Sub-Saharan Africa's Infrastructure Gap: A Failure of Financial Markets?

Kofi B. Afful
Ghana Institute of Management and Public Administration, Accra, Ghana

Charles C. Okeahalam
Africa Growth Holdings, Johannesburg, South Africa

Melvin Ayogu
Standard Bank, Johannesburg, South Africa

Abstract
This research examines the role of financial market failure in explaining Sub-Saharan Africa's (SSA) infrastructure gap. The core infrastructure examined are energy, telecommunication and transport. The model includes a nonlinear interaction variable as well as elements of expectation models. The study finds that fixed effects are dominant for all infrastructure except mobile telecommunication facilities in SSA. The dynamic panel regression results indicate that for most of the considered infrastructure, financial sector intermediation to the private sector is most critical. Banking and stock market development are, generally, less important. There is evidence that there is an interaction between most considered infrastructure and financial sector intermediation.
JEL Classification: G2, O1, G10.
Keywords: Financial markets, Infrastructure gap, Sub-Saharan Africa.

1. INTRODUCTION

More than half of Sub-Saharan Africa's (SSA's) recent high economic growth is attributed to improved infrastructure (Brixiova, Mutambatsere, Ambert and Etienne, 2011). Such facilities, however, are different from private goods and services (World Bank, 2010). As public goods, they involve significantly large initial capital, periodic maintenance as well as upgrading expenditure (World Bank, 2008). However, their net efficiency gains and returns are derived only in the long-run.

Out of the annual $ 80 billion needed to address SSA's infrastructure gap, less than half of this is actually invested (Africa Infrastructure Country Diagnostic, 2017). Furthermore, while $ 40 billion must be devoted each year to meet the sub-continent's energy requirements, only about $ 11.66 billion is actually spent for this purpose (Brixiova *et al.,* 2011). SSA's infrastructure gap is illustrated by the fact that it spends approximately 4 to 7 percent per annum of its Gross Domestic Product (GDP) on infrastructure as compared to the 15 percent required to meet its infrastructure deficit (World Bank, 2015).

The foregoing highlight the inadequacy of existing financial resources for infrastructural development on the sub-continent (Arestis, Demetriades and Luintel 2001). The critical importance of funds for development from SSA financial markets is accentuated by the fact that most of these economies lack the fiscal space to invest sufficiently in infrastructure. In some of the considered countries, as much as 70 percent of total annual government revenue is used to pay state and quasi-public sector employees. Recurrent expenditure in the form of consumables also take up a significant portion of the remaining resources. There is relatively little residual funds for the aforementioned capital outlay (Norman, 2011). The issue is further compounded when one considers the following. Financial sector reforms and rapid stock market establishment in SSA from the mid-1980s were meant to enhance capital markets but these objectives have still not been achieved (Afful and Okeahalam, 2006; Singh, 1999).

The problem statement this study addresses arises from the paucity of studies on the efficacy of the sub-continent's financial systems to enhance its infrastructural development. The research decomposes financial market development into: banking industry, financial sector intermediation to the private sector and stock exchanges. The study also examines four core infrastructure as dependent variables, namely: energy, fixed-line telecommunication, mobile telecommunication and transport.

To meet its objectives, the study begins with an introduction. This situates the topic of interest within the larger context. It provides a succinct background and overview. The succeeding chapter reviews relevant literature. Chapter 3 describes the analytical framework, data and methodology used. The subsequent chapter discusses the results and consequent implications while the final section concludes.

2.LITERATURE REVIEW

Theoretically, infrastructure has peculiar features that tend to negate the use of markets for their production (Helm, 2010). They engender market failures as they are characterized by free-rider problems as well as significant externalities and sunk expenditures. Traditionally defined market-based systems find it difficult produce these public commodities.

One school of thought views financial markets as part of a production function. They are inputs for producing infrastructure, the output. In this vein, Esfahani and Ramirez (2003) model this theoretically using variations of an extended Cobb-Douglas production function. Others develop standard linear models as their underlying analytical framework (McDonald and Schumacher, 2007; Jun, Yuan, Yong and Hong, 2007).

Alternatively, financial markets are systems that efficiently pool and allocate resources for infrastructural development (Briceno-Garmendia, Smits, Foster, 2008). Therefore, they are not the inputs themselves, but resource providers. This theory differs slightly from the prior hypothesis that financial markets are inputs. These two aforementioned theories, however, are variants of the resource-based theory. They both agree that financial markets are directly or indirectly inputs in the production function for infrastructure (Quinn, 2005).

A different hypothesis states that both financial markets and infrastructure are each a network (Barabási, 2002). As networks, they yield the highest returns to investment with a greater number of users (Chang Lin, 2006). This optimizes and speeds up cost-recovery. Further, combining financial markets and infrastructure into a larger network significantly expands scale and scope economies. Moreover, infrastructure enjoys substantial externalities from enhanced financial market development. Complex network theory asserts that both of these systems are characterized by growth in extra sub-networks. Also, new network nodes choose to connect themselves to similar constituent systems with the greatest number of links. This theory predicts that the strength of the influence of financial markets on infrastructure will depend on how highly interconnected the former is to other systems within the economy. Added to the foregoing, network characteristics and the nature of their interconnections determine their efficiency and efficacy (Barabási and Beka, 2002).

Associated to the network hypothesis, systemic failure theory hypothesizes that there exists a symbiotic interconnections between different components of a system(s). Assuming all infrastructure is a system, while financial markets are another, then flaws in one will adversely affect both. This results in total systemic failure (Barabási, Newman and Watts, 2006). Consequently, systemic weaknesses affect the whole integrated economy.

The theory on incentive design and mechanisms is also applicable to the problem of infrastructure financing. This emanates from the disparity between average and marginal costs (Briceno-Garmendia *et al.,* 2008). Political authorities want to provide infrastructure to improve society's welfare. Private sector, on the other hand, want to do the same thing so as to maximize profits. The former also want to lower price per capita of the infrastructure provided, thereby decreasing the cost recovery earnings and profit margins of private sector financiers. This is especially the case where the regime has incentives to minimize cost repayments by citizens in order to garner votes in upcoming elections. This highlights the conflict of interest between public and private sector stakeholders relating to financing infrastructure.

Coase (1960) underscores the peculiar nature of raising finance to produce and manage public goods / services. It stresses the need to develop a framework to ensure that users internalize the social benefits and costs of infrastructure. This is demonstrated by the modern pay-per-user principle for socio-economic amenities and facilities (Banerjee *et al.,* 2008; Engel, Fischer and Galetovic, 2010; Estache, 2010). This is related to the externalities hypothesis as the Coase theorem holds that markets, in and of themselves, are unsuited to producing and managing infrastructure. Therefore, fees, levies, subsidies and taxes can be used to restructure the aforementioned facilities as quasi-private goods / services.

Empirical research indicates that there has been significant financial market reforms as well as establishment of stock exchanges in SSA over the last two decades. These were to stimulate development and growth (Arestis *et al.,* 2001; Heber, 1996). However, Irving (2000), Kenny and Moss (1998) and Singh (1999) question the relevance of stock markets in SSA. Irving and Manroth (2008) adopt a slightly different argument that suggests that stock markets are a necessary but insufficient component of financial systems. They find that financial markets in SSA are unable to raise sufficient capital funds for real sector investment.

Africa Infrastructure Country Diagnostic (2015) emphasizes that governance and institutional weaknesses in SSA explain the undue heavy reliance on public sector financing for infrastructural development. Private provision is severely restricted because of the existing unconducive regulatory framework (World Bank, 2006). For this reason, between 70-90 percent of infrastructure financing in SSA is from state-owned enterprises. Empirical evidence reveals that private financing is severely restricted and that local financial markets have a very limited role (Infrastructure Consortium for Africa, 2011).

3.ANALYTICAL FRAMEWORK, DATA AND METHODOLOGY

Let INF_t be the stock of infrastructure at time *t* while $F.MKT_{t-1}$ is the degree of financial market development at time *t-1*. Assume ε_t estimates the impact of all other possible determinants not explicitly considered. Consequently:

$$INF_t = F.MKT_{t-1} + \varepsilon_t \quad (1)$$

According to Equation (1), $F.MKT_{l-1}$ has a positive effect on INF_t. As this study uses panel data, the dependent and independent variables must be standardized to ameliorate potential adverse effects of outliers. Such standardization may also be necessary for appropriate comparison of cross-country data. Therefore, INF_t is replaced by γ_t, per capita stock of infrastructure at time *t*. If $F.MKT^*$ is the optimal financial development level, then let $\tau_{t-1} = F.MKT^* - F.MKT_{t-1}$. In this context, τ_{t-1} measures the degree of financial market failure.

$$\gamma_t = \tau_{t-1} + \varepsilon_t \quad (2)$$

Both Equations (1) and (2), however, ignore possible nonlinear interactions between the considered variables. This is to take into cognizance the network / systems as well as systemic failure theories discussed earlier. The interaction term models the theorized interrelationship between the two considered networks. Consequently, let $\frac{\tau_{t-1}}{\gamma^* - \gamma_{t-1}}$ approximate the nonlinear interaction between γ_t and τ_{t-1}. As such:

$$\gamma_t = \tau_{t-1} + \frac{\tau_{t-1}}{\gamma^* - \gamma_{t-1}} + \varepsilon_t \quad (3)$$

Equation (3) implies that the nonlinear interaction effect is a function of the inverse of the corresponding per capita infrastructure gap, $\gamma_i^* - \gamma_{t-1}$. Thus far, however, the analytical framework is silent on how γ_t changes annually. Consequently, suppose that $\gamma_{i,t}$ is generated by some form of adaptive expectation process, modelled as: $\gamma_t = \gamma_{t-1} + \lambda_t(\gamma^* - \gamma_{t-1})$. Let λ_t be the percentage addition or decrease in per capita stock of infrastructure at time *t*. It is worth noting that λ_t is period-specific. As such, the altered model becomes:

$$\lambda_t(\gamma^* - \gamma_{t-1}) = \tau_{t-1} + \frac{\tau_{t-1}}{\gamma^* - \gamma_{t-1}} - \gamma_{t-1} + \varepsilon_t \quad (4)$$

The inclusion of γ_{t-1} on the right-hand side of Equation (4) introduces an autoregressive dynamic lag (ARDL) process (Shittu, Yemittan and Yaya, 2012). However, since the study focuses on the infrastructure gap, let $\gamma^* - \gamma_{t-1} = \phi_{t-1}$ and posit equation (4) as:

$$\phi_{t-1} = \frac{\tau_{t-1}}{\lambda_t} + \frac{\tau_{t-1}}{\lambda_t(\gamma^* - \gamma_{t-1})} - \frac{\gamma_{t-1}}{\lambda_t} + \frac{\varepsilon_t}{\lambda_t} \quad (5)$$

Let $\lambda_t \cong \exp\frac{y_t}{y_{t-1}}$. One implication of equation (5) is that as the infrastructure gap narrows, $\phi_{t-1} \rightarrow 0$. In the ensuing regression model based on equation (5), $\tau_{j,t-1}$ is a vector of the three examined elements of financial market development. These are comprised of the banking industry, financial sector intermediation to the private sector and stock exchanges. These are denoted as $\tau_{b,t-1}$, $\tau_{f,t-1}$ and $\tau_{s,t-1}$ respectively. Also, for the dependent variable, three different infrastructure amenities are considered, namely: energy, telecommunication and transport. For infrastructure *i*, Equation (5) is expanded to:

$$\phi_{i,t-1} = \frac{\tau_{b,t-1}}{\lambda_t} + \frac{\tau_{f,t-1}}{\lambda_t} + \frac{\tau_{s,t-1}}{\lambda_t} + \frac{\tau_{j,t-1}}{\lambda_t(\gamma^* - \gamma_{i,t-1})} - \frac{\gamma_{i,t-1}}{\lambda_t} + \frac{\varepsilon_{i,t}}{\lambda_t} \quad (6)$$

Related past studies mostly use panel regression econometric methodology. Yepes, Pierce and Foster (2008), use a dynamic panel methodology based on Arellano and Bond (1991). Similar to Boopen (2006), this study first compares the fixed and random effects regression results. These are computed using generalized least squares (GLS) to improve consistency and efficiency of parameter estimates. It later uses the Areallano-Bond general method of moments (GMM) methodology for further dynamic empirical analysis. These provide more consistent, efficient and rigorous results (Gujarati, 2005; Kiviet, Pleus and Poldermans, 2016; Woolridge, 2013).

This study uses panel data obtained from World Bank (2016). The examined SSA economies are: Botswana, Cote d' Ivoire, Ghana, Kenya, Malawi, Mauritius, Morocco, Namibia, Nigeria, South Africa, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe. These are chosen because, they are the only SSA economies with all three considered facets of financial market development. The study covers the years 1990 to 2015 and uses STATA 16 for its analysis. The dataset is an unbalanced panel.

As already mentioned, this study considers three dimensions of financial markets: banking industry, financial sector intermediation to the private sector and stock exchanges. For the banking sector, the proxy indicator is ratio of bank deposits to GDP. On the other hand, the quotient of private sector credit by deposit money banks and other financial institutions to GDP represents financial sector intermediation development while the stock market capitalization to GDP index substitutes for stock market improvement. In a detailed exposition, Beck and Maimbo (2012), Huang (2010), Mbulawa (2015) and Yartey and Adjasi (2007) emphasize that the selected indicators appropriately represent the considered aspects of financial market development. The other independent variables are computed as espoused in equation (6).

The aforementioned analyzed dependent variables are: energy, telecommunication and transport infrastructure. The energy and transport proxy variables are electricity consumption per capita (kilowatts) and ratio of roads in kilometres per land size respectively. Two different proxies are used for telecommunication infrastructure, namely: fixed telephone subscriptions (per 100 people) and mobile cellular subscriptions (per 100 people). The last mentioned amenity is separated for greater in-depth analysis because mobile telecommunication infrastructure is considered more as a private good relative to the former (Brixiova *et al.,* 2011, Briceno-Garmendia *et al.,* 2008; Infrastructure Consortium for Africa, 2011). The benchmarks, γ_i^* and $F.MKT^*$, are approximated by the geometric mean of each examined variable for high-income economies as defined by World Bank (2016). This standardization procedure avoids the adverse effects of outliers (Focardi and Fabozzi, 2004).

Rather than use an *a priori* or theoretical determination of whether fixed or random effects best explain financial market influence on each type of infrastructure in SSA, the study computes respective Breusch-Pagan Lagrangian multiplier test indicators. This is especially relevant because on the one hand, each country has different legal and regulatory financial market frameworks (World Bank, 2016). On the other hand, financial markets are assumed to be theoretically efficient implying that they only respond to random variables (Focardi and Fabozzi, 2004). Let country *l* and infrastructure *i* be the representative economy and amenity respectively, then the fixed-effects equivalent of equation (6) is:

$$\phi_{i,l,t-1} = \frac{\tau_{i,b,t-1}}{\lambda_{i,l,t}} + \frac{\tau_{l,f,t-1}}{\lambda_{i,l,t}} + \frac{\tau_{l,s,t-1}}{\lambda_{i,l,t}} + \frac{\tau_{i,l,t-1}}{\lambda_{i,l,t}(\gamma^* - \gamma_{i,l,t-1})} - \frac{\gamma_{i,l,t-1}}{\lambda_t} + \frac{\varepsilon_{i,l,t}}{\lambda_{i,l,t}} \quad (7)$$

In equation (7), ε_i is influenced by country-specific factors such as business environment as well as legal and regulatory arrangements. In this case, country-specific financial market characteristics are critical for infrastructural development. On the other hand, the corresponding random effects model is posited as:

$$\phi_{i,t-1} = \frac{\tau_{i,b,t-1}}{\lambda_{i,t}} + \frac{\tau_{i,f,t-1}}{\lambda_{i,t}} + \frac{\tau_{i,s,t-1}}{\lambda_{i,t}} + \frac{\tau_{i,t-1}}{\lambda_{i,t}(\gamma^* - \gamma_{i,t-1})} - \frac{\gamma_{i,t-1}}{\lambda_{i,t}} + \upsilon_{i,t} \quad (8)$$

Here, $\upsilon_{i,t} = u_{i,t} + \varepsilon_i$, noting that ε_i is as defined in equation (6). On the other hand, $u_{i,t}$ is the residual from combined cross-sectional and time-series factors (Woolridge, 2013). The study extends the analysis to include dynamic panel regressions based on a GMM approach, modeled as:

$$\Psi_{i,t-1} = \tau_{b,t} + \tau_{b,t-1} + \tau_{f,t} + \tau_{f,t-1} + \tau_{s,t} + \tau_{s,t-1} + \frac{\tau_{j,t-1}}{\gamma^* - \gamma_{i,t-1}} - \gamma_{i,t-1} + \varepsilon_l \quad (9)$$

From the functional construct of equations (1)-(9), it may be inferred that a positive regression coefficient of $\frac{\tau_{b,t-1}}{\lambda_t}$, $\frac{\tau_{f,t-1}}{\lambda_t}$ and $\frac{\tau_{s,t-1}}{\lambda_t}$ indicates a direct effect between each respective dimension of financial market failure and examined infrastructure gaps.

4. EMPIRICAL RESULTS AND FINDINGS

4.1 Pre-regression diagnostic tests

i. Multi-collinearity:

The following multi-collinearity test indicators are computed for all considered infrastructure regressions: condition index, eigenvalue, r-squared, tolerance factor, variance inflation factor (VIF) and VIF square root (Wooldridge, 2013).

Table 1: Road infrastructure variables - multi-collinearity tests

Variable	VIF	VIF square root	Tolerance factor	R-squared	Eigen-value	Condition index
Bank sector failure	2.50	1.58	0.40	0.60	0.09	7.23
Financial sector failure	2.53	1.59	0.40	0.60	0.49	3.08
Financial sector-transport nonlinear interaction	1.05	1.02	0.96	0.04	0.03	11.99
Previous stock of roads (km) per land size	1.48	1.22	0.68	0.32	4.63	1.00
Roads (km) per land size	1.02	1.01	0.99	0.01	0.69	2.59
Stock market failure	1.36	1.16	0.74	0.26	1.05	2.10

Table 1 presents the test statistics for the transport infrastructure proxy, road (kms) per land size. The VIFs are all less than 10 but greater than 0.10, implying there is no multi-collinearity. The condition indices, eigenvalues and tolerance factors affirm the conclusion of no collinear relations.

Table 2: Energy infrastructure variables - multi-collinearity tests

Variable	VIF	VIF square root	Tolerance factor	R-squared	Eigen-value	Condition index
Bank sector failure	2.37	1.54	0.42	0.58	0.07	7.88
Electricity consumption per capita (kwh)	1.94	1.39	0.52	0.48	4.30	1.00
Financial sector failure	7.85	2.80	0.13	0.87	0.43	3.15
Financial sector-energy nonlinear interaction	1.02	1.01	0.98	0.02	1.17	1.92
Previous electricity consumption per capita (kwh)	5.26	2.29	0.19	0.81	0.02	15.45
Stock market failure	1.33	1.15	0.75	0.25	0.99	2.08

Tables 2, 3 and 4 present similar diagnostic test indicators for energy, fixed and mobile telecommunication infrastructure regression variables respectively. Each of these illustrate that there is no multi-collinearity between examined indicators.

Table 3: Telecommunication (fixed line) infrastructure variables - multi-collinearity tests

Variable	VIF	VIF square root	Tolerance factor	R-squared	Eigen-value	Condition index
Bank sector failure	3.10	1.76	0.32	0.68	0.14	5.30
Financial sector failure	6.82	2.61	0.15	0.85	0.52	2.71
Financial sector-fixed line nonlinear interaction	9.46	3.08	0.11	0.89	0.02	13.87
Fixed line per 100 people	1.03	1.02	0.97	0.03	0.99	1.95
Previous fixed line per 100 people	4.70	2.17	0.21	0.79	3.80	1.00
Stock market failure	1.34	1.16	0.74	0.26	1.52	1.58

Table 4: Telecommunication (mobile phone) infrastructure variables - multi-collinearity tests

Variable	VIF	VIF square root	Tolerance factor	R-squared	Eigen-value	Condition index
Bank sector failure	2.02	1.42	0.50	0.51	3.28	1.00
Financial sector failure	2.51	1.58	0.40	0.60	1.13	1.71
Financial sector-mobile nonlinear interaction	1.01	1.00	0.99	0.01	0.60	2.34
Mobile phone subscriptions per 100 people	1.03	1.02	0.97	0.03	0.09	6.01
Previous mobile phone subscriptions per 100 people	1.04	1.02	0.96	0.04	0.84	1.98
Stock market failure	1.38	1.17	0.73	0.27	1.02	1.80

ii. Stationarity:
Table 5 presents panel stationarity test results for each variable. Because the data is an unbalanced panel, the Fisher-type augmented Dickey-Fuller as well Philps-Perron stationarity indicators are computed. The underlying null hypothesis states that the examined variables have a unit root. The alternative hypothesis, asserts that the panel is stationary. Table 5 indicates that all the null hypothesis may be rejected in favor of the alternative, inferring stationarity (Yong and Shaowen, 2001).

Table 5: Panel stationarity tests

Variable	**ADF statistic**	**P-value**	**Philip-Perron Statistic**	**P-value**
Bank sector failure	642.96	0.00	79.13	0.00
Electricity consumption per capita (kwh)	87.08	0.00	49.01	0.00
Financial sector failure	579.56	0.00	70.95	0.00
Financial sector-energy infrastructure interaction	613.80	0.00	85.13	0.00
Financial sector-fixed line infrastructure interaction	275.09	0.00	33.01	0.00
Financial sector-mobile infrastructure interaction	115.45	0.00	60.84	0.00
Financial sector-transport infrastructure interaction	288.87	0.00	33.42	0.00
Fixed-line telecommunication infrastructure	330.93	0.00	37.09	0.00
Lagged electricity consumption per capita (kwh)	87.08	0.00	19.10	0.00
Lagged fixed-line telecommunication infrastructure 100 people	378.55	0.00	45.00	0.00
Lagged mobile phone telecommunication infrastructure	650.03	0.00	80.05	0.00
Lagged stock of roads (km) per land size	715.46	0.00	88.49	0.00
Mobile phone subscriptions per 100 people	317.26	0.00	46.57	0.00
Roads (km) per land size	996.41	0.00	124.76	0.00
Stock market failure	354.35	0.00	41.87	0.00

4.2 Empirical results

i. Energy infrastructure:
Due to insufficient data, the following countries are excluded from the analysis on energy infrastructure: Malawi, Swaziland and Uganda. In table 6, the GLS fixed and random effects regressions indicate that financial sector intermediation failure adversely influence energy infrastructure in SSA. This confirms the network / systems theory espoused by Barabási (2002); Chang Lin (2006) and Dunn *et al.* (2013). The random effect regression results, however, demonstrates that banking sector failure also has a similar effect. Further, SSA stock markets are not critical for energy facilities. This buttresses the findings of Afful and Okeahalam (2005), Irving (2000), Irving and Manroth (2008; 2009) and Singh (1999).

These results reveal that, perhaps, intermediation to the private sector is the most critical dimension of financial market development. It is central as it involves almost all financial activities, processes and transactions in economic systems (Beck and Maimbo, 2012; Norman, 2011). For instance, it influences the costs and speed of payments and transactions. All of these impact cost recovery, viability and sustainability of energy infrastructure (Engel *et al.,* 2010). The banking sector and stock markets are less critical in this regard because in SSA, most energy providers are less dependent on local financial markets. They, usually source their finance externally or from the state.

Table 6: Energy infrastructure regression results – Fixed versus random effects

Variables	Coefficient	Standard error	Z-statistic	P-value
FIXED EFFECTS				
Bank sector failure	0.42	1.23	-0.34	0.73
Financial sector failure	2.77	0.83	3.32	0.00
Financial sector-energy nonlinear interaction	0.40	0.04	9.42	0.00
Previous stock of electricity infrastructure	5,125.55	3,185.77	1.61	0.11
Stock market failure	0.04	0.11	-0.31	0.76
Constant	684.25	83.42	8.20	0.00
RANDOM EFFECTS				
Bank sector failure	34.65	15.85	-2.19	0.02
Financial sector failure	58.83	17.82	3.30	0.00
Financial sector-transport energy interaction	45,284.29	83,980.97	0.54	0.59
Previous stock of infrastructure	1.54	0.39	-3.93	0.00
Stock market failure	0.78	2.96	0.26	0.79
Constant	21,123.34	1,154.25	18.30	0.00

The related Arellano-Bover/Blundell-Bond GMM dynamic panel regression results are contained in table 7. The study finds that previous increases in per capita energy infrastructure enhances current stock as it narrows the gap. This result confirms the prior GLS results. As well, previous banking sector deficiency has an adverse effect. On the whole, the GMM results are in tandem with Estache (2010); Irving and Manroth (2008; 2009) and Singh (1999).

Table 7. Energy infrastructure GMM dynamic panel regression

Variables	Coefficient	Standard error	Z-statistic	P-value
Bank sector failure	9.80	32.62	0.30	0.76
Bank sector failure (LAGGED)	83.84	42.33	-1.98	0.04
Energy infrastructure (LAGGED)	-0.41	0.06	6.30	0.00
Financial sector failure	162.92	23.75	6.86	0.00
Financial sector failure (LAGGED)	6.57	28.51	-0.23	0.82
Financial sector-energy nonlinear interaction (LAGGED)	-93,915.44	98,283.18	0.96	0.34
Stock market failure	8.90	5.35	-1.66	0.09
Stock market failure (LAGGED) 00000	5.92	3.90	1.51	0.13

Table 8 presents the pertinent regression diagnostics. The adjusted r-squared indicates that financial markets explain about half the variation in the energy regression, suggesting that this infrastructure is less dependent on financial markets in SSA.

Table 8: Energy infrastructure regression diagnostics

REGRESSION DIAGNOSTIC INDICATOR	VALUES
FIXED EFFECTS	
Wald-statistic	13.70
P-value	0.00
Adjusted r-squared	0.50
RANDOM EFFECTS	
Wald-statistic	12.77
P-value	0.02
Adjusted r-squared	0.55
Breusch-Pagan lagrangian multiplier test statistic (H_0 : random effect is dominant)	819.98
P-value	0.00
DYNAMIC PANEL REGRESSION	
Wald-statistic	296.29
P-value	0.00
Sargan test (H_0 : over-identifying restrictions are valid)	-6.64
P-value	1.00
Arellano-Bond test (H_0 : no autocorrelation) – first order	-1.27
P-value	0.20
Arellano-Bond test (H_0 : no autocorrelation) – second order	-0.52
P-value	0.60

Further, the null hypothesis of random effects being dominant is rejected because the p-value of the Breusch-Pagan Lagrangian test statistic is 0.00. Therefore, fixed effects or country-specific factors best explain the energy infrastructure-financial market relation. These include: business and market conditions as well as existing legal and regulatory environments. Additionally, the Sargan test highlights that the model is not over-identified. This supports the Wald statistic conclusion of correct model specification. Both the Arellano/Bond first and second order autocorrelation tests show that there is no auto correlation.

ii. Telecommunication infrastructure:

Table 9 reports the fixed and random effects regression results for fixed-line telecommunication infrastructure. The results conclude that there is a nonlinear negative interaction between financial sector intermediation failure and additional increases in fixed telecommunication facilities. Additionally, previous such infrastructure improves current stock. This confers with Briceno-Garmendia *et al.* (2008); Chang Lin (2006) and World Bank (2010).

Table 9: Fixed-line telecommunication infrastructure regression – Fixed versus random effects

Variables	Coefficient	Standard error	Z-statistic	P-value
FIXED EFFECTS				
Bank sector failure	0.39	0.28	-0.14	0.89
Financial sector failure	0.07	0.21	0.33	0.74
Financial sector-fixed-line nonlinear interaction	-16.28	6.51	-2.50	0.01
Previous stock of fixed-line infrastructure	-2.38	0.92	-2.58	0.01
Stock market failure	0.01	0.03	0.07	0.94
Constant	165.95	17.47	9.50	0.00
RANDOM EFFECTS				
Bank sector failure	34,058.1	11,283.63	-3.02	0.00
Financial sector failure	1,570.60	10,911.46	0.14	0.89
Financial sector- fixed-line nonlinear interaction	156,355.70	478,003.5	-0.33	0.74
Previous stock of fixed-line infrastructure	72,143.52	45,466.65	-1.59	0.11
Stock market failure	233.07	2,018.72	0.12	0.91
Constant	2,467,497	929,594	2.65	0.00

Further, the Breusch-Pagan Lagrangian test in table 11 supports the fixed-effects regression. The related GMM regression results indicate that deficiencies in all examined facets of financial market development widen the infrastructure gap. However, intermediation failure has the most significant impact in SSA (Huang, 2010; Singh, 1999; Yartey, and Adjasi, 2007).

Table 10. Fixed-line telecommunication infrastructure dynamic panel (GMM) regression

Variables	Coefficient	Standard error	Z-statistic	P-value
Bank sector failure	0.41	0.18	2.27	0.02
Bank sector failure (LAGGED)	0.31	0.43	0.72	0.47
Financial sector failure	1.70	0.15	11.75	0.00
Financial sector failure (LAGGED)	1.07	0.49	-2.17	0.03
Financial sector-fixed-line nonlinear interaction (LAGGED)	-12.84	5.81	2.21	0.02
Fixed-line infrastructure (LAGGED)	0.0000003	0.0000005	-0.58	0.56
Stock market failure	0.08	0.03	-2.53	0.01
Stock market failure (LAGGED)	0.04	0.03	1.57	0.12

The afore-mentioned results also indicate that interaction between the financial sector intermediation and fixed-line facilities narrows the gap. This accords with the network and systemic failure theories (Barabási, 2002; Dunn *et al.,* 2013).

Table 11: Fixed-line telecommunication infrastructure regression diagnostics

VARIABLES	VALUES
FIXED EFFECTS	
Wald-statistic	17.03
P-value	0.00
Adjusted r-squared	0.30
RANDOM EFFECTS	
Wald-statistic	74.04
P-value	0.00
Adjusted r-squared	0.28
Breusch-Pagan lagrangian multiplier test statistic (H_0: random effect is dominant)	10.71
P-value	0.00
DYNAMIC PANEL REGRESSION	
Wald-statistic	49.24
P-value	0.00
Sargan test (H_0: over-identifying restrictions are valid)	212.60
P-value	0.98
Arellano-Bond test (H_0: no autocorrelation) – first order	-1.12
P-value	0.26
Arellano-Bond test (H_0: no autocorrelation) – second order	0.50
P-value	0.62

The mobile telecommunication infrastructure regression results are presented in table 12. The Breusch-Pagan Lagrangian test indicates that the random effect is most dominant. This implies that in SSA, country-specific factors do not determine mobile telephony facilities. Such infrastructure is affected by random variables. This may be explained by their quasi-private goods features.

Table 12: Mobile telecommunication infrastructure regression – Fixed versus random effects

Variables	Coefficient	Standard error	Z-statistic	P-value
FIXED EFFECTS				
Bank sector failure	363.06	1402.95	-0.26	0.80
Financial sector failure	1178.21	967.08	1.22	0.22
Financial sector-transport nonlinear interaction	55.96	979.88	-0.06	0.95
Previous stock of roads (km) per land size	0.24	0.06	4.22	0.00
Stock market failure	297.79	256.73	-1.16	0.25
Constant	-67,542.82	67,456.86	-1.00	0.32
RANDOM EFFECTS				
Bank sector failure	358.08	773.02	-0.46	0.64
Financial sector failure	1243.38	1,304.93	0.95	0.34
Financial sector-transport nonlinear interaction	82.91	171.14	-0.48	0.63
Previous stock of roads (km) per land size	2.51	0.56	-4.46	0.00
Stock market failure	281.74	334.10	-0.84	0.40
Constant	-74,575	67,938.55	-1.10	0.27

Both the fixed and random effects regressions illustrate that only the previous year's per capita stock of mobile telephony affects the current infrastructure gap. This implies that past increases tend to gain positive momentum.

Table 13. Mobile telecommunication infrastructure dynamic panel (GMM) regression

Variables	Coefficient	Standard error	Z-statistic	P-value
Bank sector failure	3,894.9	1,156.85	-3.44	0.00
Bank sector failure (LAGGED)	8,590.87	2,343.14	3.67	0.00
Financial sector failure	900.91	933.33	0.97	0.33
Financial sector failure (LAGGED)	6,517.26	3,066.20	-2.13	0.03
Financial sector-energy nonlinear interaction (LAGGED)	-199.81	441.49	-0.45	0.65
Mobile phone infrastructure (LAGGED)	1.09	0.01	98.99	0.00
Stock market failure	1.94	207.95	0.01	0.99
Stock market failure (LAGGED)				
00000	70.33	166.73	0.42	0.67

The corresponding GMM regression results are reported in table 14. It illustrates that previous rises in per capita mobile phone infrastructure raise current stock. This is similar to the fixed and random effect regression results. This may be because mobile telecommunication providers can easily leapfrog similar bottlenecks that impede other infrastructure. One reason is that, most SSA mobile network operators are private multinationals with more capital and resources. As such, very few, if any, source funds from African stock exchanges. This may explain why banks and prior financial intermediation enhancements are critical but stock markets are ineffective. This supports the findings of Afful and Okeahalam (2006), Irving (2000) and Singh (1999).

Table 14: Mobile phone infrastructure regression diagnostics

VARIABLES	**VALUES**
FIXED EFFECTS	
Wald-statistic	16.30
P-value	0.00
Adjusted r-squared	0.71
RANDOM EFFECTS	
Wald-statistic	25.00
P-value	0.00
Adjusted r-squared	0.78
Breusch-Pagan lagrangian multiplier test statistic (0 H : random effect is dominant)	1.87
P-value	0.09
DYNAMIC PANEL REGRESSION	
Wald-statistic	15.53
P-value	0.00
Sargan test (H_0 : over-identifying restrictions are valid)	253.51
P-value	0.64
Arellano-Bond first order-autocorrelation test (H_0 : no autocorrelation)	-1.35
P-value	0.18
Arellano-Bond second order-autocorrelation test (H_0 : no autocorrelation) – second order	0.78
P-value	0.43

iii. Transport infrastructure:

The regression results for transport infrastructure are reported in table 15.

Table 15: Transport infrastructure regression results – Fixed versus random effects

Variables	**Coefficient**	**Standard error**	**Z-statistic**	**P-value**
FIXED EFFECTS				
Bank sector failure	194.82	42.01	4.64	0.00
Financial sector failure	194.72	38.74	-5.03	0.00
Financial sector-transport nonlinear interaction	125.55	34.96	-3.59	0.00
Previous stock of roads (km) per land size	6,411.83	5,795.90	1.11	0.27
Stock market failure	2.62	5.08	-0.51	0.61
Constant	26,714.27	3,063.25	8.72	0.00
RANDOM EFFECTS				
Bank sector failure	48.02	22.88	2.10	0.03
Financial sector failure	78.06	24,37	-3.20	0.001
Financial sector-transport nonlinear interaction	78.74	29.71	-2.65	0.008
Previous stock of roads (km) per land size	4163.34	2262.32	1.84	0.06
Stock market failure	2.82	4.60	0.61	0.54
Constant	26754.45	2145.06	12.47	0.00

Both the fixed and random effects indicate that banking and financial sector intermediation failures negatively affect additional transport facilities. Such deficiencies increase transaction costs and decrease the capacity of local systems to raise financing for this purpose.

Table 16. Transport infrastructure dynamic panel (GMM) regression

Variables	Coefficient	Standard error	Z-statistic	P-value
Bank sector failure	-257.08	19.89	12.92	0.00
Bank sector failure (LAGGED)	-113.94	47.51	-2.40	0.02
Financial sector failure	37.67	16.95	2.22	0.00
Financial sector failure (LAGGED)	-28.42	63.68	-0.45	0.65
Financial sector-transport nonlinear interaction (LAGGED)	-52.59	24.24	-2.17	0.03
Stock market failure	-13.38	3.83	-3.50	0.00
Stock market failure (LAGGED	6.11	3.22	1.89	0.06
Transport infrastructure (LAGGED)	0.21	0.03	6.84	0.00

Further, there is a nonlinear interaction between the two considered networks, confirming the network and systemic failure theories (Barabási, A. 2002; Barabási *et al.,* 2006; Boopen, 2006).

Table 17: Transport infrastructure regression diagnostics

VARIABLES	VALUES
FIXED EFFECTS	
Wald-statistic	7.45
P-value	0.00
Adjusted r-squared	0.29
RANDOM EFFECTS	
Wald-statistic	18.80
P-value	0.00
Adjusted r-squared	0.30
Breusch-Pagan lagrangian multiplier test statistic (H_0: random effect is dominant)	56.19
P-value	0.00
DYNAMIC PANEL REGRESSION	
Wald-statistic	21.90
P-value	0.00
Sargan test (H_0: over-identifying restrictions are valid)	204.93
P-value	0.99
Arellano-Bond test (H_0: no autocorrelation) – first order	-1.23
P-value	0.22
Arellano-Bond test (H_0: no autocorrelation) – second order	-1.78
P-value	0.08

The dynamic panel regression results, in table 16, indicate that all three facets of financial market failure contribute to transport infrastructure deficits. This accords with the arguments of Ayogu (2007); Dunn *et al.* (2013) and Fonseca (2007). The findings further illustrate that there is a dynamic relation between financial market failures and transport infrastructure in SSA. According to the Breusch and Pagan Lagrangian test, in table 17, the fixed effect is dominant. Like the other regressions, there is no autocorrelation, misspecification or over-identification.

5. CONCLUSION

This study examined the influence of financial market failure on infrastructural development in SSA. This is decomposed into banking industry, financial sector intermediation and stock markets. The three considered core infrastructure are, namely: energy, telecommunication and transport. Pre-diagnostic tests indicate that none of the examined variables and models are multi-collinear. They are also stationary. The results for energy indicate that the GLS fixed effects regression best describes the financial market-power infrastructure relation. Further, financial sector intermediation failure and its interaction with the amenity have an adverse impact. The GMM results also find that intermediation and lagged banking failures have an adverse impact on the considered infrastructure.

Fixed-line telecommunication was also characterized by fixed effect, country-specific factors. The said regression found the interaction effect and previous stock to be relevant determinants. The dynamic panel results, on the other hand, find that all dimensions of financial market development were pertinent determinants. For mobile telecommunication, random instead fixed factors were critical. Only previous per capita stock impacted telecommunication infrastructure from the random effect results. From the related dynamic panel regression, banking failure, its lagged variant as well as previous financial sector deficiencies widen the gap.

For transport facilities too, fixed effects were also found to be relevant. Its regression results are similar to those of energy infrastructure. On the other hand, failures in all three different dimensions of financial market development as well as lagged banking deficits had a deleterious influence. Lagged interaction with intermediation had an akin impact.

One critical finding of this study is that the adjusted r-squared for mobile telecommunication regressions are significantly larger than for all other infrastructure. This suggests that it is most sensitive to financial market development. This may be because these facilities are more of a private commodity. This implies that while all dimensions of financial market development are critical, they are not equally important.

Overall, intermediation was found to be the most critical for almost all infrastructure. This suggests that, while other financial markets are important, intermediation enables an array of basic as well as complex services and transactions between different networks / systems. These results accord with a prediction of network theory (Barabási, Newman and Watts, 2006). Intermediation has greater interconnections within an economy and, therefore, has greater effect on infrastructure, another integrated system. Consequently, it is recommended that other financial markets must be significantly incorporated into the economy. An instance of this is demonstrated by the fact that less than 1 percent of Ghana's population actively invests or participates in the country's stock market. Excluding South Africa, this is the situation in most SSA economies. Addressing such deficiencies would meaningfully improve the sub-continent's financial systems and their capability to raise finance for infrastructure.

In line with Singh (1999), this study indicates that there may be fundamental deficiencies and inconsistencies in the architecture of SSA's financial systems. Intermediation is the most important aspect, followed by the banking sector. Stock exchanges are found to be almost irrelevant for infrastructure in SSA. As a result, it is suggested that stakeholders work around centers of strength by enhancing the banking industry and intermediation.

A further insight from this study is that policies and regulation can alter the features of infrastructure, such that that are redesigned as a quasi-private commodity. This would better enable financial markets to more efficiently provide infrastructure in SSA. Such would expand government's fiscal space as well as reduce its expenditure burden. These market-based solutions to society's needs are more sustainable and self-regulating (Williamson, 2005).

This study confirms the inability of SSA financial markets to raise needed long-term project-like funding for infrastructural development (Banerjee *et al.,* 2008; Brixiova *et al.,* 2011). It emphasizes the need to strengthen institutional and regulatory frameworks. Concerns, such as full disclosure of corporate and public information and stringent protection of investor rights, must be quickly addressed. Engel *et al.* (2013) and Estache (2010) emphasize the stunted capabilities of SSA capital markets. Greater credibility is a necessary pre-requisite. Accurate, complete and timely disclosure of pertinent information must be enforced. Also, investor rights must be rigidly protected. Confidence in SSA financial markets must be significantly bolstered (Yartey and Adjasi, 2007). Mispricing, low utility payment collection rates and severe leakages should be addressed.

This study advocates market financing of infrastructure in SSA. Firstly, it is another stringent mechanism to monitor public sector financing, infusing greater efficiency and productivity. Past regimes have exercised almost unfettered power regimes in this regard. Additionally, external lenders and development partners cannot effectively police SSA governments to ensure effective associated financial management. Further, such outside stakeholders lack critical local knowledge of domestic norms and nuances. Having domestic financial markets serve as an extra system of checks and balances will augment existing safeguards.

REFERENCES

Afful, K. B. and Okeahalam, C. C. (2006). "Stock Markets, Development Indicators and Investment in Sub-Saharan Africa", *African Review of Money, Banking and Finance* **1**, 39-60.

Arellano, M. and Bond, S. (1991). "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Questions", *Review of Economic Studies* **76**, 277–297

Ayogu, M. D. (2007). "Infrastructure and Economic Development in Africa: A Review", *Journal of African Economies*, 16, 75 - 126.

Barabási, A. (2002). *Linked: The New Science of Networks,* Pesseus Publishing, USA.

Barabási and Réka, A. (2002). Statistical Mechanics of Complex Networks, *Review of Modern Physics*, 74, 47-97.

Barabási, A., Newman, M. and Watts, D. J. (2006). *The Structure and Dynamics of Networks*, Princeton University Press, USA.

Beck, T. and Maimbo, S. M. (2012). *Financial Sector Development in Africa: Opportunities and Challenges*, World Bank, USA, Retrieved from:

https://openknowledge.worldbank.org/bitstream/handle/10986/.../9780821396285.pdf, Accessed in: June 2015.

Boopen, S. (2006). "Transport Infrastructure and Economic Growth: Evidence from Africa using Dynamic Panel Estimates", *The Empirical Letters* **5**(1), 37-52.

Breusch, T. S. and Pagan, A. R. (1980). "The Lagrange Multiplier Test and Its Applications to Model Specification in Econometrics", *Review of Economic Studies* **47**, 239-253.

Briceno-Garmendia, C., Smits, K. and Foster, V. (2008). Financing Public Infrastructure in Sub-Saharan Africa: Patterns, Issues and Options, Background Paper #15, *Background Papers*, Africa infrastructure Country Diagnostic, World Bank, USA, Retrieved from: *http://*siteresources.worldbank.org/INTAFRICA/.../aicd_overview_english_no-embargo.pdf, Accessed in: July 2015.

Brixiova, Z., Mutambatsere, E., Ambert, C. and Etienne, D. (2011). "Closing Africa's Infrastructure Gap: Innovative Financing and Risks, *Africa Economic Brief* **2**(1), 1-8.

Chang Lin, C., A. (2006). "An Integral Constrained Generalized Hub-and-Spoke Network Design Problem", *Transportation Research Part B: Logistics and Transportation Review* **44**, 6-19.

Coase, R. (1960). "The Problem of Social Cost", *Journal of Law and Economics* **3**, 1-44.

Delmon, J. 2009. Private Sector Investment in Infrastructure: Project finance, PPP Projects and Risks, World Bank, USA, World Bank Publications, Retrieved from: http://www.fa.ru/chair/gcp/Documents/%D0%94%D0%BB%D1%8F%20%D0%B1%D0%B8%D0%B1%D0%BB%D0%B8%D0%BE%D1%82%D0%B5%D0%BA%D0%B8%20%D0%BA%D0%BD%D0%B8%D0%B3/Private%20sector%20investment%20in%20infrastructure,%20Jeffrey%20Delmon.docx, Accessed in: August 2015.

Dunn, S., Fu, G., Wilkinson S. and Dawson R. (2013). "Network Theory for Infrastructure Systems Modelling", *Proceedings of the ICE Engineering Sustainability Conference* **166**(5), 281-292.

Engel, E. M. R. A., Fischer, R. D. and Galetovic, A. (2010). "The Economics of Infrastructure Finance: Public-Private Partnerships versus Public Provision", *Working Papers*, European Investment Bank **15**(1), 40-69.

Engel, E., Fischer, R. and Galetovic, A. 2013. "The Basic Public Finance of Public-Private Partnerships", *Journal of the European Economic Association* **11**, 83-111.

Esfahani, H. S. and Ramirez, M. T. (2003). "Institutions, Infrastructure and Economic Growth", *Journal of Development Economics* **70**, 443-477.

Estache, A. (2010). Infrastructure Finance in Developing Countries: An Overview", *EIB Papers* **15**(2), 60-88.

Focardi, S. M. & Fabozzi, F. J. (2004), "*The Mathematics of Financial Modeling and Investment Management*", Wiley Finance Series, John Wiley & Sons Incorporated, USA.

Fonseca, A. E. (2007). *Contemporary Network Theory: Concepts and Implications for Transportation Asset Management*, Thesis submitted in partial fulfillment for degree of Master of Science (Civil Engineering), Virginia Polytechnic Institute and State University, USA.

Irving, J. (2000). "Africa's Struggling Stock Exchanges, Boost to Economic Development or "Costly Irrelevance?", *Africa Recovery* **14**, 25-28.

Irving, J. and Manroth, A. (2008). "Potential for Local Private Finance of Infrastructure in Africa", *Working Paper Series,* No. 549, Africa Infrastructure Country Diagnostic, World Bank, Retrieved from: http://siteresources.worldbank.org/INTAFRICA/Resources/AICD_exec_summ_9-30-08a.pdf, Accessed in: July 2015.

Jun, Z., Yuan, G. Yong, F. and Hong, Z. (2007). "Why Does China Enjoy So Much Better Physical Infrastructure?", *Economic Research Journal* **3**, 4-19.

Kiviet, J. F., Pleus, M. and Poldermans, R. W. (2016). "Accuracy and Efficiency of Various GMM Inference Techniques in Dynamic Micro Panel Models", *Econometrics,* 5, 2-54.

Mbulawa, S. (2015). "Determinants of Financial Development in Southern Africa Development Community (SADC): Do Institutions Matter?", *European Journal of Auditing and Finance Research* **3**(6), 39-62.

McDonald, C. A. and Schumacher, L. B. (2007). Financial Deepening in Sub-Saharan Africa: Empirical Evidence on the Role of Creditor Rights Protection and Information Sharing", International Monetary Fund, Retrieved from: http://www.imf.org/~/media/Websites/IMF/imported-full-text-pdf/external/pubs/ft/wp/2007/_wp07203.ashx, Accessed in: December 2015.

Norman, A. (2011). "Innovative Financing for Infrastructure in Low Income Countries", *Occasional Paper Series, #1,* African Center for Transformation, Retrieved from: http://acetforafrica.org/publication/innovative-financing-for-infrastructure-in-low-income-countries-how-might-the-g20-help, Accessed in: August 2015.

Shittu, O. I., Yemittan, R. A. and Yaya, O. S. (2012). "On Autoregressive Distributed Lag, Cointegration and Error Correction Model", *Australian Journal of Business and Management Research* **2**(8), 56-62.

Singh, A. (1999). "Should Africa Promote Stock Market Capitalism?", *Journal of International Development* **11**,

343-365.
van der Mandele, M. (2006). "Policy Development for Infrastructure Networks: Concepts and Ideas", *Journal of Infrastructure Systems* **12**(2), 69-76.
Vagliasindi, M. and Nellis, J. (2009). "Evaluating Africa's experience with Institutional Reform for the Infrastructure Sectors", *Working Paper Series*, WP/23, Africa Infrastructure Country Diagnostic, World Bank, Retrieved from: www.worldbank.org, Accessed in: August 2015.
Williams, M. D. J., Mayer, R., Minges, M. (2011). *Africa's ICT infrastructure: Building on the mobile revolution.* World Bank, USA, Retrieved from: www.worldbank.org, Accessed in: August 2015.
Williamson, O. E. (2005). "The Economics of Governance", *American Economic Review* **95**(2), 1 -18.
Wooldridge, J. M. (2010). *Econometric Analysis of Cross Section and Panel Data,* Massachusetts Institute of Technology Press, USA.
World Bank. 2010. *Africa's Infrastructure: A Time for Transformation.* Vivien, Foster and Cecilio Briceno-Garmendia (eds.), USA, Retrieved from: www.worldbank.org, Accessed in: July 2015.
————————. 2015. *Africa development indicator database*, World Bank, USA, Retrieved from: www.worldbank.org, Accessed in: December 2015.
Yartey, C. A. and Adjasi, C. K. (2007). "Stock Market Development in Sub-Saharan Africa: Critical Issues and Challenges", *Working Paper Series,* WP/07/209, International Monetary Fund, USA, Retrieved from: www.imf.org, Accessed in: Augusts 2015.
Yong, Y. and Shaowen, W. (2001). *Stationarity Tests in Heterogeneous Panels*, In 'Non-stationary panels, panel cointegration, and dynamic panels (*Advances in econometrics*, vol. 15), Badi, H. B., Fomby, B. T., Hill, C. R. (eds.), Emerald Group publishing ltd., USA.