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Revisiting the finance-growth nexus in Nigeria using frequency domain approach

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Abstract. *In this paper, we reexamine the causal relationship between financial development and economic growth in Nigeria using annual data over the period 1960-2020. we employ the novel frequency domain causality test based on Granger and Toda-Yamamoto causality tests to identify the direction of the causality in the short (temporary), medium (intermediate) and long-run (permanent). To this end, first, the paper takes advantage of the principal component analysis (PCA) to construct a financial development index using three standard ratios introduced in the literature to measure financial development, namely the broad money stock, the domestic credit to private sector, and the domestic credit to private sector by banks, all expressed as a percentage of GDP. Then economic growth is captured by real GDP per capita. The empirical results suggest a unidirectional permanent causal relationship running from economic growth to financial development.*

Keywords: Financial development, Economic growth, Frequency domain causality test, Nigeria.

JEL Classification: O1, O4, C22, O55, G21.

1. Introduction

The debate on the finance-growth nexus is far from settled. The controversy concerning the direction of causality suggests four possible hypothesises to explain the relationship between financial development and economic growth.

The first is the supply-leading hypothesis or finance-led growth hypothesis. The origin of this view can be traced back to the seminal work by Schumpeter (1911), who argues that a well-functioning financial system encourages technical innovation and spurs economic growth. This view was also endorsed by Gurley and Shaw (1955), Goldsmith (1969), McKinnon (1973), Shaw (1973), Greenwood and Jovanovic (1990), Bencivenga and Smith (1991), Spears (1992), King and Levine (1993), Pagano (1993), Levine (1997), Darrat (1999), Luintel and Khan (1999), Rajan and Zingales (1998), and Xu (2000), among others.

The second is the demand-following hypothesis or growth-led finance maintaining that productive economic growth stimulate the demand for finance by entrepreneurs. This hypothesis suggests that financial development follows economic growth, and not the reverse causality. This view was initially defended by Robinson (1952) and endorsed by Kuznets (1955), Lucas (1988), Stern (1989), Gupta (1984), Chandavarkar (1992), Stiglitz (1994), Demetriades and Hussein (1996), Sing and Weisse (1998), Al-Yousif (2002), and Roseline (2012), among others.

The third is the feedback hypothesis which suggests that financial development and economic growth are mutually related. According to Patrick (1966), at the early stage of economic development, the supply-leading hypothesis prevails but metamorphose into the demand-following hypothesis at a later stage of economic development. This view was initially put forward by Lewis (1955), one of the “pioneers” of development economics, and furthermore supported by a number of studies such as Greenwood and Jovanovic (1990), Greenwood and Bruce (1997), and Berthelemy and Varoudakis (1996), Wood (1993), Demetriades and Hussein (1996), Luintel and Khan (1999), Al-Yousif (2002), and Hondroyiannis et al. (2005), among others.

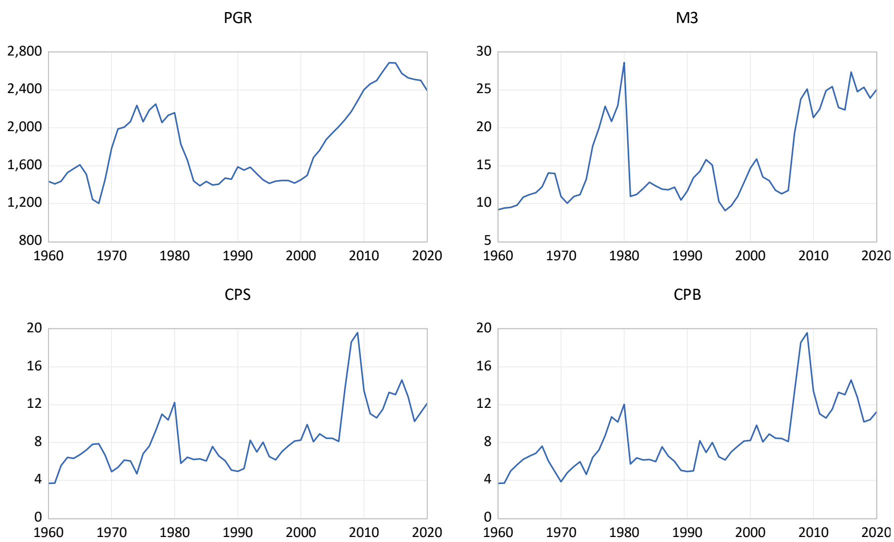
The fourth is the neutrality hypothesis which states that financial development and economic growth are not causally related. This implies that financial development and economic growth neither lead nor follow each other (see Lucas, 1988; Stern, 1989; Demetriades and James, 2011; Misati and Nyamongo, 2012; Menyah et al., 2014; Santos, 2015, among others).

In the sub-Saharan African (SSA) context as well, although there is not a plethora of empirical studies, the findings of existing studies do not establish a consensus about the direction of causality between financial development and economic growth. The results of selected recent studies in SSA are summarized in Table A1 in Appendix.

The conflicting results mentioned above could be explained by the fact that previous empirical studies used different measures for financial development across different sample periods, and empoyed different techniques such as cross-sectional, time-series or panel data models (see, for example, Khan and Senhadji, 2003). To the present of author's knowledge, in the sub-saharan African context as a whole, and in the Nigerian context in particular, empirical studies on the finance-growth nexus using the frequency domain approach are scarce (see, Aka and Konan, 2023). This study seeks to contribute to that empirical literature by filling this gap.

The goal of this paper is to reexamine whether financial development leads to economic growth or vice versa in Nigeria, using the Granger causality in the frequency domain, over the period 1960-2020. Nigeria is an interesting case study for several reasons. First, it is Africa's biggest economy, and has made remarkable economic progress over about two decades, as shown in Figure 1 below. In 1999, Nigeria's real GDP per capita which stood to USD 1416.52 increased sharply to USD 2688.27 in 2014, before decreasing slightly to 2396.04 in 2020, due to unsound macroeconomic policies. Figure 1 shows that all the standard financial development indicators exhibit an upward trend in line with the increase in real GDP per capita. For example, the domestic credit to private sector ratio stood to 8.16% in 1999; it increased to 13.30% in 2014, before decreasing slightly to 12.13 in 2020. Second, since 1987, Nigeria had embarked on liberalized economic institutions in order to grasp the beneficial effects of these policies.

Figure 1. *Overview of sampled data series*



Notes: PGR is the real GDP per capita; M3 is the broad money stock as a share of GDP; CPS is the domestic credit to private sector as a share of GDP; CPB is the domestic credit to private sector by banks as a share of GDP.

To archieve our goal, first, the paper exploits the principal component analysis (PCA) to construct a financial development index. The PCA uses three standard ratios introduced in the literature to measure financial development, namely the broad money stock (M3), the domestic credit to private sector (CPS) and the domestic credit to private sector by banks (CPB), all expressed as a percentage of GDP. Second the paper investigates the causal relationship between finance and economic growth by taking advantage of the novel frequency domain approach developed by Breitung and Candelon (2006). Hence, we perform the frequency domain causality test based on Granger (1969) and Toda-Yamamoto (1995) causality tests. The frequency domain causality test allows to determine the causality relationship for different frequencies corresponding to different time periods (long, medium and short-run).

The remainder of the study is structured as follows. Section 2 describes the data and econometric methodology. Section 3 reports the empirical results. Finally, Section 4 contains some conclusing remarks.

2. Data and Methodology

2.1. Data source

Annual data series covering the period 1960-2020 are used in this study. Economic growth is captured by real GDP per capita (constant 2010 US dollar). We use three standard ratios introduced in the literature to measure financial development: the broad money stock (M3), the domestic credit to private sector (CPS) and the domestic credit to private sector by banks (CPB), all expressed as a percentage of GDP (see McKinnon, 1973; Shaw, 1973; Jung, 1986; King and Levine, 1993; Levine, 1997; Levine and Zervos, 1998; Beck et al., 2000; Hassan et al., 2011, among others). We convert all series into natural logarithms for statistical purposes. All the data are sourced from the World Bank's World Development Indicators online database.

2.2. Construction of financial development index

In measuring financial development, although there is no consensus on a single measure, the three standard ratios mentioned above are often used. The first indicator, that is broad money stock as a share of GDP (M3), reflects the extent of transaction services. And, the second ones, namely both domestic private credit ratios, reflect the extent of efficient resource allocation. That is the ability of the financial system to channel funds from depositors to investment opportunities. The matter for these standard measures is that they are highly correlated (see Table 1-Panel A). In order to construct a single index encompassing these three standard measures, we take advantage of the principal component analysis.

Table 1-Panel B displays the results of the principal component analysis. The eigenvalues indicate that the first principal component (PCA1) explains 92.3% of the standardized variance; and the second (PCA2) and third (PCA3) principal components totalize only 7.7% of the variance. In other words, the first principal component captures 92.3% of the information from the standard measures. This suggests that the first principal component is the best financial development index, denoted by LFDX, in the current study. The first principal component is computed as a linear combination of the three standard measures of financial development (LM3, LCPB and LCPS) with weights given by the first eigenvector. In the following sections, we consider the financial development index.

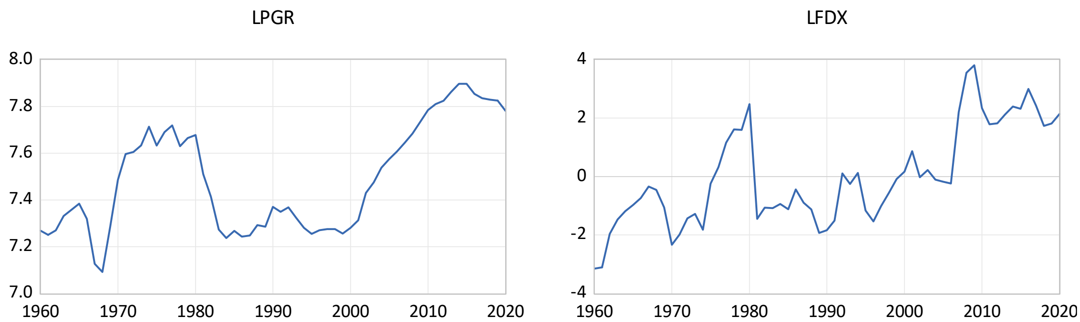
Table 1. *Principal component analysis for financial development index and descriptive statistics*

Panel A. *Correlation matrix*			
Variables	LM3	LCPB	LCPS
LM3	1.000		
LCPB	0.823	1.000	
LCPS	0.842	0.967	1.000
Panel B. Principal component analysis for financial development index (LFDX)			
	PCA1	PCA2	PCA3
Eigenvalues	2.767	0.217	0.013
% of variance	0.923	0.073	0.004
Cumulative %	0.923	0.996	1.000
Variable	Vector 1	Vector 2	Vector 3
LM3	0.554	0.831	0.046
LCPB	0.587	-0.429	0.687
LCPS	0.591	-0.354	-0.725
Panel C. *Descriptive statistics*			
Statistics	LPGR		LFDX
Mean	7.492		-1.32E-15
Median	7.430		-0.250
Max.	7.897		3.810
Min.	7.091		-3.150
Std. Dev.	0.230		1.678
Skew.	0.269		0.420
Kurt.	1.689		2.282
JB	5.106		3.102
(P-Value)	0.078		0.212
Obs.	61		61

Notes: LM3 is the logarithm of broad money stock as a share of GDP; LCPB is the logarithm of domestic credit to private sector by banks as a share of GDP; LCPS is the logarithm of domestic credit to private sector as a share of GDP; LFDX is the financial development derived from the principal component analysis.

Figure 2 plots real the GDP per capita (LPGR) and the financial development index (LFDX). Theoretically, the financial development index (LFDX) is able to capture more information than standard measures taken separately. The index appears erratic, revealing a less developed financial sector in Nigeria. However, the financial development index exhibits an upward trend in line with the increase in real GDP per capita.

Figure 2. *Overview of the real GDP per capita and the financial development index*



Notes: LPGR is the natural logarithms of real GDP per capita; LFDX is the financial development index derived from the principal component analysis.

2.3. Econometric methodology

The empirical methodology consists of a three-stage process. In the first stage, we investigate the stationary proprieties of the variables using the tests suggested by Dickey and Fuller (1979, 1981)-ADF test, and Phillips and Perron (1988)-PP test. In the second stage, we select the optimal lag using Akaike Information Criterion (AIC). In the third stage, we investigate the causal relationship using the frequency domain causality test developed by Breitung and Candelon (2006). This test is based on the fact that causality between two stationary time-series can vary along the time-scale as well as over different frequencies.

The Breitung-Candelon approach, based on earlier works by Geweke (1982) and Hosoya (1991), can be explained as follows and we refer the reader to the original paper for further details.

First, let $z_t = [x_t, y_t]'$ be a two-dimensional vector of time series length $t = 1, \dots, T$. It is assumed that z_t has a finite order vector auto-regression (VAR) process of the form:

$$\Theta(L) z_t = \varepsilon_t \tag{1}$$

$$\Theta(L)\begin{pmatrix} x_t \\ y_t \end{pmatrix} = \begin{pmatrix} \Theta_{11}(L) & \Theta_{12}(L) \\ \Theta_{21}(L) & \Theta_{22}(L) \end{pmatrix}\begin{pmatrix} x_t \\ y_t \end{pmatrix} = \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \tag{2}$$

where:

$\Theta(L) = I - \Theta_1 L - \dots - \Theta_p L^p$ is a 2×2 lag polynomial and $\Theta_1, \dots, \Theta_p$ are 2×2 autoregressive parameter matrices, with $L^k x_t = x_{t-k}$ and $L^k y_t = y_{t-k}$. The error vector ε_t is assumed to be white noise with $E(\varepsilon_t) = 0$ and $E(\varepsilon_t \varepsilon_t') = \Sigma$, where Σ is a positive definite covariance matix.

We let G be the lower triangular matrix of the Cholesky decomposition $G'G = \Sigma^{-1}$ such that $E(\eta_t \eta_t') = I$ and $\eta_t = G\varepsilon_t$. Assuming that the variables are stationary, the moving-average (MA) representation of vector z_t can be expressed as follows:

$$\begin{pmatrix} x_t \\ y_t \end{pmatrix} = \Phi(L)\varepsilon_t = \begin{pmatrix} \Phi_{11}(L) & \Phi_{12}(L) \\ \Phi_{21}(L) & \Phi_{22}(L) \end{pmatrix}\begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \tag{3}$$

$$\begin{pmatrix} x_t \\ y_t \end{pmatrix} = \Psi(L)\eta_t = \begin{pmatrix} \Psi_{11}(L) & \Psi_{12}(L) \\ \Psi_{21}(L) & \Psi_{22}(L) \end{pmatrix}\begin{pmatrix} \eta_{1t} \\ \eta_{2t} \end{pmatrix} \tag{4}$$

Where:

$\Phi(L) = \Theta(L)^{-1}$ and $\Psi(L) = \Phi(L)G^{-1}$. Applying this representation, the spectral density of x_t can be expressed as:

$$f_x(\omega) = \frac{1}{2\pi}\left\{\left|\Psi_{11}(e^{-i\omega})\right|^2 + \left|\Psi_{12}(e^{-i\omega})\right|^2\right\}. \tag{5}$$

The causality test suggested by Geweke (1982) and Hosoya (1991) can be written as

$$M_{y\to x}(\omega) = \log\left(\frac{2\pi f_x(\omega)}{\left|\Psi_{11}(e^{-i\omega})\right|^2}\right) = \log\left(1 + \frac{\left|\Psi_{12}(e^{-i\omega})\right|^2}{\left|\Psi_{11}(e^{-i\omega})\right|^2}\right). \tag{6}$$

Within this framework, if $\left|\Psi_{12}(e^{-i\omega})\right|^2 = 0$, then the measure $M_{y\to x}(\omega)$ is zero. This means that y_t does not Granger cause x_t at frequency ω. Breitung and Candelon (2006) show that y does not cause x at frequency ω if the following holds:

$$\left|\Theta_{12}(e^{-i\omega})\right| = \left|\sum_{k=1}^{p}\theta_{12,k}\cos(k\omega) - i\sum_{k=1}^{p}\theta_{12,k}\sin(k\omega)\right| = 0 \tag{7}$$

where:

$\theta_{12,k}$ is the (1, 2)th element of Θ_k, such that a necessary and sufficient set of conditions is given by:

$$\sum_{k=1}^{p}\theta_{12,k}\cos(k\omega) = 0 \text{ and } \sum_{k=1}^{p}\theta_{12,k}\sin(k\omega) = 0, \tag{8}$$

Breitung and Candelon (2006) reformulated these restrictions by rewriting the equation for x_t in the bivariate vector autoregressive (VAR) model:

$$x_t = \alpha_1 x_{t-1} + 6 + \alpha_p x_{t-p} + \beta_1 y_{t-1} + 6 + \beta_p y_{t-p} + \varepsilon_{1t} \tag{9}$$

where:

$\alpha_j = \theta_{11,j}$ and $\beta_j = \theta_{12,j}$.

The null hypothesis of Granger causality from y_t to x_t at frequency ω is tested by $M_{y\to x}(\omega) = 0$, which is equivalent to the null linear restriction:

$$H_0 : R(\omega)\beta = 0 \tag{10}$$

where:

$\beta = [\beta_1, \cdots, \beta_p]'$ and $R(\omega)$ is a $2 \times p$ restriction matrix.

$$R(\omega) = \begin{bmatrix} \cos(\omega) & \cos(2\omega) & \cdots & \cos(p\omega) \\ \sin(\omega) & \sin(2\omega) & \cdots & \sin(p\omega) \end{bmatrix}$$

Standard F-statistics are used to test the null hypothesis in the frequency interval, $\omega \in [0, \pi]$. The test procedure follows a $F(2, T-p)$ distribution for every $\omega \in [0, \pi]$, with 2 being the number of restrictions, and T and p indicating the number of observations of a series and optimal lag order of the VAR model, respectively.

Finally, in this study, for comparaison purposes, the Breitung and Candelon (2006) frequency domain causality test is performed using the VAR(p) model used in the Granger (1969) causality test and the VAR (p + d_{max}) model used in Toda-Yamamoto (1995) causality test, with p the optimal lag value and d_{max} the order of integration of the series under consideration. While the frequency domain causality test based on the Granger causality test is performed after differencing the variables, variable differencing is not required for the frequency domain causality test based on the VAR (p + d_{max}) model. In the later model original value of variables are used, so there is no information loss. It is worth mentioning that, in the Toda-Yamamoto (1995) approach, variables can be stationary at different levels, and it is not necessary to perform cointegration testing before proceeding to causality test. We refer the reader to Toda-Yamamoto (1995) for more details.

3. Empirical results

3.1. Unit root test and frequency domain analysis

In this study, unit root tests are performed to determine the stationary levels of the variables. The empirical results from the ADF and PP tests are shown in Table 2-Panel A. They reveal that all series have a unit root at the level, but they are all stationary at first difference. This implies that all the series are integrated of first order, I(1).

In the next stage of the empirical analysis, we investigate the frequency domain causality between financial development and economic growth at frequencies $\omega = 0.5$, $\omega = 1.5$ and $\omega = 2.5$ corresponding to the long-run, medium-run, and short-run relationships, respectively. A long, medium or short-run causality relationship means that the resulting causality is permanent, intermediate, or temporary, respectively. In addition, Tastan (2015) suggests using the formula $2\pi / \omega$ to calculate the duration of the causality relationship. The formula indicates that the wavelength is calculated by determining where ω is significant. Next, it is calculated how many periods the related causality relationship lasts.

Table 2-Panel B exhibits the results of frequency domain causality tests based on the Granger causality test (i) and the Toda-Yamamoto causality test (ii). According to the results, on the one hand, there is no causality between ΔLFDX and ΔLPGR, across the

horizon ranging from $\omega \in [0, \pi]$ (see Panel B-(i)). On the other hand, there is a unidirectional permanent causal relationship from LPGR to LFDX (see Panel B-(ii)).

Table 2. *ADF and PP unit root test and Frequency domain Granger causality results*

Panel A. *Results of ADF and PP unit root test*							
	Levels				First differences		Outcome
	ADF	PP			ADF	PP	
LPGR	$-1.887^{b}(1)$	$0.725^{c}(2)$			$-4.778^{c}(0)^{***}$	$-4.790^{c}(2)^{***}$	I(1)
LFDX	$-3.074^{a}(0)$	$-3.222^{a}(3)^{*}$			$-5.630^{c}(2)^{***}$	$-7.523^{c}(3)^{***}$	I(1)
Panel B. *Frequency domain Granger causality results*							
	H_0 : LFXD does not Granger cause LPGR				H_0 : LPGR does not Granger cause FDX		
	Permanent	Intermediate	Temporary		Permanent	Intermediate	Temporary
	ω = 0.5	ω = 1.5	ω = 2.5		ω = 0.5	ω = 1.5	ω = 2.5
(i) Frequency domain causality test results based on the Granger causality test							
ΔLFDX	0.337 (0.845)	1.7535 (0.416)	2.333 (0.311)		3.372 (0.185)	1.076 (0.584)	1.522 (0.467)
(ii) Frequency domain causality test results based on the Toda-Yamamoto causality test							
LFDX	3.162 (0.206)	3.853 (0.146)	3.216 (0.200)		6.393^{**} (0.041)	0.185 (0.912)	0.322 (0.851)

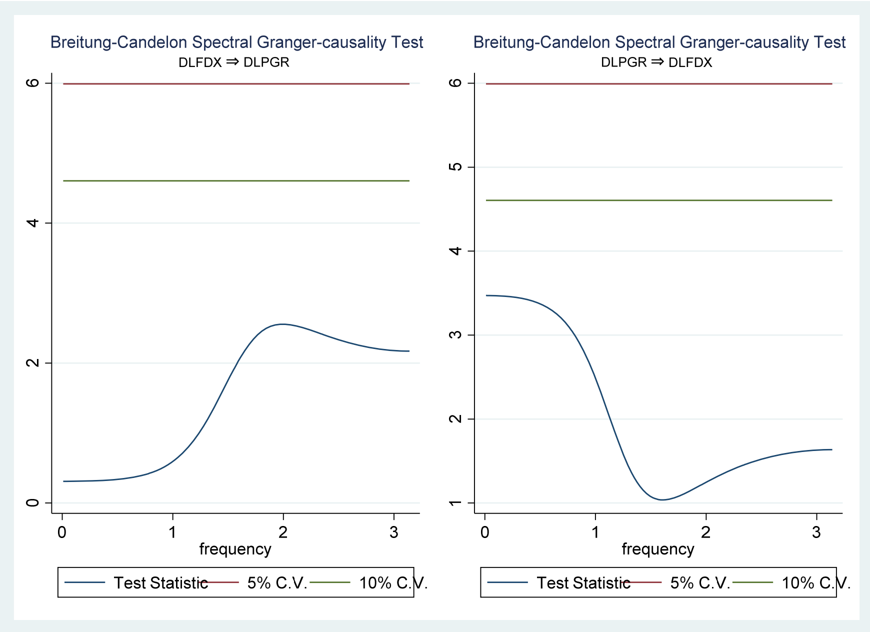
Notes: LPGR is the logarithm of real GDP per capita; LFDX is the financial development index (FDX) derived from the principal component analysis. Panel A: H_0 = the series has a unit root; (a) denotes a model with trend and intercept; (b) denotes a model with intercept; (c) denotes a model with no trend and no intercept; *** (**) indicate the rejection of the null hypothesis at 1% (5%) level of significance. For ADF, Akaike Information Criterion (AIC) is used to select the lag length in parenthesis; the maximum number of lags is set at four.

All the results are presented as figures (see Figures 3 and 4) for better understanding. Figure 3 shows the Wald statistics for $\omega \in [0, \pi]$ frequencies calculated using the frequency domain causality test based on the Granger causality test. Whilst Figure 4 presents the Wald statistics for $\omega \in [0, \pi]$ frequencies calculated using the frequency domain causality test based on the Toda and Yamamoto causality test.

The main results are two-fold. First, Figure 3 shows that the test statistics obtained to calculate the causality both from ΔLFDX to ΔLPGR, and from ΔLPGR to ΔLFDX are not above the line representing 10% critical value for any ω value. These results suggest that there is no causal relationship between variables for the long, medium, and short run. Second, Figure 4 shows a significant unidirectional permanent causality running from LPGR to LFDX with frequency range $\omega \in [0, 0.5]$.

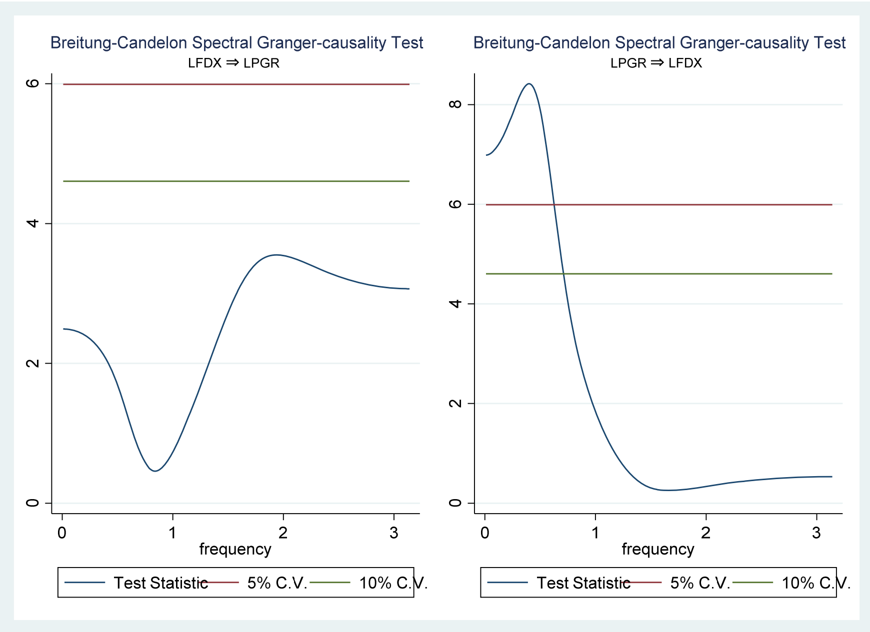
To sum up, the results show that economic growth is a good predictor for financial development in Nigeria, but only for low frequencies. These results mean that the effect of economic growth on financial development is permanent. Using the formula $2\pi / \omega$, we calculate that a shock occurring in LPGR affects LFDX for approximately ($2\pi / 0.5$) 12.57 years.

Figure 3. *Frequency domain causality test results based on the Granger causality test between ΔLFDX and ΔLPGR*



Notes: (a) No causality from ΔLFDX to ΔLPGR ; (b) No causality from ΔLPGR to ΔLFDX.

Figure 4. *Frequency domain causality test results based on the Toda-Yamamoto causality test between LFDX and LPGR*



Notes: (a) No causality from LFDX to LPGR; (b) Permanent unidirectional causality from LPGR to LFDX.

3.2. Discussion

In this study, we find that the causality relationship between financial development and economic growth varies depending on the time horizon. It appears that, only in the long run, the results are in line with the "*demand-following hypothesis*" supported by Robinson (1952), Kuznets (1955), Gupta (1984), Stiglitz (1994), Demetriades and Hussein (1996), Sing and Weisse (1998), Al-Yousif (2002), Ang and McKibbin (2007) and Aka and Konan (2023), among others. They proposed that economic development leads finance because of the increasing demand for financial services that, in turn, accelerate the development of the financial sector. In the Nigerian context, evidence of the "*demand-following hypothesis*" is scarce and is shown, for example, by Adeyeye et al. (2015). Furthermore, in the sub-Sahara African context as a whole, the "*demand-following hypothesis*" is supported by Demetriades and James (2011) for 18 SSA countries, Odhiambo (2009, 2010) for South Africa, Odhiambo (2008) for Kenya.

On the other hand, the results are in contrast to the "*supply-leading hypothesis*" widely supported by Schumpeter (1911), Gurley and Shaw (1955), Patrick (1966), Goldsmith (1969), McKinnon (1973), Shaw (1973), Greenwood and Jovanovic (1990), Bencivenga and Smith (1991), Spears (1992), King and Levine (1993), Levine (1997), Darrat (1999), Luintel and Khan (1999), Rajan and Zingales (1998), and Xu (2000), among others. In the SSA context, the results are not supportive to the "supply-leading hypothesis" evidenced, for example, by Ehigiamusoe et al. (2017) for Côte d'Ivoire, Taiwo (2021) for 38 SSA countries, Aluko et al. (2020) for 33 SSA countries, Elijah and Hamza (2019) and Asaleye et al. (2018) for Nigeria, Walle (2014) for 17 SSA countries, Ahmed and Wahid (2011) for 7 SSA countries.

Lastly, our findings are not consistent with the "*feedback hypothesis*" suggesting a two causal relationship between financial development and economic growth. This view was initially postulated by Lewis (1955) followed by Greenwood and Jovanovic (1990), Greenwood and Smith (1997), and Berthelemy and Varoudakis (1996). On the empirical ground, the feedback hypothesis is supported by Wood (1993), Demetriades and Hussein (1996), Berthelemy and Varoudakis (1996), Luintel and Khan (1999), Al-Yousif (2002), and Hondroyiannis et al. (2005), among others. In the SSA context, recent studies in support of the feedback hypothesis include Okunlola et al. (2020) for Nigeria, Fowowe (2011) for 17 SSA countries, Akinlo and Egbetunde (2010) for 10 SSA countries. Futhermore, the results do not confirm the « *neutrality hypothesis* » which states that financial development and economic growth are not causally related (see Lucas, 1988; Stern, 1989; Demetriades and James, 2011; Misati and Nyamongo, 2012; Menyah et al., 2014; Santos, 2015; and Aka and Konan, 2023, among others).

4. Conclusion

In the present study, we re-explore the Granger causality between financial development and economic growth in the Nigerian context, using annual data covering the period 1960-2020. To this end, first, the paper exploits the principal component analysis (PCA) to construct a financial development index. The PCA uses three standard ratios introduced in the literature to measure financial development, namely the broad money stock (M3), the domestic credit to private sector (CPS) and the domestic credit to private sector by banks (CPB), all expressed as a percentage of GDP. Second, our investigation of the causality takes advantage of the novel frequency domain causality test based on the Granger (1969) and Toda and Yamamoto (1995) causality tests. The results are two-fold. First, there is no causal relationship between financial development and economic growth across the horizon ranging from $\omega \in [0, \pi]$ (i.e. in the long, medium, and short run). Second, there is a unidirectional permanent causal relationship running from economic growth to financial development.

In the view of these findings it is recommended that policymakers in Nigeria put in place policies to maintain high economic growth and thereby promote financial development.

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Appendix

Table A1. *Summary on selected recent empirical studies on the finance-growth nexus in sub-Saharan Africa*

Studies	Time period	Countries	Methodology	Evidence
Aka & Konan (2023)	1962-2020	Cote d'Ivoire	Frequency domain approach	Neutrality/Demand-following
Okunlola et al. (2020)	1985-2015	Nigeria	Toda-Yamamoto causality test	Supply-leading and Feedback
Taiwo (2021)	1986-2015	38 SSA countries	Hansen threshold model	Supply-leading
Aluko et al. (2020)	1990-2015	33 SSA countries	Dumitrescu and Hurlin (2012) panel causality test	Feedback
An et al. (2020)	1985-2015	30 SSA countries	Granger causality test	Supply-leading
Elijah & Hamza (2019)	1981-2015	Nigeria	VECM causality test	Supply-leading
Asaleye et al. (2018)	1981-2016	Nigeria	VECM causality test	Supply-leading
Ehigiamusoe et al. (2017)	1980-2014	Côte d'Ivoire and Nigeria	ARDL Bound test	Supply-leading in Côte d'Ivoire, and Feedback effect in Nigeria
Adeyeye at al.(2015)	1981-2013	Nigeria	Pairwise causality test	Demand-following
Menyah et al. (2014)	1965-2008	21 SSA countries	Bootstrap panel causality test	Neutrality
Walle (2014)	1975-2005	17 SSA countries	DOLS	Supply-leading
Fowowe (2011)	1975-2006	17 SSA countries	Hurlin and Venet panel causality test	Feedback
Demetriades & James (2011)	1975-2006	18 SSA countries	Continuously-updated and bias-corrected and Continuously-updated and fully-modified estimators	Demand-following
Ahmed & Wahid (2011)	1986-2007	7 SSA countries	FMOLS	Supply-leading
Akilo & Egbetunde (2010)	1980-2005	10 SSA countries	VECM causality test	Feedback
Odhiambo (2010)	1969-2006	South Africa	VECM causality test	Demand-following
Wolde-Rufael (2009)	1966-2005	Kenya	Toda-Yamamoto causality test	Feedback
Odhiambo (2009)	1960-2006	South Africa	VECM causality test	Demand-following
Acaravci et al. (2009)	1975-2005	24 SSA countries	GMM	Supply-leading/ Demand-following/ Feedback
Odhiambo (2008)	1968-2002	Kenya	VECM causality test	Demand-following

Source: Author's compilation based on Aluko et al. (2020), Ustarz and Fanta (2021) and Aka and Konan (2023).