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Manuscript

Non-linear relationship between financial development, economic growth and growth volatility: evidence from Nigeria.

By

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2.1 Introduction

This study investigates the nature of the relationship between financial development (FD), economic growth (EG) and growth volatility (EGV). Currently, literature has seen this relationship as being monotonic, non-monotonic, U-shaped, or inverted U-shaped. Extant literature maintains that the relationship between the variables depends on the level of economic development while others are living in denial of the fact that relationships do exist between the variables. In providing insight into the nature of the relationship between the variables, many relevant questions have been asked and answered. For example (King & Levine, 1993a; 1993b and Levine, 1997; 2002; 2005) believe and empirically demonstrate that financial system or more precisely financial development positively influence economic growth. Yeh & Lin (2013) and Demirgüç-Kunt, Feyen, & Levine (2013) answered some questions pertaining to the relationship that exist between financial structure and economic growth. However, some relevant questions are yet to be answered.

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Incidentally, research has not so far dealt conclusively with why these relationships move from positive(negative) to zero and from zero to negative(positive) over time. Additionally, although a good chunk of research has investigated the link between FD and EG in the advance economies, far less is known about these relationships in developing countries. The research gap in establishing 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 markedly different from the economies of developing countries in structure, institutions and the way they respond to various 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 largely incomplete. Financial intermediation therefore, in the advanced and the developing economies is expected to be different and the effect of FD on growth is also expected to be more impactful in the advanced economies than in developing countries.

Unfortunately, there is 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 that neither finance explains growth nor growth explains finance. They attributed such phenomenon to the existence of a very large informal

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economic sector in the region. In the other studies, where data are taken 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 the context of developing countries with the aim of reaching a more stable conclusion. Besides, most of the research on finance/growth relationship in developing countries use cross-countries and panel data. This study avoids heterogeneity problems in cross-country and panel data parameters and adjustment dynamics uncovered by Luintel et al. (2008) and Arestis et al. (2010) by using time series data of Nigeria.

This study intends to fill the gaps of inconsistent conclusions and inappropriate data type by investigating the nature of the relationship between measures of financial development, first with economic growth, and then with growth volatility. Then how important is our research intervention? Knowing how FD relates with EG and EGV provides critical inputs to policy makers on reforms capable of answering growth questions. For example, if the relationship is found to be linear, policy effort could be to increase the finance sector while maintaining the existing financial structure. If the relationship is inverted U-shaped, and financial deepening is isolated 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

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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.

This study will also attempt 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. Furthermore, information on the nature of the relationship between finance and growth would influence the priority that policy makers attach to growth-oriented financial sector policies (Levine, Loayza, & Beck, 2000). Additionally, empirically-supported research 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 remainder of this paper continues first with the background to the study. This will be followed by a brief review of literature on what has been done to see what still needs to be done in this area of investigation. Next section examines data, variables and methodologies to be adopted in the study. This will be followed by the discussion of the results of the empirical analysis. The paper will end with the conclusions drawn based on the findings and recommendations for policy consideration.

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2.1.1 Background

This study is a part of a long search for theories to explain both the determinants of economic growth and the differences in growth rates among nations. Academic investigation to explain growth and growth differences among nations underscore the activities of even the classical economists. In the early 1990s these enquiries took a different turn with the work of King and Levine (1993b). In this epoch-making publication, Levine (1993b), standing on the shoulders of the then renown economists such as Schumpeter (1911), Gurley and Shaw (1955), Goldsmith (1969) and McKinnon (1973), postulated that various measures of financial development strongly associate with GDP growth. These early research including those of Bencivenga and Smith (1991) ; Greenwood and Jovanovic (1990); King & Levine (1993a), modeled FD – growth as linear relationship. The linear FD/growth relationship became the dominant view in the subject area in the past three decades.

Things were soon to change, no thanks to the global financial crisis of 2008. Researchers (Arcand, Berkes, & Panizza, 2015; Cecchetti & Kharroubi, 2012b); Rousseau and Wachtel (2011) began to see the possibility of a limit of influence of FD on the economic growth. This commenced the era of modeling FD – growth relationship as a non-monotonic function and the birth of the phrase "too much finance" and the "vanishing effect of finance" on growth. Arcand, Berkes and Panizza (2015) and a few other after them demonstrate that FD – growth relationship mediates a threshold, which is indicated by a

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change in the sign of their elasticity from positive (negative) to negative (positive) making it either an inverted U-shaped or a U-shaped function. This assertion has been confirmed by recent research including Sahay, Cihak, N'Diaye, Barajas, Ayala, Gao, Kyobe, Nguyen, Saborowski, Svirydzenka & Yousefi (2015).

In a similar line of thinking, Easterly et al (2001) show that FD also has a nonlinear relationship with growth volatility. According to the authors, the relationship is a U-shaped function, implying that increase in FD dampens growth volatility up to a point then it begins to amplify it. This claim had been confirmed by Dabla-Norris and Srivisal (2013) and Sahay et al (2015). These varying conclusions and the dearth of research in verifying data from developing countries become the motivation for our study.

In summary, we want to establish the nature of the relationship between FD and economic growth in Nigeria. Secondly, we want to confirm the direction in which FD affect growth volatility. We want to examine the theoretical explanation for the "too much finance" phenomenon. We also want to discuss the policy implications of these relationships. In the following sections, we examine literature on the state of investigation on the FD/growth/growth volatility relationships.

2.2 Literature review

This section reviews existing literature on issues relating to the questions to be addressed in this study. The review has three broad objectives namely: to describe the research

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context, to provide the insight necessary to understand the research questions or hypothesis, and lastly to place the research questions or hypothesis in the context of the past research findings and in theories. The section is organized as follows: the next paragraphs discuss the theoretical framework linking finance to growth and growth volatility; this is followed by the examination of the empirical literature that tested the claims about these relationships.

2.2.1 The relationship between finance and growth: theoretical literature

Literature on the finance-growth relationship is traced 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 is connected to real output when financial assets and liabilities are connected to the real capital stock – its optimal consumption, rate of growth, its efficient allocation and utilization. He maintains that the relationship between capital stock and real output is strong, direct and monotonic. Patrick's research was supported by Gurley and Shaw (1955) and Goldsmith (1969) who re-echoed that more developed financial markets promote economic growth by mobilizing savings to finance the most profitable investments.

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McKinnon (1973) and Shaw (1973) in their contributions were concerned about financial repression especially 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 available 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 the emergence of 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 as well as faster technological progress that are needed to boost economic growth. This position in the finance – growth argument was supported by Greenwood and Jovanovic (1990) who argue that these services mentioned in the Lucas (1988) and Romer (1986) are provided by financial intermediaries who promote investment and growth by ensuring high rates 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 the

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development of financial institutions. Bencivenga and Smith (1991)'s contribution in the argument was that the financial intermediaries do not only support investment and growth, they also help individuals to hold diversified portfolios to manage risks and bring their investment to the level of their liquidity preferences.

2.2.2 The relationship between finance and growth: empirical literature

Formal empirical work investigating the relationship between FD and economic growth 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), empirically demonstrated that there is a positive and long-run association between the indicators of financial development and economic growth. They generally believe that a well-developed financial market is growth-enhancing, and agree with the assertion of "more finance, more growth". This linear-function of FD/growth relationship dominated the thinking of researchers until after the 2008 financial crisis. After the crisis, researchers began to imagine the possibilities of threshold(s) in the FD/economic growth 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 that the relationship between finance and growth is non-

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monotonic. Arcand, Berkes & Panizza (2015) and Cecchetti and Kharroubi (2012a) were among the first to formally report their contrary views on the finance – growth relationship. It is believed that their work may have been influenced by those of Minsky (1974), De Gregorio and Guidotti (1995), Kindleberger (1978), Singh (1997) and Rousseau & Wachtel (2011). In explaining the non-linearity, Minsky and Kindleberger were concerned about the increase in macroeconomic volatility which they suspected was caused by the overly extensive financial deepening. 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 economic growth. Tobin (1984) believes that expanding financial system would takes talents from the real sector slowing down output growth. De Gregorio & Guidotti (1995) empirically show that the advanced economies may have reached a threshold where FD no longer increase investment efficiency and therefore constitute 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 have anticipated the financial crisis of 2008 that came from the heels of complicated mortgage financing and its derivatives.

The new findings of non-linear relationship between finance and growth had been supported by several recent studies. For example, Arcand, Berkes & Panizza (2015a) employ quite different estimation methods and types of data – pure cross-section, cross

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country panels and industry-level data – and find that the relationship between FD and economic growth is non-linear. Their estimated point of inflection on the Finance-growth function is where 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 that 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 that the "too much finance" result was not driven by poor institutions, financial crisis or microeconomic volatility as were claimed by extant research. Panizza's comment implies that 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 that 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 in the level institutional factors affecting the point of inflexion in the FD/EG/EGV relationship has not yet been further 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 the introduction of quadratic terms in the finance-growth model

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as spurious. He demonstrates that 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 the variable was made 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 used in the function. The second critic has been Beck (2015). Beck is concerned with the use of credit to private sector as a percentage of GDP to proxy FD. According to the author, not all private credit affect investment and therefore growth as could be assumed. Beck further argues that in the lower-middle-income countries, banks' balance sheets are dominated by government bonds and short-term corporate loans (recorded as credits) 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 the Credit cards and as mortgage finance with only 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 the 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 matter. Kalaitzidakis, Mamuneas, Savvides, and Stengos (2001) and Mamuneas, Savvides, and Stengos (2006) had demonstrated that the nonlinear relationship exists

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between economic growth and two of growth's determinants – initial income and human capital. They further argue that when these nonlinearities between growth, initial income and human capital are accounted for, FD and growth will exhibit linear relationship. Our independent empirical examination of these assertions shows that growth does relate non-linearly with FD without any influence of human capital or initial income. Further research in this area would be very helpful.

2.2.3 The nature of finance-growth volatility relationship

The pioneering work on the nonlinear function of the FD-growth volatility is credited to 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, analyzed a panel of 70 countries from 1956 -1998 and found that countries with highly 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 that relative share of banks in the financial structure of the economy and the proportion of credit to the private sector would affect the system's effectiveness in dampening the volatility of consumption and outputs. Other authors, including Raddatz (2006) who contributed to the argument, explains that the financial

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depth of intermediaries is important in how much FD can do. Raddatz (2006) analyses industry data in 48 countries and found that FD dampens a large proportion of volatility of outputs in the economic sectors that have a high liquidity needs in their operations. In other words, if the economic sector's operation is not liquidity dependent, FD may not be successful in dampening growth volatility. Again, this assertion requires further independent investigation which is outside the objects of this study.

More recently, Dabla-Norris & Srivisal (2013) using data from 110 countries from 1974-2008 confirm the relationship between FD and growth volatility and added that the relationship is a U-shaped function. These assertions were supported by Sahay et al (2015) who explain that FD initially dampens growth volatility by expanding opportunities for economic agents to effectively manage their risks; however, as financial depth intensifies, risk increases and volatility is amplified. They conclude that financial stability of a country depends on the depth of financial intermediation and the pace of financial deepening. They believe that if financial intermediation intensifies, financial stability risks would be lower; and that 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 that 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

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stage, as finance deepens, leverage is increased, 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).

2.2.4 Explaining nonlinearity in the FD, growth and volatility relationships

The preponderance of evidence so far reviewed proves that the relationships between financial development, economic growth and growth volatility are nonlinear. The finance – growth relationship observed to be inverted U-shaped while finance – volatility like the FD/EG relationship, is observed to be symmetric U-shaped function. There are two exceptions to these conclusions of nonlinearity: first, is the argument in Ketteni et al (2007) who believe that 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 considered. Secondly, Adeniyi, Oyinlola, Omisakin & Egwaikhide (2015), using data from Nigeria from 1960-2010, found that the actual relationship between FD and economic growth is U-shaped.

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. Tobin (1984) is associated with the earliest thought on the "to much finance" dilemma. Tobin highlighted the issue of resources misallocation that results from an oversize financial sector. According to Tobin, skill labor would be attracted away from the real production sector by finance sector as it expands in depth and complexity. He

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

In another spirited argument, Beck, Degryse, and Kneer (2014) demonstrate that the expansion in finance does not necessarily amount to expansion of intermediation. They tested economic growth against the size of FD and against intermediation measured by credit to private sector enterprises. The authors conclude that the size of FD does not correlate with growth when intermediation in accounted for in the model. They further argue that it is only the part of financial development devoted to intermediation that promote economic growth, the other part of the FD that goes to providing public services

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such as the provision of access to basic payment and transaction services does not affect growth. These authors report that financial institutions, because they focus increasingly on proprietary trading, market making, and the 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 economic growth. In another argument, Beck (2015) show that credit to private sector used as proxy for FD has less impact on growth because part of these credit goes to finance consumption rather than investment. Private credit, according to the author, consist of mortgage finance, in some countries, and mortgage finance is principally consumer- finance and has very 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 that increase in physical capital that comes with new technology, is associated with positive externality in the form of new knowledge 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. The argument of positive externality of investment is supported by Jorgenson, Gollop, and Fraumeni (2016), and Greenwood, Hercowitz, and Krusell (1997). Jorgenson and Greenwood and their friends maintain that investment in physical capital has a larger influence on economic growth than is suggested by the

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factor share. The investment, according to the authors, does not only affect the stock of physical capital but raises 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 which is credited to Abramovitz (1994). Abramovitz summarized his argument under social capabilities and concludes that without it countries would be unable to experience economic growth even if there is 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. The social capabilities are accumulated through formal education and the evolution of technologies (Gong et al (2015).

In the same line of argument, Jorgenson, Gollop & Fraumeni (2016) demonstrate that countries with a low stock of physical capital but a relatively large stock of knowledge capital would experience a very large marginal product of physical capital and therefore economic growth. Japan and Germany were cited as an example of countries with such credentials. These countries lost 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 that increase in investment in physical capital that does not generate knowledge capital, and where this knowledge is generated and there are no

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social capabilities to adopt them, will result in diminishing returns to physical capital and therefore decrease or stagnation in economic growth.

2.3 Data and methodology

2.3.1 Data description

This study uses time-series data of Nigeria from 1970 to 2015. Nigeria is important here because it is a good example of resource-dependent and undiversified - developing economy. A resource-dependent economy without effective macroeconomic management policies is expected 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 take-over of government in 1975, political transition in 1979, military coup in 1983 and 1985, political disturbance in 1993 after election cancellation, and several turbulent democratic 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. Economic growth is measured by the growth rate of per capita GDP. Economic growth volatility is

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measured 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 that countries' economic output grows or declines exponentially over time (Pritchett, 2000). Our per capital growth rate of GDP figure comes from the World Development Index (WDI) and the GDP volatility is computed from that data.

For financial development, we use bank credit to private sector as a percentage of GDP and the data comes from WDI. Additionally, we use the newly compiled composite index of financial development (FD) from IMF databank for robust check. FD is made up of market index (MI) and bank index (BI). MI is further divided into the market depth index, market access index and market efficiency index. Similarly, BI is made up of bank and other financial institutions depth index, access index and efficiency index. Our control variables are the broad set of variables typically used in growth literature (Samargandi, Fidrmuc, & Ghosh, 2015). They comprise gross fixed capital formation (GFCF), which represents total investment in physical capital; population growth (POPG), which indicates growth in the labor force; trade to GDP (TGDP), which represents trade openness to international markets; government expenditure as 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). These annual data for control variables are sourced

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from WDI. Some of these variables were screened out because they added no effect on the parameters of the variables of interest in the process of regression.

2.3.2 Methodology and model specification

Our methodology 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 nonlinearity between the variables are confirmed, we take a further step to investigate if the nonlinearity is caused by FD or by the other determinants of growth such as the lag of GDP per capita and human capital. This further investigation is informed by the argument in the Ketteni et al (2007) to the effect that FD correlates linearly with economic growth when the nonlinear relationships between growth and the initial GDP per capita and human capital are accounted for.

To do the first step, we use quadratic polynomial of financial development in the model. This technique had been used by Yeh, Huang & Lin (2013) and Arcand et al (2015). Additionally, we use dynamic threshold estimator used in 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 highly persistent. This is followed by testing for U and inverted U-shaped functions technique by Lind and Mehlum (2010).

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To do the second step we use semi-parametric partially linear (PLR) model. This model is chosen because it allows for the additive semi-parametric components and the graphical representation of the nonparametric components could be obtained which is used to arrive at a more suitable model specification.

2.3.2.1 Quadratic polynomial of financial development

We specify the following model:

$$gdpg_t = aFD_t + bFD_t^2 + Z_t + \mu_t \text{ ---------- (1)}$$

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

Then we test the joint hypothesis:

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

Against the alternative hypothesis:

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

Where $FD_{min}\ and\ FD_{max}$ represent the minimum and maximum values of financial development, respectively. If the null hypothesis is rejected, it confirms the existence of an inverted U-shape and the opposite for U-shaped is also true.

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2.3.2.1The 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).

The structural equation with one potential threshold – γ is given by

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

Where t = 1---T represents period; μ_t stands for country specific effect; I (.) is an indication function and depending on the value of threshold variable compared to γ, which divides the observations into two regimes separated by differing regression slopes $\beta_1 \, and \, \beta_2$; δ_1 is the regime intercept which is the same for all individuals; and Z_t is an m-dimensional vector of explanatory variables, including lagged GDP. The control variables entered the equation simultaneously.

2.3.2.2 Semi-parametric partially linear model specification:

$$gdpg_t = x_t\beta + \theta(z_t) + \epsilon_t \text{ - - - - - - - - - - - - - - - - (5)}$$

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. $E(\epsilon_t/x, z) = 0$. 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 estimate of β ($\tilde{\beta}$).

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By obtaining $\tilde{\beta}$, the redefined variable $gdpg_t - x\tilde{\beta}$ 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 nonlinearly enter the model. This model is then specified thus:

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

The components of the model in (6) are estimated using marginal integration used in Linton and Nielsen (1995).

Models analyzed for non-linearity include:

$$gdppcg_t = c + \{popg_t + gindex_t\} + \{credp_t\} + \in_t \text{ ---------- (7)}$$

Equation 7 could be specified as follow for purpose of testing for the thresholds

$$\text{Growth} = \in_t + \beta_1 FD_t I(FDD_t \leq \gamma) + \partial_1 I(FD \leq \gamma) + \beta_2 FD_t I(FD > \gamma) + \emptyset Z_t + \mu_t \text{ -- (7a)}$$

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

$gdppcg_t$ = 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

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war, coup, national election, or political riots and 1 otherwise. $lifexp_t$ = life expectancy as a proxy for human capital development. Life expectancy is regularly used in growth literature as proxy for human capital development (Lucas, 1988). $Credp_t$ = credit by banks to private enterprises as a percentage of gdp; $lifexp_t$ and $Credp_t$ 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 have negative relation with growth and positive relation with volatility; e_t and u_t represent disturbance terms respectively in the equations. I(.) is an indicator function and depending on the whether the threshold is greater or smaller than Υ. Υ divides the observations into two regimes distinguished by the changing values of $\beta_1 and\ \beta_2$; $\delta_1\ is\ the\ regime\ intercept\ which\ is\ the\ same\ for\ all,\ and\ Z_t$ is an m-dimensional vector of explanatory variables.

2.4. Results of the empirical analysis

This section reports the descriptive statistics of the variables used in the analysis.

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

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Observations	46	45	46	46	46	46	46	46	46

Notes: 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.

Table 2 Cross correlation of variables

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

Notes: 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.

Our discussion here starts with the examination of descriptive statistics in Table 1 and cross correlation of variables in Table 2. Our descriptive statistics enable us to understand our data, choose method and techniques of analysis and choose methods and tools of diagnoses. From table 1, we observed that most of our series have low standard of deviation compared to their means except for gdppcg. It indicates that the variables have

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less than average volatility. It is also observed that most of our data are not normally distributed judging from the value of the 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 simultaneously, we employ instrumental variables.

2.4.1 Our regression results

Recall that equation 7 models the relationship between FD and economic growth. Here, the idea is to examine the nature of the relationship between the two variables. The results shown in Table 3 indicate that 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 become 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 highly significant at 1%. The changing signs of the coefficients from negative to positive at the point of inflexion give us the idea of a U-shaped relationship. Governance index also relates positively with economic growth with a coefficient of 5.1553*** and population growth correlates negatively with a coefficient of -12.1297*** with growth.

In equation 8, we modeled the relationship between economic growth volatility and FD. The results reported in table 4 indicate that the relationship is U-shaped. The interesting

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thing in the results is that the first attempt of the analysis produced 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. They were correlated and the model was unstable, as confirmed by CUSUM test. In the second regression, instrumental variable – lagged gdp volatility was introduced. CUSUM test was done and it indicated that the model has become stable. The result of our second attempt is recorded in table 4. According to the results, private credit correlates negatively with gdp volatility in regime 1 with a coefficient of -0.0045*** and with a positive coefficient of 0.000441 in regime 2. The changing signs of the coefficients from negative to positive at the point of inflexion indicate a U-shaped relationship.

In the same equation, log of life expectancy and the lag of gdp volatility correlate negatively with gdp volatility with coefficients of -2.6815 and -0.0958 in regime 1 respectively. In regime 2, the lagged gdp volatility correlates positively and logged life expectancy correlates negatively with coefficients of -0.0529 and 0.9296*** respectively indicating that life expectancy has a U-shaped relationship with growth volatility.

2.4.2 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 alternative hypothesis of serial correlation was

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rejected. Coefficient diagnostic was done using the dual tests of coefficient restriction Wald – test and Variance Inflation Factors. The H0 in the Wald test was rejected and the result of VIF test indicates that the coefficients were not abnormally loaded. 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: Υ	15.6199	Threshold Value: Υ	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: Υ	8.7099	Threshold Value: Υ	75.864 = $(8.7099)^2$
Impact of FD			
α_1	-0.0045***	α_1	-0.00037***
	(0.0008)		(0.00849)

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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***	Log life expectancy	-2.6352***
	(0.2431)		(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 Error! No text of specified style in document.-1: Result of stability diagnostic for equation 7 model 1

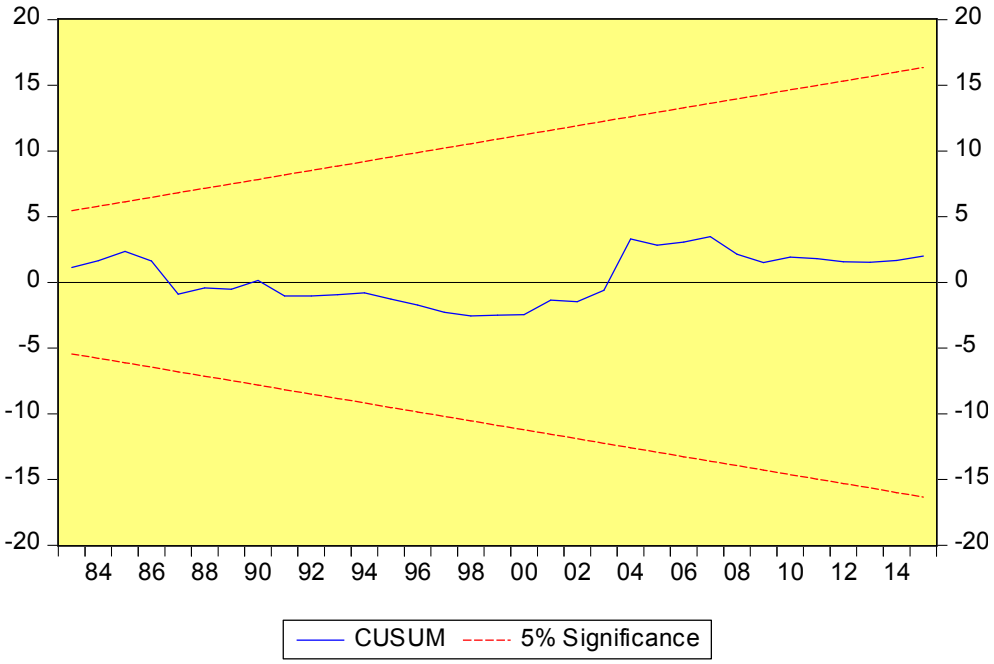

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Figure Error! No text of specified style in document.-2: Result of stability diagnostic for equation 7 model 2

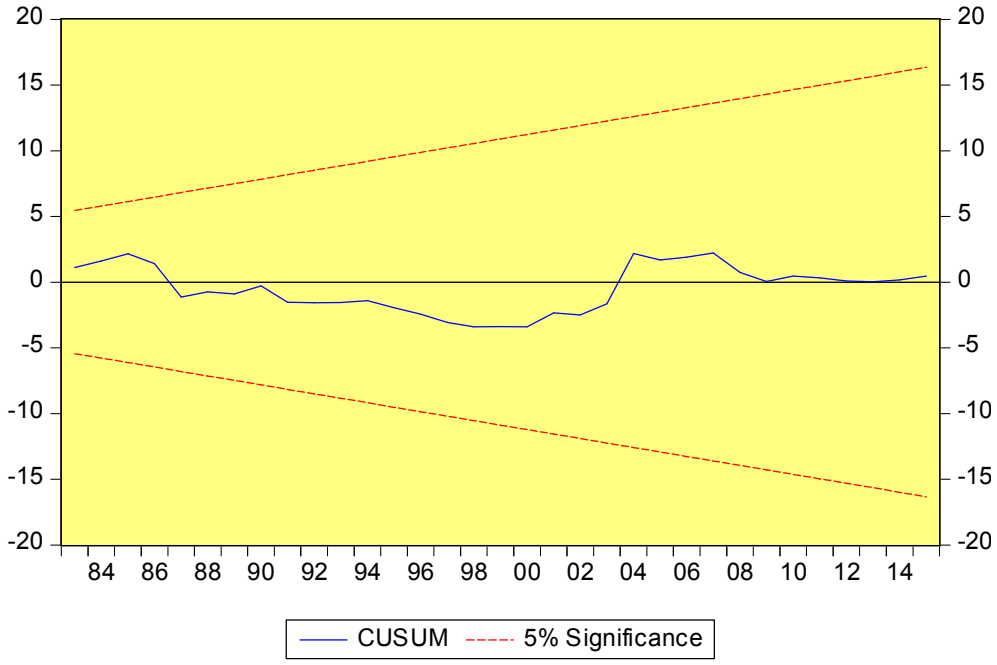

Figure Error! No text of specified style in document.-3: Result of CUSUM test of stability for equation 8 model 1

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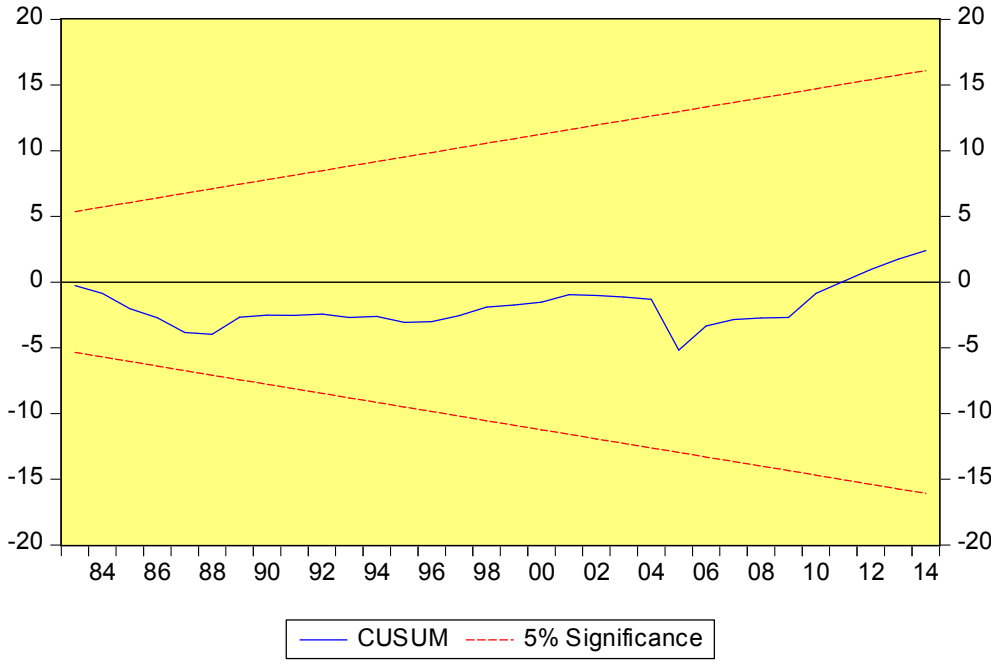
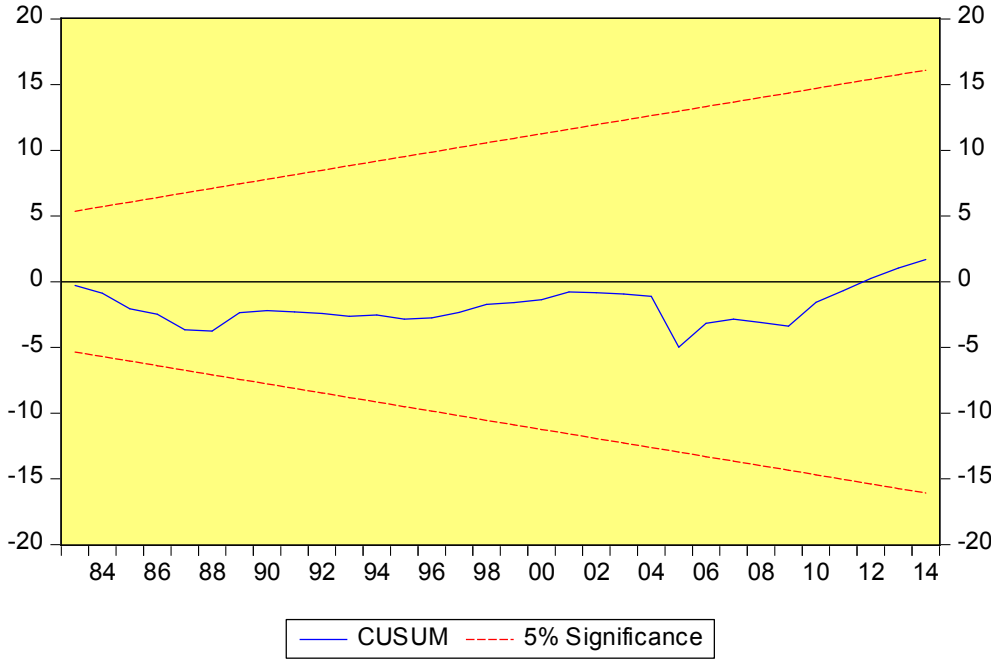


Figure Error! No text of specified style in document.-4: Result of CUSUM test of stability for equation 8 model 2



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2.5 Discussing the empirical results

In our analysis of the nature of the relationship between financial development (FD) and economic growth, we have seen evidence of a relationship between the two variables. 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 statistically significant. 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 indicates a U-shaped relationship and it is consistent with the result reported by Adeniyi et al (2015) on Nigeria. Our result is however different from those of Yeh and Shin (2013), Arcand et al (2015) and Cecchetti and Kharroubi (2015) in respect of the FD/EG relationship. 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) in 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 percentage of GDP.

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There appears to be a marked disparity between other countries' average data at inflection point (80% - 110%) and that of Nigeria (15.6199%). Consistent with the findings in Sahay et al (2015), such disparity could be explained by the differences in institutional and macroeconomic management qualities. 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. Additionally, Nigeria according to Karl (2004) is a rentier state. This is a state that lives on externally generated rents rather than from the surplus production (through taxation) of its populace. From the above description, a rentier state has no obligation or incentives to have in place credible institutions and the rule of law (because it has 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 unique in Nigeria is the low quality of institutions.

It was observed that our result did not change so much after the polynomial of private credit was used in the regression. The threshold value in the second regression was 243.984 which is approximately 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, interestingly, the use of the composite index of FD in the regression did not return any threshold effect in the relationship between the variables. The failure of the composite

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index of FD to indicate 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. Excess financial depth has severally been reported as the source of reversal in growth after a given threshold value in 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 at the same time banks fail to provide additional needed services to the firms resulting in 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 positively influences economic growth and not just the size of the financial sector.

The U-shaped relationship between FD and growth could be interpreted 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 quantitatively marginal, growth effect. This quickly flags the idea that the level of FD is

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important for growth. In the case of 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 the case of 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 benefit from FD. Suspected reasons 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 threshold value of 8.7099% of private credit to GDP. Possible explanation for this low point of equilibrium in the case of Nigeria as compared to other countries, and as explain elsewhere in this paper, is weak 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 critical value of 75.864 which is the square of 8.7099. Like the situation in equation 7, the introduction of the composite index of FD into equation 8 did not return any threshold effect. Incidentally, our results agree with those of Easterly,

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Islam, and Stiglitz (2001) and Sahay et al. (2015). According to Easterly et al (2001), expansion in finance is connected to tempering 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 is believed to determine the point of inflection 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. In other words, where macroeconomic policies are not effectively managed, FD may only do a little to temper growth volatility. The third explanation for the early peak phenomenon for threshold in the finance-growth volatility is the type of financial growth. Easterly et al (2001) report that financial sector itself could exacerbates period of economic downturns, particularly if debt increases relative to equity. The explanation of these authors is that equity markets provide better risk diversification than do debt markets, and thus make economy less vulnerable to economic downturns.

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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 opportunity for 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 (Malaysia was chosen arbitrarily; Nigerian data can be compared with any country). Similarly, 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.

2.6 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. Credit to private sector was selected to represent FD for two reasons: it is widely used in the finance-growth literature and our research was to confirm a few other researches on this subject using different parameters; secondly

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other proxies were inadequate in giving us data that were more than thirty years. We were interested in using a long data series. We estimated growth volatility using exponential weighted moving average because of our understanding that most macroeconomic variables fluctuate in exponential fashion. We used threshold model estimator for our analysis because literature reviewed had been persuasive that finance-growth relationship is non-monotonic. We used Nigerian data 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 case of finance – growth relationship is consistent with Adeniyi et al (2015), a prior research that used Nigerian data. In the case of 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 indicates that FD relates negatively with growth initially until FD reaches the threshold point, and non-linearly but positively thereafter. This signals a warning that policy-makers should not expect economic growth from FD shocks in the initial stage of FD. Additionally, policy makers should accelerate FD to catch up with the threshold value to experience economic growth. Next is the choice

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of reforms needed to attain the desired volume of FD: Our results indicate that the composite index of FD displays no threshold effect both with growth and growth volatility. This shows that certain elements of the FD such as access and efficiency can still be expanded to grow the financial sector and to reap economic growth even when financial deepening hits the threshold. Additionally, developing countries need heavy dosage of financial deepening in the initial stage of financial sector development to hit the threshold quicker and begin the period of growth. For purpose of financial reforms, effort should be made to balance financial deepening with policies to increase access to finance and to improve the efficiency of financial products and services.

Access to financial services could be increased by a couple of ways. We discuss two of those methods here. First is to make financial service available to small and medium businesses (SMEs). This could be done 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 to finance problem for SMEs. Several researchers have found that stock exchange services are sensitive to spatial proximity to the locations of the exchanges (Fafchamps and Schundeln, 2013). Independent and autonomous regional exchange is recommended here to solve the problem. Secondly, financial innovation has been reported as being correlated with improved access to financial services even in developing countries (Beck, Senbet and Simbanegavi, 2015). Financial innovation is defined here as an intentional restructuring of financial products, markets and the market

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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). The following facilities and innovations have been found to increase access to finance in various parts of Africa. They are ATM, M-pesa, Susu, internet banking, cell-phone banking, Islamic banking etc. In addition, Nigeria needs to improve financial market efficiency by improving 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.

Policy should be adopted 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 circuit breaker than the bank in times of financial crisis (Easterly et al, 2001). Furthermore, research should be extended to identifying country specific determinants of financial sector development, and the impact of institutions and regulations on the financial market development. Finally, this study should be taken as an agenda-setting on the issues discussed. A more informed and deeper analysis of issues using increased size of data, standard and emerging control variables to ensure better results should be pursued.

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