Nonlinearities in Financial Development-Economic Growth Nexus: Evidence from sub-Saharan Africa (SSA)

Muazu Ibrahim and Paul Alagidede

ERSA working paper 728

January 2018

Economic Research Southern Africa (ERSA) is a research programme funded by the National Treasury of South Africa.

Nonlinearities in Financial Development-Economic Growth Nexus: Evidence from sub-Saharan Africa (SSA)*

Muazu Ibrahim[‡] and Paul Alagidede[§]

January 16, 2018

Abstract

The impact of financial development on economic growth has received much attention in recent literature. However, there are potential discontinuities mediating finance-growth nexus that existing empirical studies have not rigorously examined. This study investigates whether the impact of finance on economic growth is conditioned on the initial levels of countries' income per capita, human capital and financial development for 29 sub-Saharan Africa countries over the period 1980-2014 using a sample splitting and threshold estimation technique. Our findings suggest that, while financial development is positively and significantly associated with economic growth, below a certain estimated threshold, finance is largely insensitive to growth while significantly influencing economic activity for countries above the thresholds. The main conclusion drawn is that higher level of finance is a necessary condition in long run growth and so are the overall level of income and human capital.

Keywords: Financial development; economic growth; threshold

JEL Classification: F4; F31; F32; C1

*The financial assistance of the National Researh Foundation (NRF) towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at, are those of the authors and are not necessarily to be attributed to the NRF.

†School of Business and Law, Department of Banking and Finance, University for Development Studies. Post Office Box UPW 36, Wa, Upper West region, Ghana

‡Corresponding author: imuazu@uds.edu.gh

§Wits Business School, University of the Witwatersrand. 2 St. David's Place, Parktown, Johannesburg 2193, South Africa

1 Introduction

The importance of financial development to economic growth has been given much credence in the literature. Indeed, early writers on this relationship have used financial systems in the context of endogenous growth theory in investigating such nexus. One of such foremost writers is Schumpeter (1911) who first highlighted the significant role of financial sector development in economic growth through the provision of efficient financial services. This evidence has been supported by other empirical literature (see King and Levine, 1993; Levine et al., 2000; Hassan et al., 2011; Masten et al., 2008). However, Ibrahim and Alagidede (2016) note that, while finance potentially spurs economic growth, the overall effect of crucially depends on the relative speed of growth in finance and that of the real sector[1]. While both theory and the available empirical evidence have almost settled on the importance of financial development in countries' economic growth trajectory, the specific nature of effect is less than clear. Evolving theoretical studies have espoused that there may be potential thresholds in the relationship between finance and growth. Admittedly, studies on the nonlinearities are still inconclusive (Aghion et al., 2005; Cecchetti and Kharroubi, 2012; Shen and Lee, 2006; Law and Singh, 2014; Adeniyi et al., 2015; Favara, 2003) although evidence appear to support the inverted U-shaped. What is missing from these studies is the role of mediating variables in refereeing the impact of finance on growth. Theory contends discontinuities in this relationship largely as a result of host of factors that sets the stage at which finance spurs or harms growth (see for instance Saint-Paul, 1992; Berthelemy and Varaudakis, 1996; Acemoglu and Zilibotti, 1997). More specifically, the initial level of income per capita, countries' initial human capital and the initial level of financial development have been proffered as key potential threshold variables mediating how finance affects growth. However, despite the nascent theoretical evidence projecting the crucial role of these threshold variables, empirical efforts have not been rigorous in examining these effects.

More so, the existing empirical studies on the threshold effects have relied on "rudimentary" threshold estimation techniques in determining the existence of nonlinearity in finance-growth nexus by including a quadratic term of finance in the growth regression. Apart from this, while there are some studies highlighting finance-growth nexus mediated by the level of financial sector development, to the best our knowledge, there is no study on threshold effect of finance refereed by the level of human capital and per

[1] There is also evidence that financial sector development help dampen economic volatility (Beck et al., 2006; Ibrahim and Alagidede, 2017a; b) and foreign aid volatility (Kumi et al., 2017).

capita income. Our aim in this paper is therefore to fill this literature gap by rigorously examining nonlinearities in the link between financial development and economic growth using a sound technique involving an asymptotic theory for nonlinearity estimations that permits the determination of threshold within a confidence interval. We do this relying on cross-country data for 29 sub-Saharan African (SSA) countries over the period 1980-2014. This study contributes significantly to the literature in so many ways. First, we use a sample splitting and threshold estimation developed by Hansen (1996; 2000) which is better than earlier approaches employed in previous studies. Indeed, apart from not assuming *a prior* functional form of the relationship, our approach does not require exogenous specification of the threshold values of the conditions mediating the finance-growth nexus. Second, apart from estimating the threshold values, our approach permits the classification of the observations in relation to whether or not they exceed the threshold values so that the exact effect of finance on growth is determined for both when countries are below and above the threshold. With this we are able to significantly contribute to the existing literature as we show how initial values of host countries' financial development, human capital and per capita income may arbitrate the link between finance and economic growth particularly in SSA. By and large, our findings reveal that while financial development significantly affects growth, the values of the threshold variables crucially mediates this effect. Specifically, when the initial levels of per capita income, human capital and financial development are below the threshold, overall economic growth is largely insensitive to financial sector development suggesting that countries' initial level of income, human capital and financial development are necessary conditions in spurring long run economic growth.

The rest of this paper is organised as follows. The next section provides an extensive review of the literature on nonlinearities in finance-growth nexus while section 3 presents that data and empirical strategy. Section 4 discusses the findings on the nonlinearities with section 5 highlighting key implications for policy and recommendations. Section 6 concludes the study.

2 Brief literature review

At the theoretical front, there is a growing consensus that these threshold effects are motivated by the initial levels of per capita income, human capital and financial sector development. One of such theoretical works is Saint-Paul (1992). By relying on the initial level of per capita income, the author analyzes a mechanism which may give rise to multiple equilibria in financial and economic development where agents can choose between two technolo-

gies. The first is flexible and allows productive diversification but at the same time has low productivity. The second technology is rigid, more specialized and productive. The model argues that when financial institutions are less developed, risk diversification is carried out through the selection of less specialized and less productive technologies. With this form of technology, there is less risk exposure and incentives to develop financial markets are limited and can lead to " low equilibrium". In the " high equilibrium", financial markets are well developed with specialized technology. In these economies, agents choose riskier, higher yielding technologies and the impact of finance on growth is higher. However, the transition from the " low equilibrium" to a " high equilibrium" one is mediated by the initial level of income per capita that function as a threshold variable above which financial sector development is healthy for economic growth.

Zilibotti's (1994) model also espouses the initial level of per capita income as a potential threshold variable in finance-growth nexus. The model establishes the idea of " thick" and " thin" markets. There exists positive impact of finance on growth for economies with " thick" markets above the per capita income threshold with low intermediation cost, improved capital allocation and sustained growth. While for economies below the threshold of per capita income, there are " thin" markets with limited capital, the higher cost of financial intermediation prevents investors from using efficiently available capital stock and financial development to have significant impact on economic growth.

Greenwood and Jovanovic (1990) also identify the initial level of per capita income as a mediating factor in the relationship between finance and economic growth. They formally model the dynamic interactions between financial development and growth where a country passes through a development cycle from a primitive stage to a developed fast growing stage. At early stage, growth is slow and the financial sector only mobilizes savings and diversifies risk. However, as the income levels begin to increase, the financial intermediaries become more sophisticated and perform costly functions of monitoring investment and screening for cost effective innovations. Finally, during the maturity state, the country's financial system fully develops with a relatively stable and higher growth. Moreover, during the early stages of financial development, only a few relatively rich individuals have access to financial markets. However, with aggregate economic growth, higher number of people accesses the formal financial system, with spill-over effects on economic growth. The main thrust of their model reveals that the relationship between financial development and growth varies depending on the level of per capita income.

Berthelemy and Varaudakis (1996) argue that the initial level of human

capital is a crucial threshold variable in finance-growth nexus as far as the human capital accumulation is positively associated with the level of educational development. Their theoretical model exhibits multiple steady state equilibria where economies with low educational development (and human capital) are trapped in low level underdevelopment equilibrium and thus unable to enjoy the benefits of financial sector development. Consequently, these countries have low savings and " quiet" financial sector stemming from weak competition. Conversely, economies with high human capital are characterized by well-developed financial sector development and as such enjoy relatively higher savings and income. By employing the regression tree technique, Berthelemy and Varaudakis (1996) empirically examine whether the initial level of human capital mediates the effect of financial development on economic growth. The authors find that the initial level of human capital proxied by the level of secondary school enrolment is a central threshold variable that influences the unequivocal effect of finance on economic growth.

Beyond the level of human capital acting as a threshold variable influencing finance and growth, Acemoglu and Zilibotti's (1997) study highlight the initial level of financial development as a potential threshold variable mediating the finance and growth nexus. The main thrust of their study is that, projects with relatively higher rates of return require large initial investment. Apart from this, they are frequently indivisible and the financial sector has to maintain a certain minimum size before sufficient funds can be pooled to finance these projects. Acemoglu and Zilibotti (1997) therefore opine that the impact of financial deepening on economic growth may be huge in developed countries with higher income per capita and greater financial development.

Deidda and Fattouh (2002) present simple two-period overlapping generations model with risk-averse agents and costly financial transactions which establishes possible nonlinearity in financial development and economic growth relationship. They test for the threshold effect in relation to countries' initial per capita income. After splitting the sample into low and high income groups and controlling for initial level of human capital, the authors found that initially high income countries grow slower. Further findings also suggest that higher levels of financial development are associated with higher growth rates but only hold for countries with higher incomes. Replicating the results relying on the initial level of financial development shows a nonmonotonic relationship between initial financial depth and economic growth in high income countries.

Arcand et al., (2012) first estimate a semi-parametric model that allows a generic functional form for the variable that captures financial development before including a quadratic term in a linear growth equation. Their finding highlights that the finance-growth relationship turns negative for high-income

countries, where finance starts having a negative effect when credit to the private sector reaches 100% of GDP. However, Christopoulos and Tsionas's (2004) study of 10 developing countries do not find any threshold in the finance-growth relationship. Rioja and Valev (2004) show that at low levels of financial development additional improvements in financial markets have an uncertain effect on growth. In the intermediate region, financial development has a large, positive effect on growth, and in the high region, the effect is positive, but smaller.

By relying on two-stage least squares with heteroskedasticity-consistent standard errors, Ergungor (2008) examined the threshold effects of finance-growth nexus relying on data from 46 developed and developing countries over the period 1980 to 1995. The author finds a nonlinear (contingent) relationship between finance (banking sector) and economic growth and that, countries with inflexible judicial system grow faster on the back of more bank-oriented financial system.

Indeed, the majority of existing studies suggest a nonlinear relationship between finance and economic growth. As a deficiency however, these studies suffer from two important weaknesses. First, majority of these studies rely on simple threshold estimation techniques to determine the existence of nonlinearity in finance-growth nexus by including a square term of finance in the growth equation. Second, beyond establishing the threshold effects, the majority of these earlier studies have failed to rigorously stem-the-tide by empirically investigating whether these thresholds are mediated by the initial levels of per capita income, human capital and financial development.

In the current study, we avoid these problems by using Hansen (1996, 2000) sample splitting and threshold estimation technique. This approach controls for the asymptotic theory that permit the estimation of the thresholds, their confidence intervals and the level of statistical significance. We estimate three separate sets of thresholds variables focused on the initial level of per capita income, the levels of human capital and financial development. The thrust of this study is that financial development enhances growth only after exceeding a distinct threshold levels of initial income per capita, initial human capital and initial financial sector development. In other words, we proffer that the differences in the direction of effect stems from countries' heterogeneous income levels, human capital development and financial markets. The next section discusses the data and empirical strategy in pursuing the aim of this paper.

3 Data and methodology

3.1 *Data and preliminary findings*

We use a cross-country data of 29 SSA countries for the period 1980-2014[2]. The choice of these countries is based entirely on data availability for a sufficiently longer time period. We use the annual data sourced from the World Development Indicators (WDI) of the World Bank. We use two measures of financial development: private and domestic credits. Unlike the private credit which includes all credit to various sectors on a gross basis except credit to the central government, domestic credit provided by the financial sector refers to financial resources provided to the private sector by financial corporations, such as through loans, purchases of non-equity securities, and trade credits and other accounts receivable, that establish a claim for repayment. These indicators thus have clear advantage over measures of monetary aggregates, in that it more accurately represents the actual volume of funds channeled to the private sector. Therefore, the ratio private and domestic credits to GDP are more directly linked to investment and economic growth.

In line with standard literature, we used real GDP per capita based on 2005 US$ constant prices to proxy economic growth. Our control variables are based on the standard neoclassical growth theory and include inflation, investment rate, government expenditure, labour and trade openness. The inflation variable is the annual percentage change in the consumer price index and used to proxy macroeconomic (in)stability. This is expected to negatively impact on growth. We use gross fixed capital formation as a percentage of GDP to proxy investment rates and this is expected to positively influence economic growth. Government expenditure expressed as a percentage of GDP measures final government consumption expenditure and used to measure government size. Labour is proxied by the percentage of economically active population aged 15 to 64 years. We also include our threshold variables (initial level of income per capita, initial level of human capital and initial level of financial development) as control variables. The introduction of the threshold variables as slope covariates permits the identification of possible differential effect of finance on growth as such measurement highlights the theoretical arguments that a country has to develop critical threshold of income, human capital and financial sector development before financial development positively and significantly impact on economic growth. Fol-

[2]These countries are Benin, Botswana, Burkina Faso, Cameroon, Central Afr. Rep., Chad, Congo, Dem. Rep., Congo, Rep., Cote d'Ivoire, Ethiopia, Gabon, Gambia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Swaziland and Togo.

lowing from standard literature, we proxy human capital by the secondary school enrolment. However, as a robustness test, we also use the primary pupil-teacher ratio in line with Ibrahim et al., (2015). Relative to the enrolment which is a quantity-based measure, this proxy measures the quality of the training pupils' receive stemming from teacher contact hours. The descriptive statistics of the variables are presented in Table 1 below.

The variables presented in Table 1 are averaged over the sample period (1980-2014) and presented in percentage terms. The average real per capita GDP is $1,241.27 which reveals the low income status of the countries under study. Government size is estimated at about 15% of GDP and do not register much variations across the countries relative to trade openness which has a mean of 71.15%. The average percentage labour force and inflation respectively stands at 52.83 and 56.23% reiterating the evidence that majority of the countries under consideration have experienced episodes of hyperinflation[3]. With regard to secondary school enrolment, our descriptive statistic shows an average of 28.19% relative to 38.03% of the primary pupil teacher ratio suggesting that over the sample period, the mean quality of education at the primary level is exceedingly higher than gross secondary school enrolment. Our financial development indicators show higher mean domestic credit (25.6%) compared to private credit (19.52%). We estimate the relative variations of the variables using the coefficient of variation (CV) computed as the ratio of standard deviation to mean. Our findings reveal that real GDP per capita is the most volatile variable while the composition of labour is least volatile. The primary pupil teacher ratio is not only higher than the secondary school enrolment but also show much variation across the countries. Similar pattern is also observed for both financial development indicators where domestic credit exhibits severe fluctuations relative to private credit. Interestingly, all the variables are skewed to the right except the labour which is negatively skewed. The values of the skewness and kurtosis reveal that the distributions of our variables are far from being normal as they are largely leptokurtic.

3.2 *Empirical strategy*

Indeed, the assumption of a linear functional form of finance-growth nexus a major deficiency of these findings. More specifically, the earlier discussion obscures the possibility of initial per capita income, initial human capital and initial of level of financial development moderating the relationship between

[3]Given the mean inflation rate, 15 countries experienced rates below 56% while the remaining 14 exceeded the average.

finance and growth in a manner that initiates stern discontinuities in the nexus. Our main argument is that financial development may not influence growth below a certain value of the threshold variables and that the overall effect is conditioned on the initial level of per capita income, human capital and financial development.

Examining finance-growth nexus can be done by specifying a baseline model where economic growth depends on its one period lag, financial development and the set of controls as shown in equation (1) below;

$$y_{it} = \beta_o y_{it-1} + \beta_1 FD_{it} + \beta_2 V_{it} + \tau_i + \vartheta_t + \epsilon_{it} \tag{1}$$

where y_{it} is economic growth of country i at time t; y_{it-1} is the growth lag representing the initial condition; FD_{it} is financial development; V_{it} is a vector of control variables; τ_i is country-specific fixed effects; ϑ_t is time effects while ϵ_{it} is idiosyncratic error term.

Indeed, relative to earlier studies where the square term of finance is often included in their growth equation like equation (1) above, we modify the baseline model in equation (1) in two different ways: First, we identify three potential threshold variables (in their non-logarithmic form) namely the initial level of per capita income, initial level of human capital and the initial level of financial development. Second, we depart from presuming a smooth finance-growth relationship by testing for the distinct thresholds. Indeed, several authors (see for instance Adeyini et al., 2015; Ductor and Grechyna, 2015) have included quadratic terms in examining nonlinearities in the impact of finance on growth. However, the exact inflection points are usually computed via differentiation, the confidence intervals within which such thresholds fall are largely unknown. We therefore control for this by directly altering our linear growth model and testing for definite discontinuities in the relationship using the Hansen's (1996; 2000) threshold model relying on data sorting process. Our choice for Hansen's (1996; 2000) hinges on its usage of the asymptotic theory in estimating thresholds hence making it the appropriate tool. The Hansen (1996; 2000) threshold technique relies on the least square estimation of the regression parameters which is superior to the traditional regression tree and quadratic approaches because the form of nonlinearities of our chosen approach is not imposed and the confidence intervals of all the thresholds identified can empirically be verified.

From equation (1), our observed sample is $\{y_i, x_i, v_i\}_{i-1}^{n}$where y_i and v_i are real-valued and x_i is an m-vector. Our threshold variable v_i is taken as a continuous distribution and the parameters from our estimated baseline model vary depending on the value of v_i. We estimate two regime threshold

models in a single equation of the form:

$$\begin{aligned} Y_i = (\beta_{11} + \beta_{21} FD_i + \beta_{31} TH_i + \beta_{41} V_i) d_i\{v_i \leq \gamma\} \\ +(\beta_{12} + \beta_{22} FD_i + \beta_{32} TH_i + \beta_{42} V_i) d_i\{v_i > \gamma\} + \epsilon_i \end{aligned} \tag{2}$$

where Y and FD are as previously defined; TH is the vector of threshold parameters; V is a vector of conditioning variables as previously defined; $d(.)$ is the indicator function of dummy variable that takes the value 1 if the condition is satisfied and 0 otherwise; v is the threshold variable while γ is the threshold value with subscript i as country index.

In these estimations, our threshold variables v are the initial per capita income, initial human capital and initial level of financial development. We compactly write equation (2) as:

$$y_i = \beta^{|} x_i + \delta_n^{|} x_i(\gamma) + \epsilon_i \tag{3}$$

where $\delta_n = \beta_{i2} - \beta_{i1}$ while $\beta = \beta_{i2}$. It is imperative to note that $\delta_n \to 0$ as $n \to \infty$ while β_{i2} is fixed hence $\beta_{i1} \to \beta_{i2}$ as $n \to \infty$. Our equation (3) is further specified in matrix notation expressing $n \times 1$ vectors of Y and ϵ by stacking y_i and ϵ_i respectively and the $n \times m$ matrices X and X_γ by stacking the vectors $x_i^{|}$ and $x_i(\gamma)^{|}$ respectively. Given these notations, we re-estimate equation (4) below:

$$Y = X\beta + X_\gamma \delta_n + \epsilon \tag{4}$$

The regression parameters β, δ and γ are estimated using least squares where the least squares estimators (β, δ and γ) minimises the sum of squared errors (SSE) of equation (4) defined as:

$$SSE_n(\beta, \delta, \gamma) = (Y - X\beta + X_\gamma \delta_n)^{|}(Y - X\beta + X_\gamma \delta_n) \tag{5}$$

On this score, we restrict the threshold value γ to a bounded set $[\underline{\gamma}, \overline{\gamma}] = \varpi$. The least squares estimators (β, δ and γ) are estimated using the concentration approach where γ is the value that minimises $SSE_n(\gamma)$ and can therefore be uniquely estimated as

$$\gamma = \underbrace{argmin}_{\gamma ? \varpi} SSE_n(\gamma)$$

where $\varpi_n = \varpi \bigcap \{v_1, v_2, \ldots\ldots\ldots, v_n\}$ while the slope estimators are therefore estimated as $\beta = \beta(\gamma)$ and $\delta = \delta(\gamma)$. We test the hypothesis that $H_0 : \gamma = \gamma_0$ using the following likelihood ratio (LR) test:[4]

[4]Where γ_0 is the true value of γ.

$$LR_n(\gamma) = n\frac{SSE_n(\gamma) - SSE_n(\gamma)}{SSE_n(\gamma)}$$

The H_0 is rejected for large values of $LR_n(\gamma_0)$. Indeed, the reliability of γ by far depends on where it lies within the confidence interval which is commonly constructed using the inversion of Wald or t-test statistics. However, Hansen (2000) and Dufour (1997) note that, when the asymptotic sampling distribution depends on unknown estimators, the Wald statistic has weak finite sample performance especially when the parameter has a region with failed identification. Given the threshold model, when $\delta_n = 0$, our threshold value γ is not identified. Hansen (2000) newly developed threshold modelling addresses this by constructing an asymptotic confidence level (c) for γ using the $LR_n(\gamma)$ set at $\varpi = \gamma : LR_n(\gamma) \leq c$.

4 Empirical findings

This section discusses the threshold values and how financial development affects economic growth given the threshold variables. In the subsequent Tables, our first row is the estimated threshold value of the respective threshold variable, the 95% confidence interval which shows the level of precision of the estimated threshold value and its associated bootstrap p-values. Since our estimations allow one threshold γ, γ is not identified under the null hypothesis of no threshold effect. We therefore bootstrap the p-values which are asymptotically correct (Hansen, 1996) in order to examine the relevance of the sample split. The significance of a p-value for a value of v_i suggest the need for a sample split based on the threshold variable v_i. It is imperative to note that the Hansen (1996; 2000) identifies a single threshold that is significant at 10% or better. In regime 1, we present the results on the effect of finance on growth for countries below the threshold values offered in the second rows, the value of the R^2 and the number of countries trailing behind the threshold values. Regime 2 however shows the relationship between finance and growth when countries exceed the identified threshold values of the threshold variable.

On the mediating variables, as shown in Table 2 above, the threshold of initial per capita income is estimated at 0.62164 $\approx$ \$621.62 and lies within a confidence interval of 0.609 and 0.870 where about 38% of the countries fall below this threshold. In regime 1, we find that private credit is positively related to growth even below the threshold. Specifically, a unit-percentage increase in private credit spurs economic growth by 0.312% for countries with an initial per capita income below \$621.64. However, this effect is slightly

significantly at 10%. Interestingly, by using domestic credit as an indicator of finance, our finding reveals a positive coefficient of finance although this effect is flatly insignificant for countries below the threshold. In regime 2 where we estimate the impact of finance on growth, we find that economic growth increases by 0.515% following a 1% rise in private credit for countries above the threshold. Further results also suggest that financial development proxied by domestic credit positively and significantly influences growth for countries with initial per capita income above $621.64. These findings provide further evidence that development of the financial sector has a positive impact of overall growth rates especially for countries that have attained a certain income level to necessary to trigger growth. Our findings are consistent with Berthelemy and Varaudakis's (1996) theoretical work postulating that development of the financial sector largely has no significant impact on growth if a country's per capita income is below a certain threshold level. Interestingly, although financial development spurs growth, the impact of private credit is exceedingly higher than domestic credit and measures about 2.4 times greater in countries above the threshold. While this holds based on our sample evidence, what is apparent is that higher growth is registered for countries above the threshold relative to those below the minimum per capita income level. For instance, for those above the threshold income level, growth-enhancing effect of private credit is at least 1.7 times higher than those below the threshold. The values of the R^2 are also higher in regime 2 suggesting that at least 70% of the variation in economic growth in countries with initial per capita income above $621.64 is explained by our set of independent variables. Greenwood and Jovanovic's (1990) argue that at the early stages of countries' level of development, financial sector intermediaries play an imperfect role of resource allocation, risk pooling and diversification but as per capita income increases, the financial sector begins to be sophisticated thus performing costly functions with higher returns. And as postulated by theory, average growth rate increases.

Indeed, as argued earlier, apart from the initial income level, theoretical evidence suggests that the impact of finance on growth may be also mediated by the initial level of human capital. Our empirical investigation of this claim is presented in the Table 3 below where secondary school enrolment and primary pupil teacher ratio are used as proxies of human capital.

From the Table below, the mediating variable of initial human capital proxied by secondary school enrolment shows a threshold of 0.11 $\approx$11% that referees the impact of finance on growth. This threshold variable lies within a confidence interval of 0.052 and 0.192 where 9 out of the 29 countries fall below this threshold. In regime 1, we find that for countries below the human capital threshold, financial development has no significant effect on economic

growth and in the case of domestic credit, the coefficient is rather negative albeit insignificantly. With regard to the sensitivity check on this relationship using initial primary pupil teacher as a measure of human capital, we find a threshold of 18% for human capital as the threshold value at which the effect of finance on growth may switch signs. Given this threshold, our finding shows that about 66% of the countries are above this threshold. On the finance-growth nexus below the minimum threshold, although the coefficients of private and domestic credits are both positive, none of them is statistically significant revealing that for countries with an initial pupil teacher ratio below 18%, economic growth is insensitive to changes in financial development.

In regime 2 where we estimate the impact of finance on growth when countries exceed the initial secondary school enrolment threshold, we find that financial development positively and significantly affect growth irrespective of the measure of finance. Specifically, economic growth increases by 0.558% following a unit-percentage rise in private credit. This finding is robust to different indicator of finance as the coefficient of domestic credit is positive and significant for countries with initial secondary school enrolment above 18%. This evidence does not differ even with the use of initial pupil teacher ratio as a measure of human capital relative to enrolment. For countries with initial pupil teacher ratio above 18%, both the coefficients of financial development indicators are positive and statistically significant at 5%. In particular, growth increases by 0.541 and 0.333% for a unit-percentage increase in private and domestic credits respectively. These findings further provide unequivocal growth-enhancing effect of finance on growth for countries with quality human capital. While this holds, we find that the impact of private credit is higher than the domestic credit for both measures of human capital. By relying on secondary school enrolment and pupil teacher ratio as measures of human capital, the impact of private credit on economic growth is about 2.6 and 1.6 times higher than domestic credit respectively. The values of the R^2 are comparatively higher in regime 2 suggesting that beyond the threshold values of both human capital indicators, majority of the variations in growth are explained by variations in our set of independent variables. In the next section, we discuss the impact of finance on economic growth given the initial level of financial development. We fix γ at the LR estimate and split the sample into two based on the initial values of private and domestic credit and mechanically invoke the analysis on each sub-sample. Results from threshold effects are presented in Table 4 below.

Starting with private credit, the threshold is estimated at 8.10% and falls within a confidence interval of 0.070 and 0.196 where 8 out of the 29 countries lie below this threshold. In regime 1 which shows the impact of finance on growth when the initial private credit is less than the threshold, our find-

ings show that although the coefficient of private credit is positive, its effect is flatly insignificant. The same conclusion is reached with domestic credit. Overall, our evidence presented here reveals that financial sector development is ineffective in promoting economic growth when the initial private credit to GDP is lower than the threshold. Apart from using private credit as a mediating variable in finance-growth nexus, we estimate the threshold effect of domestic credit at which the impact of finance changes sign. Our domestic credit threshold is estimated at $0.135 \approx 13.5\%$ and lies within a confidence boundary of $\varpi = [7.9\%, 19.1\%]$ with a bootstrap p-value of 0.0001. Given the estimated threshold, we notice that in regime 1, both coefficients of private and domestic credit are positive suggesting that financial development enhances economic growth. However, only the effect of domestic credit is slightly significant at 10%. For the majority of countries above this threshold, we find that financial development is positively and significantly related to growth irrespective of the measure of finance. Specifically, in regime 2, we find that for countries with initial private credit to GDP above 8.10%, a unit-percentage increase in private and domestic credit significantly increases growth by 0.505 and 0.211% respectively. Similarly, for countries with initial domestic credit exceeding 13.5%, higher financial development propels economic growth where a 1% increase in private and domestic credit increases economic activity by 0.611 and 0.220% respectively. Given this evidence, what is clear from the relative elasticity of growth to finance is that, although both indicators promote growth, the growth-enhancing effect of private credit is at least 2.78 times higher than the effect of domestic credit when the latter is used as the threshold variable. Similarly, by relying on the domestic credit as the mediating factor in finance-growth relationship, we find that above the threshold, the impact of private credit is about 2.39 times higher than domestic credit. Overall, our evidence suggests that below a minimum finance threshold, financial sector development weakly influences economic growth and as economies develop their financial sector above the threshold, economic activity positively and significantly respond to further increases in finance. Our data is thus akin with the call that financial services fuel growth by increasing the rate of capital accumulation as well as facilitating the efficiency with which countries employ capital.

5 Policy implications and recommendations

This section discusses the key policy implications and recommendations based on the findings of the study. Indeed, the importance of the financial sector to economic growth cannot be overlooked. In this study, we find support for the

view that development of the financial sector spurs growth partly through its ability to allocate resources efficiently. The main transmission channels are that financial sector development ameliorates information asymmetry, diversifies risks, efficiently and effectively allocates resources for productive investment thus accelerating overall economic growth. Given this conclusion however, there are theoretical studies positing discontinuities in the relationship between financial development and economic growth. Starting with the level of initial per capita income as a mediating variable in finance-growth nexus, we deduce that although financial development positively affects economic activity in SSA, this effect is only significant for countries with initial per capita income above $621.64. What is also observed is that, even though private and domestic credit improves long run growth, growth elasticity to financial development is higher for private relative to domestic credit. A key implication emanating from this is that for economies in SSA to register the growth-enhancing effect of finance, it is important for countries to first improve on their income levels. As long as a country's per capita income is above the threshold, finance drives growth. This is rightly so because as income levels increase, agents begin to demand to more financial services thus improving financial intermediation thereby increasing the impact of finance on growth. This presents a feedback effect where higher per capita income increases finance which in turn spurs overall economic growth. Thus financial development disproportionately benefits countries with higher income with no apparent significant effect on relatively low income economies in the subregion. It therefore suggests that policies aimed at reducing the rather high rates of poverty in the region would potentially improve the finance-growth relationship.

Building the human capital is also crucial in mediating the overall impact of finance on economic growth. Indeed, countries show variations albeit not significantly in the level of their human capital stock proxied by secondary school enrolment and pupil teacher ratio at the primary schools. By refereeing the finance-growth effect using the stock of human capital, our key finding suggests that although finance positively impacts on growth, the significance of that relationship is only determined by countries' initial human capital. Thus, the impact of finance on economic activity might not be the same in countries with different human capital development. Specifically, our evidence shows that at low human capital, growth is insensitive to the role of finance but after exceeding a threshold level of human capital accumulation, increases in financial development significantly drives growth. One plausible elucidation is that, for countries with low human capital level, innovation and technological advancement is constrained and level of participation in financial sector activities (and financial inclusion) in minimal

thus hindering the development of the financial sector with a concomitant effect on growth. However, as economies' human capital accumulation speeds up, agents' risk taking behaviour may increase thus raising investment and credit demand and an expanded financial system. Ultimately, the greater financial sector development therefore facilitates investment through financial intermediation. Apart from influencing agents' risk-taking attitude, higher human capital permits innovation and technology thus improving financial sector efficiency in financial intermediation which are crucial for accelerating faster economic growth. Following from this finding, it is imperative for countries in SSA to encourage school enrolment while reducing pupil teacher ratios. In all these, it is important for education policy makers to improve on the curricular in such a way that inspires ingenuity and teacher motivation.

While financial development promotes growth, the initial level of finance significantly matters in mediating the impact of finance on economic activity. In other words, below a certain threshold, the intrinsic drive of the financial sector insignificantly affects growth. An underdeveloped financial sector may be associated with high transaction cost, rigidities and sub-optimal resource allocation with consequential effect on overall growth. However, as the financial sector continue to develop above a threshold, growth increases suggesting that countries with relatively high financial sector development enjoy higher growth. A key implication is that the link between economic growth and finance is contemporaneous and financial development importantly impact on economic activity. Thus, within this framework, policies that alter the efficiency of financial intermediation invariably provide a first order stimulus on overall level of growth. At the policy level, countries in SSA need to design strategies to enhance credit allocation, competition and regulations in order to make it possible for the financial development to stimulate economic growth as these appear to be necessary condition for long run growth.

6 Conclusion

The impact of financial development on economic growth has received much attention in the recent literature. The general conclusion is that development of the financial sector is positively related to the level of growth. However, theoretical studies have espoused discontinuities in the relationship. More importantly, the relationship between finance and economic activity is well mediated by the level of initial per capita income, human capital and existing financial development. While this is well documented at the theoretical front, empirical literature is silent on the nonlinearities in finance-growth nexus caused by the threshold variables. We re-examine the threshold ef-

fect of finance in the face of the threshold variables relying on cross-country data for 29 SSA countries over the period 1980-2014. Our evidence suggests that, in almost all cases, financial sector development is positively related to growth albeit insignificantly below the estimated thresholds. In other words, below the threshold level of per capita income, human capital and the level of finance, economic growth is largely insensitive to financial development. The only exception is the impact of private credit on growth below the income threshold where the impact is slightly significant. Similar trend is also noticed when domestic credit mediates the finance-growth nexus. The main conclusion drawn is that higher level of finance is a necessary condition in long run growth and so are the overall level of income and countries' human capital.

Our results are of crucial importance to policymakers with regard to the optimisation of the level of income, human capital and financial development that needs to be vigorously improved to ensure higher potential benefits for the economy through the financial sector. The evidence presented here reveals that predetermined components of countries' structural characteristics are a good predictor of long run economic growth and that the level of countries' income, human capital development and finance shape the ability of financial sector development in ameliorating information asymmetry, diversifying risk and efficiency with which resources are allocated.

References

[1] Acemoglu, D. and Zilibotti, F., (1997). Was Prometheus unbound by chance? risk, diversification and growth, *Journal of Political Economy*, *105*(4), 709-751

[2] Adeniyi, O., Abimbola Oyinlola, A., Omisakin, O., and Egwaikhide, F. O., (2015). Financial development and economic growth in Nigeria: Evidence from threshold modelling, *Economic Analysis and Policy, 47*, 11-21

[3] Aghion, P., Howitt, P., and Mayer-Foulkes, D., (2005). The effect of financial development on convergence: Theory and evidence. *The Quarterly Journal of Economics*, *120*(1), 173-222.

[4] Arcand, J., Berkes, E., and Panizza, U., (2012). Too much finance? International Monetary Fund working paper number 161. (Washington: International Monetary Fund).

[5] Azariadis, C., and Drazen, A., (1990). Threshold externalities in economic development, *The Quarterly Journal of Economics*, *105*(2), 501-526

[6] Barro, R. J., and Sala-i-Martin, X. (1995). *Economic growth*, New York: McGraw-Hill.

[7] Beck, T., Lundberg, M., and Majnoni, G., (2006). Financial intermediary development and growth volatility: Do intermediaries dampen or magnify shocks? *Journal of International Money Finance, 25*(7), 1146-1167.

[8] Bencivenga, V. R., and Smith, B. D., (1991). Financial intermediation and endogenous growth, *Review of Economics Studies*, *58*(2), 195-209.

[9] Berthelemy, J. C. and Varoudakis, A. (1996). *Models of financial development and growth. A survey of recent literature in Financial Development and Economic growth, Theory and Experience from developing countries*, Routledge Studies in Development Economics.

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

[11] Cecchetti, S., and Kharroubi, E., (2012). Reassessing the impact of finance on growth. *Bank for International Settlements working paper number* 381

[12] Christopoulos, E. G., and Tsionas, D. K., (2004). Financial development and economic growth: Evidence from panel unit root and cointegration tests, *Journal of Development Economics, 73*(1), 55-74.

[13] Deidda, L., and Fattouh, B., (2002). Non-linearity between finance and growth. *Economics Letters*, *74*(3), 339-345.

[14] Ductor, L., and Grechyna, D., (2015). Financial development, real sector, and economic growth. *International Review of Economics and Finance*, *37*(C), 393-405

[15] Dufour, J. M. (1997). Some Impossibility Theorems in Econometrics with Applications to Structural Variables and Dynamic Models, *Econometrica*, *65*(6), 1365-1387.

[16] Ergungor, O. E., (2008). Financial system structure and economic growth: structure matters. *International Review of Economics and Finance, 17*(2), 292-305.

[17] Favara, G., (2003). An empirical reassessment of the relationship between finance and growth. *IMF Working Paper Number*. 03/123, (Washington: International Monetary Fund).

[18] Goldsmith, R. W., (1969). *Financial structure and development* , New Haven, CT: Yale University Press.

[19] Greenwood, J., and Jovanovic, B., (1990). Financial development, growth, and the distribution of income, *Journal of Political Economy* , *98*(5), 1076-1107.

[20] Hansen, B. E. (1996). Inference when a nuisance parameter is not identified under the Hypothesis, *Econometrica*, *64* (2), 413-430

[21] Hansen, B. E. (2000). Sample splitting and threshold estimation, *Econometrica*, *68*(3), 575-603.

[22] Hassan, M. K., Sanchez, B., and Yu, J-S., (2011). Financial development and economic growth: New evidence from panel data, *The Quarterly Review of Economics and Finance, 51*(1), 88-104.

[23] Ibrahim, M., and Alagidede, P., (2016). Effect of financial development on economic growth in sub-Saharan Africa: Does sectoral growth matter? 1st African Review of Economics and Finance Conference, August 11-12, KNUST, Kumasi.

[24] Ibrahim, M., and Alagidede, P., (2017a). Financial sector development, economic volatility and shocks in sub-Saharan Africa. *Physica A* , *484*, 66-81.

[25] Ibrahim, M., and Alagidede, P., (2017b, forthcoming). Financial development, growth volatility and information asymmetry in sub-Saharan Africa: does law matter? *South African Journal of Economics,* doi: 10.1111/saje.12176

[26] Ibrahim, M., Kumi, E. and Yeboah, T., (2015). Greasing or sanding the wheels? Effect of corruption on economic growth in sub-Saharan Africa, *African Journal of Economic and Sustainable Development*, *4*(2), 157-173.

[27] Khan, M. A., (2008). Financial development and economic growth in Pakistan: Evidence based on Autoregressive Distributed Lag (ARDL) approach, *South Asia Economic Journal, 9*(2), 375-391.

[28] Khan, S. M., and Senhadji, A.S., (2000). Financial development and economic growth: an overview. IMF Working Paper 00/209, Washington, DC.

[29] King, R. G., Levine, R., (1993a). Finance and growth: Schumpeter might be right. *The Quarterly Journal of Economics, 108*(3), 717-737.

[30] King, R. G., Levine, R., (1993b). Finance, entrepreneurship and growth. *Journal of Monetary Economics, 32*(3), 30-71.

[31] Kumi, E., Ibrahim, M., and Yeboah, T., (2017), Aid, aid volatility and sectoral growth in sub-Saharan Africa: Does finance matter? *Journal of African Business*, *18*(4), 435 - 456.

[32] Law, S. H., and Singh, N., (2014). Does too much finance harm economic growth? *Journal of Banking and Finance*, *41*(C), 36-44.

[33] Levine, R., Loayza, N., Beck, T., (2000). Financial intermediation and growth: causality and causes. *Journal of Monetary Economics*, *46*(1), 31-77.

[34] Lucas, R. E. J., (1988). On the mechanics of economic development. *Journal of Monetary Economics, 22*(1), 3-42.

[35] Mankiw, N. G., David, R., and Weil, D. N., (1992). A contribution to the empirics of economic growth, *Quarterly Journal of Economics*, *107*(2), 407-37

[36] Masten, A.B., Coricelli, F., and Masten, I., (2008). Non-linear growth effects of financial development: Does financial integration matter? *Journal of International Money and Finance*, *27* (2), 295-313.

[37] Rioja, F., and Valev, N., (2004). Does one size fit all? A reexamination of the finance and growth relationship, *Journal of Development Economics, 74*(2), 429-447.

[38] Saint-Paul, G., (1992). Technological choice, financial markets and economic development, *European Economic Review*, *36* (4), 763-781

[39] Schumpeter, J., (1911). *The Theory of Economic Development*. Harvard University Press, Cambridge, MA.

[40] Shen, C., and Lee, C., (2006). Same financial development yet different economic growth, why? *Journal of Money, Credit and Banking*, *38*(7), 1907-1944.

[41] Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM Estimators, *Journal of Econometrics*, *126*(1), 25-51.

[42] Xu, Z., (2000). Financial development, investment and economic growth. *Economic Inquiry*, *38*(2), 331-344.

[43] Zilibotti, F., (1994). Endogenous growth and intermediation in an 'Archipelago' economy, *The Economic Journal, 104* (423), 462-473.

Table 1: Summary statistics

Variables	Mean	Std. dev	Coefficient of Variation	Skewness	Kurtosis
Real GDP per capita	1,241.27	1,804.98	1.45	2.36	7.65
Government expenditure	14.88	6.31	0.42	1.57	7.15
Inflation	56.23	36.63	0.65	0.30	2.60
Trade openness	71.15	36.48	0.51	1.10	3.83
Labour	52.83	4.65	0.09	–1.24	30.73
Capital formation	19.69	9.65	0.49	1.59	8.25
Secondary school enrolment (% gross)	28.19	11.02	0.39	2.03	7.91
Primary pupil teacher ratio	38.03	19.85	0.52	4.11	11.58
Private credit	19.52	21.72	1.11	3.78	19.68
Domestic credit	25.60	29.66	1.16	2.39	13.48

Table 2: Empirical results

Dependent variable: Real GDP per capita	**1**	**2**	**3**	**4**
Initial GDP per capita	–1.035 (0.488)**	–1.108 (0.535)**	–1.221 (0.639)*	–1.508 (0.522)**
Government expenditure	–0.217 (0.132)	0.098 (0.081)	–0.106 (0.071)	–0.111 (0.058)*
Trade openness	0.191 (0.062)***	0.204 (0.101)**	0.230 (0.116)**	0.319 (0.139)**
Labour	0.065 (0.024)**	0.079 (0.039)**	0.058 (0.029)*	0.060 (0.030)**
Capital formation	0.151 (0.037)***	0.300 (0.129)**	0.185 (0.071)**	0.466 (0.193)**
Inflation	–0.018 (0.011)	–0.041 (0.024)	–0.023 (0.013)	–0.091 (0.048)*
Secondary school enrolment	0.431 (0.159)**	0.337 (0.112)**	–	0.279 (0.068)***
Pupil teacher ratio	–	–	0.201 (0.079)**	0.372 (0.177)**
Private credit	0.631 (0.284)**	0.581 (0.237)**	–	0.609 (0.288)**
Domestic credit	–	0.372 (0.098)***	0.288 (0.123)**	0.216 (0.101)**
Diagnostics:				
Country fixed effects	YES	YES	YES	YES
Time effects	YES	YES	YES	YES
Number of countries	29	29	29	29
AR(1) z – value [*p*–value]	–3.011 [0.003]	–3.139[0.002]	–3.440[0.003]	–3.120 [0.002]
AR(2) z – value [*p*–value]	–2.510 [0.103]	–2.252[0.116]	–2.071[0.138]	–2.130 [0.155]
Sagan chi-square [p-value]	18.301[0.202]	18.092[0.211]	18.174[0.230]	18.109[0.235]
Wald chi-square [p-value]	0.0000	0.0000	0.000	0.000

Notes: ***, ** and * denote significance at 1, 5 and 10% level. All variables are in logs. Windmeijer (2005) robust standard errors are in parentheses.

Table 3: Results when per capita income is the threshold variable

Threshold variable: Per capita income	**Financial development indicators**	
	Private credit	**Domestic credit**
Dependent variable: Real GDP per capita		
Coefficients of financial development indicators from Table 2	0.609 (0.288)**	0.216 (0.101)**
Threshold value	0.62164 ≈ $621.64	0.62164 ≈ $621.64
95% Confidence interval ($\widehat{\varpi}$)	[0.690, 0.870]	[0.690, 0.870]
Bootstrap *p*–value	0.0001	0.0000
Regime 1		
Coefficient of financial development below the threshold	0.312 (0.158)*	0.201 (0.137)
R^2	0.721	0.693
Number of countries below the threshold	11	11
Regime 2		
Coefficient of financial development above the threshold	0.515 (0.125)***	0.211 (0.091)**
R^2	0.753	0.701
Number of countries above the threshold	18	18

Notes: ***, ** and * denote significance at 1, 5 and 10% level. Values in ( ) are the standard errors.

Table 4: Results when human capital is the threshold variable

Dependent variable: Real GDP per capita	**Threshold variable: Human capital (proxied by secondary school enrolment)**		**Threshold variable: Human capital (proxied by primary pupil teacher ratio**	
	Financial development indicators			
	Private credit	**Domestic credit**	**Private credit**	**Domestic credit**
Coefficients of financial development indicators from Table 2	0.609 (0.288)**	0.216 (0.101)**	0.609 (0.288)**	0.216 (0.101)**
Threshold value	0.11 ≈ 11%	0.11 ≈ 11%	0.1802 ≈ 18.02%	0.1802 ≈ 18.02%
95% Confidence interval ($\widehat{\varpi}$)	[0.052, 0.192]	[0.052, 0.192]	[0.127, 0.301]	[0.127, 0.301]
Bootstrap *p*–value	0.0000	0.0001	0.0000	0.0000
Regime 1				
Coefficients of financial development below the threshold	0.301 (0.178)	–0.222 (0.147)	0.401 (0.264)	0.195 (0.115)
R^2	0.522	0.517	0.613	0.599
Number of countries below the threshold	9	9	10	10
Regime 2				
Coefficients of financial development above the threshold	0.558 (0.231)**	0.211 (0.106)*	0.541 (0.200)**	0.333 (0.118)**
R^2	0.691	0.640	0.634	0.603
Number of countries above the threshold	20	20	19	19

Notes: ***, ** and * denote significance at 1, 5 and 10% level. Values in ( ) are the standard errors.

Table 5: Results when financial development is the threshold variable

Dependent variable: Real GDP per capita	**Threshold variable: Financial development (proxied by private credit)**		**Threshold variable: Financial development (proxied by domestic credit)**	
	Financial development indicators			
	Private credit	**Domestic credit**	**Private credit**	**Domestic credit**
Coefficients of financial development from Table 2	0.609 (0.288)**	0.216 (0.101)**	0.609 (0.288)**	0.216 (0.101)**
Threshold value	0.081 ≈ 8.10%	–	–	0.135 ≈ 13.5%
95% Confidence interval ($\widehat{\varpi}$)	[0.070, 0.196]			[0.079, 0.191]
Bootstrap *p*–value	0.0001			0.0001
Regime 1				
Coefficients of financial development below the threshold	0.410 (0.256)	0.119 (0.078)	0.391 (0.225)	0.113 (0.057)*
R^2	0.621	0.593	0.671	0.653
Number of countries below the threshold	8	8	12	12
Regime 2				
Coefficients of financial development above the threshold	0.505 (0.126)***	0.211 (0.099)**	0.611 (0.282)**	0.220 (0.103)**
R^2	0.661	0.605	0.679	0.670
Number of countries above the threshold	21	21	17	17

Notes: ***, ** and * denote significance at 1, 5 and 10% level. Values in ( ) are the standard errors.