
INT	-1.22	-3.64	I(1)
CPI	-2.78	-4.64	I(1)
REM	-2.82	-11.66	I(1)

RGDP real GDP; *Cred* private sector credit as a share of GDP, *Depgdp* bank deposits as a share of GDP, *Int* deposit interest rate, *CPI* inflation, *ER* Exchange rate, *Topen* trade openness, *Rem* total remittances, *Lending* lending interest rates

Table 3 Credit to the private sector as a share GDP is the dependent variable

Variables	F-Statistics	Co-integration
(CRED, RGDP, TOPEN, ER, CPI, REM, INT)	5.283***	Co-integration
Critical values	Lower Bound	Upper Bound
1%	3.595	5.225
5%	2.643	4.004
10%	2.238	3.461

***shows one of the standard ways of indicating statistical significance at 1 percent

integration results while Tables 6 and 7 present the results from the long-run and error-correction models, respectively.

Unit root tests

This sub-section presents the unit root tests and ARDL findings based on different indicators of financial development as dependent variables. Although ARDL models do not require unit root tests, these tests are conducted to ensure that the variables considered in our models are either I(0) or I(1), as the inclusion of I(2) variables can collapse the system, rendering the computed F-statistics invalid, (Nkoro and Uko 2016; Sharaf 2014; Narayan 2005; Pesaran et al. 2001). To satisfy the condition for using the ARDL model, we transform all our variables except interest rates into logs, and use an augmented Dickey-Fuller (ADF) test to establish that all variables are either I(1) or I(0) as reported in Table 2.

Co-integration tests

We conducted five co-integration tests based on the five different dependent variables, but we only present the results that exhibit long-run relationships between the dependent and independent variables. Table 3 reveals that credit to the private sector as a share of GDP was considered as the dependent variable in testing for the presence of co-integration or a long-run relationship between the dependent and explanatory variables. We conducted an F-test by restricting the independent variables' coefficients at a one-period lagged level as equal to zero.

The results in Table 3—and specifically as noted in the second row—indicate F-statistics of 5.28, which is greater than the upper- and lower-bound values, signifying the presence of a co-integration between credit to the private sector as a share of GDP and its determinants. In Tables 4 and 5, we replaced credit to the private sector as a

Table 4 Value of mobile transactions is the dependent Variable

Variables	F-Statistics	Co-integration
(MOB, RGDP, TOPEN, ER, CPI, REM, INT)	5.08**	Co-integration
Critical values	Lower Bound	Upper Bound
1%	3.644	5.464
5%	2.676	4.130
10%	2.260	3.534

** shows one of the standard ways of indicating significance levels at 5 percent

Table 5 Number of bank accounts is the dependent variable

Variables	F-Statistics	Co-integration
(ACC, RGDP, TOPEN, ER, CPI, REM, INT)	5.260*	Co-integration
Critical values	Lower Bound	Upper Bound
1%	3.595	5.225
5%	2.643	4.004
10%	2.238	3.461

* shows one of the standard ways of indicating statistical significance levels at 1 percent

share of GDP with the value of mobile transactions (*Mob*) and number of bank accounts as other indicators of financial development or inclusion, respectively. In both cases, we obtained F-statistics greater than the upper bound values, at 5% and 1 % levels of statistical significance for the value of mobile transactions and the number of bank accounts, respectively. Therefore, we draw similar conclusions regarding the presence of long-run relationships between the dependent and independent variables in both cases.

However, our F-test results changed when we substituted credit to the private sector as a share of GDP, with deposits to GDP and the number of bank branches as indicators of financial development. Our results in this case were inconclusive, with F-statistics of 3.47 and 3.42 when the deposits to GDP or the number of bank branches are the dependent variable, respectively; this is lower than our upper-bound values, at 5% and 1 % significance levels. These values lie between the lower- and upper-bound values provided by Narayan (2005), indicating inconclusive results.

The long-run model’s econometric results

This section presents the coefficients of the long-run equations for the credit to the private sector to GDP, value of mobile transactions, and number of bank account equations. Although we did not report the Wald’s test results for the numbers of mobile agents and mobile transactions, we use them separately as dependent variables by replacing the value of mobile transactions in each case; Table 6 reports the long-run results. Accordingly,

Table 6 Estimated long-run coefficients

Independent variablesxx	Coefficient (The dependent variable is credit to the private sector to GDP)	Coefficient (The dependent variable is Value of mobile transactions)	Coefficient (The dependent variable is Number of mobile agents)	Coefficient (The dependent variable is Number of mobile transactions)	Coefficient (Number of bank accounts)
RGDP	0.6069 (4.61)***	7.15E-07 (0.17)	0.0129 (0.63)	0.0414 (1.36)	0.7153 (8.12)***
Topen	2.3219 (2.14)**	5.469 (0.56)	2.5584 (2.70)***	3.1390 (2.44)**	0.5784 (5.86)***
ER	0.0142 (4.50)***	5.28 (1.82)*	5.3733 (3.46)***	0.0766 (2.70)**	-0.2202(-1.14)
CPI	-0.0008(-0.24)	0.0322 (1.00)	-0.0665(-3.18)***	-0.0378(- 1.21)	-0.0008(-0.29)
Int	0.0454 (3.44)***	-2.653(-2.93)***	-0.9905(- 1.56)	-0.149(- 1.90)**	0.0106 (0.11)
Rem	0.5416 (5.30)***	2.293 (2.43)**	1.4333 (2.93)***	1.3524 (2.02)**	0.2700 (3.81)***
R ²	0.97	0.81	0.91	0.84	0.95

For all the coefficients the t-statistics are in parenthesis; *, **, *** shows the standard way of indicating statistical significance levels at 10%, 5% and 1% significance levels, respectively. x × RGDP GDP, Int deposit interest rate, CPI inflation, ER Exchange rate, Topen trade openness, Rem total remittances

Table 7 Econometric results for the error correction model

Independent variables××	Coefficient (The dependent variable is Δ in credit to the private sector to GDP)	Coefficient (The dependent variable is Δ in the value of mobile transactions)	Coefficient (The dependent variable is in number of mobile transactions)	Coefficient (Δ in the number of bank accounts)
$\Delta RGDP$	0.1350 (2.81)***			0.0402 (1.03)
$\Delta RGDP_{t-1}$		2.3510 (1.81)*		
ΔER	0.3030 (3.16)***			-0.0511(-0.62)
ΔER_{t-1}			-3.2015(-2.44)**	
ΔRem	-0.0497(-1.75)*	-0.3592(-0.8108)	-1.8052(-3.55)***	
ΔRem_{t-1}			-1.9484(-3.20)***	0.0440 (2.01)**
ΔRem_{t-2}	-0.0542 (2.26)**		-1.1626(-2.29)***	
$\Delta Topen$	1.0226 (3.52)***	10.3785 (2.74)***	6.0101 (2.09)**	0.5069 (2.09)**
$\Delta Topen_{t-1}$		7.6800 (2.11)**		
$\Delta Topen_{t-2}$	0.4713 (2.92)***	7.2356 (1.92)*		
ΔCPI				-0.0002(-0.23)
ΔCPI_{t-1}		-0.0355(-1.62)		
ΔCPI_{t-2}	-0.3348(-21.65)			
ECM	-0.1117(-2.47)***	-0.3977(-5.72)***	-0.3950(-5.18)***	-0.0947(-2.13)**
R^2	0.50	0.56	0.65	0.25

For all the coefficients the t-statistics are in parenthesis; *, **, *** denote 10%, 5% and 1% significance levels, respectively. × × RGDP GDP, Int deposit interest rate, CPI inflation, ER Exchange rate, Topen trade openness, Rem total remittances

Table 6 reports the results of five different models from Columns 2 through 6, in which we use five different dependent variables as indicators of financial depth and inclusion.

The relationship between remittances is positive and significant in all the models presented in Table 6. This implies that remittances and financial development are important for both financial depth and inclusion, as the relationship persists regardless of the indicator for financial development. Column 2 displays the credit to the private sector as a share of GDP, and the positive coefficient of remittances implies that higher remittances increase savings, therefore facilitating more credit to the private sector. A similar interpretation is applicable to the relationship between remittances and number of bank accounts, as displayed in Column 6. This result is anticipated, as remittance flows provide opportunities for recipients to open bank accounts and access financial systems, and particularly in areas where banks serve as the primary remittance-paying agents. Moreover, received remittances can potentially expose both banked and unbanked remittance recipients to new financial products. These results corroborate findings from Fromentin (2017), Karikari et al. (2016), and Aggarwal et al. (2011), among others.

Columns 3 through 5 involve proxies for mobile remittance transfers, and the results seem to suggest that higher remittances boost the values and numbers of mobile transactions, as well as the number of agents involved in mobile transfers. This strong, positive relationship implies that more remittances are channeled through mobile technologies; further, migrants who take advantage of the low costs and convenience of mobile transfer channels can possibly increase their remittances through formal channels and subsequently deepen their financial inclusion, and especially in rural areas. As rural areas have substantial mobile coverage but low formal services through banks, this result suggest a potentially enhanced role of remittances on financial inclusion in such areas.

Moreover, mobile-to-mobile remittances also save costs related to travel and man-hours that would otherwise be wasted in traditional queues. These saved costs can subsequently boost remittance flows. The positive relationship between all indicators of mobile transactions and remittances further reflect the enabling regulatory environment that has led to the growth and acceptance of online remittance platforms, such as Skrill and Worldremit, which facilitate international remittance transfers. This analysis and its results are also supported by Kim et al. (2018), Ouma et al. (2017), International Fund for Agricultural Development-IFAD and the World Bank (2015), Mago and Chitokwindo (2014), and Mashayekhi (2014), among others.

The results demonstrate that the level of economic activity as represented by real GDP positively affects financial development, but its coefficient is only significant in the two models in which private sector credit to GDP and number of bank accounts are used as dependent variables. The results conform to the demand-pulling hypothesis of financial development as postulated by Patrick (1966). The relationship between trade openness and financial development is also positive as expected, and significant in all models except one. This result supports the theory that trade openness increases the demand for new financial products, including instruments for trade finance and the hedging of risks. Ho and Iyke (2018), Kim et al. (2010), and Law and Demetriades (2004) found similar results. The interest rate's coefficient is positive and significant as expected in Column 2 of Table 6, in which we used private sector credit to GDP as the dependent variable. However, when we replace private sector credit to GDP with the value and number of mobile transactions, the sign becomes negative, with a significant coefficient. A plausible explanation for this negative relationship between the deposit interest rate and mobile transactions would be that, as the commercial bank deposit interest rates increases, most bank deposits are kept in bank accounts, rather than in mobile accounts. Thus, more bank deposits will attract more savings toward commercial banks, rather than in mobile accounts where they earn no returns. The coefficient of inflation has a negative sign, as anticipated, but it is not significant in any of the models, except where we use the number of mobile agents as the dependent variable.

Table 7 presents the results of the short-term model and the error correction term, the latter of which represents the dependent and independent variables' adjustment speed to their long-run equilibrium following any shock. The coefficient measures the proportion of the last period's equilibrium error, which is corrected in the current period. The coefficient is negative and statistically significant in all estimated models, implying a convergence in the variables' long-run dynamics. The error-correction term in Column 2 implies that 11% of the last period's disequilibrium is corrected in the current period. In the case of a shock, it takes nearly ten quarters for the dependent variable and independent variables to restore their long-run equilibrium relationship. Columns 3 and 4 indicate that approximately 39% of the last period's disequilibrium is corrected in the current period; in this case, it takes approximately two and half quarters for the variables' equilibrium relationship to be restored.

In the last column, approximately 9% of the last period's disequilibrium is corrected in the current period, while it takes approximately 10 quarters for the equilibrium relationships among the variables to be restored. The results also demonstrate that remittances negatively affect financial development and inclusion in the short-run. This can be explained by arguing that when migrants initially move, they focus on sending money for

consumption, but as time passes and their families are stable, the possibilities of savings and increased deposits occur, an outcome visible in our long-run results.

Conclusions

Remittance flows have steadily increased over the last two decades to developing countries in general, and Kenya in particular, necessitating a review of the importance of the various remittance channels that impact growth aside from consumption smoothing. Thus, research on remittances' possible role in various macro-dimensions: the balance of payments through boosted foreign exchange reserves; increased financial inclusion and development through increased savings and enhanced bank deposits; and economic growth through increased diaspora investments has dominated the last one decade.

Against this background, this study examined the relationship between remittances and financial development using the ARDL co-integration technique on quarterly data from Kenya covering the period of 2006 to 2016. The study considered private sector credit as a share of GDP, indicators of mobile transactions, the number of bank accounts and bank branches, and commercial bank deposits to GDP as dependent variables. The results revealed a sensitivity to the indicators used for financial development. They also demonstrated co-integration relationships between the dependent variable and explanatory variables when private sector credit as a share of GDP, indicators of mobile transactions, and the number of bank accounts were used as dependent variables. However, no long-run relationship could be observed when deposits to GDP and the number of bank branches were used as dependent variables.

Therefore, our long-run models only considered those equations that indicated a co-integration between the dependent variable and the independent variables of interest. These model results demonstrated a strong, positive connection between remittances and financial development, regardless of the indicators selected for the latter. This relationship persisted when private sector credit as a share of GDP, the value of mobile transactions, number of mobile agents, number of mobile transactions, and number of bank accounts were used as dependent variables. This remittance-financial development connection implies that the potential exists for remittance flows to encourage the opening of bank accounts, which will enhance savings and influence credit allocations in Kenya. Thus, mobile technologies can be used as an international remittance transfer channel to expose the unbanked population to both existing and new financial products. This will ultimately promote the opening of bank accounts and positively impact financial depth and inclusion.

These results reveal a policy window for not only reducing remittance transfer costs by continuing to expand the regulatory space for more international remittance payment platforms, but also increasing remittance flows and financial inclusion. Therefore, it may be important to promote policies that encourage the use of modern, less expensive technology in the remittance-transfer business. Given remittances' importance in credit allocations, commercial banks may find it useful to increase tailored products for migrants and tap into the huge unexploited potential of the diaspora that can increase their deposit base and enhance savings and credit creation. These would include offering higher interest rates on deposits of remittances compared to local currency deposits to encourage the opening of diaspora accounts in local banks, as well as considering regular remittance flows as collateral for credit allocation. Additionally, an avenue worth exploration in Kenya involves the reactivation of bonds for diaspora participants to raise funds for infrastructure projects. This would

simultaneously provide an opportunity for these participants to not only accumulate savings, but also invest and participate in national development.¹⁶ Other relatively new diaspora frontiers not yet fully exploited include evolving the drive for increased remittances, savings mobilization, and the investment of diaspora funds through the Kenya Savings and Credit Co-operative Societies (SACCO)s, which have substantial potential to enhance financial inclusion in Kenya. This initiative's success would depend on a collaboration among the Ministry of Industry, Trade and Cooperatives; the Ministry of Foreign Affairs; the Ministry of Labor and Social Protection; the National Treasury; diaspora organizations; and private sector developers. These groups would ultimately develop strategies on the following issues, among others: the identification, mapping, profiling, and registration of the diaspora; the mobilization of savings; and the provision of information, education, and sensitization and training of the diaspora on prospects not yet tapped through the cooperative movement.¹⁷

This study's main limitation is assessment of remittances channeled through informal channels. Whether the amounts are substantial is not clear as data through these channels is unrecorded implying possibilities of understatements, which would be impeding capacities of policy makers to design appropriate policies aiming at leveraging remittances on development. Further research covering possibilities of capturing this data would enrich knowledge in this area and would trigger interest across the private sector, academia, policy makers and government in general.

Endnotes

¹The bottom billion refers to the world's poorest people, (For details, see Collier 2007)

²Financial development refers to the improvement of the quantity, quality and efficiency of financial services and products. It occurs when financial instruments, markets and institutions emerge to minimize the effects of information asymmetry, limited enforcement and transaction costs, which, in turn influences savings rate, investment decisions, technological innovation and growth, (Svirydzenka 2016; Cihak et al., 2013; Chong and Chan 2011). In this study, we mainly focus on the linkage between remittances and financial institutions or intermediaries, which are mainly banks as well as bank-like products facilitated by technology, mainly, mobile financial services.

³Financial inclusion refers to all initiatives that make formal financial services available, accessible and affordable to all segments of the population.

⁴A detailed account of Kenya's experience with M-Pesa is provided in Appendix 1.

⁵While this study acknowledges that remittances have both negative aspects highlighted in the text and positive ones as summarized in Amuedo-dorantes, (2014), it mainly focuses on examining the impact of remittances on financial development given the surge in remittances to Kenya in the recent past and the possibility of leveraging on technology to increase financial inclusion of the unbanked.

⁶M-Pesa products are explained in Appendix 1.

⁷The debate on aid is extensive and rich but largely inconclusive and biased towards ineffectiveness, particularly in Sub-Saharan countries. While a number of reasons such as poor policy environment, moral hazard, corruption and lack of coordination, among others, have been advanced for failure of aid effectiveness, no consensus exists of one set of reasons and differences abound in terms of the impact of the different components of aid in different countries and contexts. In this paper, the analysis focuses on the potentially greater benefits of remittances that are directly transferred to recipients

rather than aid that passes through the state or non-governmental agencies, who more often do not transfer it to the beneficiaries.

⁸Apart from the latest numbers specifically referenced, the series on prior years is based on data from various issues of the Migration and data, Remittance Price Worldwide and Send Money Africa websites.

⁹Target 10c of the sustainable development goals requires-All countries to reduce to less than 3% the transaction costs of migrant remittances and eliminate remittance corridors with costs higher than 5% by 2030.

¹⁰In an attempt to leverage on remittances for financial development and encourage usage of formal remittance channels, some countries such as Zimbabwe, Ethiopia, Kenya and Cape Verde have initiated remittance related incentive systems. In 2016, Zimbabwe introduced the Diaspora Remittance Incentive Scheme (DRIS), which is a bonus programme to incentivize remittances to Zimbabwe by adding a percentage of the funds remitted to the total remittance amount. Transfers to mobile money accounts are eligible to receive an extra 7% added to the funds sent while the transmitting agent and recipient are paid 2% and 3% of the amount remitted, respectively, in cases where payments are terminated through the banking system, (details are available in Truen et al. 2016). In 2018, through an amendment to Tax Procedures Act of the Finance Act 2016, Kenya offered a temporary tax amnesty to the diaspora for incomes earned since 2010, (Kenya Gazette Special Issue 2018). This may have partly led to an improvement in remittances in 2018. Moreover, the strong retail payment infrastructure facilitated through adoption of the agency model and M-Pesa enabled settlements, discussed elsewhere in this paper has also led to cost reduction of remitting funds to Kenya. Other countries such as Egypt, India, Sri Lanka and Ethiopia have positively influenced remittance flows through tax breaks, (Hagen-Zanker 2014).

¹¹See other possible forms of money laundering not extensively monitored but associated with cross-border capital flows including remittances in Chao et al. (2019).

¹²See [Appendix 3](#) for details of the methodology

¹³There is no consensus in the literature on the definition of trade openness. Some authors define it based on trade intensity while other base their definition on policies associated with the extent of outward orientation. Depending on the availability of data, various measures have been adopted in the literature with volume of trade as a share of GDP being one of the standard measures used in the literature, (Polat 2018; Fujii 2017; Karman et al. 2016; Squalli and Wilson 2011; Chinn and Ito 2006)

¹⁴Unit root test are carried out to establish whether the data used is stationary or non-stationary. If the data used is found to have a unit root, then one may need to difference to make it stationary in order to use it in time series regression. Regressing non-stationary data leads to spurious regressions.

¹⁵We also conducted causality tests and the results largely show unidirectional relationship from remittances to financial development for most of the financial development indicators. The results are reported in [Appendix 2](#).

¹⁶Kenya has had plans to launch Diaspora bonds since 2009. In the last decade it floated one major infrastructure bond to the Kenyan diaspora in 2011 for USD 600 million and got USD 141 million. The diaspora bond was unsuccessful due to restrictions in marketing the bond in foreign jurisdictions and perceived foreign exchange risk experienced in Kenya during that time, among other factors. Kenya has since offered other five infrastructure bonds targeting interested foreign and local investors without

explicitly targeting the Kenyan diaspora. The government jointly with its newly established diaspora office is working on developing and enhancing modalities to ensure diaspora bonds floated in future works. Diaspora bonds have been issued in Ethiopia and Nigeria but were successful only in Nigeria. Kenya and other countries would draw lessons on diaspora bonds as highlighted in Seliatou and Nana, (2012).

¹⁷According to the International Cooperative Alliance, Kenya is rated first in the co-operative movement in Africa and seventh globally and it belongs to the Group 10 of the most developed Sacco movement in the World. The SACCO movement had a savings base of Kshs. 380 billion as at 31st December 2012 with a capacity of 30% savings mobilization per annum. Thus, given that the Diaspora SACCO initiative is a new venture with the first SACCO (Kenya USA Diaspora SACCO) registered in 2012, (Gatuguta, Kimotho and Kiptoo, 2014), there is still great potential evident from the strong local development of these savings mobilization and investment movement.

¹⁸FinAccess Geospatial Survey 2015

¹⁹Communication Authority of Kenya Sector Statistics Report for The Financial Year 2018/2019, (July–September 2018)

²⁰Interoperability allows for sharing of same infrastructure across networks while non-exclusivity allows agents to seek contracts with multiple service providers

²¹Details of initial development of M-Pesa as a bank product in partnership with SafariCom company and commercial bank of Africa and operations of M-Pesa loan products as well as discussion of the regulatory aspects that paved way for the fast take off for M-pesa is available in Ndung'u, (2017)

²²Through such products as M-pesa lipa kodi, lipa karo, changa na M-pesa, e-citizen, lipa na M-pesa fuel loyalty, Okoa stima, M-pesa kadogo and Madaraka express ticket.

Appendix 1

Summary of M-Pesa operations in Kenya

M-Pesa

M-pesa is a mobile phone money transfer system launched in Kenya in 2007 by Vodafone, operated by SafariCom, the largest telecommunication network provider in Kenya. Initially, M-pesa was introduced as a means of making small –value person to person electronic transactions. However, over the years, it has undergone significant innovations leading to huge increases in volumes and values. For instance, since the adoption of mobile financial services in 2007, the mobile phone transfer service agents have brought about 70% of Kenyans within 3 km of a financial access touch-point.¹⁸ As of September 2018, mobile phone subscriptions stood at 46,630 million and mobile penetration was quoted at 100.10%, with the number of active registered mobile money transfer subscriptions at 29,678 million and 206,940 registered mobile money agents.¹⁹ In December 2018 alone, 155.774 million transactions worth KShs. 367.77 billion were conducted using mobile payment platforms. In addition, the products under the M-pesa platform have tremendously evolved to include person to business transactions, business to business services and credit and savings services thus contributing to financial inclusion.

With this phenomenal growth of the usage of M-Pesa, over the years, the Central Bank has been at the forefront in developing regulation that would safeguard the public from usury and misuse. The bank revised the National Payment System (NPS) Act by providing

regulations for electronic retail transfers, E-money regulation, regulation for the designation of a payment system and instrument, and a guide on Anti-Money Laundering. The regulations standardized operations in the mobile phone money transfer industry and strengthened the central bank in carrying out its mandate of promoting safety and efficiency of payment systems. Some of the regulations under the Central Bank Act Cap 491 are directly related to remittances and are mainly focused on facilitating operations and increasing remittance flows. Notably, the National Payment System Regulations have provided for interoperable payment systems both locally and internationally and revoked exclusivity clauses whereas Money Remittance Regulations govern establishment and licensing of money remittance operations.²⁰ In this case, NPS Regulations encouraged competition by prohibiting exclusive dealings with agents (Kenya Subsidiary Legislations-National Payment System Regulations 2014; Money Remittance Regulations, 2013). Moreover, the mobile networks and banks are accessible even in the remotest areas in Kenya facilitated by the agency banking model (branchless banking) where even retail shops/nonbank agents have been transacting banking services since 2010 when the Central Bank of Kenya provided agency banking guidelines, (CBK, 2010).

As described by Andiva (2015), provision of mobile financial services is categorized into the bank model, the mobile network operator model and the hybrid model. The bank model involves a bank or any other licensed financial services institutions as the main provider of mobile financial services under the Banking Act. In this case the clients should own a bank account consistent with prudential guidelines provided by the Central Bank of Kenya. The mobile banking services available under this model include payments, transaction between accounts and online banking, among others, and they are exclusively concluded by the client. The telecommunications company only provides menu based communication services in partnership with the bank. Mobile money transfer services under the mobile network operator model are operated under the telecommunications license and do not require ownership of a bank account. The hybrid model combines mobile banking services and mobile money transfer to offer such services as savings and loan products described below.

The M-pesa products are diverse including: provision of saving and loan products; payment services; investment channel; cross border transactions and international remittances services. For instance, commercial banks in Kenya have partnered with mobile network operators to enable customers to access their bank accounts through mobile phones. Mobile phones can be used for opening and operating virtual bank accounts and accessing traditional banking services like deposits, withdrawals and credit facilities without physical representation to the bank. Examples of such products

Appendix 2

Table 8 Granger Causality Tests

Causality from remittances to financial development and inclusion indicators	F-Statistic	Probability	Causality from financial development and inclusion indicators to remittances	F-Statistic	Probability
Credit to the private sector as a share of GDP	3.90	0.028**	Credit to the private sector as a share of GDP	0.75	0.475
Number of bank accounts	2.56	0.089*	Number of bank accounts	0.95	0.394
Number of mobile transactions	5.13	0.011***	Number of mobile transactions	7.14	0.002***
Value of mobile transactions	3.89	0.030**	Value of mobile transactions	0.63	0.537
Number of mobile agents	0.85	0.433	Number of mobile agents	1.80	0.180

*, ** and *** is the standard way of showing significance at 10%; 5% and 1%, respectively

include M-Shwari, Kenya Commercial Bank M-pesa, M-pesa Chama account and Mobi-Chama. Provision of these products has expanded financial access to the bottom billion in Kenya because mobile account holders can deposit, save and obtain micro credit as low as one dollar through these facilities. No minimum balances are required in maintaining the mobile accounts and no fee is charged on the account as was the case with most products offered in traditional banking systems.²¹ While the first two products mainly benefit individuals, the last two examples are for groups, in which members are allowed to perform transactions such as funds transfer, deposits, loan applications and loan approvals through the mobiles platform.

In addition, most payments in Kenya are made via M-pesa including government services such as fees for licenses, passports, court fees and fines; utilities such as electricity, water and garbage collection; transport fares, hotel accommodation and restaurants and many more.²² M-pesa registered customers also enjoy lower rates than other modes of sending and receiving international remittances. Empirical studies on the use of mobile money in Kenya show that the use of mobile money bring positive outcomes to persons. A market-level analysis conducted by Mbiti and Weil (2011) found that the introduction of M-pesa in Kenya led to significant decrease in the price of money transfer among competitors. Furthermore, they found an increase in the frequency of receiving remittances that contributed toward more financial inclusiveness in Kenya (Mbiti and Weil 2011; Jack and Suri 2011). Mobile Money Transfer has a clear edge over banks especially because it is fast, cost-effective and convenient (Ndung'u 2017 and Ndung'u 2018). One does not have to incur the opportunity cost of having to physically visit a bank to receive or send the payments.

Appendix 3

Details on methodology

Various methods have been used in time series analysis of single equation frameworks but three approaches are more widely used. The most popular is the Engle and Granger two step procedure (Engle and Granger 1987). Under this framework, the variables in the model are first tested for unit roots or order of integration to ensure they are of the same order of integration. Then a co-integrating test through OLS is conducted and the stationarity of the residuals from the co-integrating equation is tested (Tolcha and Rao 2016; Bo 2008). Stationary residuals imply co-integration and hence an error correction model constituting the residual from the co-integrating equation, lagged once, which is used as the error correction term is formulated. However, this approach does not work well when variables are more than two as there can be more than one co-integrating vector in such cases yet the method only provides one co-integrating relationship. Moreover, since it is a two-step regression involving estimation of residual series and another testing of unit root implies possibility of errors from first estimation being transferred to the final regression. The method also lacks power when considering finite samples and it is prone to simultaneous equation bias. Further, the approach is not applicable when testing hypothesis concerning the actual co-integration defined in the long-run regression equation in the first step of estimation. The second approach is the Johansen and it is most suitable in cases of multiple co-integrating vectors and a large sample size, (Koay and Choong 2013; Mostafavi 2012).

The autoregressive distributive lag model (ARDL) which is a linear time series model in which both the dependent and independent variables are related not only contemporaneously but across historical values as well, is the third method that is gaining preference over the other two due to its advantages. ARDL also referred to as bound co-integration technique is a least squares regressions using lags of the dependent and independent variables as regressors. ARDL allows application of co-integration tests to time series having different integration orders. It also has better statistical properties relative to Engle-Granger co-integration test because ARDL approach uses unconstrained error correction models and this approach also gives more reliable results in small samples relative to Engel-Granger and Johansen co-integration test. The ARDL also captures dynamic effects of both the dependent and independent variables, besides eliminating error serial correlation by including sufficient lags and allowing estimation of short-term and long-run simultaneously, (Nkoro and Uko 2016; Karamelikli and Bayar 2015; Datta and Sarkar 2014; Alimi 2014).

Abbreviations

2SLS: Two stage least squares; ACC: Number of bank accounts; ADF: Augmented Dickey Fuller; AML/CFT: Anti-Money Laundering/Countering Financing of Terrorism; ARDL: Autoregressive distributed lag; CBK: Central Bank of Kenya; CPI: Consumer price index; CRED: Private sector credit as a share of GDP; ECM: Error correction model; ER: Exchange rate; FinD: Financial development; GDP: Gross Domestic Product; GMM: Generalized method of moments; IFAD: International Fund for Agricultural Development; Int: Interest rate; Mob: Mobile transactions; NPS: National Payment Systems; OLS: Ordinary least squares; Rem: Remittances; RGDP: Real gross domestic product; SACCOs: Savings and Credit Co-operative Societies; SSA: Sub-Saharan Africa; TOPEN: Trade openness; VAR: Vector autoregression; VECM: Vector Error Correction Model

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Authors' contributions

RM (Corresponding author), Introduction, Part of remittance flows to Kenya, Part of literature review, Methodology, Estimation and discussion of findings, Conclusions, Consolidation of entire paper. AK, Data collection, Part of literature review. HN, Part of remittance flows to Kenya, Part of literature review. All authors read and approved the final manuscript.

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The data sets used in this study is available in the World Bank Websites (<http://www.worldbank.org/en/topic/migrationremittancesdiasporaissues/brief/migration-remittances-data>) <https://remittanceprices.worldbank.org/en> Kenya National of Statistics websites- <https://www.centralbank.go.ke/> Central Bank of Kenya websites- <https://www.knbs.or.ke/>

Competing interests

The authors declare that they have no competing interests.

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