Chireshe, Jaison

Article

Finance and renewable energy development nexus : evidence from Sub-Saharan Africa

Reference: Chireshe, Jaison (2021). Finance and renewable energy development nexus : evidence from Sub-Saharan Africa. In: International Journal of Energy Economics and Policy 11 (1), S. 318 - 325.
https://www.econjournals.com/index.php/ijeep/article/download/10417/5596.
doi:10.32479/ijeep.10427.

IJEEP

INTERNATIONAL JOURNAL OF ENERGY ECONOMICS AND POLICY

EJ EconJournals ISSN: 2146-4553

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2021, 11(1), 318-325.

EJ EconJournals

Finance and Renewable Energy Development Nexus: Evidence from Sub-Saharan Africa

Jaison Chireshe*

A-One Business Services, Zimbabwe. *Email: jaisonchireshe@yahoo.com

Received: 15 July 2020 **Accepted:** 17 October 2020 **DOI:** https://doi.org/10.32479/ijeep.10427

ABSTRACT

Renewable energy technologies provide an opportunity for sub-Saharan Africa countries to reduce energy poverty, achieve energy security and economic growth. This paper examined the relationship between financial development and renewable energy development using data from 17 selected sub-Saharan Africa countries for a 17-year period from 2000 to 2016. The study sought to understand whether financial development is associated with increased renewable energy generation capacity. The investigation adopted a fixed effects and system generalised methods of moments estimation approaches to understand the relationship between financial development and renewable energy development. The results show that financial development is positively correlated with renewable energy production capacity. These results imply that policy makers in sub-Sahara Africa must foster financial development in their respective countries to ensure increased investment in renewable energy production capacity.

Keywords: Financial Development, Renewable Energy Development, Sub Saharan Africa
JEL Classifications: G21, G42, O1

1. INTRODUCTION

Energy contributes to both economic growth and social development, directly and indirectly (Kraft and Kraft, 1978; Belke et al., 2010). The contribution comes through increasing the productivity of capital, labour and other factors of production as well as improving quality of life through healthcare and education (Solarin, 2011). Adequate and reliable energy supply is required to transform input materials into both tangible and intangible outputs (Stern and Cleveland, 2004). The absence of reliable energy supply constrains economic growth and social development as in the case of sub-Saharan Africa (SSA). The SSA region produces the least amount of energy in the world and the supply is often erratic. In addition, the region has the highest level of energy poverty. In 2017, 55 per cent of households in SSA lacked access to electricity and this figure rises to over 83 percent in rural areas (WDI, 2020). SSA is the only region in the world where the number of people with no access to electricity is increasing (IEA, 2014). The energy deficit continues to increase despite that SSA has a large and varied resource pool to produce surplus energy for current and future consumption (IEA, 2018).

In addition to high levels of energy poverty, the region relies heavily on non-renewable energy sources. Over 70 percent of Africa's energy comes from fossil fuels such as coal, oil and gas IEA (2018). At household level, reliance on unclean energy for cooking and lighting is associated with respiratory diseases (Agenor and Moreno-Dodson, 2006). According to WHO (2016) about seven percent of diseases worldwide are caused by indoor air pollution from wood smoke, resulting in an estimated 1.6 million premature deaths each year. The SSA region accounts for about 38 percent of these deaths.

The low energy production and correspondingly high energy poverty levels in the region are attributed to a huge investment gap in the energy sector. Finance remains a major hindrance to investment in SSA's vast renewable energy resource base (Karekezi and Kithyoma, 2003). According Kaminker and

Stewart (2012) renewable energy projects just like any other infrastructure project suffers from lack of investor capability and understanding of the risks specific to infrastructure investing. There is also a shortage of suitable investment vehicles particularly collective debt instruments with suitable scale, satisfactory rating and liquidity. The lack of investment is more pronounced in the renewable electricity sub-sector hence the reliance on fossil fuels. This calls for increased investment to boost power output from renewable sources.

SSA have prime opportunities for renewable energy production which can be harnessed to eliminate power shortages, bring electricity and development opportunities to rural villages that have never enjoyed those benefits, spur industrial growth, create entrepreneurs, and support increased prosperity across the continent (Future Energy Africa, 2018). Renewable energy technology also facilitates a cost-effective transformation to a cleaner and more secure energy sector. Despite the recognition that renewable energy sub-sector is an important source of energy for SSA, the sector has attracted neither the requisite level of investment nor tangible policy commitment (Karekezi and Kithyoma, 2003).

This paper argues that renewable energy development requires well developed financial systems which can mobilise both domestic and foreign financial resources for investment in the sector. According to the finance-industry growth nexus literature (Rajan and Zingales, 1998, 2003; Beck et al., 2004; 2007; 2008) which has its roots in Bagehot (1873) and Schumpeter (1911), financial development facilitates easy entry of new firms and spur growth of existing firms. Industries and firms that rely heavily on external financing grow disproportionately faster in countries with well-developed banks than in countries with poorly developed financial systems (Rajan and Zingales, 1998).

Well-developed financial institutions accelerate capital flow to sectors with high growth potential and investment prospects (Fisman and Love, 2013). The renewable energy sector is one such area in the SSA which presents potential growth and investment. Renewable energy will make up almost half of SSA's power generation growth by 2040, (IEA, 2014). Globally, renewable energy constitutes more than half of all global energy capacity additions since 2012 (Gielen et al., 2019) revealing the huge growth potential that the sector has.

As alluded earlier, investment in the renewable energy sector is hindered by among other things by poor or non-existent sovereign creditworthiness, under-developed financial markets which do not offer enough capital and proper financial instruments, information asymmetry, high start-up costs and high economic risk of infrastructure projects (Ba et al., 2010; Brunnschweiler, 2010). However, well developed financial systems can overcome these challenges through pooling of savings, amelioration of risk, information sharing among other functions (Levine, 1997). By performing these functions well developed financial systems overcome moral hazard and adverse selection problems thereby promoting investment and growth of the renewable energy sector (Kim and Park, 2015).

The study is motivated by two important factors. Investment in renewable energy production technologies provide a vital opportunity to reduce energy poverty in SSA, boost economic growth and ensure energy security. Renewable energy production enables countries to move away from reliance on fossil fuel to clean energy sources reducing greenhouse gas emissions (Panwar et al., 2011). Secondly, the role of financial development on renewable energy development in SSA is conspicuously absent. Globally, existing studies literature linking financial development and the energy sector are focused on energy consumption. The literature on finance and renewable energy development is very limited despite the fundamental role played by financial development in the renewable energy sector (Brunnschweiler, 2010; Scholtens and Veldhuisa, 2015). The few existing empirical studies have a limited focus on SSA. Empirical studies on the determinants of renewable energy development in SSA are not only limited but they also neglect the role of the financial development (e.g. Lokonon and Salami, 2017; da Silva et al., 2018). The existing literature on renewable energy in SSA have been engrossed in discussing the potential of renewable energy and barriers to investment (Odero, 2014).

The remainder of the paper is organised as follows; section 2 presents a review of both theoretical and empirical literature, section 3 discusses the methodology, section 4 presents results and discussion and the section 5 provides a conclusion to the study.

2. LITERATURE OVERVIEW

2.1. Theoretical Review

There are several schools of thought in the finance growth literature and the prominent theories include the finance-led growth (Schumpeter, 1911; Patrick, 1966; McKinnon, 1973; Shaw, 1973) and growth-led finance hypothesis (Robinson, 1952, Lewis, 1956). In addition to these two schools of thought, other scholars perceive that the role of financial development in economic activities is overemphasised (Lucas, 1988, de Gregorio and Guidotti, 1995; Arcand et al., 2015) whilst others view finance as destructive to the process of economic growth (Minsky, 1974; Tobin, 1984; Cihak et al., 2012).

The finance-led growth school of thought argues that the financial system by performing its functions it leads to investment, technological innovation and subsequently economic growth. The functions performed by the financial system include mobilisation and pooling of savings, allocation of resources, amelioration of risk, exertion of corporate control as well as easing of trading of goods services and contracts (Levine, 1997). Despite a well-developed literature on this school of thought, there are dissenting voices regarding the role of financial development in investment, economic growth and human welfare. The growth-led finance (demand following) hypothesis argues that financial development follows economic growth or where enterprise leads finance follows (Robinson, 1952). Growth in economic activities increase the demand for financial instruments and arrangements leading to the growth of the financial sector as it responds to growing demand.

In the disruptive school of thought, financial development is considered to disrupt the process of economic growth as financial deepening could cause macroeconomic instability, distorting society's savings, leading to inefficiency in bank lending (Minsky, 1974, Cihak et al., 2012). In addition to causing inefficiency in bank lending, overly sophisticated financial instruments lead to financial fragility which can lead to economic meltdown (Rajan, 2005; Gennaioli et al., 2012). Empirical studies have shown contraction of growth in the aftermath of banking crises and in the presence of 'too much finance' (Arcand et al., 2015; Reinhart and Reinhart, 2015). Tobin (1984) indicates that the financial sector attracts resources away from the real sector leading to inefficiency and impediment of the process of economic growth. A recent study by Dabla-Norris and Narapong (2013) similarly argues that, before the 2008 global financial crisis, resources in advanced economies were being diverted toward the financial sector away from more productive sectors.

Other scholars view finance as a neutral factor in the process of economic growth, with Lucas (1988) arguing that the role of finance in economic growth has been overemphasised. Arguments by de Gregorio and Guidotti (1995), Cecchetti and Kharroubi (2015) and Arcand et al. (2015) suggest that financial development does not always lead to economic growth. de Gregorio and Guidotti (1995) suggest that high-income countries may have reached the point at which financial depth no longer contributes to increasing the efficiency of investment and ultimately to economic growth. Similarly, Arcand et al. (2015) argue that when finance reaches a certain threshold its positive effects on economic growth may disappear.

This study follows the finance-led growth school of thought. The recognition of the role of finance in energy development stems from the works of Churchill and Saunders (1989), Babbar and Schuster (1998) and Head (2000). These researchers suggested several innovative financing options to improve performance and investment in the energy sector especially by the private sector. Kim and Park (2015) echoes the same sentiments by arguing that the financial sector by mobilising savings, ameliorating risk, exerting corporate control and allocating resources it leads to renewable energy sector growth.

2.2. Empirical Literature Review

A pioneering empirical study linking financial development and the energy sector by Sadorsky (2010) was followed by a series of studies exploring the relationship between financial development and energy consumption in different jurisdictions and using different methodologies (e.g. Chitioui, 2012; Çoban and Topcu, 2013; Ali et al., 2015, Roubaud and Shahbaz, 2018). The evidence from these studies is mixed as some studies have showed a positive relationship between financial development and energy consumption whilst another set have shown a negative relationship. Another strand of literature focused on financial development and carbon emissions (Zhang, 2011; Abbasi and Riaz, 2016). These two strands of literature posit that financial development leads to economic growth and household income hence increased energy consumption and carbon emissions. However, as alluded earlier the evidence from studies based on this hypothesis is inconclusive.

Scholars have also studied the determinants of investment in renewable energy. Studies by Brunnschweiler (2010), Scholtens and Veldhuisa (2015) and Kim and Park (2015) found that financial development has a significant positive effect on renewable energy investment and output. These studies are discussed below one after the other. Brunnschweiler (2010) studied the impact of financial development on renewable energy output using panel data for 119 non-OECD countries from 1980-2006. The study used a general methods of moments (GMM) approach. It showed that financial development has positive and significant impact on the amount of renewable energy output. The impact was greatest on non-hydropower sources like geothermal, wind, solar and biomass. Similarly, Fangmin and Jun (2010) examined the relationship between financial systems and renewable energy using panel data from 1980 to 2008 for 55 countries. The study showed a positive correlation between the development level of financial intermediation and the total power output of the renewable energy projects in these countries.

In a similar study, Kim and Park (2015) studied the role of financial development in energy output using panel data from 30 countries selected from the Americas, Asia and Oceania and Europe for a 14 year period ranging from 2000 to 2013. The results showed that financial development has a positive and significant impact of renewable energy output. Countries with well-developed financial systems experienced a disproportionate growth in renewable energy output as compared to countries with poorly developed financial systems. Scholtens and Veldhuisa (2015) also studied the impact of financial development and energy sector development using data from panel of 198 countries from 1980-2008. The study employed random and fixed effects as well as GMM estimation approaches. The results showed that financial development as measured by the size of the commercial banking sector, commercial bank credit to the private sector and the size of the financial industry has a positive impact of renewable energy capacity.

In summary, the empirical literature on financial development and renewable energy sector growth is still in its infancy with the majority of the evidence emanating from case studies and anecdotes (Fangmin and Jun, 2010). Secondly, the bulk of the existing literature linking the finance sector and the energy sector focuses on financial development and energy consumption. Thirdly, all the strands of literature linking financial development and the energy sector have a limited focus on SSA. Studies focusing on the determinants of renewable energy in SSA exclude financial development in their analysis. With the quest to decarbonise the world by switching from fossil fuels to sustainable energy sources, it is important that the role of financial development in renewable energy is examined. The study therefore seeks to contribute to the literature on financial development and renewable energy sector growth by focusing on SSA.

3. MATERIALS AND METHODS

3.1. Empirical Model and Estimation Techniques

To achieve the study objectives, Equation (1) was estimated using real gross domestic product (GDP) per capita, energy consumption, foreign direct investment and energy imports as explanatory variables. All the variables used were transformed by taking their logarithms to normalize the data and linearise the relationships among the variables. The empirical model is specified as follows;

$$lnRE=\alpha_0+\beta_1\ lnFD+\beta_2\ lnGDP_{capita}+\beta_3\ lnImports +\beta_4\ lnFDI+\beta_5\ lnCons+v_t \quad (1)$$

Where, *RE* measures the installed generation capacity of renewable energy; *GDP_capita* is the real gross domestic product per capita; *Cons* is the demand for energy as proxied by energy consumption per year; *Imports* represents energy imports; *FDI* represents foreign direct investment; *FD* represents financial development. The data on renewable energy was sourced from the EIA databases and data financial development was obtained from the International Monetary Finance (IMF) data. The remaining data on real GDP per capita, FDI, was sourced from World Development Indicators.

3.2. Measurement of Variables

3.2.1. Renewable energy development (non hydro capacity)

This variable measure the level of renewable energy development in country. The variable was proxied by the amount of renewable electricity production capacity installed. The renewable energy variable excludes hydropower installed capacity. Inclusion of hydropower distorts the renewable energy development levels as governments have been actively financing investment in hydropower for a long time and has matured as an energy source (REN21, 2015).

3.2.2. Financial development (findex, accesindex and depthindex)

The variable measures the level of financial development in a country. The variable was proxied by three composite indices namely the financial development, financial institutions depth and access indices. Svirydzenka (2016) for details on the construction of these indices. The use of composite indices aims to circumvent the pitfalls that comes with using a single dimension index like private sector credit to GDP or automated teller machines (ATMS) per 100,000 people. The financial development index measures the overall development of the financial sector of a country. It's a multidimensional index measuring depth, access efficiency and efficiency of the financial sector. The index is made up of the banking sector, insurance sector and capital market variables. The financial institutions depth index is made up of private-sector credit to GDP, pension fund assets to GDP, mutual fund assets to GDP and insurance premiums (life and non-life) to GDP. Deep financial systems are efficient and allocate funds to their most productive uses (World Bank, 2008). They also offer savings, payments, and risk-management products to as large a set of participants as possible and seeking out and financing good growth opportunities wherever they may be (Beck et al., 2008). The financial institutions access index is made of number of commercial bank branches per 100 000 people and number of automated teller machines (ATMs) per 100 000 people. According to the IMF (2008), access to finance can expand opportunities for those with higher levels of access. Additionally, the use of banking services is associated with lower financing obstacles for both people and businesses. Access to financial services by the SSA population is both relatively and absolutely limited. Lack of access to finance is a key constraint on the growth of small and medium enterprises in SSA (IFC, 2013a). Financial development variables are expected to be positively correlated for renewable energy production variables.

3.2.3. Real GDP per capita

This a proxy measure of a country's level of income per capita. The variable is expected to be positively correlated with renewable capacity. Countries with higher income levels are expected to investment in renewable energy resources.

3.2.4. Foreign direct investment (FDI)

The variable measures the net inflow of foreign direct investment in a country. FDI increases renewable energy installed capacity. FDI is also a vehicle for technology transfer from developed to less developed countries (Findlay, 1978; Blalock and Gertler, 2008). The variable is expected to be positively correlated with renewable installed capacity.

3.2.5. Consumption

The variable measures the amount of energy consumed in a country per year from both renewable and non-renewable sources. The consumption variable is a proxy measure of the demand for power in a country. The variable is expected to be positively correlated to renewable installed capacity.

3.2.6. Imports

The variable measures the amount of electricity imported by a country in a year. Reliance on imported energy has a negative effect on investment in the local energy generation capacity. This variable is expected to be negatively correlated with renewable electricity installed capacity.

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics and Diagnostic Tests

The summary statistics show that an average of 16.29 billion kilowatts hours (KwH) of electricity were consumed over the study period whilst 765,000 KwH of renewable energy capacity were installed. The average real GDP per capita stood at US$1,860. Table 1 for details.

The variables and estimation methods were subjected to a series of tests to ensure that the results were not misleading. The tests carried out included unit root, heteroskedasticity and autocorrelation and tests that relate to the choice of estimation methods and instrumental variables. The study tested the stationarity of all the variables used in the analysis to avoid running spurious regressions. The Fisher-type Phillips-Perroni test was used to determine the stationarity of the data series. The tests showed that all the variables are stationary in levels. Table A1 in the Annex for detailed results.

4.2. Fixed Effects Estimation

Equation 1 was estimated using the fixed effects estimation approach as guided by the results of the Hausman test. The fixed effects estimation approach captures countries-specific effects that influence the level of renewable energy production capacity. but are not observable. The results of the fixed effects estimation approach show that financial development is positively and

Table 1: Descriptive statistics

Variables	Observations	Mean	Standard. deviation	Minimum	Maximum
Consumption (billion Kwh)	289	16.29	47.61	0.123	220.4
FinIndex	289	0.166	0.136	0.024	0.618
Depth index	289	0.177	0.246	0.004	0.895
FDI (US$ billion)	287	4.157	6.012	–4.844	50.02
Access index	289	0.09	0.11	0.003	0.459
GDP_capita (US$)	289	1.860	2.300	193.9	9,834
Imports (million kw)	289	1.262	2.990	0.00	13.06
Non hydro capacity (million kw)	289	0.0765	0.302	0.00	3.784

significantly correlated with renewable energy generation capacity. A one percent increase in the overall financial development index, financial sector depth index and financial access index is associated with a 3 percent, 2.1 percent and 1.7 percent increase renewable energy installed capacity respectively. The results confirmed the study hypothesis which postulated that well-developed financial systems foster the development of the renewable energy sector. Table 2 presents the complete results of the analysis.

The results also show that electricity consumption is positively correlated renewable energy installed capacity whilst electricity imports is negatively correlated renewable energy installed capacity.

4.3. Generalised Method of Moments Estimation (GMM)

In addition to using the fixed effects estimation approach, the study used the system generalised methods of moments (Blundell and Bond, 1988) to deal with potential endogeneity with the financial development variables. The GMM approach facilitates the extraction of the exogenous component of the financial development variables (Aguirregabiria, 2009; Alonso-Borrego, 2010). A two-step system GMM approach which is robust to heteroskedasticity was used. A correction for down biasedness of standard errors was also done (Windmeijer, 2005). Following Beck et al. (2008), the study averaged the data over non-overlapping 3-year periods to end up with seven observations per country. The results of the regressions analysis were tested for second order serial correlation (AR2) using the Arellano and Bond test (Arellano and Bond, 1991). The null hypothesis on the presence of serial correlation was reject in all regressions. The Sargan test of overidentification also showed that all the instruments used were valid. The system GMM regression analysis confirmed the results of the fixed effects analysis and the study's priori expectation. The results showed that a one percent increase in the overall financial sector development (Findex) leads to a 4.5 percent increase in renewable energy generation capacity. Similarly, a one percent increase in the financial sector depth and access indices leads to a 3.9 percent and 1.6 percent increase in renewable energy generation capacity respectively. Table 3 shows the results of the system GMM regression analysis.

The results from the fixed effects and system GMM regression analysis are in tandem with the broad finance-industry growth nexus in which financial development facilitates easy entry of new firms, spur growth of existing firms and increase productivity (Rajan and Zingales, 1998). Additionally, the above findings are like those from previous studies on renewable energy and finance by Brunnschweiler (2010), Fangmin and Jun (2010)

Table 2: Financial development and renewable energy: A fixed effects estimation approach

Independent variables	Non-hydro capacity		
	Model 1	Model 2	Model 3
logFindex	3.05***	-	-
	(0.35)		
logDepthIndex	-	2.11***	-
		(0.20)	
logAccesindex	-	-	1.67***
			(0.30)
logConsumption	1.029***	1.07**	1.82***
	(0.058)	(0.06)	(0.08)
logGDP_capita	–1.515***	–1.88***	–2.79**
	(0.1)	(0.07)	(0.31)
logImports	–0.613***	–0.51**	–0.57***
	(0.06)	(0.04)	(0.09)
logFDI	0.00143	–0.04	–0.54***
	(0.07)	(0.02)	(0.16)
Constant	10.25***	11.3***	16.0***
	(1.12)	(0.78)	(2.6)
R-squared	0.75	0.74	0.61
Number of countries	17	17	17
Number of observation	158	158	158
Hausman test	41.4 (0.00)	25.0 (0.00)	23.6 (0.00)

Standard errors in parentheses ***P<0.01, **P<0.05, *P<0.1

as well as Kim and Park (2015). These studies also found that financial development had a significant impact on renewable energy capacity.

The overall financial development variable had the largest effect on renewable energy production capacity when compared to financial depth and access variables. This shows that the different sub-sectors of the financial sector play synergic roles in fostering investment in the renewable sector. Governments in SSA must formulate policies that foster holistic growth of their respective financial sectors as opposed to piece meal approaches. Focusing of the sub-sector indices the results show that, the financial depth has a stronger positive association with renewable energy capacity as compared to financial access. The variation can be explained by the crucial roles played by deep financial systems. Deep financial systems enhance access to finance and help industries and firms most reliant on external financial resources as well as by allowing smaller firms to overcome financing constraints and grow faster (Beck, 2006).

4.4. Control Variables

In all the six regressions, energy consumption is positively and significantly correlated with renewable energy production capacity. Energy consumption represents the demand for energy and as such

Table 3: Financial development and renewable energy; A system GMM estimation approach

Independent variables	Non-hydro capacity		
	Model 4	Model 5	Model 6
logFindex	4.50*** (0.95)	-	-
logDepthindex	-	3.93*** (0.96)	-
logAccessindex	-	-	1.61** (0.75)
logConsumption	0.62* (0.36)	0.79* (0.42)	0.91*** (0.28)
logGDP_capita	–2.19*** (0.25)	–3.31*** (0.42)	–1.6 (1.17)
logImports	–0.30 (0.26)	–0.369 (0.290)	–0.10 (0.40)
logFDI	0.09 (0.086)	0.0665 (0.10)	–0.30 (0.424)
Constant	18.58*** (3.39)	25.62*** (4.35)	10.43 (9.72)
Observations	70	70	70
Countries	17	17	17
Number of Instruments	13	13	13
AR (2) P-value	0.68	0.39	0.75
Sargan test of overid. restrictions	0.50	0.29	0.21

Standard errors in parentheses ***P<0.01, **P<0.05, *P<0.1

increased demand stimulates renewable and non-renewable energy production. The results are in line with the priori expectation. The study also shows that imports are negatively and significantly correlated with renewable production capacity in line with the priori expectation. Importing energy acts as a disincentive for countries to investment in renewable energy.

However, the results of GDP per capita and FDI contradicted the priori expectation as these two variables were negatively and significantly correlated with installed capacity of renewable energy. FDI in the renewable energy sector in SSA is largely constrained by lack of conducive energy policies, price distortions and lack of infrastructure (Karekezi and Kithyoma, 2003).

5. CONCLUSION

Renewable energy technology provides an opportunity for SSA countries to reduce energy poverty, achieve energy security and economic growth. Financial development plays a vital role in mobilising resources and efficient allocation of capital among other functions which foster investment in the renewable energy sector. The existing literature on finance and energy is largely focused on financial development and energy consumption. There is also limited research on the link between financial development and renewable energy in SSA.

The study explored the relationship between financial development and renewable development in selected SSA countries. It used data from 17 selected SSA countries for a 17 year period from 2000 to 2016. Renewable energy development was measured by the amount renewable generation capacity installed in a country. The study used fixed effects and system GMM estimation approaches. The results showed that financial development is positively and significantly correlated with renewable energy production capacity. The results also showed that energy consumption is positively and significantly correlated to installed renewable energy production capacity. Energy imports were found to be negatively and significantly correlated with renewable energy capacity. Importing energy acts as a disincentive for countries to investment in renewable energy generation capacity.

In terms of policy implications, the study showed that SSA countries must foster the development of their respective financial sector to mobilise both domestic and offshore financial resources for investment in the local renewable energy sector. Strengthening the regulation, deregulation of the financial sectors and reducing government ownership of banks are policy instruments that can spur the development of the local financial sector. Government must also reduce reliance on energy imports to enable the development of the renewable energy sector. Many energy imports are generated from mature fossil fuels and hydro sources which enjoy preferential regulation making it difficult for local renewable energy plants to compete with the pricing of electricity generated from fossil fuels.

REFERENCES

Abbasi, F., Riaz, K. (2016), CO_2 emissions and financial development in an emerging economy: An augmented VAR approach. Energy Policy, 90, 102-114.

Agenor, P.R., Moreno-Dodson, B. (2006), Public Infrastructure and Growth: New Channels and Policy Implications. World Bank Policy Research Working Paper No. 4064.

Aguirregabiria, V. (2009), Econometric Issues and Methods in the Estimation of Production Functions. MPRA Paper No. 15973. Available from: https://www.mpra.ub.uni-muenchen.de/15973. [Last accessed on 2020 Jun 01].

Ali, H.S., Yusop, Z.B., Hook, L.S. (2015), Financial development and energy consumption nexus in Nigeria: An application of ARDL bound testing approach. International Journal of Energy Economics and Policy, 5(3), 816-821.

Alonso-Borrego, C. (2010), Firm Behavior, Market Deregulation and Productivity in Spain. Documentos de Trabajo No. 1035. Available from: https://www.bde.es/f/webbde/ses/secciones/publicaciones/publicacionesseriadas/documentostrabajo/10/fic/dt1035e.pdf.

Arcand, J.L., Berkes, E., Panizza, U. (2015), Too much finance? Journal of Economic Growth, 20(2), 105-148.

Arellano, M., Bond, S. (1991), Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies, 58(2), 277-297.

Ba, L., Gasmi, F., Noumba, U.P. (2010), Is the Level of Financial Sector Development a Key Determinant of Private Investment in the Power Sector? Washington, DC, Policy Research Working Paper No. WPS5373.

Babbar, S., Schuster, J. (1998), Power Project Finance: Experience in Developing Countries. RMC Discussion Paper Series No. 119. Washington, DC: The World Bank.

Bagehot, W. (1873), Lombart Street: A Description of the Money Market. New York: Wiley & Sons.

Beck, T. (2006), Creating an Efficient Financial System: Challenges in a Global Economy. World Bank Policy Research Working Paper No. 3856. Available from: https://www.pdfs.semanticscholar.org/3c68/9eb20002d9728f4a2bd72b5526f3597a207d.pdf.

Beck, T., Demirguc-Kunt, A., Laeven, L., Levine, R. (2004), Finance, Firm Size, and Growth. NBER Working Paper Series Working Paper No. 10983.

Beck, T., Demirgüç-Kunt, A., Laeven, L., Levine, R. (2008), Finance, firm size, and growth. Journal of Money Credit and Banking, 40(7), 1379-1405.

Beck, T., Demirgüç-Kunt, A., Levine, R. (2007), Finance, Inequality and the Poor. Washington, DC: The World Bank. Available from: http://www.siteresources.worldbank.org/dec/resources/finance_inequality_and_the_poor.pdf. [Last accessed on 2016 Jun].

Belke, A., Dreger, C., de Hanan, F. (2010), Energy Consumption and Economic Growth New Insights into the Cointegration Relationship. Ruhr Economic Paper Series No. 190. Available from: http://www.repec.rwi-essen.de/files/rep_10_190.pdf.

Blalock, G., Gertler, P.J. (2008), Welfare gains from foreign direct investment through technology transfer to local suppliers. Journal of International Economics, 74(2), 402-421.

Blundell, R., Bond, S. (1998), Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics, 87(1), 115-143.

Brunnschweiler, C. (2010), Finance for renewable energy: An empirical analysis of developing and transition economies. Environment and Development Economics, 15(3), 241-274.

Cecchetti, S.C., Kharroubi, E. (2015), Why Does Financial Sector Growth Crowd Out Real Economic Growth? BIS Working Papers No 490. Monetary and Economic Department February 2015.

Cecchetti, S.G., Kharroubi, E. (2012), Reassessing the Impact of Finance on Growth. Bank for International Settlements, Working Papers No 381. Available from: http://www.bis.org/publ/work381.pdf.

Chitioui, S. (2012), Does economic growth and financial development spur energy consumption in Tunisia? Journal of Economics and International Finance, 4(7), 150-158.

Churchill, A.A., Saunders, R.J. (1989), Financing of the Energy Sector in Developing Countries, World Bank Industry and Energy Department Working Paper, Energy Series Paper No. 14.

Cihak, M., Demirgüç-Kunt, A., Feyen, E., Levine, R. (2012), Benchmarking Financial Systems Around the World. Policy Research Working Paper No. WPS6175. Washington, DC: The World Bank.

Çoban, S., Topcu, M. (2013), The nexus between financial development and energy consumption in the EU: A dynamic panel data analysis. Energy Economics, 39, 81-88.

da Silva, P.P., Cerqueira, P.A., Ogbe, W. (2018), Determinants of renewable energy growth in Sub-Saharan Africa: Evidence from panel ARDL. Energy, 156(C), 45-54.

Dabla-Norris, E., Narapong, S. (2013), Revisiting the Link between Finance and Macroeconomic Volatility. IMF Working Paper No. 13/29. Washington, DC: International Monetary Fund.

de Gregorio, J., Guidotti, P.E. (1995), Financial development and economic growth. World Development, 23(3), 433-448.

EIA. (2014), Africa Energy Outlook. A Focus on Energy Prospects in Sub-Saharan Africa, World Energy Outlook Special Report. Available from: https://www.usaid.gov/sites/default/files/documents/1860/iea-africa-energy-outlook-2014.pdf.

Fangmin, L., Jun, W. (2010), Financial system and renewable energy development: Analysis based on different types of renewable energy situation. Energy Procedia, 5, 829-833.

Findlay, R. (1978), Relative backwardness, direct foreign investment, and the transfer of technology: A simple dynamic model. The Quarterly Journal of Economics, 92(1), 1-16.

Fisman, R., Love, I. (2003), Financial Development and Intersectoral Allocation: A New Approach. Washington, DC: The World Bank. Available from: http://www.siteresources.worldbank.org/dec/resources/patterns_final.pdf.

Future Energy Africa. (2018), An African Energy Industry Report: 2018. Available from: https://www.futureenergyafrica.com/media/1751/1-mir-africa-mir-18-2-es_685804715-05-2018.pdf. [Last accessed on 2018 Sep 09].

Gennaioli, N., Shleifer, A., Vishny, R.W. (2012), Neglected risks, financial innovation, and financial fragility. Journal of Financial Economics, 104(3), 452-468.

Gielen, D., Boshell, F., Saygin, D., Bazilian, M.D., Wagner, N., Gorini, R. (2029), The role of renewable energy in the global energy transformation. Energy Strategy Reviews, 24, 38-50.

Head, C. (2000), Financing of Private Hydropower Projects, World Bank Discussion Paper No. 420.

IEA. (2014), Africa Energy Outlook. A Focus on Energy Prospects in Sub-Saharan Africa. World Energy Outlook Special Report. Available from: https://www.usaid.gov/sites/default/files/documents/1860/IEA-Africa-Energy-Outlook-2014.pdf.

IEA. (2018), Building Africa's Energy Capacity. A Report. Available from: https://www.iea-coal.org/building-africas-energy-capacity. [Last accessed on 2020 Aug 03].

Kaminker, C., Stewart, F. (2012), The Role of Institutional Investors in Financing Clean Energy, OECD Working Papers on Finance, Insurance and Private Pensions No. 23. Paris: OECD.

Karekezi, S., Kithyoma, W. (2003), Renewable Energy in Africa: Prospects and Limits. Paper Present on The Workshop for African Energy Experts on Operationalizing the NEPAD Energy Initiative Operationalizing the NEPAD Energy Initiative2-4 June, 2003 Novotel, Dakar, Senegal. Available from: https://www.sustainabledevelopment.un.org/content/documents/nepadkarekezi.pdf. [Last accessed on 2019 Aug 25].

Kim, J., Park, K. (2015), Financial Development and Deployment of Renewable Energy Technologies, KAIST College of Business Working Paper Series No. 2015-023.

Kraft, J., Kraft, A. (1978), On the relationship between energy and GNP. Energy and Development, 3, 401-403.

Levine, R. (1997), Financial development and economic growth: Views and agenda. Journal of Economic Literature, 35(2), 688-726.

Lewis, W.A. (1956), Theory of Economic Growth. London: George Allen and Unwin Ltd.

Lokonon, B.O.K., Salami, A.O. (2017), Climate Change and Renewable Energy Generation in Africa, Working Paper Series No. 269. Abidjan, Côte d'Ivoire: African Development Bank.

Lucas, R.E. (1988), On the mechanics of economic development. Journal of Monetary Economics, 22, 3-42.

McKinnon, R.I. (1973), Money and capital in economic development. Washington, DC: The Brookings Institution Press.

Minsky, H.P. (1974), The modeling of financial instability: An introduction. Modeling and Simulation, 5(1), 267-272.

Odero, K.K. (2014), Africa: Transforming Africa's energy sector: Lessons from international experience. Renewable Energy Law and Policy Review, 5(2), 191-198.

Panwar, N.L., Kaushik, S.C., Kothari, S. (2011), Role of renewable energy sources in environmental protection: A review. Renewable and Sustainable Energy Reviews, 15(3), 1513-1524.

Patrick, H.T. (1966), Financial development and economic growth in underdeveloped countries. Economic Development and Cultural Change, 14(2), 174-189.

Rajan, R.G. (2005), Has Financial Development Made the World Riskier? NBER Working Paper No. 11728. Cambridge: National Bureau of Economic Research.

Rajan, R.G., Zingales, L. (1998), Financial dependence and growth. The American Economic Review, 88(3), 559-586.

Reinhart, C., Reinhart, V. (2015), Financial Crises, Development, and Growth: A Long-Term Perspective. MPRA Paper No. 64488, Munich Personal RePEc Archive (MPRA), Munich University Library.

REN21. (2015), SADC Renewable Energy and Energy Efficiency: Status

Report 2015. Renewable Energy Policy Network for the 21st Century. Available from: https://www.ren21.net/wp-content/uploads/2019/05/ren21_webfile.pdf. [Last accessed on 2019 Sep 18].
Robinson, J. (1952), The Generalisation of the General Theory in the Rate of Interest and Other Essays. London: Macmillan.
Roubaud, D., Shahbaz, M. (2018), Financial Development, Economic Growth, and Electricity Demand: A Sector Analysis of an Emerging Economy. MPRA Paper No. 87212.
Sadorsky, P. (2010), The impact of financial development on energy consumption in emerging economies. Energy Policy, 38, 2528-2535.
Scholtens, B., Veldhuis, R. (2015), How Does the Development of the Financial Industry Advance Renewable Energy? A Panel Regression Study of 198 Countries Over Three Decades, Beiträge Zur Jahrestagung des Vereins Für Socialpolitik 2015: Ökonomische Entwicklung-Theorie und Politik-Session: Environmental Economics III, No. C13-V2, ZBW-Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft. Available from: http://www.hdl.handle.net/10419/113114.
Schumpeter, J.A. (1911), The Theory of Economic Development. Cambridge, MA: Harvard University Press.
Shaw, E. (1973), Financial Deepening in Economic Development. New York: Oxford University Press.
Solarin, S.A. (2011), Electricity consumption and economic growth: Trivariate investigation in Botswana with capital formation. International Journal of Energy Economics and Policy, 1(2), 32-46.
Stern, D.I., Cleveland, C.J. (2004), Energy and Economic Growth. Rensselaer Working Papers in Economics Number No. 410.
Svirydzenka, K. (2016), Introducing a New Broad-based Index of Financial Development. IMF Working Paper WP/16/5. International Monetary Fund. Available from: https://www.imf.org/external/pubs/ft/wp/2016/wp1605.pdf.
Tobin, J. (1984), On the Efficiency of the Financial System, Lloyds Bank Review. p1-15.
WHO. (2002), World Health Report: Reducing Risks, Promoting Healthy Life. Geneva: WHO.
WHO. (2009), The Energy Access Situation in Developing Countries. A Review Focusing on the Least Developed Countries and Sub-Saharan Africa. Available from: https://www.undp.org/content/dam/undp/library/environment%20and%20energy/sustainable%20energy/energy-access-situation-in-developing-countries.pdf. [Last accessed on 2020 Mar 18].
WHO. (2016), Ambient Air Pollution: A Global Assessment of Exposure and Burden of Disease. Geneva: World Health Organisation. Available from: https://www.apps.who.int/iris/bitstream/handle/10665/250141/9789241511353-eng.pdf?sequence=1.
Windmeijer, F. (2005), A finite sample correction for the variance of linear efficient two-step GMM estimators. Journal of Econometrics, 126(1), 25-51.
World Bank. (2008), Finance for All? Policies and Pitfalls in Expanding Access. World Bank Policy Research Report. Washington, DC: World Bank. Available from: https://www.openknowledge.worldbank.org/handle/10986/6905
Zhang, Y. (2011), The impact of financial development on carbon emissions: An empirical analysis in China. Energy Policy, 39(4), 2197-2203.

ANNEX

Table AI: Panel unit root test

Variable	Phillips-Perron test	Result
	Model with trend	
Imports	443.9***	I(0)
FDI	309.0***	I(0)
GDP_capita	246.4***	I(0)
Non hydro capacity	519.9***	I(0)
Depth index	329.7***	I(0)
Access index	218.0***	I(0)
Consumption	679.4***	I(0)

Significance Level *** p<0.01, ** p<0.05, * p<0.1