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Modeling Causality between Gross Fixed Capital Formation and Credit to the Private Sector

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Abstract:
The current paper examines the causality nexus between finance and investment flow in Ghana during the period 1970-2011. Using the Granger causality test model on a single time series variables, it is found that finance (proxied by credit to the private sector) Granger causes investment flow (proxied by gross fixed capital formation) without feedback effect. The financial sector should be developed to generate investment and not the vice versa. Future study should consider other financial and investment variables as well as panel analysis and structural breaks.

Key words: *Gross fixed capital formation; credit to the private sector; unidirectional causality*
Jel Classification: C40; C50: O10; O55

1. Introduction

Investment is considered by researchers (Ogbuagu et al., 2014; Asongu, 2012; Afangideh, 2010; Misati & Nyamongo, 2010) in finance, economic and development as one of the factors that is relevant in growth models of any economy, whether developed or developing. Investment plays significant role in entrepreneurship development, reduction of poverty, diffusing of new technologies, and improvement in productivity of labour and economic growth (Asongu, 2012; Misati & Nyamongo, 2010). According to researchers (Frimpong & Adam, 2010; Misati & Nyamongo, 2010; Odhiambo, 2005; Hibibullah & End, 2006; Calderon & Lin, 2003; Al-youssif, 2002) the financial sector provides the needed platform for investment to perform its role in ensuring economic growth. The notion is that without a well developed financial sector, investment cannot play its role to influence growth of an economy (Asongu, 2012).

This has resulted in the restructuring of the financial sector of various economies to ensure financial sector development. Policies such as Financial Sector Liberalisation, introduction of Universal Banking and financial sector Adjustment programmes have been implemented in the economies (example, Ghana) to ensure economic growth as a result of investment (Frimpong & Adam, 2010; Quartey, 1997). The role of investment in economic growth through the financial sector has attracted the attention of researchers in finance, economics and development to empirically examine the link and causality between investment and financial development. The findings are found in the works of various researchers (Asongu, 2012; Afangideh, 2010; Forbes, 2010; Misati & Nyamongo, 2010Landon & Smith, 2009; Forssbaeck & Oxelheim, 2008; Desai, 2006; Huang, 2006; Love & Zichinno, 2006; Ndikumana, 2005; Rousseau & Vuthipadadorn, 2005; Henry, 2000; Xu, 2000; Ndikumana, 2000; Rousseau, 1999) in the literature.

Asongu (2012) used vector error correction model and Granger causality test to examine the link and causality between investment (proxied by domestic investment; foreign investment; portfolio investment and total investment) and financial development (financial depth; financial efficiency; financial size and financial activity) for some selected African countries. Asongu (2012) reported that: (a) Granger causality within the simple VAR and VECM frameworks are bidirectional for most of the countries in the study. (b) In the short-run, while finance led investment elasticities are positive; investment elasticities of finance are negative for most of the countries. This findings support the traditional notion that financial development improves investment allocation in an economy. (c) Finance does not seem to engender portfolio investment in countries such as Togo; Mozambique and Guinea Bissau. (d) Financial efficiency matters for investment flows as compared to financial depth. (e) There is bidirectional short-run causality between investment flows and financial development.

Tchana (2011) examined the causality between investment (proxied by foreign direct investment) and financial market development for 29 emerging market economies over the period 1994-2006. The results suggest that FDI and stock market development indicators positively impact each other at the same time. In the use of banking sector development indicators to measure financial market development, the results are inconclusive and ambiguous.

In addition to the findings of Asongu (2012) researchers such as Ang (2009) and Huang (2006) also reported of bidirectional investment-finance nexus. Huang (2006) study included 43 developing countries for the period 1970 to 1998. Studies with bidirectional causality indicate that finance cause investment inflows with feedback effect. According to Asongu (2012) there is no known empirical result on investment led finance hypothesis

The studies that established finance led investment link are Afangideh (2010) for Nigeria; Forbes (2010) for U.S.A.; Misati and Nyamongo (2010) for 18 sub-Sahara African countries; Landon and Smith (2009) for 17 OCED countries; Forssbaeck and Oxelheim (2008) for 1379 European non-financial firms; Love and Zichinno (2006) for 800 firms of 36 developed countries; Rousseau and Vuthipadadorn (2005) for 10 Asian economies; Ndikumana (2005) for 99 developing countries and developed countries; Xu (2000) for 41 developing countries; Ndikumana (2000) for 30 sub-Saharan African countries and Rousseau (1999) for Japan. According to these researchers, financial sector development causes investment inflows in an economy. To ensure investment inflows for economic development, the financial sector should be developed in these countries.

In summary, the review indicates few works on the finance-investment nexus especially on developing economies with recent developments in the financial sector. The results have not been consistent. These might result from issues such as data type used (single or panel), stages of development of the economy, models used in the analysis among other things.

1.1. Problem Statement/Motivation/Significance

Investment is theoretically and empirically understood to impact economic growth through the channeled of financial sector development. There has been much recent development in the financial sector of Ghana with the expectation that it will aid investment to cause economic growth and reduce poverty (Frimpong & Adam, 2010; Quartey, 2005; Quartey, 1997). The focus of the current paper is to empirically investigate the nature of causality between investment (proxied by gross fixed capital formation) and financial sector development (proxied by credit to the private sector). According to Asongu (2012), to establish whether financial sector influence investment flow into an economy or not is a matter of empirical verification.

In the knowledge of the researchers very few empirical works exist in the literature on small but open developing economies such as Ghana in a detail study. The empirical investigations of the causality between investment and financial sector development in the literature have also produced inconsistent results (Asongu, 2012; Misati & Nyamongo, 2010). This calls for further studies to enrich the literature. The paper adds to the scanty works in the literature on Africa. The findings of the research contribute to the understanding of macroeconomic and finance theories by providing answers to the research questions raised in the paper. The empirical results provide information to policy makers on the nature of causality between financial sector development and investment. Students of research doing similar research are provided with useful reference material.

1.2. General objective and specific objectives

The paper contributes to the literature in the area of finance-investment nexus in finance, economics and development literature by empirically examining the nature of causality between investment (proxied by gross fixed capital formation) and financial development (proxied by credit to the private sector). The paper specifically

- Examines the cointegration link between the series variables (gross fixed capital formation and credit to the private sector).
- Investigates the causality link between gross fixed capital formation and credit to the private sector.

1.3. Research Questions

The question underlying the research is;

- What is the nature of causality between gross fixed capital formation and credit to the private sector?

1.4. Hypothesis Tested

The assumption tested in the research is;

- H1: There is cointegration relationship between the series variables.
- H2: There is bidirectional causality between the series variables.

1.5. Limitations/Scope

The series variables used in the current study are secondary data from World Bank data base. Issues such as missing values, errors in variables and data massaging might not be known by the researchers if present. The paper did not consider the causality between economic growth and either investment or financial sector development. Structural breaks are also not considered. The period for the study is between 1970-2011. Single level data is used and not panel data.

The rest of the paper considers the research methodology, empirical results (unit root; descriptive statistics; correlation results; cointegration results and Granger causality test results); conclusions and policy implications.

2. Methodology

The paper is quantitative and descriptive in nature. The study is based on annual gross fixed capital formation (GCF) and credit to the private sector (CPS) series variables for Ghana for the period 1970-2011. The period was chosen for availability of data. The sample size is 41. Reviewed Articles were selected through purposive sampling method from the internet data bases.

2.1. Data Analysis Method

The analysis of the data for the current study is based on KPSS and ADF models, central tendencies; correlation models; ARDL cointegration model and Granger causality test model. The Stata and Microfit software were used. Results were presented in Tables and figures.

2.2. The ADF Model

The unit root test is performed using the Augmented Dickey-Fuller (1981) and Kwiatkowski, D., Phillips, P., Schmidt, P., Shin, Y. (1992) (KPSS). The ADF test is considered to have low power of tests as compared to the KPSS test (Nanthakumar and Subramaniam, 2010) and it is considered to easily accept a false null hypothesis of unit root. The null assumption (H_o) is that there is a unit root in the levels of the series. The alternative hypothesis (H_1) is that the series are stationary in levels. In adopting Hurng et al. (2007) model, the ADF model is specified as in equations (1) and (2).

$$\Delta GCF_t = \mu + \partial T + \beta G_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta GCF_{t-i} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\Delta CPS_t = \mu + \partial T + \beta G_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta CPS_{t-i} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where γ = trend coefficient, GCF= Gross fixed capital formation; CPS= credit to the private sector; ε_t = error term or stochastic error term; T = time trend, P = number of lags, Δ= shows the series are in their first difference. The ε_t is the error term/ white noise which have the features of normal distribution. It's expected mean value is zero and has constant variance. The errors are independent of each other.

2.3. KPSS Model

The KPSS is based on the null assumption of stationarity against the alternative hypothesis of unit root. It is used as a confirmatory test after the ADF test has been used. It is modeled based on the residuals (e_t) from an ordinary least square regression of the series variable of interest on the exogenous variable (s) (Sarbapriya, 2013). The model is specified as

$$N_t = M_t \beta + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where N_t = the series variable under investigation (gross fixed capital formation and credit to the private sector); M_t = a vector of exogenous variable(s). The Lagrange Multiplier is based on equation 4.

$$LM = T^{-2} + \sum_{i=1}^{T} S(t)^2 / f_o \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where T= the sample size; S (t) = the partial sum of residuals, given by: S(t) = $\sum_{i=1}^{t} S_r$;

ε_t = the estimated residual; f_o = an estimator of the residual spectrum at zero frequency.

2.4. ARDL Cointegration Model

The cointegration model is base on that of Pesaran et al. (2001) autoregressive distributed lag model (ARDL). The empirical model adopt that of Belke and Polleit (2006) and Shahbaz (2010) shown in equation 'f' with the error correction model (ECM).

$$\Delta y_t = C_{0y} + C_{1y} t + b_1 y_{t-1} + b_2 x_{1,t-1} + b_3 x_{3,t-1} + \ldots + b_k x_{k,t-1} + \sum_{i=1}^{m-1} \gamma_i \Delta y_{1,t-1} + \sum_{i=0}^{n_1-1} \alpha_{ik} \Delta x_{k,t-i} + e_{ty} \ldots\ldots\ldots\ldots (5)$$

Equation (5) is an unrestricted error-correction model (ECM). Variable 'y' is regress on variable 'x'. Where variable x is a vector. Where the 'b' measure the long run effects (long run Parameters). The 'γ' and 'α's are the short run parameters and measure the short run effects. The M and N are the order of lags, t is the time trend. The 'k' is the number of "forcing variables in the model under estimation. The null hypothesis (H_0) is that there is no cointegration among the series variables in the model against the alternative hypothesis (H_1) that the series variables are cointegrated. H_0: $b_1=b_2-b_3= \ldots =b_k =0$ against the alternative hypothesis H_1: Not H_0.

The decision is based on the critical values provided by Pesaran et al. (2001) for the bound testing approach. The bound is two set of variables for upper limit and lower limit for series integrated of order one I, (1) and those integrated of order zero I (0). The computed (Fob/Wald critical) values are compared with the upper and lower limit values for the bound test at various levels of significance such as 1%, 5%. If the computed F-statistics (Fob) lies between the upper limit and lower limits the results are considered as inconclusive. In the case where the Fob is greater than the upper limit values, the H_0 is not accepted. When the Fob is less than the lower limited values given as the bound critical values, the Ho is accepted.

The lag selection is based on information such as Akaike (AIC), Schwarz information criteria (SIC). The number of regressions estimated in the ARDL model according to Pesaran et al. (2001) is given by $(n+1)^k$. where 'n' is the maximum number of lags used in the model and K is the number of series variables in the model under estimation. In the ARDL model, aside the estimation of the long run coefficients, the error correction representation (short run dynamics) can also be estimated as in equation (6). The ARDL model estimated is assessed for its goodness of fit using various diagnostic tests such as J-B Normality test, Breusch-Godfred LM test, ARCH LM test, White Heteroskedasticity test, Ramsey RESET. The stability of the model is tested using the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUM sq).

$$\Delta y_t = \sum_{i=1}^{p} \alpha_i \Delta y_{t-1} + \sum_{i=1}^{s} \beta_i \Delta x_{t-1} + \sum_{k=1}^{q} \beta_k \Delta z_{t-k} \gamma ECM_{t-1} + e_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

2.5. Granger Causality Test Model

The nature of causality among the variables is examined using Granger causality test. According to Granger (1986), if series are integrated of order one and are cointegrated there is at least one form of causality. The current paper adopts the model by Fatai et al. (2004) and Esso (2009) equations '7' and '8' are estimated for causality.

$$LM_t = \alpha_0 + \sum_{i=1}^{q} \alpha_{1i} LM_{t-i} + \sum_{i=1}^{v} \alpha_{2j} LN_{t-i} + e_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$LN_t = b_0 + \sum_{i=1}^{p} b_{1i} LY_{t-i} + \sum_{i=1}^{s} b_{2j} LM_{t-i} + e_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

The null hypothesis is that H_0: $\alpha_2 = b_2 = 0$ (That is, there is no causality between the series in the model). The alternative hypothesis (H_1) is given as H_1: $\alpha_2 \neq b_2 \neq 0$ (There is causality between the series variables).

2.6. The Model

The conceptual model for the study states that: Investment is a function of financial sector development. That is GCF=f(CPS, NGDPC). NGDPC= Nominal gross domestic product in Cedis. NGDPC is included in the model to service as a control variable.

3. Empirical Results

The empirical results on descriptive statistics; correlation; ADF test results; KPSS test results; ARDL cointegration test results and Granger causality test results are presented and discussed in this section of the paper. The results are reported in Tables.

3.1. Descriptive Statistics

The results of the summary statistics of the variables are shown in Table 1. The minimum and maximum values measure the degree of variations in the variables under investigation. The mean measures the central tendency of the series variables and the values indicate a good fit. The volatility of the series variables is measured by the coefficient of variation. Of the series, the most volatile is NGDPC, GCF and CPS respectively.

The nature of the distribution of the series is measured using the coefficient of skewness. The three types of distribution are normal, positive skewness and negative skewness. In a positive distribution, the asymmetric tail moves towards the right. In a negative skewness the asymmetric tail moves to the left direction. The range of the coefficient of skewness is between positive one (1) and negative one (-1). The results are shown in Table1. All the series variables except GCF (-0.00313257) are positively skewed. The value of the coefficient of skewness of NGDPC is outliers since it is greater than unity (1).

The nature of the peakness of the series variables were measured using the coefficient of kurtosis. There are three forms of the nature of peakness. They are platykurtic (more flat-topped distribution- $\gamma<0$); leptokurtic (less flat-topped distribution-$\gamma>0$) and leptokurtic (equally flat-topped distribution- $\gamma=0$). A higher coefficient value of kurtosis is an indication of more extreme observation or the distribution is more single-peaked. The results of the values of the coefficients of kurtosis are shown in Table 1. The coefficient values of the kurtosis of the series variables CPS and GCF are less than zero (0) which indicates more flat-topped distribution. The coefficient value of the kurtosis of NGDPC series is more than unity (1) which indicates less flat-topped distribution.

Variable	Mean	Median	Minimum	Maximum
Nominal gross domestic product (NGDPC) (Cedis)	8.48×10^9	$5.35. \times 10^9$	2.10×10^9	3.90×10^{10}
Credit to the private sector (CPS)	25.8236	25.8978	16.3827	39.2976
Gross fixed capital formation(GCF)	15.8286	14.2972	3.37764	29.0021
Variable	**Std. Dev.**	**C.V**	**skewness**	**Ex. Kurtosis**
Nominal gross domestic product (NGDPC) (Cedis)	8.78×10^9	1.03522	2.14873	3.52014
Credit to the private sector (CPS)	5.74795	0.222586	0.376133	-0.618862
Gross fixed capital formation(GCF)	7.57837	0.478776	-0.00313257	-1.27896

Table 1: Summary Statistics, using the observations 1970 - 2011

3.2. Correlation Analysis

Multi-collinearity among the series variables was tested using the correlation matrix. The results are reported in Table 2. There is positive relationship between CPS and NGDPC; CPS and GCF, though not significant. There is significant link between GCF and NGDPC. The magnitudes of the correlation coefficients indicate that multi-collinearity is not a potential problem in the regression models and the dataset together with the variables are appropriate for the current study.

Variables	NGDPC	CPS	GCF
NGDPC	1.0000		
CPS	0.0376	1.0000	
GCF	0.4876*	0.2376	1.0000

Table 2: Correlation Matrix For Test's Variables
*NOTE: 5% critical value (two-tail) = 0.3044: * denotes significance at 5%*

3.3. Results of Unit Root Tests without Structural Breaks

The two main unit root tests used in the current thesis are the Augmented Dickey-Fuller test (ADF) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS).

3.3.1. The ADF Test

The unit root test results based on the ADF test are reported in Table 3 and Table 4. The results of the ADF test for unit root in levels show that the series are non-stationary in intercept. The null hypothesis of unit root was accepted for all the series in levels.

Variables (Levels)	t-statistics	ADF P-Value	1% Critical Value	5% Critical Value	10% Critical Value	Results
NGDP(CEDIS)	3.905	1.0000	-3.641	-2.955	-2.611	Accept Ho (Unit root)
CPS	-2.383	0.1466	-3.641	-2.955	-2.611	Accept Ho (Unit root)
GCF	-1.376	0.5936	-3.641`	-2.955	-2.611	Accept Ho (Unit root)

Table 3: ADF stationarity test results with a constant
Source: Author's computation, 2013

Taking the logarithm of the first difference of the series and testing these with intercept and time trend makes series stationary. That is, the null hypothesis of unit root was rejected. The results are reported in Table 4. These results indicate that the series exhibit unit root processes and are integrated of order one, I (1).

Variables (First Difference)	t-statistics	ADF P-Value	1% Critical Value	5% Critical Value	10% Critical Value	Results
Δln NGDPC	-3.410	0.0501**	-4.270	-3.552	-3.211	Reject Ho (Stationary)
ΔlnCPS	-3.780	0.0176**	-4.270	-3.552	-3.211	Reject Ho (Stationary)
ΔlnGCF	-4.540	0.0013***	-4.270	-3.552	-3.211	Reject Ho (Stationary)

Table 4: ADF stationarity test results with a constant and a time trend
Source: Author's computation, 2013

3.3.2. The KPSS Test

The KPSS test results are presented in Table 5. The KPSS is a reversed test for unit root. It is used in the current study for confirmation of the stationarity properties of the series. The series were examined in levels and in first difference as well as in their logarithm form. The results confirm that of the ADF test results. All the series have unit root in levels but attained stationarity at first differences at 1% and 5% significant levels.

Variable	T-stat	KPSS P-value	Results
NGDPC-level	0.198684	0.019	Reject Ho (Unit root)
ΔlnNGDPC-1st difference	0.112671	n. a	Accept Ho (Stationary)
CPS-level	0.147566	0.052	Reject Ho (Unit root)
ΔlnCPS-1st difference	0.0520548	n. a	Accept Ho (Stationary)
GCF-level	0.150542	0.049	Reject Ho (Unit root)
ΔlnGCF-1st difference	0.126658	0.091	Accept Ho (Stationary)

Table 5: KPSS stationarity test results with a constant and a time trend
NB: 1% and 5% Critical values are 0.212 and 0.149 respectively

In summary, the test results from the ADF and the KPSS indicates that the series exhibit unit root processes and are integrated of order one, I (1). The detection of unit roots in the series indicates that shocks to the series will have permanent effects and not transitory effects. The results indicate that cointegration analysis can be performed.

3.3.3. Bound Test for ARDL Cointegration

Table 6 reports the results of the bound test for the presence of cointegration. Each series variable in the model is used as independent variable and its associated F-statistics is then computed and compared with the critical values developed by Pesaran et al. (2001 and Narayan (2004) to determine whether there is cointegration among the series variables. The lag selection method used is the Schwarz Beyesian Criterion (SBC) and lag one is used for the estimation.

The calculated F-values exceed the critical upper bound values at 5%; 10% and 1%, which indicated rejection of the null assumption of no cointegration among the series variables. There is cointegration in only model 3 with GCF as the dependent variable and CPS and NGDPC as the explanatory variables. Hence, NGDPC and CPS are the long-run equilibrium variables that explain GCF for the period under review. The findings are in support of the findings of Asongu (2012); Afangideh (2010); Misati and Nyamongo (2010); Forbes (2010); Landon and Smith (2009) and Huang (2006) who reported of cointegration relationship between investment inflows and financial sector development. Since there is cointegration among the series, the causality analysis is performed.

Critical Bounds of the F -statistic: intercept and trend						
	90% level		95% level		99% level	
	$I(0)$	$I(1)$	$I(0)$	$I(1)$	$I(0)$	$I(1)$
	2.915	3.695	3.538	4.428	5.155	6.265
Computed F -Statistic			**Decision**			
1. F_{NGDPC}(NGDPC/CPS, GCF)	0.22723		Not Cointegrated			
2. F_{CPS}(CPS/NGDPC, GCF)	0.050525		Not Cointegrated			
3. F_{GCF}(GCF/NGDPC, CPS)	6.5577		Cointegrated			

Table 6: Test for cointegration relationship
Note: critical values are obtained from Pesaran et al., (2001) and Narayan, (2004)

3.3.4. Diagnostic Tests

The ARDL model estimated passed the various diagnostic tests (J-B Normality test, Breusch-Godfred LM test, ARCH LM test, White Heteroskedasticity test, Ramsey RESET) used to assess the goodness of fit. The CUSUM and CUSUM sq plot indicated that the estimated model is stable.

3.4. The Causality Link between Gross Capital Stock (GCF) and Credit to the Private Sector (CPS)

The Granger causality test is based on the null assumptions that credit to the private sector does not Granger cause gross capital stock and gross fixed capital formation does not Granger cause credit to the private sector. The alternative assumptions are that credit to the private sector Granger cause gross fixed capital stock and gross fixed capital formation Granger cause credit to the private sector. The results are reported in Table 7. The results in Table 7 shows that the null hypothesis that credit to the private sector does not Granger cause gross fixed capital formation is rejected at 1% level. This means credit to the private sector causes gross fixed capital formation.

The results means that the past values of credit to the private sector are useful to forecast the value of gross capital formation in Ghana, whereas the past values of gross capital formation are not useful in forecasting the values of credit to the private sector. The findings are in support of finance led investment hypothesis identified in literature. The results indicate that developments in the financial sector contribute to the growth of investment flows in an economy and not the reverse-effect in Ghana. The results here are not consistent with those of Asongu (2012) and Huang (2006) who determined that there is bidirectional causality between finance and investment using different proxies for financial sector development and investment. The results are consistent with those of Afangideh (2010); Misati and Nyamongo (2010); Forbes (2010); Landon and Smith (2009); Forssbaeck and Oxelheim (2008) which support the notion of finance led hypothesis.

Variables	Chi-square value	P-values	Decision
CPS does not Granger cause GCF	100.62	0.000***	Reject the null hypothesis
GCF does not Granger cause CPS	2.9275	0.570	Accept the null hypothesis

Table 7. Granger Causality test between gross fixed capital formation and credit to the private sector
*Note: *** denote significant at 1% level of significance*

4. Conclusion and Policy Implications

The objective of the paper has been achieved. The paper contributes to existing literature on finance investment nexus by examining the causality between investment (proxied by gross fixed capital formation) and financial development (proxied by credit to the private sector). There is unidirectional Granger causality with the VAR and VECM framework for Ghana during the years under consideration. The results are in support of the classical notion that financial development improves investment allocation. Policy makers should incorporate these findings into their policies and focus on the development of the financial sector in order to ensure investment flows. Future studies should consider other proxies of financial sector development (money supply; efficiency and size) as well as other proxies of investment (foreign direct investment, total investment). Different model such as panel unit root, panel cointegration and structural breaks should be considered in future research.

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