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The non-linear relationship between financial development, economic growth and growth volatility: Evidence from Nigeria

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Abstract

The aim of this paper is to examine how Financial development correlates with economic growth and growth volatility in Nigeria. We use a semi-parametric partially linear model and sample splitting threshold models to analyse Nigeria data from 1970 to 2015. Our results show U-shape for both financial development (FD) and economic growth (EG) and financial development and growth volatility (GV) relationships. We report points of inflexion in FD/EG function to be 15.62% and 8.71% for the FD/GV function. We interpret these points in FD/EG as the ratio of private credit to GDP that triggers growth, and in FD/GV as a point where growth volatility is triggered. We discussed the policy implications of our findings and suggest policy reforms.

Keywords: Nigeria; Financial development; Economic growth; Threshold regression; Growth volatility.

1. Introduction

This study investigates the nature of the relationship between financial development (FD), economic growth (EG) and growth volatility (GV). Literature found this relationship to be monotonic, non-monotonic, U-shaped, or inverted U-shaped. A few researchers maintain that the relationship between the variables depends on the level of economic development while others are living in denial that relationships exist between the variables. Various attempts have been made to examine the relationships between FD, EG and GV. For example (King & Levine, 1993a; 1993b and Levine, 1997; 2002; 2005) believe that financial system or financial development influence economic growth positively. Yeh & Lin (2013) and Demirgüç-Kunt, Feyen, & Levine (2013) answered questions on financial structure and economic growth relationship. However, some relevant questions are still unanswered.

Research has not conclusively dealt with why these relationships move from positive (negative) to zero and from zero to negative (positive). Although a good chunk of research has investigated the link between FD and EG in the advance economies, we know far less about these relationships in developing countries. The research gap in understanding the nature of the relationship between these important macroeconomic variables is keeping researchers and policymakers from knowing how to influence policy reforms to bring about sustainable economic growth in developing economies. Developed economies are different from the economies of developing countries in structure, institutions and the way they respond to shocks. While the financial markets in the advanced countries are big, developed, liquid and complete, those of the developing economies are small, developing, illiquid and incomplete. We therefore, expect financial intermediation in the advanced and the developing economies to be different, we also expect the effect of FD on growth to be more impactful in the advanced economies than in developing countries.

There are dearth of research investigating finance-growth relationships in developing economies. Where such research exists, their conclusions are inconsistent and ambiguous. For example, Atindehou, Gueyie and Amenounve (2005) studied West African countries and found neither finance explains growth nor growth explains finance. They attributed such a phenomenon to a very large informality in the economies of the region. In the other studies using data from Nigeria, Akpan, Nwosu and Eweke (2017) found a positive relationship between finance and growth but Nkoro and Uko (2013) reported a negative relationship between the two variables. This inconsistency suggests the

need to re-examine the relationship between finance and growth in developing countries to reach steady conclusions. Besides, most of the research on finance/growth relationship in developing countries use cross-countries and panel data and techniques. This study avoids heterogeneity problems in cross-country and panel data parameters and the change dynamics reported by Luintel *et al*. (2008) and Arestis *et al*. (2010) and uses time series data of Nigeria.

This study intends to fill the gaps of inconsistent conclusions and inappropriate data type by investigating how the measures of financial development relate, first with economic growth, and then with growth volatility. Then how important is our research objective? Knowing how FD relates with EG and EGV provides critical inputs to policymakers on reforms capable of answering the economic growth questions. For example, if FD relates linearly with EG, policy effort could be to increase the finance sector while maintaining the existing financial structure. If it relates in a U-shaped fashion, and they identify financial deepening as the cause of the threshold as reported by Sahay *et al*., (2015), then policy effort could be to improve financial market efficiency and access to the market services. Doing these would complement the already confirmed high financial deepening and its positive influence on growth or growth volatility. Knowing therefore, the nature of the relationship between the two variables is important. We use semi-parametric, and dynamic threshold estimators for data analysis and observed that the relationships between FD/EG and FD/GV were U-shape.

This study also attempts to identify channels or sources of non-linearity effects in the two relationships. Identifying these channels is important because of their economic policy relevance. Research conclusions that throw light on the role of finance in economic growth could shape future policy-oriented research. Information on how finance relates with growth would influence the priority that policy makers attach to growth-oriented financial sector policies (Levine, Loayza, & Beck, 2000). Empirically, evidence that financial development supports long-term economic growth will provoke urgent need to research on various determinants of financial development. These issues, in addition, underscore the motivation for this study.

The rest of this paper continues first with the background to the study. A brief review on what research has done and what needs to be done in this area of enquiries will follow. Next section examines data, variables and methodologies in the study. The discussion of the results of our empirical analysis will follow. The paper will end with the conclusions drawn based on our findings and recommendations for policy consideration.

1.1. Background: Overview of the Nigerian economy

Nigeria is a West African and sub-Saharan country. It is a lower middle-income ranked 30th largest economy in the world judging from its nominal GDP. Nigeria is also the largest economy in Africa ranked by its nominal GDP. It has the GDP of $492.986 billion (nominal 2016) (WDI, 2017). It has a per capita GDP growth rate of 2.7% in 2015, an average of 1.726% between 1970 and 2015, a maximum of 30.356% in 2004 and a minimum of -15.454% in 1981 with a standard deviation of 19.6205 which stands it out as a country with high growth volatility. Between 1970 and 2015, Nigeria has an average population growth rate of 2.602, a maximum growth rate of 3.044 in 1984 and a minimum of 2.2849 in 1970. By 2015, services composed 55% of the Nigerian GDP, agriculture 18% while manufacturing and petroleum products 16% and 8% respectively. The revenue from oil is 67% of its total revenue, but oil contributes only 9% toward its GDP (CBN, 2017). Oil revenue fluctuates constantly and so is the GDP to the extent of the influence of oil revenue.

Nigeria has an interesting architecture of financial sector development. Central bank regulates its money markets and monetary policies while the Securities and Exchange Commission regulates its capital markets. The country has 21 commercial banks from 89 legacy banks before the banking consolidation of 2005. It has 5 Merchant banks and six development finance institutions. In 2015, the country had 2991 Bureaux-de-change, 942 Micro-finance banks, and 64 finance companies, all involved in various stages of financial intermediation. Nigeria also has 36 primary mortgage banks, a stock exchange, one commodity exchange, 16 insurance companies, one capital market regulator and one insurance regulator. Apart from the regulators, most of these institutions are private companies. One, therefore, expects these institutions to compete in financial intermediation exacerbating financial deepening which could mediate early threshold effects in the FD/EG/GV relationships.

The Nigeria economy had witnessed several financial reforms including the Structural Adjustment Programme (SAP) of 1986 and the bank consolidation of 2005. There have been several shocks, economic and political, in the sample period which may have had an impact on growth. The examples are the oil price upsurge of 1973, the military coup of 1975 and 1983, and the political disturbance of 1993. These events and the market regulation of the financial sector could explain our suspicion of non-linearity in the relationships between FD/EG/GV.

2. Literature review

In this section, we review issues in our research questions. The review has three broad objectives: to describe the research context, to provide insights necessary to understand the research questions or hypothesis, and place the research questions or hypothesis in the research findings and in theories. The next paragraphs discuss the theoretical framework linking finance to growth and growth volatility.

2.1. The relationship between finance and growth: theoretical literature

We traced the finance-growth relationship back to the early twentieth century with the initial influential paper of Schumpeter (1911). In his article, Schumpeter highlighted the need for financial institutions to finance productive investments and innovation to bring about economic growth. Patrick (1966) laid a foundation for understanding the link between financial development and economic growth. Patrick asserted that FD connects to real output when financial assets and liabilities also connect to the real capital stock. He maintains that the relationship between capital stock and real output is strong, direct and monotonic. Gurley and Shaw (1955) and Goldsmith (1969) who re-echoed more developed financial markets promote economic growth by mobilizing savings to finance the most profitable investments supported Patrick's position on the issue.

McKinnon (1973) and Shaw (1973) contributed by being concerned about financial repression in the developing countries. They argued that pervasive financial regulations involving interest rate ceilings and stringent reserve requirements would impede intermediation and frustrate economic growth. The authors therefore, recommend financial liberalization that would lead to increase in loanable funds and a more efficient allocation of the investible funds.

In the 1980s and early 1990s, there was a new wave of interest in the relationship between FD and economic growth. This interest was driven by endogenous growth theory credited to Lucas Jr (1988) and Romer (1988). These authors posit that financial development bolster economic growth through savings mobilization, efficient allocation of resources, reduction in information, transaction and monitoring costs, diversification of risks, and facilitation of exchanges of goods and services. They conclude that these services of the financial sector would transmit into more rapid accumulation of physical and human capital and faster technological progress to boost economic growth. Greenwood and Jovanovic (1990) supported this argument. They argue that financial intermediation helps to transmit physical and human capital accumulation into economic growth by

ensuring a high rate of returns on capital. Greenwood and Jovanovic (1990) also show that the financial intermediation/growth process is self-sustaining because while intermediation spurs growth, growth also promotes financial institutions. Bencivenga and Smith (1991)'s contribution in the argument was that the financial intermediaries support investment and growth and help individuals to hold diversified portfolios to manage risks and bring their investment to the level of their liquidity preferences.

2.2. The relationship between finance and growth: empirical literature

Formal empirical work investigating the relationship between FD and EG is associated with the works of King & Levine (1993a, b, c); Levine (1997); Levine and Zervos (1998); Rajan and Zingales (1996); and Beck, Demirguc-Kunt, and Levine (2004). These authors, influenced by the works of Schumpeter, and the endogenous growth theory of Romer (1988) and Lucas (1988), demonstrated that there is a positive and long-run correlation between indicators of FD and EG. They believe a well-developed financial market is growth-enhancing, and agree with "more finance, more growth". This linear-function of FD/growth relationship dominated research until after the 2008 financial crisis. After the crisis, researchers saw the possibilities of threshold(s) in the FD/EG relationship. This thinking drives a non-linear modeling technique for FD/growth relationship which has gained popularity in the recent literature.

However, a few studies on finance–growth nexus hold contrary opinions to those of the linear paradigm. They believe the relationship between finance and growth is non-monotonic. Arcand, Berkes & Panizza (2015) and Cecchetti and Kharroubi (2012a) were among the first to report their contrary views on the finance–growth relationship. Their work was influenced by those of Minsky (1974), De Gregorio and Guidotti (1995), Kindleberger (1978), Singh (1997) and Rousseau & Wachtel (2011). While it concerned Minsky and Kindleberger about the increase in macroeconomic volatility, Tobin (1984) was worried about the misallocation of human resources away from the real sector of the economy by the excess financial deepening which affected sustainable economic growth. Tobin (1984) believes that expanding financial system would take talents from the real sector slowing down output growth. De Gregorio & Guidotti (1995) show the advanced economies may have reached a threshold where FD no longer increase investment efficiency and therefore, starts a drag on economic growth. A more recent Rajan (2005)'s paper warned that a large and complicated financial system could breed or make a system vulnerable to financial crisis and therefore inimical to economic growth. This warning appeared to foresee

the financial crisis of 2008 that came from the heels of complicated mortgage financing and its derivatives.

Several recent studies had supported the new findings of non-linear relationship between finance and growth. For example, Arcand, Berkes & Panizza (2015a) used different estimation methods and types of data – pure cross-section, cross country panels and industry-level data – and find the relationship between FD and economic growth is non-linear. Their estimated point of inflection on the Finance-growth function is where the credit to private sector reaches 80-100% of GDP. Law and Singh (2014) using dynamic panel threshold methods on data from 87 countries over a period 1980-2010, found the threshold beyond which private credit no longer contribute to growth is 88% of GDP. Panizza (2014) confirms that FD-growth relationship is non-monotone. The author further noted poor institutions, financial crisis or microeconomic were not responsible for economic fluctuations as claimed. Panizza's comment implies the relationship between FD and EG could be non-linear in any economic setting notwithstanding the stage of the country's economic development.

In a similar argument, Sahay *et al*., (2015) confirm the relationship between FD and economic growth is non-linear but the point of inflection, contrary to the conclusions of the other researchers, is not unique. The inflection point, according Sahay *et al*., (2015), depends on the country's institutions and the methods used in the analysis. This uncertainty of whether institutional factors affect the point of inflexion in the FD/EG/EGV relationship is not investigated. It remains hypothetical until empirical examination explicates the claims.

The non-monotonic function of finance/growth relationship attracted a few critics. First is Cline (2015). Cline sees quadratic terms in the finance-growth model as spurious. He shows the quadratic term in the function was not unique. According to the author, it is possible for any variable to behave the way FD does if turns into a polynomial. Cournède, Denk, and Hoeller (2015) responded to Cline's argument by reporting a non-linear regression function of FD and growth where quadratic term was not included. The second critic is Beck (2015). His argument was with the use of credit to private sector as a percentage of GDP to proxy FD. According to the author, not all private credit goes into boosting investment and therefore growth. Beck further argues that in the lower-middle-income countries, banks' balance sheets are dominated by government bonds and short-term corporate loans with a limited amount of credit going to SMEs. In the upper-middle-income countries, another authors explain that private credit is dominated by consumer credit in Credit cards and as mortgage finance

with a small fraction of it going to private firms for investment (Langfield & Pagano, 2016).

Another significant critic of the non-linear relationship of FD and growth comes from Ketteni, Mamuneas, Stengos, and Savvides (2007). These authors see the non-linearity conclusion of various other authors in the FD/EG/EGV relationships as spurious. According to Ketteni *et al*., (2007), these authors reached their conclusions the way they did because they never considered the conclusions of extant publications on the subject. Kalaitzidakis, Mamuneas, Savvides, and Stengos (2001) and Mamuneas, Savvides, and Stengos (2006) had shown that the nonlinear relationship exists between economic growth and initial income and human capital. They further argue that when these nonlinearities between growth, initial income and human capital are controlled, FD and growth will exhibit a linear relationship. Our independent empirical investigation of these assertions shows that growth relates non-linearly with FD with no influence of human capital or initial income. Further research in this area would be very helpful.

2.3. The nature of finance-growth volatility relationship

Researchers credit the pioneering work on the nonlinear function of the FD-growth volatility to the Easterly *et al*., (2001). In their work titled "shaken and stirred: explaining growth volatility", the authors show that FD could dampen growth volatility up to a point and thereafter, a further increase in FD will amplify the volatility creating a U-shaped relationship between FD and growth volatility. A group of authors – Denizer, Iyigun, and Owen (2002) in their contribution, analysed a panel of 70 countries from 1956 to 1998 and found that countries with developed financial sector experience less fluctuation in their real per capita output, consumption and investment growth. These authors also assert that the way financial sector develops is important to how it dampens growth volatility. They highlight relative percentage of banks in the financial structure of the economy and the proportion of credit to the private sector that would affect the system's effectiveness in dampening the volatility of consumption and outputs. Other authors, including Raddatz (2006) who contributed explains that the financial depth of intermediaries is important in how much FD can do. Raddatz (2006) analyses industry data in 48 countries and found FD dampens a large proportion of volatility of outputs in the economic sectors that have high needs of liquidity in their operations. If the economic sector's operations are not liquidity dependent, FD may not succeed to dampen growth volatility.

Again, this assertion requires further independent investigation and is outside the objects of this study.

Recently, Dabla-Norris & Srivisal (2013) using data from 110 countries from 1974 to 2008 confirm the relationship between FD and growth volatility and added that the relationship is a U-shaped function. Sahay *et al*., (2015) supported these assertions and explain that FD dampens growth volatility initially by expanding opportunities for economic agents to manage their risks; however, as financial depth increases, risk increases and volatility amplifies. They conclude that financial stability of a country depends on the depth of financial intermediation and the pace of financial deepening. They believe if the depth of financial intermediation intensifies, financial stability risks would be lower; the faster the pace of financial deepening, the greater the risk of financial crisis. These authors also accept the notion of "too much finance" in the finance-volatility relationship but add the point of inflection in the relationship differs from country to country depending on the country's income level, quality of institutions, financial regulation and supervision. We conclude this section by arguing that FD dampens volatility by smoothening consumption and investment in the initial stage, as finance deepens, leverage escalates, risk and uncertainty crop in and output volatility returns, making the relationship a U-shaped function. This argument is consistent with Easterly *et al*. (2001).

2.4. Explaining nonlinearity in the FD, growth and volatility relationships

The preponderance of evidence so far reviewed proves the relationships between financial development, economic growth and growth volatility are nonlinear. The finance–growth relationship is U-shaped while finance/GV is also a symmetric U-shaped function. There are two exceptions to these conclusions of nonlinearity: first, is the argument in Ketteni *et al*. (2007) who believe the relationship between FD and economic growth is linear only if the nonlinearity in the relationships between economic growth and the initial income and human capital are controlled; second, Adeniyi, Oyinlola, Omisakin & Egwaikhide (2015), using data from Nigeria from 1960 to 2010, found that the actual relationship between FD and economic growth is U-shaped. Baring these two exceptions, we take the results as they are until there are contrary findings.

Theoretical explanation for these nonlinear FD-growth-volatility relationships is still evolving. This section examines the latest attempts in the literature to account for them. Researchers associate Tobin (1984) with the earliest thought on the "too much finance" dilemma. Tobin highlighted resources misallocation

that results from an oversize financial sector. According to Tobin, financial sector development attracts away skilled labour from the real production sector. He recommended transaction tax known as "Tobin tax" to discourage investors from using financial instruments for pure speculation. Dabla-Norris & Srivisal (2013) and Cecchetti & Kharroubi (2013) upheld Tobin's argument. In their paper, Cecchetti and Kharroubi (2013) demonstrate growth of financial sector causes skilled manpower to move from the real sector to finance, reducing aggregate productivity of the sector and therefore growth. The authors further explain that financial sector's growth hurts liquidity-dependent and R & D[1] intensive industries. Cecchetti and Kharroubi also link the increase in the financial sector to the decrease in total factor productivity in the real sector. According to the authors, financial sector expansion profits high collateral but low productivity projects, and this affects growth.

In another spirited argument, Beck, Degryse, and Kneer (2014) show the expansion in finance does not amount to expansion of intermediation. They tested growth against the size of FD and against intermediation measured by a credit to private sector enterprises. The authors conclude size of FD does not correlate with growth when intermediation is accounted for in the model. They further argue it is only the part of financial development devoted to intermediation that promote economic growth, the other part that goes to providing public services such as access to basic payment and transaction services does not affect growth. These authors report financial institutions, because they focus on proprietary trading, market making, and provision of advisory services, insurance, and other non-interest income - generating activities do less of intermediation. These non-intermediation activities support a little or no growth. In another argument, Beck (2015) show credit to private sector used as a proxy for FD has less impact on growth because a part of these credit goes to finance consumption rather than investment. Private credit, according to the author, comprises mortgage finance, in some countries, and mortgage finance is consumer-finance and has little impact on growth.

Another credible explanation to the nonlinear relationship between finance and growth is that of Gong, Greiner, and Semmler (2015). These authors, using a neoclassical growth model with externality made popular by Paul Michael Romer (1989), argue increase in physical capital that comes with new technology, correlates with a positive externality in the form of new knowledge

[1] Research and development.

stock. Such investment, according to Paul M. Romer (1986), will raise production possibilities function for the investors and still leave positive effects on the aggregate economic variables. Jorgenson, Gollop, and Fraumeni (2016), and Greenwood, Hercowitz, and Krusell (1997) support positive externality of investment argument. These authors maintain investment in physical capital has a larger influence on economic growth than factor shares suggest. The investment, according to the authors, affects the stock of physical capital and the intangible capital stock (new knowledge) such that the social returns of the investment become larger than the private returns.

Gong *et al*. (2015) provided a link between the externality argument and zero or negative growth by highlighting the concept of social capabilities credited to Abramovitz (1994). Abramovitz summarized his argument under social capabilities and concludes without it countries will hardly experience economic growth even if there is a positive investment stock. He defines social capabilities as the technical competence that enables countries to adopt new technologies, modern production methods and operate them to achieve economic growth. Gong *et al*. (2015) believe Formal education and technologies help in the accumulation of social capabilities.

In the same line of argument, Jorgenson, Gollop & Fraumeni (2016) show countries with a low stock of physical capital but a large stock of knowledge capital would experience a very large marginal product of physical capital and therefore economic growth. They cited Japan and Germany as an example of countries with such credentials. These countries lost a large amount of their physical capital during the world wars (Kusago,2007; Carlin,1996), but had a tremendous stock of knowledge that help their economies to grow back at an average of 9% between 1955 and 1975. In summary, Gong *et al*. (2015) believe an increase in investment in physical capital that does not generate knowledge capital, and where this knowledge abounds and there are no social capabilities to adopt them, will experience diminishing returns to physical capital and therefore decrease or stagnation in economic growth.

3. Data and methods

3.1. Date description

This study uses time-series data for Nigeria from 1970 to 2015. Nigeria is important here because it is a good example of resource-dependent and undiversified - developing economy. Researchers expect a resource-dependent

economy without effective macroeconomic management policies to experience volatile growth. The choice of the period – 1970 to 2015 – allows us to examine the behavior of the finance/growth relationship in both the period of increased oil prices of 1973 (OPEC, and Suez-canal closure related) and the oil price collapse of 1980s. It also allows us to see the influence of finance on growth subject to political instabilities in the country. There had been military takeover of government in 1975, political transition in 1979, a military coup in 1983 and 1985, political disturbance in 1993 after election cancellation, and several turbulent political transitions before 2015.

To examine the dynamic relationship between financial development and economic growth in one hand and financial development and growth volatility on the other, the dependent variables are economic growth and economic growth volatility. We measure economic growth by the growth rate of per capita GDP. We also measure economic growth volatility by exponential weighted moving average (EWMA) of the growth rate of per capita GDP used in Koop and Korobilis (2014). We use EWMA because we believe countries' economic output grow or decline over time at an exponential rate (Pritchett, 2000). Our per capital growth rate of GDP figure comes from the World Development Index (WDI) and we compute the volatility of GDP from these data.

For financial development, we use bank credit to private sector as a percentage of GDP and the data comes from WDI. We also use the compiled composite index of financial development (FD) from IMF databank for robust check. FD index comprises market index (MI) and bank index (BI). MI comprises market depth index, market access index and market efficiency index. BI represents bank and other financial institutions depth index, access index and efficiency index. Our control variables are the broad set of variables used in growth literature (Samargandi, Fidrmuc, & Ghosh, 2015). They comprise gross fixed capital formation (GFCF), which represents the total investment in physical capital; population growth (POPG), which shows growth in the labour force; trade to GDP (TGDP), which represents trade openness to international markets; government expenditure as a percentage of GDP (GEXGDP), which captures public spending and also a distortion through taxation; consumer price index (CPI), which proxies macroeconomic policy management; initial income per capita (INI); and school enrollment (SCH), which represents human capital or social capability (Gong *et al*., 2015). We source these annual data from WDI. We screened out some of these variables because they added no effect on the parameters of variables of interest in the process of regression.

3.2. Methods and model specification

Our method involves two steps. First, we investigate the potential nonlinearity in the relationship between financial development and economic growth on one hand, and financial development and growth volatility on the other. Where we confirm the nonlinearity between the variables, we take a further step to investigate if FD, a lag of GDP per capita or human capital is the cause of the nonlinearity. This further investigation is informed by the argument in the Ketteni *et al*., (2007) to the effect that FD correlates with economic growth linearly when the model nonlinear relationships between growth and the initial GDP per capita and human capital.

To do the first step, we use a quadratic polynomial of financial development in the model. Yeh, Huang & Lin (2013) and Arcand *et al.*, (2015) had used this technique. We also use dynamic threshold estimator used in Hansen (2000) and Kremer, Bick, and Nautz (2013) to investigate the potential existence of a discrete shift in the framework. This estimator is appropriate because macroeconomic variables such as GDP growth are extremely persistent. We follow this up by testing for U and inverted U-shaped functions technique from Lind and Mehlum (2010).

To do the second step, we use semi-parametric partially linear (PLR) model. We choose this model because it allows us to obtain additive semi-parametric components and graphical representation of the nonparametric components. We use this to arrive at a more suitable model specification.

3.2.1. Quadratic polynomial of financial development

We specify the following model:

$$gdpg_t = aFD_t + bFD^2_t + Z_t + \mu_t \tag{1}$$

Where $gdpg_t$ = rate of *gdp* per capita growth; FD_t = financial development at time t; FD^2_t = quadratic term of financial development; Z_t = vector of control variables; and μ = error term $E_{(\mu)} = 0$,

Then we test the joint hypothesis:

$$H_0: (a + b_2 FD_{min} \leq 0) \cup (a + b_2 FD_{max} \geq 0) \tag{2}$$

Against the alternative hypothesis:

$$H_1: (a + b_2 FD_{min} > 0) \cup (a + b_2 FD_{max} < 0) \tag{3}$$

Where FD_{min} and FD_{max} represent the minimum and maximum values of financial

development, respectively. If we reject the null hypothesis, it confirms the existence of an inverted U-shape relationship and the opposite for a U-shaped relationship is also true.

3.2.2. The dynamic threshold models

Another approach to examine nonlinearity in the FD-growth-volatility nexus is to apply the dynamic threshold estimator used in Kremer *et al*. (2013) and Hansen (2000).

We give structural equation with one potential threshold –γ as

$$gdpg_t = \mu_t + \beta_1 FD_t I(FD_t \leq \gamma) + \delta_1 I(FD_t \leq \gamma) + \beta_2 FD_t I(FD_t > \gamma) + \emptyset z_t + \varepsilon_t \quad (4)$$

Where t = 1---T represents period; μ_t stands for country specific effect; I (.) is an indicator function and depending on the value of the threshold variable compared to γ, which divides the observations into two regimes separated by differing regression slopes β_1 and β_2; δ_1 is the regime intercept which is the same for all individuals; and z_t is an m-dimensional explanatory variables, including lagged gdp. The control variables enter the equation all at the same time.

3.2.3. Semi-parametric partially linear model specification:

$$gdpg_t = x_t\beta + \theta(z_t) + \varepsilon_t \quad (5)$$

where gdpg is the rate of economic growth, x_t and z_t are determinants of dimension q and p respectively, of the rate of growth and β is a parameter and θ is an unknown functional form. E(ε_t /*x*, z) = 0. Our interest in this section is to specify the determinants of economic growth that belong to the linear component, x, and those to the unknown nonlinear component $\theta(z)$. Using a Kernel based approach as in Robinson (1988), we obtained the estimate of β ($\widetilde{\beta}$).

By obtaining $\widetilde{\beta}$, the redefined variable $gdpg_t - x\widetilde{\beta}$ can be expressed on z nonparametrically using kernel technique to obtain the estimate of the unknown function θ(.). To obtain a graphical representation of the individual components of z to confirm the non-linearity, we assume that the components of z have additive structure.

To estimate the model in (5), we allow several variables including FD, initial GDP per capita and human capital to enter the model nonlinearly. We specify this model thus:

$$gdpg_t = x_t\beta + \theta(z_1, z_2, \ldots z_p) + \varepsilon_t = x_t\beta + \sum_{s=1}^{p} \theta_s(z_s) + \varepsilon_t \quad (6)$$

We estimate the components of the model in (6) using marginal integration used in Linton and Nielsen (1995).

Models analyzed for non-linearity include:

$$gdppcg_t = c + \{popg_t + gindex_t\} + \{credp_t\} + \varepsilon_t \quad (7)$$

We could specify equation 7 as follows testing for the threshold:

$$\text{Growth} = \varepsilon_t + \beta_1 FD_t I(FDD_t \leq \gamma) + \delta_1 I(FD_t \leq \gamma) + \beta_2 FD_t I(FD_t > \gamma) + Øz_t + \mu_t \quad (7a)$$

$$gdpvola_t = b + \{cpi_t + gindex_t + popg_t\} + \{lifexp_t + credp_t + gdpvola(-1)\} + \mu_t (8)$$

$gdppcg_t$ = annual *gdp* per capita growth rate; $popg_t$ = annual growth rate of population; $gindex_t$ = index of political stability. It is a dummy of 0 for the years where there was civil war, coup, national election, or political riots and 1 otherwise. $lifexp_t$ = life expectancy as a proxy for human capital development. Researchers regularly use life expectancy for human capital development (Lucas, 1988). $lifexp_t$ = credit by banks to private enterprises as a percentage of gdp; $lifexp_t$ and $lifexp_t$ are used as threshold variables while cpi_t, $gindex_t$, $popg_t$ are non-threshold variables. cpi_t = consumer price index to proxy for inflation or macroeconomic stability and is expected to have negative relationship with growth and positive relationship with volatility; ε_t and μ_t represent disturbance terms respectively in the equations. I(.) is an indicator function and depending on whether the threshold is greater or less than γ. γ divides the observations into two regimes distinguished by the changing values of β_1 and β_2 ; δ_1 is the regime intercept which is the same for all, and z_t is an m-dimensional vector of explanatory variables.

4. Results of the empirical analysis

Our discussion here starts with descriptive statistics in Table 1 and cross correlation of variables in Table 2. Our descriptive statistics enable us to understand our data, choose the method and techniques of analysis and choose methods and tools of diagnoses. From Table 1, we observed that most of our series have a low standard of deviation compared to their means except for gdppcg. It shows the variables have less than average volatility. We observe most of our data are not normally distributed judging from the value of Jarque-Bera statistics. Linear regression would therefore, not be suitable here. In table 2, life expectancy highly correlates with private credit. To use the two variables in an equation at the same time, we use instrumental variables.

Table 1: Descriptive Statistics

	credp_	gdpvola	gdppcg	gindex	lifexp	loglife	popg	logtrade	cpi
Mean	13.314	0.1313	1.7263	0.7391	46.529	3.8382	2.6024	3.7984	32.604
Median	12.990	0.0893	0..970	1.0000	45.980	3.8283	2.5820	3.8679	5.1170
Maximum	38.390	0.4647	30.356	1.0000	52.977	3.9698	3.0440	4.4044	158.94
Minimum	4.7100	0.0048	-15.454	0.0000	40.965	3.7127	2.2840	2.9766	0.1010
Std. Dev.	6.3633	0.1228	7.7451	0.4439	2.8792	0.0612	0.1570	0.3819	45.398
Skewness	2.0182	0.9959	0.9883	-1.0891	0.4516	0.2872	0.9322	-0.5410	1.3805
Kurtosis	8.5554	3.0570	6.6749	2.1862	2.9600	2.9296	4.4014	2.2923	3.7586
Jarque-Bera	90.381	7.4456	33.374	10.363	1.5672	0.6419	10.428	3.2041	15.716
Probability	0.0000	0.0241	0.0000	0.0056	0.4567	0.7254	0.0054	0.2014	0.0003
Observ-ations	46	45	46	46	46	46	46	46	46

Note: CREDP_ represents a credit to private enterprises; GDPVOLA = gdp volatility; GDPPCG = gdp per capita growth; GINDEX = governance index; LIFEXP = life expectancy; LOGLIFE = log of life expectancy; POPG = population growth; LOGTRADE = log of trade as% of gdp; CPI = consumer price index

Table 2: Cross Correlation of Variables

Correlation Probability	**CREDP_**	**GINDEX**	**LIFEXP**	**LOGLIFE**	**POPG**	**LOGTRADE**	**CPI**
CREDP_	1.000000						

GINDEX	-0.113411	1.000000					
	(0.4530)	-----					
LIFEXP	0.545768	0.010031	1.000000				
	(0.0001)	(0.9472)	-----				
LOGLIFE	0.556561	0.004133	0.999166	1.000000			
	(0.0001)	(0.9783)	(0.0000)	-----			
POPG	0.120456	-0.001358	0.202786	0.208970	1.000000		
	(0.4252)	(0.9929)	(0.1765)	(0.1634)	-----		
LOGTRADE	0.223511	0.148059	0.180658	0.205309	0.116255	1.000000	
	(0.1354)	(0.3261)	(0.2296)	(0.1711)	(0.4417)	-----	
CPI	0.358788	0.103426	0.904649	0.888699	0.087758	0.036854	1.000000
	(0.0143)	(0.4940)	(0.0000)	(0.0000)	(0.5620)	(0.8079)	-----

Note: ( ) = p-value; CREDP_ represents credit to private enterprises; GDPVOLA = gdp volatility; GDPPCG = gdp per capita growth; GINDEX = governance index; LIFEXP = life expectancy; LOGLIFE = log of life expectancy; POPG = population growth; LOGTRADE = log of trade as % of gdp; CPI = consumer price index.

4.1. Our regression results

Recall that equation 7 models the relationship between FD and EG. Here, the idea is to examine the nature of the relationship between the two variables. The results shown in Table 3 shows bank credit to private enterprises, used as a measure of FD, has a U-shaped relationship with economic growth. The threshold value at the point of inflexion in this relationship is 15.6199% which is the point of equilibrium or a point where growth is zero even when finance was increasing. In the first regime, financial development has a negative coefficient of -0.24092 with economic growth. In the second regime, it has a positive coefficient of 0.5674 and the coefficient is statistically significant at 1%. The changing signs of the coefficients from negative to positive at the point of inflexion give us a threshold and U-shaped relationship. Governance index also show a positive correlation with economic growth with a significant coefficient of 5.1553 and population growth shows a negative correlation with EG.

In equation 8, we modeled the relationship between economic growth volatility and FD. The results reported in table 4 shows the relationship is U-shaped. The interesting thing in the results is that the first attempt of the analysis produced a similar result as the second with minor changes in the coefficients. Diagnosis of the first regression showed that the model had endogeneity bias. We confirmed this by regressing our independent variables against the error term. There was a positive correlation, but the model was unstable as confirmed by CUSUM test. In the second regression, we introduce instrument variable (lagged GDP volatility) our CUSUM test showed the model was stable. We record the result of our second attempt in Table 4. According to the results, private credit shows a negative correlation with gdp volatility in regime 1 with a coefficient of -0.0045 and a positive correlation with a coefficient of 0.000441 in regime 2. The changing signs of the coefficients from negative to positive at the point of inflexion denotes a threshold and U-shaped relationship.

In the same equation, log of life expectancy and the lag of gdp volatility show a negative correlation with gdp volatility with coefficients of -2.6815 and -0.0958 in regime 1. In regime 2, the lagged gdp volatility shows a positive correlation and logged life expectancy show a negative correlation with growth volatility. The result means life expectancy has a U-shaped relationship with growth volatility.

4.2. Specification and diagnostic checks

We used recursive estimation and CUSUM test to examine the stability of the models. The results are in Figure 1 and 2 confirming that the models are stable. We tested for serial correlation using L M test. The result rejected the alternative hypothesis of serial correlation. We did coefficient diagnostic using the dual tests of coefficient restriction Wald – test and Variance Inflation Factors. We rejected the H0 in the Wald test and the result of VIF test shows the coefficients were not loaded abnormally. The model selection criteria in the FD/growth / growth volatility regressions confirmed 2 regimes with the minimum sum of square residual of 0.0015.

Table 3: Results of Threshold Regression Analysis of Equation 7

Regressors	**Model 1**	**Regressors**	**Model 2**
Threshold Value: γ	15.6199	Threshold Value: γ	$243.984 = (15.6199)^2$
Impact of FD			
β_1	-0.2409	β_1	-0.00904
	(0.3564)		(0.0168)
β_2	0.5674***	β_2	0.01001***
	(0.1552)		(0.00289)
Impact of covariates			
Governance index	5.1553***	Governance index	5.1123***
	(1.8833)		(1.9215)
Population rate	-12.1297***	Population growth	-12.4103***
	(4.6794)		(4.9372)
Adjusted R^2	0.3384	Adjusted R^2	0.3271
SSR	1232.943	SSR	1216.0015
Observations	46	Observations	46

Note: ( ) = standard error; *** = significant at 1%;
Model 1 uses private credit as a regressor;
Model 2 uses the polynomial of private credit as a regressor.

TABLE 4: RESULTS OF THRESHOLD REGRESSION ANALYSIS OF EQUATION 8

Regressors	**Model 1**	**Regressors**	**Model 2**
Threshold Value: γ	8.7099	Threshold Value: γ	75.864 = $(8.7099)^2$
Impact of FD			
α_1	-0.0045***	α_1	-0.00037***
	(0.0008)		(0.00849)
α_2	0.00044***	α_2	0.000837***
	(0.00011)		(0.002111)
Impact of covariates			
Governance index	-0.00212*	Governance index	-0.00199*
	(0.00157)		(0.00154)
Population rate	0.00987	Population growth	0.00959
	(0.01289)		(0.01317)
Log life expectancy	-2.6815*** (0.2431)	Log life expectancy	-2.6352*** (0.2513)
Gdp volatility (-1)	-0.09581	Gdp volatility (-1)	-0.8685
	(0.05916)		(0.0632)
Adjusted R^2	0.9972	Adjusted R^2	0.99726
SSR	0.0015	SSR	0.00151
Observations	46	Observations	46

Note: ( ) = standard error; *** = significant at 1%;
Model 1 uses private credit as a regressor;
Model 2 uses the polynomial of private credit as a regressor.

FIGURE 1: RESULT OF STABILITY DIAGNOSTIC FOR EQUATION 7 MODEL 1

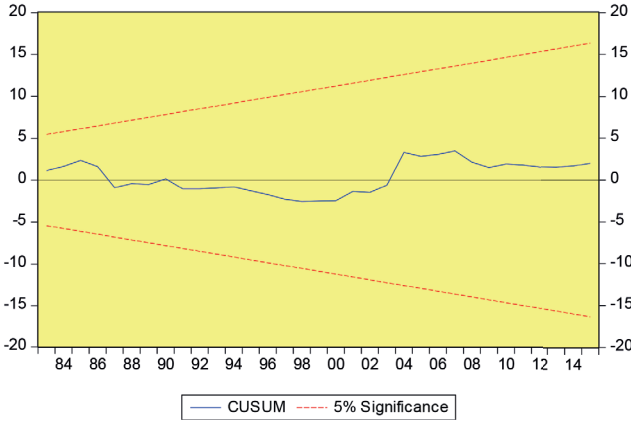


FIGURE 1B: RESULT OF STABILITY DIAGNOSTIC FOR EQUATION 7 MODEL 2

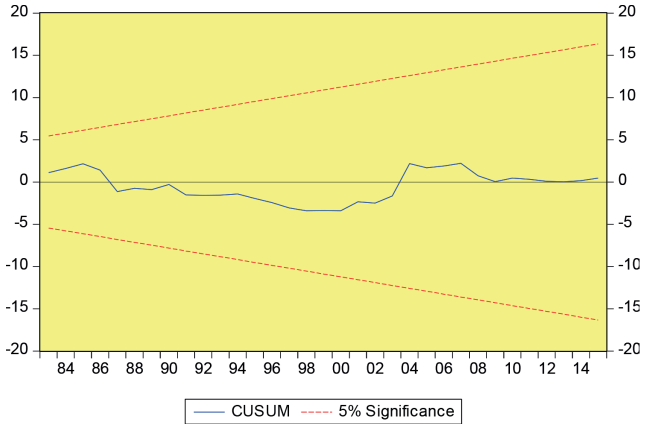


FIGURE 2: RESULT OF CUSUM TEST OF STABILITY FOR EQUATION 8 MODEL 1

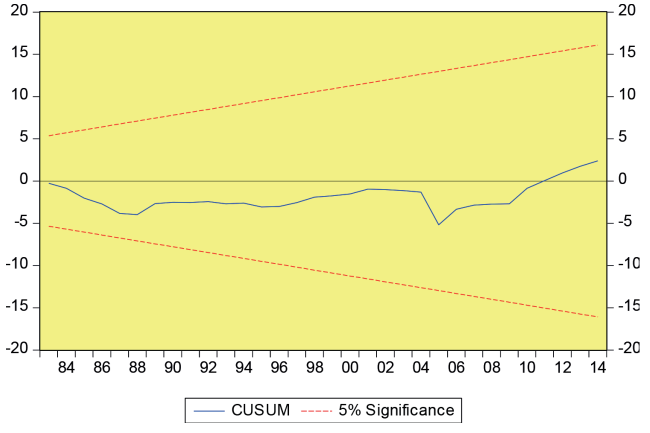
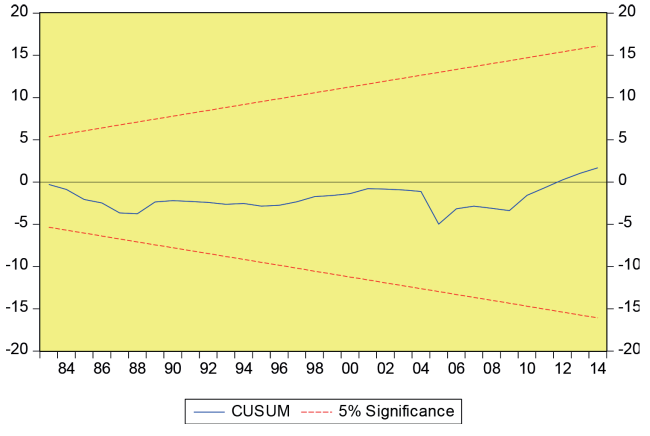


FIGURE 2A: RESULT OF CUSUM TEST OF STABILITY FOR EQUATION 8 MODEL 2



5. Discussing the empirical results

In our analysis of how financial development (FD) correlate with economic growth, we have evidence that the two variables enjoy a long run relationship. We do not observe evidence of 'Too Much Finance' which appear to be popular in the recent literature. We have also noticed evidence of the relationship between FD and growth volatility. These relationships are marginal in value but significant statistically. For our purpose in this study the signs and changes in signs provide information that enables us to answer our research questions. We are therefore more interested in these signs than in the values of the coefficients of the regressors. Bank credit to private sector used in the study to proxy FD have its coefficient of correlation with economic growth changed from negative -0.24092 to positive 0.5674 at the point where private credit to GDP crosses 15.6199%. This shows a U-shaped relationship, and it is consistent with Adeniyi *et al*. (2015) on Nigeria. Our result however, differs from those of Yeh and Shin (2013), Arcand *et al.* (2015) and Cecchetti and Kharroubi (2015). These three sets of authors, among others, reported evidence of an inverted U-shaped relationship between FD and economic growth. Our result, as it pertains to the point of inflexion, however agrees with the conclusion in Sahay *et al*., (2015) that the actual point of inflexion in the relationship between the variables depends on the peculiar circumstances of each country. The point of inflexion in other studies ranges from 88% - 100% of private credit as a percentage of GDP.

There appears to be a marked disparity between other countries' average data at an inflexion point (80% - 110%) and that of Nigeria (15.6199%). Consistent with the findings in Sahay *et al*. (2015), we suggest such disparity may associate with the differences in the quality of institutions and macroeconomic management. According to the World Development Index (2017), indices for the following governance measures for Nigeria for ten years up to 2015 are in most cases negative. The measures include the rule of law, governance effectiveness, regulatory quality and political stability. According to Karl (2004), Nigeria is a rentier state. Rentier state is a state that lives from rents generated outside its borders. From the above description, a rentier state has no obligation or incentives to have in place credible institutions and the rule of law (because they have no tax revenue expectation) which explains why the point of inflexion in the finance/growth relationship is as low as about 16% as compared to an average of 80–88% for other countries. The summary of what is different in Nigeria is the low quality of institutions.

We observed our result did not change so much after we introduce the polynomial of private credit into the regression. The threshold value in the second regression was 243.984 which is the square of 15.619. The signs of the coefficient changed from -0.00904 in the first regime to 0.01008 in the second regime. In another check, the use of the composite index of FD in the regression that show no threshold effect in the relationship between the variables. The failure of the composite index of FD to show any threshold effect in its relationship with economic growth most likely signals the discrimination between financial deepening and the FD comprising access, efficiency and depth. It confirms financial deepening as the candidate for the threshold effect in the finance-growth relationship. Several research reports excess financial depth as the source of reversal in growth after a threshold value Cole (1974); Darrat (1999); Rousseau and Wachtel (2011); Cecchetti and Kharroubi (2012); and Bhattarai (2015).

A few researches associate the negative impacts of the excess financial depth on growth to excessive bank competition (Law and Singh, 2014). According to the authors, excessive bank competition makes more credit available to firms, but banks do not provide additional needed services to the firms resulting in a high probability of investment failing. Beck *et al*. (2014) also attribute this negative effect of excess financial deepening to a phenomenon where there is an increase in the size of financial sector with no corresponding increase in financial intermediation. According to these authors, it is the financial intermediation that influences economic growth and not just the size of the financial sector.

We interpret the U-shaped relationship between FD and growth to mean that the initial expansion in the financial sector did not seem to matter so much for growth until FD got to a critical level and surpass it before there appear to be a positive, although marginal, growth effect. This flags the levels of FD is important for growth. In Nigeria, growth became evidenced only when FD crosses 15.6199% of private credit to GDP. This understanding may also be useful to explain the puzzle in Fiji Island reported in (Sharma & Roca, 2012). The low point of breaks (or equilibrium) in the FD/growth/growth volatility relationships implies that the Nigerian economy is not able to draw maximum growth and volatility reduction from FD. Suspected reason for this situation is a low quality of institutions earlier identified.

Our result for equation 8 reported in Table 4 shows that FD also correlates in a U-shaped fashion with economic growth volatility. The coefficients in this analysis change from a negative -0.0045 to positive 0.00441 on each side of

the threshold value of 8.7099% of private credit to GDP. Possible explanation for this low point of equilibrium in Nigeria as compared to other countries, and as explain elsewhere in this paper, is the rule of law, governance effectiveness, regulatory quality and political instability. The nature of this relationship did not change even when we used the polynomial of credit to the private sector in the regression. In this second regression, private credit (squared) relates with growth volatility in a U-shaped fashion like the first regression. The coefficient of correlation in the second regression changed from negative -0.00037 to a marginal positive of 0.000873 around a critical value of 75.864 which is the square of 8.7099. Like the situation in equation 7, the composite index of FD into equation 8 did not show a threshold effect. Our results agree with those of Easterly, Islam, and Stiglitz (2001) and Sahay *et al*. (2015). Easterly et al. (2001) connect financial expansion to the tempering of growth volatility by smoothening consumption and investment up to the threshold value. Beyond the threshold point, the expansion in finance exacerbates risks and therefore growth volatility.

A further point that caught our attention in the analysis of equation 8 is that the threshold value came too soon at 8.7099% of credit to private sector. It means that the economy is prone to volatility as finance expands. Finance literature contains at least three explanations to this early peak phenomenon of the threshold value in the Finance/volatility relationship. First is the popular issue of the institutional and regulatory weakness of the country which determines the point of inflexion in the relationship (Sahay *et al*., 2015). Second is what Sahay *et al*. (2015) termed economic fundamentals, which includes the effectiveness of macroeconomic management. Research opines that inflation exacerbates volatility and dampens growth. Where macroeconomic policies are not effective, FD may only do a little to temper growth volatility. The third explanation for the early peak phenomenon for a threshold in the finance-growth volatility is how the financial sector grows. Easterly *et a*l. (2001) report that financial sector itself could exacerbate a period of economic downturns, where debt increases relative to equity. These authors explain equity markets provide better risk diversification than debt markets and thus make economy less vulnerable to economic downturns.

Explaining the low equilibrium in the finance/growth volatility using data from Nigeria, the immediate call is the weak institutions. These weak institutions manifest in the low financial market and institution efficiency and access indices published by IMF. Access measures the ability of individuals and companies

to access financial services while efficiency measures the ability of financial institutions to provide services at low cost without eroding the value of the assets. Financial market access index for Nigeria stands at 0.006681 in 2014 from 0.000785 in 1980. This same index for Malaysia equals 0.702115 in 2014 up from 0.04584 in 1980. The financial market efficiency index for Nigeria stands at 0.08637 in 2014 up from 0.004011 in 1980. That of Malaysia is 0.280766 from 0.06977 in 1980 (Svirydzenka, 2016). These levels and growth rate of market access and efficiency in Nigeria, appears to be a good reason for the low equilibrium in the finance/growth/growth volatility relationships.

6. Conclusion and policy suggestions

We recall that our objectives in this study were to determine the nature of the relationship between financial development and economic growth on one hand and FD and growth volatility on the other. We used bank credit to private sector to proxy for FD and GDP per capita growth for economic growth. We selected credit to represent FD for two reasons: researchers widely use it in the finance-growth literature and our research was to confirm a few of researches using different parameters; second, other proxies had insufficient data. We estimated growth volatility using exponential weighted moving average because of our understanding that most macroeconomic variables fluctuate in an exponential fashion. We used threshold model estimator for our analysis because literature reviewed had been persuasive that finance-growth relationship is non-monotonic. Our data came from Nigeria for a period between 1970 and 2015. This section concludes our study and proffer policy suggestions.

We have evidence that FD returns threshold effects with economic growth and growth volatility in their relationships. Contrary to popular conclusions in the finance/growth literature, our results show that FD has a U-shaped relationship with growth and a U-shaped relationship with growth volatility. Our results in the finance/growth relationship is consistent with Adeniyi *et al.*, (2015), a prior research that used Nigerian data. With finance/growth volatility relationship, our result is consistent with both Easterly *et al*., (2001) and Sahay *et al*., (2015). Both results have several policy implications.

Our result in the finance–growth analysis shows FD correlates with growth negatively in the first instance until it reaches the threshold point. It also correlates positively with growth after the point of inflexion.

This signals a warning that policy-makers should not expect economic growth from FD shocks in the initial stage. Policymakers should fast-track FD

to catch up with the threshold value to experience economic growth. Next is the choice of reforms needed to attain the desired volume of FD: Our results show the composite index of FD displays no threshold effect both with growth and growth volatility. This shows that we can still expand certain elements of the FD such as access and efficiency to grow the financial sector and to reap economic growth even when financial deepening hits the threshold. In addition, developing countries need a heavy dose of financial deepening in the initial stage of financial sector development to hit the threshold quicker and begin the period of growth. For financial reforms, we should try to balance financial deepening with policies to increase access to finance and to improve the efficiency of financial products and services.

A couple of ways could increase access to financial services. We discuss two of those methods here. First is to make financial service available to small and medium businesses (SMEs). This could be by decentralizing capital and credit markets. The current policy of locating capital market in a central business center of the country does not appear to solve access problem to SMEs. Several researchers have found that stock exchange services respond to spatial proximity to the exchanges (Fafchamps and Schundeln, 2013). We suggest setting up of the independent regional exchanges to solve the problem. Research found financial innovation improving access to financial services even in developing countries (Beck, Senbet and Simbanegavi, 2015). We defined financial innovation as an intentional restructuring of financial products, markets and the market processes to make it suitable for a greater number of savers to hold financial assets and liabilities (Allen and Santomero, 2001). Financial innovation also reduces perceived market risks, transforms weak and non-existing markets sometimes by using technologies (Beck, Chen, Lin and Song, 2016). Beck *et al*. (2016) have found the following facilities and innovations to increase access to finance in various parts of Africa. They are ATM, M-pesa, Susu, internet banking, cell-phone banking and Islamic banking. In addition, Nigeria needs to improve financial market efficiency by improving on market regulation and the rule of law. Improvement in the law regulating property rights and litigation process will go a long way in this direction.

Policymakers should adopt a policy to address the quick peaking of threshold points in the finance/growth and finance/growth volatility models. Taking cues from our results, capital market development appears to be better than credit market because as explained in this paper, equity market helps to diversify risks better than the debt counterpart. Capital market also appears to be better

in acting as a circuit breaker than the bank in times of financial crisis (Easterly *et al*., 2001). This study should be an agenda-setting research to inform deeper analysis of issues reported, increase the size of data of the variables used and bring in standard and emerging control variables to ensure better results.

Biographical notes

Oro Ufuo Oro was born in Nigeria in 1963. He has a degree in economics, business administration and he is a chartered accountant. He has worked in the public service of Nigeria, commercial banks and as a capital market regulator. He is obsessed with academic and research. To satisfy this longing, Oro enrolled and completed a master's degree in accounting and PhD in Finance both at University of the Witwatersrand, Johannesburg in 2018.

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