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**Working Paper**

# Remittances, the diffusion of information and industrialisation in Africa

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# A G D I Working Paper

## WP/19/024

**Remittances, the Diffusion of Information and Industrialisation in Africa**[1]

Forthcoming: Contemporary Social Science

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Research Department

# Remittances, the Diffusion of Information and Industrialisation in Africa

**Simplice A. Asongu & Nicholas M. Odhiambo**

January 2019

## Abstract

This study examines the role of information and communication technology (ICT) on remittances for industrialisation in a panel of 49 African countries for the period 1980-2014. The empirical evidence is based on three simultaneity-robust estimation techniques, namely: (i) Instrumental Fixed Effects (FE) in order to control for the unobserved heterogeneity; (ii) Generalised Method of Moments (GMM) to account for persistence in industrialisation; and (iii) Instrumental Quantile Regressions (QR) to control for initial levels of industrialisation. Our best estimators are from FE and QR estimations because the GMM regression outputs largely fail post-estimation diagnostic tests. The following findings are established: (i) There are positive marginal effects from the interaction between remittances and ICT in the FE regressions whereas there are negative marginal impacts from the interaction between remittances and ICT; (ii) Interactions between remittances and mobile phone penetration are positive in the bottom and 90$^{th}$ quantiles whereas the interaction between internet penetration and remittances is positive in the bottom and top quantiles of the industrialisation distribution. Overall, the role of ICT in remittances for industrialisation is much more apparent when existing levels of industrialisation are accounted for. The findings contribute to the debates on the importance of external flows and information infrastructure in economic growth as well as the relevance of remittances in driving economic development in environments where institutions are weak. The value of the study to scholars and policy makers also builds on the fact that the potential for ICT and remittances in Africa can be leveraged to address development challenges on the continent such as the low level of industrialisation.

*JEL Classification*: F24; F43; F63; O30; O55
*Keywords*: Remittances; Industrialisation; ICT; Africa

## Introduction

The positioning of this inquiry is motivated by three fundamental factors, namely, the: (i) growing trend of remittances in Africa; (ii) high potential for the penetration of instruments of information diffusion on the continent; and (iii) lagging position of Africa in terms of industrialisation.

First, remittances have been increasing in Africa since the year 2000. In accordance with recent literature, remittances are as relevant as other external flows (e.g. foreign aid and foreign direct investment) in boosting African industrialisation (Efobi et al., 2019); output per worker (Ssozi & Asongu, 2016a) and total factor productivity (Ssozi & Asongu, 2016b). Other potential benefits of remittances over other forms of external capital flows include: their less volatile and cyclical nature, which ensures the reliability of this source of finance. The potential for remittances in African development has recently been the focus of many development practitioners, who are consistent on the need to harness all sources of external capital flows. For instance, the Joint African Union Economic Commission for Africa (ECA) in 2013 articulated the need for countries on the continent to leverage the potential of remittance inflows (Efobi et al., 2019).

Second, compared to the rest of the world, the potential for information and communication technology (ICT) in Africa is higher. In accordance with recent literature, whereas high-end countries in Asia, Europe and North America are experiencing saturation levels in ICT growth, there is great room for its penetration in Africa (Penard et al., 2012; Tchamyou, 2017; Efobi et al., 2018; Asongu, 2018; Afutu-Kotey et al., 2017; Bongomin et al., 2018; Asongu & Boateng, 2018; Gosavi, 2018; Humbani & Wiese, 2018; Minkoua Nzie et al., 2018; Muthinja & Chipeta, 2018; Isszhaku et al., 2018; Abor et al., 2018). This implies that policy can harness such potential for penetration in order to tackle development issues, *inter alia*: limited industrialisation.

Third, compared to other regions of the world, Africa is lagging in terms of industrialisation. The relatively low progress of the industrial sector on the continent has been traceable to the *inter alia*: poor infrastructure and skills levels and an unappealing climate of investment (Page, 2012; Gui-Diby & Renard, 2015) and lack of the investment capital needed to fund processes of industrialisation (Tuomi, 2011; Darley, 2012; Asongu & Odhiambo, 2019a).

The present study aims to complement existing literature and address challenges to policy by merging the three strands above. It is important to merge the three strands because the potential for remittance inflows (covered in the first strand) and ICT penetration

(engaged in the second strand) in Africa can be leveraged to address development challenges in the continent such as the low level of industrialisation (covered in the third strand). Accordingly, macroeconomic factors that have a high potential of growth can be used to enhance macroeconomic development outcomes such as industrialisation. To this end, we investigate how ICT interacts with remittances to enhance industrialisation. As we shall articulate in section 2, the literature on the nexus between remittances and industrialisation has failed to engage linkages between ICT, remittances and industrialisation. The intuition for this inquiry builds on the fact that, on the one hand, ICT has substantially facilitated remittance flows into developing countries (Munyegera & Matsumoto, 2016; Asongu & Nwachukwu, 2016a) and on the other hand, ICT also facilitates the doing of business and entrepreneurship (Efobi et al., 2018). Moreover, the relationship between remittances and characteristics of industrialisation has been established in the literature (Massey & Parrado, 1998; Woodruff & Zenteno, 2007; Efobi et al., 2019). Hence, the study builds on established evidence that remittances represent a source of new venture capital and the establishment of businesses in developing countries (Woodruff & Zentano, 2001; Efobi et al., 2019). In the study, ICT is considered as a policy channel through which the effect of remittances on industrialisation can be enhanced. Hence, the main channel being considered is the policy channel of ICT.

In summary, we argue that ICT can facilitate the role of remittances in industrialisation when the dependence on remittances for industrialisation by an economy is facilitated by policies designed to boost ICT penetration. Accordingly, households, entrepreneurs and business owners receiving remittances can more easily use the funds to boost industrialisation if ICT penetration is high in an economy, compared to an economy with a seemingly low ICT penetration. This is essentially because ICT has been established to facilitate, *inter alia*, entrepreneurship, the development of new businesses and economic participation (Efobi et al., 2018). Hence the importance of ICT in facilitating the role of remittances in industrialisation is both ex-ante (before the remittance process) and ex-post (after the remittance process) because respectively, ICT facilitates the flow of remittances into developing countries and the use of such remittances to exploit business opportunities. To us this intuition for the connection between remittances, ICT and industrialisation is sound. Moreover, applied econometrics based on sound intuition is a useful scientific activity that could provide insights for theory-building (Costantini & Lupi, 2005; Narayan et al., 2011).

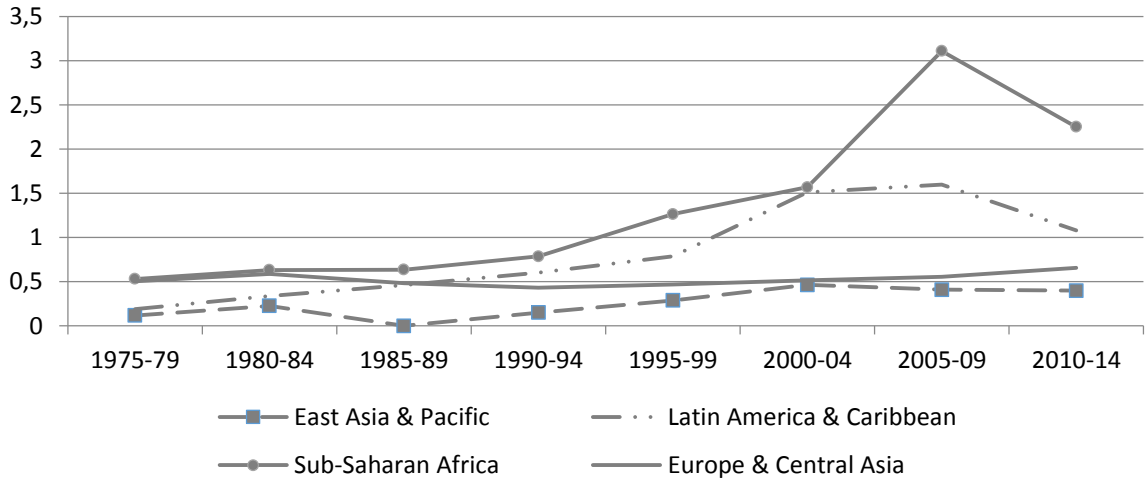
The rest of the study is structured as follows. A section on stylized facts and related literature follows this introduction after which there is a section on the data and methodology. The penultimate section on presentation of results discloses and discusses the empirical findings while the last section concludes with future research directions.

## Stylized Facts and Related Literature

### *Stylized facts on remittances and industrialisation in Africa*

The stylized facts are discussed in two main strands, namely: (i) recent trends in Diaspora remittance inflows and (ii) an exploratory nexus between remittances and industrialisation. First, like foreign direct investment (FDI) and official development assistance, remittances have both direct and indirect consequences for the industrialisation process in recipient countries. The relevance of increasing remittances in the development of African countries is apparent in Figure 1 in which, compared to other regions of the world, the underlying external flow in some sub-regions of the continent like sub-Saharan Africa (SSA) is relatively high. The graph is abundantly clear on the leading position of SSA compared to East Asia and the Pacific, Central Asia and Europe. Accordingly, from an average perspective, since the year 2000, the inflow of remittances into SSA has been higher than 1.5% as a percentage of GDP. Conversely, corresponding remittance inflows into the other regions (Europe, East Asia and Central Asia) did not reach the threshold (Efobi et al., 2019).

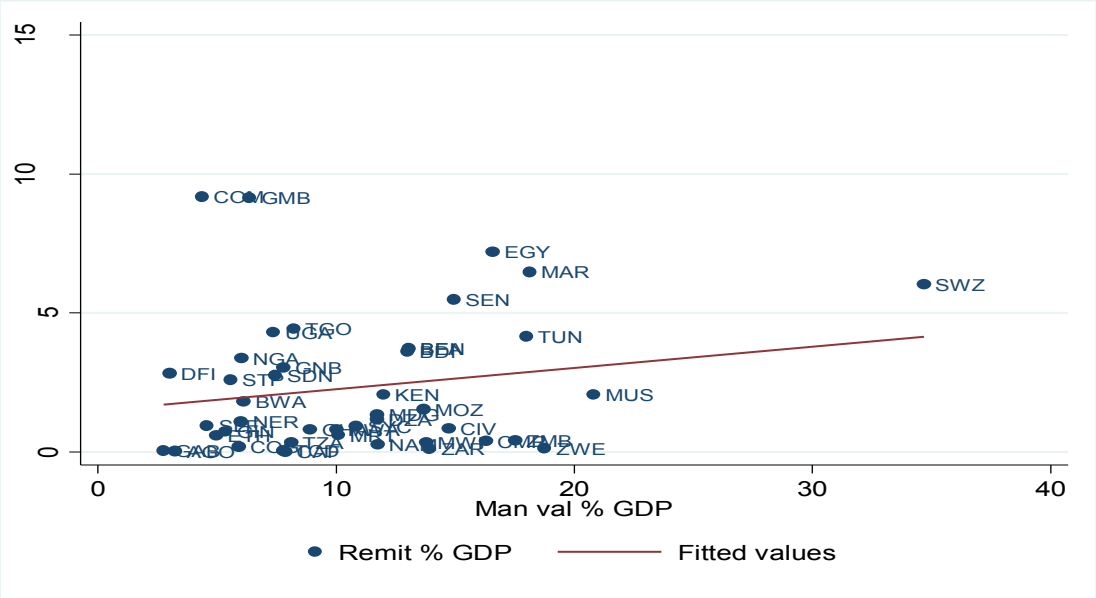
**Figure 1: Remittance Inflow as a Percentage of GDP**




**Source:** Computed from World Development Indicators (2016).

In the second strand, we show in Figure 2 that a positive relationship can be expected between remittances and industrialisation. The scatter plot proxies for industrialisation with the manufacturing value added as a % of GDP (see Gui-Diby & Renard, 2015) while remittances are appreciated with personal remittances received from the Diaspora as a % of GDP. For each of the sampled nations, increasing remittances enhances the volume of added value in the manufacturing sector. The nexus implies that we can be confident that some positive causal relationship between remittances and industrial development can be expected from the empirical analysis in Section 4.

**Figure 2: Scatter Plot (Remittance and Industrialisation in Africa – 1980-2015)**




Source: Authors' Computation

**Remittances and Industrialisation**

In accordance with Naude et al. (2013) and Efobi et al. (2019), industrialisation can be understood as a socio-economic process of quick transformation in the manufacturing sector with respect to a multitude of production avenues and work done within an economy. It consists of the added value in the manufacturing sector when the overall economic size is taken into consideration. Consistent with Gui-Diby and Renard (2015), when there is comparatively high development in the manufacturing sector in relation to other sectors in the economy, there is a faster rate of the country's industrialisation process. In the light of the definitions, two components are essential for the enhancement of the industrialisation process. They entail: (i) the provision of production incentives to the manufacturing sector and (ii) the sustainability of the corresponding production in order to fulfil local and international requirements.

While remittances have fundamentally been considered as a form of altruism designed to play a role in social insurances (Kapur, 2004; Agarwal & Horowitz, 2002), the externalities of remittances go beyond household rewards (Efobi et al., 2019). According to the narrative, the wealth of literature on the subject documents the usage of remittances beyond final consumption demands. Moreover, in the absence of a formal banking sector and capital markets, remittances may provide the capital for business start-ups and entrepreneurial activities. This position is consistent with Woodruff and Zentano (2001), who have shown that about 27% of corporations in Mexico were dependent on Diaspora remittances to finance their liquidity. The same authors also maintain that such remittances also made up about 20% of capital that is invested for the development of corporations in the country.

In the light of the above, the positive direct relevance of remittances in entrepreneurship is consistent with a bulk of literature on the subject, notably: for the growth and expansion of Mexican enterprises (Massey & Parrado, 1998; Woodruff & Zenteno, 2007); investment in entrepreneurship by Filipinos (Yang, 2008); the positive long term impact of remittances on investment in Bangladesh (Hossain & Hasanuzzaman, 2015); promotion of skills transfers to homelands in Afghanistan, Philippines and the Peoples Republic of China (PRC) (Brinkerhoff, 2006); boosting of market-oriented agricultural investments (Syed & Miyazako, 2013); improvement of farm and non-farm production in Ghana (Tsegai, 2004); increasing manufacturing growth (Dzansi, 2013); enhancing per-worker output (Ssozi & Asongu, 2016a) and improving total factor productivity (Barajas et al., 2009; Ssozi & Asongu, 2016b).

Some indirect channels via which remittances could influence industrialisation which have also been substantially documented in the literature include: the exchange rate (see Rajan & Subramanian, 2005; Lartey et al., 2008; Barajas et al., 2009; Acosta et al., 2009; Lartey & Mandelman, 2009; Selaya & Thiele, 2010; Dzansi, 2013; Amuedo-Dorantes, 2014) and financial sector development (Aggarwal et al., 2011;Bettin et al, 2012; Osabuohien & Efobi, 2012; Efobi et al, 2014; Kaberuka & Namubiru, 2014; Karikari et al., 2016; Efobi et al., 2019).

Whereas the engaged strands of the literature broadly agree on the positive direct and indirect roles of remittances on the industrial process, as far as we have reviewed, the role of ICT has not been engaged. ICT can substantially boost remittances because the process of mobile money transfer to domestic economies substantially depends on communication facilities such as mobile phones and the internet. These ICT facilities are used to

communicate underlying remittance transfer details from the sender in an advanced country to a recipient in Africa.

## Data and Methodology

### *Data*

The inquiry examines a panel of forty nine nations with data for the period 1980-2014 from the United Nations Conference for Trade and Development (UNCTAD) database and the World Bank Development Indicators (WDI) of the World Bank. While Quantile and Fixed Effects regressions depend on an annual periodicity that spans 35 years, the Generalised Method of Moments (GMM) is based on non-overlapping intervals or data averages. Hence, we have seven data points: 1980-1984; 1985-1989; 1990-1994; 1995-1999; 2000-2004; 2005-2009 and 2010-2014. The purpose of employing data averages for the GMM estimation approach is to reduce concerns about instrument proliferation or over-identification.

The adopted dependent variable is the measure of industrialisation which is proxied as the manufacturing added value in constant prices as a percentage of GDP. This measurement of industrialisation is traceable to the International Standard Industrial Classification (section D). The indicator proxies for units of productive manufacturing are categorised with respect to the type of principal activity, which entails activities that are undertaken manually or by power-tailored machinery, as well as household or factor-related work (United Nations, 1990). Furthermore, the underlying industrialisation measurement has been preferred in recent literature (Kang & Lee, 2011; UNIDO, 2013; Gui-Diby & Renard, 2015).

Two principal explanatory indicators are used: (i) personal remittances received (as % of GDP) and (ii) ICT proxied with mobile phone penetration and internet penetration. It is important to note that while remittances are the principal orientation of the inquiry, ICT is employed as a channel through which remittances are boosted to ultimately affect the industrialisation process. Hence, the employment of ICT policy variables is in accordance with the imperative to assess both direct and indirect effects of remittances in the process of industrialisation.

Five control indicators are employed to account for omitted variable bias in the regressions. These include trade openness, domestic investment in terms of gross fixed capital formation, population growth, financial intermediation efficiency and private credit to the domestic sector. Whereas from an intuitive perspective positive effects can be expected from the underlying control variables, in reality the nature of the sign is contingent on market

expansion and dynamism. For example, if domestic investment is more oriented towards health, educational and social amenities, the direct effect on industrialisation may not be apparent. Furthermore, the deviation of such domestic investment from the productive sector may even negatively influence the process of industrialisation. On the other hand, an increase in demography may not have a positive incidence on industrialisation if the incremental demand from the population is for foreign commodities. This narrative also doubles to elucidate why trade openness could still bear negatively on industrialisation. The effect of financial development indicators depends on the ability of banks to transform mobilised deposits into credit for economic operators. In essence, surplus liquidity issues whichhave been substantially documented in African financial institutions (Saxegaard, 2006; Asongu, 2014) may translate into the financial development indicators affecting industrialisation negatively because economic operators do not have access to the much needed credit for investment purposes.

The full definitions of the variables are disclosed in Appendix 1, whereas the correlation matrices are provided in Appendix 2. Whereas Panel A of Appendix 2 shows independent and control variables that are not instrumented, Panel B discloses corresponding variables that are instrumented. The instrumented (uninstrumented) variables are used in the Fixed Effects and Quantile (GMM) regressions.

## Methodology

*Instrumentation and instrumental Fixed effects estimations*

We employ three simultaneity-robust estimation approaches, namely: (i) Instrumental Variable (IV)[2] Fixed Effects to account for the unobserved heterogeneity; (ii) GMM to control for persistence in industrialisation; and (iii) IV Variable Quantile regressions to control for initial levels of industrialisation. The use of a battery of estimation approaches is consistent with the behaviour of the data (Asongu & Nwachukwu, 2016b; Boateng et al., 2018; Asongu et al., 2018). For instance: (i) given that the research is dealing with many African countries, it is relevant to account for country-specific effects with Fixed Effects regressions. (ii) The correlation between the level values and first lags of the industrialisation variable is higher than 0.800 which is the rule of thumb for establishing that significant stochasticity is apparent in the outcome variable to justify the use of an estimation technique such as the GMM that accounts for persistence in the outcome variable

[2] Instrumental Variable and Instrumental are used interchangeably throughout the study.

(Tchamyou, 2019a). (iii) There is significant variation in the outcome variable to inform the study that countries with low levels of industrialisation can respond differently to ICT and remittance inflows, compared to their counterparts with higher levels of industrialisation. This justifies the use of an estimation technique that accounts for initial levels of industrialisation such as quantile regressions (Asongu & Odhiambo, 2019b).

The concern about simultaneity (which is an aspect of endogeneity) in the explanatory indicators is addressed by instrumenting them with their first lags. The procedure for instrumenting ICT is as follows in equation (1) below.

$$\mathrm{Re}_{i,t} = \alpha + \delta_j\left(\mathrm{Re}_{i,t-1}\right) + \eta_i + \varepsilon_{i,t} \ , \qquad (1)$$

where $\mathrm{Re}_{i,t}$, denotes remittances of country $i$ in period $t$, $\alpha$ is a constant, $\mathrm{Re}_{i,t-1}$, represents remittances in country $i$ in period $t-1$, $\eta_i$ is the country-specific effect and $\varepsilon_{i,t}$ the error term.

The process of instrumentation in equation (1) entails regressing the explanatory variables on their first lags and later saving the corresponding fitted values that are subsequently employed as the principal independent variables in the Quantile and Fixed Effects estimations. It is important to note that the instrumentation processes are Heteroscedasticity and Autocorrelation Consistent (HAC) in standard errors.

The panel Fixed Effects (FE) models are presented in equation (2) as follows:

$$I_{i,t} = \partial_0 + \partial_1 \mathrm{Re}_{i,t} + \partial_2 ICT_{i,t} + \partial_3 \mathrm{Re}\, ICT_{i,t} + \sum_{h=1}^{5} \omega_h W_{h,i,t-\tau} + \eta_i + \varepsilon_{i,t} \ , \qquad (2)$$

where, $I_{i,t}$ is the industrialisation indicator of country $i$ in period $t$, $\partial$ is a constant, $\mathrm{Re}$ is remittances, $ICT$ represents information and communication technology (mobile phone penetration or internet penetration), $\mathrm{Re}\,ICT$ is the interaction between remittances and ICT, $W$ is the vector of control variables (trade openness, gross fixed capital formation, population growth, financial intermediation efficiency and private credit to the domestic sector), $\eta_i$ is the country-specific effect and $\varepsilon_{i,t}$ the error term.

*Generalised method of moments: specification, identification and exclusion restrictions*

There are many motivations for adopting a GMM technique (Tchamyou et al., 2018). First, the N(49)>T(7) criterion which is essential for applying the estimation technique is met because the number of cross sections (or countries) is considerably higher than the related number of years in each cross section. Note should be taken of the fact that we are employing 5 year data averages or non-overlapping intervals for the GMM approach. Second, the

dependent variable under consideration is persistent because the correlation between industrialisation and its first lag (0.968) is above the 0.800 rule of thumb. Third, since the GMM methodology is consistent with a panel data structure, cross-country differences are not eliminated in the regressions. Fourth, inherent biases in the *difference* estimator are considered in the *system* estimator. Fifth, endogeneity is controlled-for by the estimation technique because the issue of simultaneity in the explanatory variables is addressed by an instrumentation process. Furthermore, the employment of time-invariant omitted indicators also boosts the control for endogeneity.

Following Bond et al. (2001), the *system* GMM estimator (see Arellano & Bond, 1995; Blundell & Bond, 1998) has better properties of estimation relative to the *difference* estimator (Arellano & Bond, 1991). The Roodman (2009a, 2009b) extension of Arellano and Bover (1995) is adopted in this study because it has been established to: (i) limit instrument proliferation or restrict over-identification and (ii) control for cross-sectional dependence (Love & Zicchino, 2006; Baltagi, 2008; Boateng et al., 2018; Tchamyou, 2019a, 2019b; Agoba et al., 2019; Fosu & Abass, 2019). Therefore the extended estimation procedure adopts forward orthogonal deviations as opposed to first differences.

A *two-step* procedure is adopted instead of a *one-step* approach because it addresses concerns of heteroscedasticity given that the *one-step* procedure only controls for homoscedasticity. The following equations in level (3) and first difference (4) summarise the standard *system* GMM estimation procedure.

$$I_{i,t} = \sigma_0 + \sigma_1 I_{i,t-\tau} + \sigma_2 \mathrm{Re}_{i,t} + \sigma_3 ICT_{i,t} + \sigma_4 \mathrm{Re}\, ICT_{i,t} + \sum_{h=1}^{5} \delta_h W_{h,i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (3)$$

$$I_{i,t} - I_{i,t-\tau} = \sigma_1 (I_{i,t-\tau} - I_{i,t-2\tau}) + \sigma_2 (\mathrm{Re}_{i,t} - \mathrm{Re}_{i,t-\tau}) + \sigma_3 (ICT_{i,t} - ICT_{i,t-\tau}) + \sigma_4 (\mathrm{Re}\, ICT_{i,t} - \mathrm{Re}\, ICT_{i,t-\tau}) + \sum_{h=1}^{5} \delta_h (W_{h,i,t-\tau} - W_{h,i,t-2\tau}) + (\xi_t - \xi_{t-\tau}) + (\varepsilon_{i,t} - (\varepsilon_{i,t-\tau}) \quad (4)$$

where, $\tau$ represents the coefficient of auto-regression and $\xi_t$ is the time-specific constant.

It is important to engage identification properties and exclusion restrictions which are relevant to a sound GMM specification. In accordance with recent literature, all independent variables are considered as suspected endogenous or predetermined indicators and only years or time-invariant omitted indicators are considered to exhibit strict exogeneity (Boateng et al., 2018; Asongu & Nwachukwu, 2016b; Tchamyou et al., 2019). The intuition for the

underlying variables builds on the common sense that it is not likely for the time-invariant omitted variables to become endogenous after a first difference (Roodman, 2009b)[3].

Given the above emphasis, the time-invariant omitted indicators affect the dependent variable exclusively via the suspected endogenous indicators. Moreover, the statistical relevance of the exclusion restriction is assessed with the Difference in Hansen Test (DHT) for instrument exogeneity. In essence, the null hypothesis of the DHT should not be rejected for the time-invariant indicators to elicit the dependent variable exclusively through the suspected endogenous variables. Therefore, in the findings that are reported in Section 5, the assumption of exclusion restriction is validated if the alternative hypothesis of the DHT related to instrumental variables (IV) (year, eq(diff)) is not accepted. This is broadly consistent with the standard IV procedure in which a rejection of the null hypothesis of the Sargan Overidentifying Restrictions (OIR) test is an indication that the instruments affect the outcome variable beyond the suggested suspected endogenous variable channels (Beck et al., 2003; Asongu & Nwachukwu, 2016c).

*Instrumental Quantile regressions*

The FE and GMM estimation approaches are founded on mean values of the dependent variable. Modelling on mean values of the dependent variable has the shortcoming of presenting blanket policies which are less likely to be effective unless such policies account for initial values of the outcome variable. Hence, in order to address this shortcoming, a Quantile Regressions (QR) approach is used because it accounts for existing levels of industrialisation. Hence, the estimation approach articulates countries with high, intermediate and low levels of industrialisation. Hence, the issue of QR enables the study to investigate the underlying nexus throughout the conditional distributions of the outcome variable (Okada & Samreth, 2012; Billger & Goel, 2009; Asongu, 2013).

In light of the above, inquiries that investigate mean effects with Ordinary Least Squares (OLS) are based on the assumption that errors are normally distributed. The hypothesis of normally distributed error terms does not hold for the QR approach. Furthermore, the empirical strategy is robust to the presence of outliers since the technique enables the estimation procedure to model estimated parameters at multiple points of the conditional distribution of industrialisation (see Koenker & Bassett, 1978; Keonker & Hallock, 2001)

[3]Hence, the procedure for treating *ivstyle* (years) is 'iv (years, eq(diff))' whereas the *gmmstyle* is employed for predetermined variables.

The $\theta^{th}$ quantile estimator of industrialisation is obtained by solving the following optimisation problem, which is presented without subscripts for simplicity in equation (5)

$$\min_{\beta \in R^k} \left[ \sum_{i \in \{i: y_i \geq x_i'\beta\}} \theta \left| y_i - x_i'\beta \right| + \sum_{i \in \{i: y_i < x_i'\beta\}} (1-\theta) \left| y_i - x_i'\beta \right| \right], \quad (5)$$

where $\theta \in (0,1)$. As opposed to OLS that is fundamentally based on minimising the sum of squared residuals, with QR, the weighted sum of absolute deviations are minimised. For instance, the $10^{th}$ or $90^{th}$ quantiles (with $\theta$=0.10 or 0.90 respectively) are investigated by approximately weighing the residuals. The conditional quantile of industrialisation or $y_i$ given $x_i$ is:

$$Q_y(\theta / x_i) = x_i'\beta_\theta \ , \quad (6)$$

where unique slope parameters are modelled for each $\theta^{th}$ specific quantile. This formulation is analogous to $E(y / x) = x_i'\beta$ in the OLS slope where parameters are assessed only at the mean of the conditional distribution of industrialisation. In equation (6), the dependent variable $y_i$ is industrialisation while $x_i$ contains a constant term, remittances, ICT(internet penetration and mobile phone penetration), interaction between remittances and ICT, trade openness, gross fixed capital formation, population growth, financial intermediation efficiency and private credit to the domestic sector. Since all independent variables are instrumented, the OLS modelling in the QR approach becomes an exercise of Two Stage Least Squares.

**Presentation of Results**

The interactive and non-interactive Fixed Effects and GMM regressions are presented in Table 1 whereas Table 2 and Table 3 respectively present the non-interactive and interactive QR. Whereas, the non-interactive regressions enable the study to assess direct effects of remittances on industrialisation, corresponding interactive regressions enable the estimation of indirect effects through ICT. In other words, the interactive regressions enable the study to examine the role of ICT in facilitating the effect of remittances on industrialisation. The overwhelming significance of the Hausman test is used to ascertain the fit of the FE over Random Effects (RE) regressions.

## Table 1: Fixed Effects and GMM Interactive and Non-Interactive Regressions

**Dependent variable: Industrialisation**

| | **Instrumental Variable Fixed Effects** | | | | | **GMM (with 5 Year NOI)** | | | |
|---|---|---|---|---|---|---|---|---|---|
| Industrialisation(-1) | --- | --- | --- | --- | | **0.915*** (0.000)** | **1.029*** (0.000)** | **0.954*** (0.000)** | **1.001*** (0.000)** |
| Constant | **14.002*** (0.000)** | **14.098*** (0.000)** | **15.158*** (0.000)** | **15.461*** (0.000)** | Constant | **3.171*** (0.001)** | **-0.381 (0.603)** | **2.956*** (0.000)** | **0.127 (0.854)** |
| Remit(IV) | -0.0005 (0.895) | -0.0001 (0.663) | **-0.001*** (0.000)** | **-0.002*** (0.000)** | Remit | **0.050*** (0.000)** | **0.098*** (0.000)** | **0.053*** (0.000)** | **0.077*** (0.000)** |
| Mob (IV) | **-0.001*** (0.006)** | --- | **-0.004*** (0.000)** | --- | Mob | 0.008 (0.172) | --- | **0.010* (0.067)** | --- |
| Inter (IV) | --- | **-0.001** (0.016)** | --- | **-0.006*** (0.000)** | Inter | ---- | **0.084*** (0.000)** | --- | **0.094*** (0.000)** |
| Remit(IV)×Mob(IV) | --- | --- | **0.000005*** (0.000)** | --- | Remit×Mob | --- | --- | **-0.001*** (0.000)** | --- |
| Remit(IV)×Inter(IV) | --- | --- | --- | **0.000007*** (0.000)** | Remit×Inter | --- | --- | --- | **-0.004*** (0.002)** |
| Trade (IV) | **0.010*** | **0.009*** | **0.009*** | **0.009*** | Trade | -0.0005 | **-0027***** | -0.004 | **-0.023*** (0.000)** |
| | **(0.066)** | **(0.095)** | **(0.070)** | **(0.074)** | | (0.910) | **(0.000)** | (0.351) | |
| GFCF(IV) | **-0.087*** (0.000)** | **-0.088*** (0.000)** | **-0.085*** (0.000)** | **-0.083*** (0.000)** | GFCF | -0.015 (0.366) | **0.045** (0.017)** | -0.020 (0.164) | **0.037** (0.027)** |
| Population(IV) | **-0.030** (0.029)** | **-0.032** (0.018)** | **-0.031** (0.022)** | **-0.029** (0.033)** | Population | 0.003 (0.211) | **-0.006* (0.087)** | 0.001 (0.482) | **-0.006* (0.076)** |
| Bank Efficiency(IV) | **-0.004* (0.071)** | **-0.004* (0.095)** | **-0.007*** (0.005)** | **-0.007*** (0.004)** | Bank Efficiency | -0.005 (0.231) | 0.002 (0.613) | -0.004 (0.354) | -0.002 (0.577) |
| Private credit (IV) | **-0.022** (0.027)** | **-0.023** (0.026)** | **-0.018* (0.073)** | -0.016 (0.116) | Private credit | -0.003 (0.684) | **-0.051*** (0.000)** | -0.001 (0.892) | **-0.040*** (0.001)** |
| | | | | | AR(1) | (0.009) | (0.011) | (0.008) | (0.015) |
| | | | | | AR(2) | **(0.173)** | (0.051) | **(0.178)** | (0.060) |
| | | | | | Sargan OIR | **(0.166)** | **(0.367)** | **(0.298)** | **(0.368)** |
| | | | | | Hansen OIR | **(0.631)** | **(0.802)** | **(0.739)** | **(0.570)** |
| | | | | | DHT for instruments (a)Instruments in levels | | | | |
| | | | | | H excluding group | **(0.565)** | **(0.354)** | **(0.488)** | **(0.523)** |
| | | | | | Dif(null, H=exogenous) | **(0.568)** | **(0.902)** | **(0.757)** | **(0.524)** |
| | | | | | (b) IV (years, eq(diff)) | | | | |
| | | | | | H excluding group | **(0.534)** | **(0.825)** | **(0.551)** | **(0.528)** |
| | | | | | Dif(null, H=exogenous) | **(0.644)** | **(0.454)** | **(0.901)** | **(0.519)** |
| R²(within) | 0.0554 | 0.0542 | 0.077 | 0.0877 | | | | | |
| Hausman | **16.46**** | **16.34**** | **17.05**** | **17.77**** | | | | | |
| Fisher | **11.72***** | **11.43***** | **14.73***** | **16.78***** | Fisher | **207.20***** | **213.71***** | **959.66***** | **399.55***** |
| | | | | | Instruments | 36 | 36 | 40 | 40 |
| Countries | 49 | 49 | 49 | 49 | Countries | 49 | 49 | 49 | 49 |
| Observations | 1453 | 1453 | 1453 | 1453 | Observations | 233 | 203 | 233 | 203 |

*,**,***: significance levels of 10%, 5% and 1% respectively. DHT: Difference in Hansen Test for Exogeneity of Instruments' Subsets. Dif: Difference. OIR: Over-identifying Restrictions Test. The significance of bold values is twofold. 1) The significance of estimated coefficients, Hausamantest and the Fisher statistics. 2) The failure to reject the null hypotheses of: a) no autocorrelation in the AR(1) and AR(2) tests; and b) the validity of the instruments in the OIR and DHT tests.
IV: Instrumented value. Remit: Remittances. Bank efficiency: Bank Credit to Bank Deposits. Private credit: Domestic credit to the private sector. GFCF: Gross Fixed Capital Formation. Pop: Population. Mob: Mobile Phone penetration. Inter: Internet penetration. Industria: Industralisation.

The following FE findings are established from Table 1: (i) remittances do not directly affect industrialisation and (ii) there are positive marginal effects from the interaction between remittances and ICT. Conversely in the GMM specifications: (i) remittances positively affect industrialisation and (ii) there are negative marginal impacts from the interaction between remittances and ICT. It is important to note that four principal

information criteria are employed to assess the validity of the GMM model with forward orthogonal deviations[4]. Most of the control variables are significant.

**Table 2: Instrumental Non-Interactive Quantile Regressions**

**Dependent variable: Industrialisation**

**Panel A: Non-Interactive Regressions with Mobile Phone Penetration**

| | 2SLS | Q.10 | Q.25 | Q.50 | Q.75 | Q.90 |
|---|---|---|---|---|---|---|
| Constant | **12.818*** ** | **5.194*** ** | **6.583*** ** | **12.537*** ** | **19.943*** ** | **26.762*** ** |
| | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** |
| Rem(IV) | **0.001*** ** | 0.00008 | **0.001*** ** | -0.0002 | 0.0006 | 0.001 |
| | **(0.008)** | (0.838) | **(0.003)** | (0.567) | (0.273) | (0.143) |
| Mobile(IV) | -0.0003 | **0.001*** ** | **0.001*** ** | 0.001 | **-0.003*** ** | **-0.006*** ** |
| | (0.615) | **(0.003)** | **(0.007)** | (0.156) | **(0.000)** | **(0.000)** |
| Trade (IV) | 0.008 | **-0.020*** ** | **-0.010** ** | **-0.021*** ** | 0.001 | **0.049*** ** |
| | (0.225) | **(0.000)** | **(0.028)** | **(0.001)** | (0.845) | **(0.000)** |
| GFCF(IV) | **-0.178*** ** | **-0.040*** | **-0.071*** ** | **-0.123*** ** | **-0.217*** ** | **-0.331*** ** |
| | **(0.000)** | **(0.082)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** |
| Population(IV) | **-0.028*** ** | -0.002 | **-0.019** ** | **-0.024*** ** | **-0.041*** ** | **-0.065*** ** |
| | **(0.000)** | (0.820) | **(0.014)** | **(0.002)** | **(0.000)** | **(0.000)** |
| Bank Efficiency(IV) | **-0.014*** ** | -0.002 | **-0.009** ** | **-0.016*** ** | **-0.032*** ** | **-0.053*** ** |
| | **(0.000)** | (0.608) | **(0.019)** | **(0.000)** | **(0.000)** | **(0.000)** |
| Private credit (IV) | **0.136*** ** | **0.076*** ** | **0.143*** ** | **0.185*** ** | **0.176*** ** | **0.144*** ** |
| | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** |
| $R^2$/Pseudo $R^2$ | 0.1423 | 0.0655 | 0.0879 | 0.1263 | 0.1163 | 0.1073 |
| Fisher | **56.78*** ** | | | | | |
| Observations | 1453 | 1453 | 1453 | 1453 | 1453 | 1453 |

**Panel B: Non-Interactive Regressions with the Internet Penetration**

| | 2SLS | Q.10 | Q.25 | Q.50 | Q.75 | Q.90 |
|---|---|---|---|---|---|---|
| Constant | **12.845*** ** | **5.132*** ** | **6.408*** ** | **12.807*** ** | **20.374*** ** | **26.755*** ** |
| | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** |
| Rem(IV) | **0.001*** ** | **0.001** ** | **0.001*** ** | 0.00009 | 0.0001 | 0.0008 |
| | **(0.003)** | **(0.016)** | **(0.000)** | (0.874) | (0.823) | (0.404) |
| Internet(IV) | -0.0004 | -0.001 | 0.0005 | 0.0006 | **-0.004*** ** | **-0.006*** ** |
| | (0.627) | (0.156) | (0.481) | (0.488) | **(0.000)** | **(0.000)** |
| Trade (IV) | 0.008 | **-0.013** ** | -0.006 | **-0.022*** ** | -0.002 | **0.046*** ** |
| | (0.223) | **(0.028)** | (0.222) | **(0.002)** | (0.694) | **(0.000)** |
| GFCF(IV) | **-0.178*** ** | **-0.053** ** | **-0.079*** ** | **-0.124*** ** | **-0.218*** ** | **-0.332*** ** |
| | **(0.000)** | **(0.034)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** |
| Population(IV) | **-0.029*** ** | -0.001 | **-0.017** ** | **-0.025*** ** | **-0.041*** ** | **-0.062*** ** |
| | **(0.000)** | (0.860) | **(0.041)** | **(0.006)** | **(0.000)** | **(0.000)** |
| Bank Efficiency(IV) | **-0.014*** ** | -0.004 | **-0.010** ** | **-0.018*** ** | **-0.032*** ** | **-0.050*** ** |
| | **(0.000)** | (0.465) | **(0.015)** | **(0.000)** | **(0.000)** | **(0.000)** |
| Private credit (IV) | **0.136*** ** | **0.087*** ** | **0.148*** ** | **0.183*** ** | **0.176*** ** | **0.134*** ** |
| | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** |
| $R^2$/Pseudo $R^2$ | 0.1423 | 0.0633 | 0.0855 | 0.1257 | 0.1176 | 0.1056 |
| Fisher | **56.96*** ** | | | | | |
| Observations | 1453 | 1453 | 1453 | 1453 | 1453 | 1453 |

***,**,*: significance levels of 1%, 5% and 10% respectively. IV: Instrumented value. Remit: Remittances. GFCF: Gross Fixed Capital Formation. Lower quantiles (e.g., Q 0.1) signify nations where industrialisation is least. IV: Instrumented value. Remit: Remittances. Bank efficiency: Bank Credit to Bank Deposits. Private credit: Domestic credit to the private sector. GFCF: Gross Fixed Capital Formation. Pop: Population. Internet: Internet penetration.

[4] "First, the null hypothesis of the second-order Arellano and Bond autocorrelation test (AR (2)) in difference for the absence of autocorrelation in the residuals should not be rejected. Second the Sargan and Hansen over-identification restrictions (OIR) tests should not be significant because their null hypotheses are the positions that instruments are valid or not correlated with the error terms. In essence, while the Sargan OIR test is not robust but not weakened by instruments, the Hansen OIR is robust but weakened by instruments. In order to restrict identification or limit the proliferation of instruments, we have ensured that instruments are lower than the number of cross-sections in most specifications. Third, the Difference in Hansen Test (DHT) for exogeneity of instruments is also employed to assess the validity of results from the Hansen OIR test. Fourth, a Fischer test for the joint validity of estimated coefficients is also provided" (Asongu& De Moor, 2017, p.200).

## Table 3:Instrumental Interactive Quantile Regressions

**Dependent variable: Industrialisation**

**Panel A: Interactive Regressions with Mobile Phone Penetration**

| | 2SLS | Q.10 | Q.25 | Q.50 | Q.75 | Q.90 |
|---|---|---|---|---|---|---|
| Constant | **13.431*** ** | **5.575*** ** | **7.051*** ** | **12.568*** ** | **21.215*** ** | **27.399*** ** |
| | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** |
| Remit(IV) | 0.0007 | -0.0004 | **0.0007*** | -0.0004 | -0.001 | -0.001 |
| | (0.364) | (0.368) | **(0.092)** | (0.526) | (0.116) | (0.135) |
| Mobile(IV) | **-0.002**** | -0.0007 | -0.0007 | 0.0007 | **-0.004*** ** | **-0.010*** ** |
| | **(0.013)** | (0.341) | (0.420) | (0.615) | **(0.005)** | **(0.000)** |
| Remit(IV)×Mobile(IV) | **0.000003**** | **0.000003*** ** | **0.000002** * | 0.0000003 | 0.000002 | **0.000007*** ** |
| | **(0.032)** | **(0.000)** | **(0.020)** | (0.815) | (0.151) | **(0.008)** |
| Trade (IV) | 0.009 | **-0.022*** ** | **-0.009**** | **-0.022*** ** | 0.006 | **0.045*** ** |
| | (0.185) | **(0.000)** | **(0.048)** | **(0.001)** | (0.415) | **(0.000)** |
| GFCF(IV) | **-0.184*** ** | **-0.037*** | **-0.083*** ** | **-0.118*** ** | **-0.248*** ** | **-0.305*** ** |
| | **(0.000)** | **(0.084)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** |
| Population(IV) | **-0.028*** ** | -0.003 | **-0.019*** ** | **-0.025*** ** | **-0.045*** ** | **-0.062*** ** |
| | **(0.000)** | (0.740) | **(0.007)** | **(0.003)** | **(0.000)** | **(0.000)** |
| Bank Efficiency(IV) | **-0.015*** ** | -0.003 | **-0.008**** | **-0.017*** ** | **-0.035*** ** | **-0.053*** ** |
| | **(0.000)** | (0.486) | **(0.016)** | **(0.000)** | **(0.000)** | **(0.000)** |
| Private credit (IV) | **0.137*** ** | **0.077*** ** | **0.143*** ** | **0.186*** ** | **0.181*** ** | **0.152*** ** |
| | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** |
| $R^2$/Pseudo $R^2$ | 0.1453 | 0.0683 | 0.0894 | 0.1264 | 0.1175 | 0.1141 |
| Fisher | **50.54*** ** | | | | | |
| Observations | 1453 | 1453 | 1453 | 1453 | 1453 | 1453 |

**Panel B: Interactive Regressions with the Internet Penetration**

| | 2SLS | Q.10 | Q.25 | Q.50 | Q.75 | Q.90 |
|---|---|---|---|---|---|---|
| Constant | **13.953*** ** | **5.324*** ** | **7.053*** ** | **13.072*** ** | **22.106*** ** | **28.420*** ** |
| | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** |
| Remit(IV) | -0.00003 | 0.0006 | **0.001**** | -0.0002 | **-0.002*** ** | **-0.002*** |
| | (0.963) | (0.188) | **(0.011)** | (0.755) | **(0.002)** | **(0.053)** |
| Internet(IV) | **-0.005*** ** | **-0.002**** | **-0.001**** | 0.0001 | **-0.008*** ** | **-0.015*** ** |
| | **(0.000)** | **(0.015)** | **(0.045)** | (0.951) | **(0.000)** | **(0.000)** |
| Remit(IV)×Internet(IV) | **0.000007*** ** | **0.000002** ** | **0.000003*** ** | 0.0000009 | **0.000006*** ** | **0.000015*** ** |
| | **(0.000)** | **(0.042)** | **(0.006)** | (0.657) | **(0.006)** | **(0.001)** |
| Trade (IV) | 0.009 | **-0.011**** | -0.005 | **-0.024*** ** | **0.012*** | **0.041*** ** |
| | (0.166) | **(0.036)** | (0.182) | **(0.001)** | **(0.089)** | **(0.000)** |
| GFCF(IV) | **-0.188*** ** | **-0.051**** | **-0.088*** ** | **-0.120*** ** | **-0.269*** ** | **-0.309*** ** |
| | **(0.000)** | **(0.033)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** |
| Population(IV) | **-0.028*** ** | -0.0008 | **-0.018*** ** | **-0.026*** ** | **-0.043*** ** | **-0.071*** ** |
| | **(0.000)** | (0.933) | **(0.007)** | **(0.005)** | **(0.000)** | **(0.000)** |
| Bank Efficiency(IV) | **-0.015*** ** | -0.003 | **-0.010*** ** | **-0.018*** ** | **-0.037*** ** | **-0.054*** ** |
| | **(0.000)** | (0.472) | **(0.003)** | **(0.000)** | **(0.000)** | **(0.000)** |
| Private credit (IV) | **0.138*** ** | **0.078*** ** | **0.144*** ** | **0.183*** ** | **0.181*** ** | **0.135*** ** |
| | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** | **(0.000)** |
| $R^2$/Pseudo $R^2$ | 0.1519 | 0.0640 | 0.0877 | 0.1259 | 0.1244 | 0.1248 |
| Fisher | **50.96*** ** | | | | | |
| Observations | 1453 | 1453 | 1453 | 1453 | 1453 | 1453 |

***,**,*: significance levels of 1%, 5% and 10% respectively. IV: Instrumented value. Remit: Remittances. GFCF: Gross Fixed Capital Formation. Lower quantiles (e.g., Q 0.1) signify nations where industrialisation is least. IV: Instrumented value. Remit: Remittances. Bank efficiency: Bank Credit to Bank Deposits. Private credit: Domestic credit to the private sector. GFCF: Gross Fixed Capital Formation. Pop: Population. Internet: Internet penetration.

In Tables 2 and 3, while Panel A focuses on mobile phone penetration, Panel B depicts 'internet penetration'-oriented estimations. Consistent variations in estimated coefficients between Two Stage Least Squares and quantiles (with respect to signs,

significance and magnitude of significance) justify the relevance of the adopted QR empirical strategy.

The following findings are established for Table 2 on non-interactive regressions. (i) In Panel A: remittances increase industrialisation in the 25$^{th}$ quantile while mobile phone penetration increases (decreases) industrialisation in the top (bottom) quantiles. (ii) In Panel B: remittances increase industrialisation in the top quantiles whereas internet penetration decreases the outcome variable in the bottom quantiles. Most of the control variables have expected signs.

The following findings are established for Table 3 on interactive regressions. In Panel A, interactions between remittances and mobile phone penetration are positive in the bottom and 90$^{th}$ quantiles whereas in Panel B the interaction between internet penetration and remittances is positive at the bottom and top quantiles of the industrialisation distribution. Most of the control variables are significant.

It is important to note that it is reasonable that various econometric models lead to different results because they account for different specificities. Fixed effects are theoretically and practically not taken into account by GMM estimations. Hence, it is reasonable that Fixed Effects and GMM regressions produce findings that are contradictory. However, the findings and policy recommendations are not based on GMM on regressions for two reasons. First, most of the GMM models fail post-estimation diagnostic tests. Second, the Fixed Effects regressions produce positive marginal effects as Quantile regressions. Hence the latter is a robustness check of the former, with the exception that the latter accounts for initial levels of industrialisation. It follows that our best estimators are FE and QR estimators.

**Further Discussion and Policy Implications**

We have established from the study that with the help of ICT, Diaspora remittances could be leveraged to boost industrialisation in Africa when initial levels of industrialisation are taken into account. The complementarity of ICT with remittances has built on the intuition that the latter fundamentally depends on the former. It follows that pro-ICT policies that are designed to boost services of technology and remittances transfer would drive industrialisation, economic growth and employment and may ultimately reduce poverty within sampled countries in the post-2015 sustainable development agenda. These findings are broadly consistent with Kumar and Vu (2016) on linkages between remittances, ICT and growth in Vietnam. Improvements in ICT mechanisms would need to move hand-in-glove

with ICT literacy as far as the establishment of remittance-oriented mobile networks are concerned.

Given that the flow of remittances via formal mechanisms is severely constrained by concerns about poor infrastructure and transaction costs, informal money transfers should be given a more direct industrialisation face. This is essentially because, whereas transactions within the formal financial sector are also mobilised as deposits or liquid liabilities that are subsequently transformed into credit for economic operators, it is difficult to track how remittances via informal transfer channels are connected to the industrialisation process. Therefore, it is important for policy to harness how informal transfers of remittances are mobilised for productive investments.

In the light of the above, sound infrastructure institutions that can enhance linkages between ICT and remittances are necessary. Whereas one dimension consists of mobile money transfers, the other dimension includes postal/courier services and systems of transportation. These recommendations are in line with the view that remittances are inherently more rewarding with an investment-friendly policy environment that is complemented by sound institutions (IMF, 2005). This is also consistent with the view that even when institutions are not well developed, remittances could still engender significant development externalities (Giuliano & Ruiz-Arranz, 2009), essentially because the Diaspora are more likely to invest in economies in which foreign investors are risk-averse.

**Conclusion and Future Research Directions**

This study has examined the role of ICT on remittances for industrialisation in a panel of 49 African countries for the period 1980-2014. The empirical evidence is based on three simultaneity-robust estimation techniques, namely: (i) Instrumental Fixed Effects (FE) in order to control for the unobserved heterogeneity; (ii) Generalised Method of Moments (GMM) to account for persistence in industrialisation; and (iii) Instrumental Quantile Regressions (QR) to control for initial levels of industrialisation. Our best estimators are from FE and QR estimations because the GMM regression outputs largely fail post-estimation diagnostic tests. The following are established. (i) There are positive marginal effects from the interaction between remittances and ICT in the FE regressions whereas there are negative marginal impacts from the interaction between remittances and ICT. (ii) Interactions between remittances and mobile phone penetration are positive in the bottom and $90^{th}$ quantiles whereas the interaction between internet penetration and remittances is positive in the bottom and top quantiles of the industrialisation distribution.

In the light of the findings, the role of ICT on remittances for industrialisation is much more apparent when existing levels of industrialisation are accounted for. Addressing the underlying problem statement with average values of industrialisation leads to blanket policy measures. Such do not adequately inform policy unless the modelling approach is contingent on initial levels of industrialisation and hence, tailored differently across countries with low, intermediate and high initial levels of industrialisation. Future research can focus on other channels through which the role of remittances on industrialisation can be enhanced. Moreover, a comparative analysis between remittances and other external financial flows would substantially enhance the extant literature.

## Appendices

### Appendix 1: Definitions of Variables

| Variables | Signs | Definitions of variables (Measurement) | Sources |
|---|---|---|---|
| Industrialisation | Industria | Manufacturing (ISIC D) | World Bank (WDI) |
| Remittances | Remit | Personal remittances, received (% of GDP) | World Bank (WDI) |
| Mobile phones | Mobile | Mobile phone subscriptions (per 100 people) | World Bank (WDI) |
| Internet | Internet | Internet subscriptions (per 100 people) | World Bank (WDI) |
| Bank Efficiency | BcBd | Bank credit to bank deposits (%) | World Bank (WDI) |
| Domestic Credit | Domcred | Domestic credit to private sector (% of GDP) | World Bank (WDI) |
| Trade | Trade | Exports and Imports of goods and services (% of GDP) | World Bank (WDI) |
| Domestic Investment | GFCF | Gross fixed capital formation (including Acquisitions less disposals of valuables) (% of GDP) | World Bank (WDI) |
| Population | Pop | Population (in millions) | World Bank (WDI) |

WDI: World Bank Development Indicators.

### Appendix 2: Correlation matrix

**Panel A: With Un-instrumented Variables (Uniform sample: 1511 )**

| Pop | GFCF | Trade | Domcred | BcBd | Internet | Mobile | Remi | Industria | |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | -0.061 | -0.266 | 0.014 | -0.122 | 0.126 | 0.165 | 0.115 | -0.063 | Pop |
| | 1.000 | 0.592 | 0.159 | -0.049 | 0.012 | 0.064 | -0.054 | -0.179 | GFCF |
| | | 1.000 | 0.180 | -0.126 | 0.082 | 0.109 | -0.013 | -0.017 | Trade |
| | | | 1.000 | 0.281 | 0.143 | 0.191 | 0.197 | 0.258 | Domcred |
| | | | | 1.000 | -0.210 | -0.208 | -0.041 | 0.007 | BcBd |
| | | | | | 1.000 | 0.823 | 0.455 | 0.082 | Internet |
| | | | | | | 1.000 | 0.522 | 0.086 | Mobile |
| | | | | | | | 1.000 | 0.151 | Remi |
| | | | | | | | | 1.000 | Industria |

**Panel B: With Instrumented Variables (Uniform sample: 1453)**

| Pop(IV) | GFCF(IV) | Trade(IV) | Domcred(IV) | BcBd(IV) | Internet(IV) | Mobile(IV) | Remi(IV) | Industria | |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | -0.068 | -0.267 | 0.020 | -0.121 | 0.121 | 0.165 | 0.113 | -0.064 | Pop(IV) |
| | 1.000 | 0.592 | 0.160 | -0.050 | 0.008 | 0.059 | -0.059 | -0.174 | GFCF(IV) |
| | | 1.000 | 0.171 | -0.128 | 0.082 | 0.107 | -0.014 | -0.017 | Trade(IV) |
| | | | 1.000 | 0.285 | 0.136 | 0.187 | 0.200 | 0.264 | Domcred(IV) |
| | | | | 1.000 | -0.213 | -0.210 | -0.046 | 0.004 | BcBd(IV) |
| | | | | | 1.000 | 0.817 | 0.441 | 0.084 | Internet(IV) |
| | | | | | | 1.000 | 0.512 | 0.089 | Mobile(IV) |
| | | | | | | | 1.000 | 0.155 | Remi(IV) |
| | | | | | | | | 1.000 | Industria |

IV: Instrumented value.Pop: Population. GFCF: Gross Fixed Capital Formation. Domcred: Domestic credit to the private sector. BcBd: Bank Credit to Bank Deposits.Internet: Internet penetration. Mobile: Mobile phone penetration. Remi: Remittances. Industria: Industralisation.

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