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Threshold and Asymmetric Effects of Financial Development on Economic Growth in BRICS Countries: Evidence from Panel Threshold-ARDL

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ABSTRACT

In this paper, we study the asymmetric effect and threshold of financial development on economic growth. We present a fresh evidence using the panel threshold-ARDL (Panel-TARDL) model for the 5 BRICS countries including Brazil, Russia, India, China and South Africa. We apply the Pool Mean Group (PMG) procedure for the estimation. The findings reveal that the long run threshold and asymmetric effects of finance taking place once the credit reached 38% of GDP. The financial development significantly improve the economic growth only below the threshold point thereafter the effect becomes negative. We find no significant threshold and asymmetry in the short run. Using a 58% as a threshold, we find a negative effect of finance for both the segments of the threshold and no asymmetry is detected. These suggest that any level of credit above 38% of GDP will produce an adverse effect of finance on growth. The Policy implications of these results are also discussed.

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1. Introduction

The financial sector has been one of the key drivers of economic growth that received considerable attention in the literature. Schumpeter (1911) was the pioneer in the area of finance and economic growth study (Adusei, 2012; King and Levine, 1993). Subsequently, literature has been striving to explore the importance of financial development on economic growth, with several studies supporting its positive role in growth enhancement (Bencivenga and Smith, 1991; Levine and Zevros, 1996; Arestis and Demetriades, 1997; Levine et al. 2000; Christopoulos and Tsionas, 2004; Wait et al., 2017; Guru and Yadav, 2019). However, there are a set of studies that demonstrated the negative impact on the growth of financial development (Owen and Temesvery, 2014; Gregorios and Guiditto, 1995; Herwartz and Walle, 2013). In the aftermath of (2007-2008) financial crisis, the researchers discovered that malfunctioned financial system may fail to efficiently allocate the resources (Law and Singh, 2014), and instead engage in a competition with the other sectors over the employment of the available skilled personnel and this may eventually limits the total factor productivity and growth (Cecchetti and Kharroubi, 2012). These have triggered the calls for the reexamination of the finance growth nexus (Ang, 2008).

In recent times, the finance-growth nexus witnessed an emergence of two strands of literature suggesting the existence of nonlinearity or threshold in the finance-growth nexus. The first view suggests that the threshold effect of finance is triggered by some developments in the financial sector and use the financial indicator as a threshold variable (Cecchetti and Kharroubi, 2012; Beck et al., 2014; Law and Singh, 2014; Samargandi et al., 2014; Adeniyi et al., 2015; Botev and Jawadi, 2019) others are on the view that the finance-growth nexus is subject to the threshold of some mediating variables other than financial factors i.e. level of income (Deidda and Fattouha, 2002; Ibrahim and Alagidede, 2018) level of income and openness (Botev and Jawadi, 2019), region (Wang et al., 2019), levels of economic development, government size and trade openness (Herwartz and Walle, 2014), institutional quality

(Law et al., 2013; Olufemi and Ibrahim, 2020) and inflation (Lee and Wong, 2005).

Several reasons have been cited as to what is responsible for the nonlinear impact of financial development on growth. Firstly, when the financial institutions divert most of their funding to the construction or real estate sectors, the productivity and competitiveness of other sectors and hence the real growth will be negatively affected (Cecchetti and Kharroubi, 2014; Botev et al., 2019). Secondly, the need for optimal size of credit necessary for growth is crucial, since the global financial crisis have manifested the rapid reaction of the non-financial real sector to the asset price-shocks associated with an excessive credit supply (Law and Singh, 2014). Thirdly, the high rate of corruption and political interference limit the growth-enhancing effect associated with financial development and therefore, the increase in financial development not necessarily ensure an increase in the growth rate (Law et al., 2013; Ibrahim and Alagidede, 2018; Erkişi, 2018).

There is a paradigm shift in the approach of modelling the threshold in finance-growth nexus from the previous method of using square terms (Arcand et al., 2012; Beck et al., 2014; Cecchetti and Kharroubi, 2014; Adeniyi et al., 2015; Samargandi et al., 2015) to the application of more advanced modelling approach (Law and Singh, 2014; Botev and Jawadi, 2019). It is follows that, the polynomial approach lacks any asymptotic distribution for the determination of threshold point (Botev and Jawadi, 2019) and the test of asymmetric hypothesis between the negative and the positive effect is also not accommodated (Law and Singh, 2014). Although Hansen (1999) and Caner and Hansen (2004) are used in Botev and Jawadi (2019) and Kremer et al. (2013) in Law and Singh (2014) to address the issue of the absence of proper distribution of threshold points, these techniques are limited to homogeneous slope models with the datasets comprising a large set of countries and relatively small time, hence, cannot be adopted in the dynamic panel model characterized by parameters heterogeneity, and in which both (T) and (N) are large

(Chiduk et al., 2016). In addition, the issue of testing asymmetric hypothesis remained unattended.

The main aim of this paper is to examine the threshold and asymmetric effects of financial development on BRICS's economic growth. We present a fresh evidence into the literature by extending the non-linear ARDL of Shin et al. (2014) to the panel threshold-ARDL (Panel-TARDL) in line with Eberhardt and Presbitero (2015) and Chudik et al. (2017). We also apply the Pool Mean Group (PMG) as it helps "to account for parameter heterogeneity and impending endogeneity in the model" (Peseran et al., 1999). This is the first attempt in the area of finance-growth.

The rest of the paper is organized as: section 2 is the brief review of the related literature, section 3 is the discussion on methodology, the data type and sources, section 4 is the presentation and the discussion of results and section 5 considers the aspects of conclusion, policy recommendation and direction for further study.

2. Literature Review

According to Bencivenga and Smith (1991), financial intermediaries affect economic growth through the transformation of saving from unproductive to productive assets. Levine and Zervos (1998) suggested that both stock market and banking development could improve capital formation and productivity. Using panel data of Brazil Russia, India, China and Turkey Mercan and Göçer (2013) revealed the positive and significant effect of financial development on growth. The same results hold in Herwartz and Walle (2013) however, the study suggested that the effect is stronger in richer countries than poor ones.

Levine et al. (2000) employed the GMM technique and the study revealed that the developed financial sector positively affect the growth and that the legal and accounting system explain the cross variation in the financial development. Using the same technique Caporale et al. (2015) augmented the Barro model with financial variables for the panel of 10 transition economies from 1994 through 2007. From the results, private credit yields an insignificant positive effect on economic growth, market capitalization somewhat affects economic growth and liquid liabilities has a significant and positive effect. The same technique was also applied to the BRICS's quarterly time series data for the stock market in Ogbeide and Akanji (2018) and the study revealed the significant relationship between stock market development and economic growth. Guru and Yadav (2019) used the size of intermediaries, the ratio of credit to deposit and that of domestic credit to the private sector as bank-based measures, and the shares traded and turnover as stock market indicators. The findings suggested that both bank and market-based indicators are re-enforcing one another in BRICS.

Rani and Kumar (2018) using Pedroni's panel co-integration test found That the co-integrating coefficients obtained by FMOL and DOLS revealed the contradictory effects of private credit and broad money, while both are reported to be positive in FMOL, the broad money is insignificant and the private credit is significantly negative in DOLS. Accordingly, the unidirectional causality is traced from GDPC to M3 and bidirectional causality is found between GDPC and DC. Malarvizhi et al. (2019) applied the King and Levine (1993) indicators for a panel of 5-ASEAN countries namely: Singapore, Thailand, Philippines, Indonesia and Malaysia and found all the financial indicators to be significant determinants of economic growth. This finding is supported by Wait et al. (2017) who compared BRICS with other non-BRICS nations and reported that the indicators contributed to BRICS economies more than the non-BRICS ones.

Examining the relationship between GDP and finance using credit to the private sector, Gregorios and Guiditto (1995) reported the negative effect of financial development on growth for the Latin countries. They attributed this negative outcome to the existence of the liberalization policy and a weak regulatory environment. Cecchetti and Kharroubi (2015) posit that financial stock may not be growth enhancing, their sectoral-based analysis shown that higher financial growth through credit boom reduces growth by limiting R&D. Owen and Temesvery (2014) examine the separate effect of foreign and indigenous banks loans and conclude that the level of the development of banking sector and the mode of operations of the foreign banks i.e. either by the affiliation or the cross-boundary lending, hugely influence the effect of the bank credit on economic growth.

In Erkişi (2018), the Broad money, domestic credit and MSCI-Indexes were used to study the effect of financial development, the results revealed that MSCI is the only significant determinant of economic growth in both the short and long run, and the broad money is significant and negative in the long-run but credit does not have any significant effect. The unidirectional causation is found from MSCI to GDP and from GDP to broad money, and they conclude that no certainty in the ability of financial growth to determine economic growth based on the variables used and the countries involved in their study.

Deidda and Fattouha (2002) observed a cross-sectional dataset from 119 economies capturing the period of 1960–1989. By employing the Hansen (1996; 2000) type threshold technique and initial GDP as triggering factor, the authors found that a significant and strong positive effect of financial development on growth is found only in developed countries. The same results are reported using the functional-coefficient model in Herwartz and Walle (2014). The study found that the effect of finance is contingent on, the levels of development achieved by the economy and financial system, the size of government and the degree of openness of both the trade and financial sector. However, the effect of credits is found to be higher in richer countries than in poor economies. The multi-threshold study conducted by Ibrahim and Alagidede (2018) considered the 29 sub-Sahara African economies and they covered 1980 to 2014. The study examine the possible contingency role of initial GDP, human capital and developed-financial system on finance to growth effect. The overall results found that in most cases the effect of finance is significant and positive only where the initial GDP, human capital and financial development are above the threshold. Another study by Wang et al. (2019) conducted the regional-based study in which he employed the regional finance-related dataset including credits and bank branches for the 1970s through 1980s, the findings suggested that credit has a regional effect while branches have no such effect. By applying the spatial correlation analysis, they discovered that the credit transfers a negative spillover from one region to another while the positive spillover is transferred across the region by a branch.

The institutional index for 85 economies is considered as a threshold variable in Law et al. (2013) and the data coverage was from 1980 to 2013. Hansen (2000) and Caner and Hansen (2004) procedures were adopted for empirical examination. The empirical results confirmed the mediating role of the institutions and established that the pronounced positive effect of finance is witnessed only after exceeding the threshold imposed by the institutional variables. Aluko and Ibrahim (2020) considered the Broad institutions index as a threshold factor, and Caner and Hansen (2004) technique are employed. The empirical findings supported the presence of an institutional threshold beyond which a finance growth effect occurred. Lee and Wong (2005) applied the threshold autoregressive model to the times series dataset of Japan and Taiwan, the financial depth is adopted as financial indicator and the inflation rate is used as threshold triggering variable. According to the results, the inflation rate limits the role of finance in Taiwan economy if it is above the threshold, however, the positive effect is found in Japan at a low and moderate inflation regime.

Arcand et al. (2012) adopted various modelling strategy in which they included the square of a credit to support the idea of “too much” finance. In particular, their study found that as soon as credit attains 100% of GDP the financial development produce an adverse effect, and suggested that this result cannot be attributed to GDP volatility, banks-crises and weak institutions. This study is strengthened by Cecchetti and Kharroubi (2012) who considered 30 years of observations, covering 50 countries including advanced and emerging ones, the square terms of private credit both total and by the bank are used as threshold indicators and the results supported the threshold effect of finance. This followed by Beck et al. (2014) who included the square terms of financial measures in the GMM model. The financial related variables like the private-credit by money banks, the stock -market capitalization, bank credit-to- deposits and a dummy variable for banking-crisis are considered. The empirical results supported the notion that after a certain threshold, the credit has no significant growth effect. In a similar approach, Samargandi et al. (2014) considered the sample of 52 middle-income economies from 1980 to 2008. The Polynomials function is considered for regression using the PMG model and the results suggested that all the sampled countries faced with negative effected from the squared term of credit, this suggest the existence of the threshold effect. The findings are reinforced by their robustness analysis using Kremer et al. (2013). Finally, Adeniyi et al. (2015) include a square term in their time series regression to capture the threshold of finance, accordingly, the share of liquid liability, private credit to GDP was used as threshold variables, and both suggested the threshold effect of finance.

Recently, a more advanced modelling strategy is adopted in Law and Singh (2014) in which they applied the threshold method of Kremer et al. (2013) to the dynamic panel data of 87 combined set of advanced and emerging countries from 1980 through 2010, three financial variables are used as thresholds "private sector and total domestic credit, as well as liquid liabilities" all these indicators unanimously reported positive and negative effect below and after thresholds respectively. These findings are supported by Samargandi et al. (2014) using the same technique and Ibrahim and Alagidede (2018). However, Botev and Jawadi (2019) reported no significant threshold effect in their study using the sample of 100 countries. The authors estimated the dynamic panel threshold with the number of threshold variables including income level, level of openness, gross domestic credit and domestic private sector credits.

3. Model, Methodology and Data

3.1 Theoretical Model

This study built upon the following Barro and Salai-matins (1990; 1995) form of production function:

$$Y_{ij} = A(H_{IJ})^{1-\alpha} \sum (X_{ij})^{\alpha} \quad (1)$$

Y is the output level, A is the efficiency parameter, H is the human capital and X is the physical capital, and the summation sign indicates the possibility of capital accumulation. The equilibrium is determined by the consumption, the production of final goods as well as the production of capital goods.

Following Hermes and Lensink (2003), the equilibrium rate of return of capital is given by(2):

$$r_{ij} = \frac{\pi_{ij}}{\eta_{ij}}[(1-\alpha)H_{ij} * (A_{ij})^{\frac{1}{1-\alpha}} * \alpha^{\frac{1+\alpha}{1-\alpha}} / \eta_{ij} \quad (2)$$

Where ∝ the proportion of capital goods is devoted to consumption and η is the cost of innovation and, it is an increasing function of capital goods produced. The improvement can be achieved in the rate of growth by introducing a financial system that will transform unproductive savings into productive capital. Thus, the activities of financial intermediation are introduced through the efficiency parameter i.e. A=f (FIN), the equilibrium rate of return of capital is rewritten as (3):

$$r_{ij} = \frac{\pi_{ij}}{\eta_{ij}}[(1-\alpha)H_{ij} * f(FIN)^{\frac{1}{1-\alpha}} * \alpha^{\frac{1+\alpha}{1-\alpha}} / \eta_{ij} \quad (3)$$

This analysis is concluded by the introduction of the behavior of household toward a decision on present or future consumption:

$$\frac{\dot{c}}{c} = \left(\frac{1}{\theta}\right) * (r - \rho) \quad (4)$$

The growth path of the consumption is given by equation (4) where θ the coefficient of elasticity of marginal utility. The gap between rate of return of capital (r) and discounted rate of consumption ρ is the main determinant of growth path of the economy.

$$Gr = \left(\frac{1}{\theta}\right) * (1-\rho) = \left(\frac{1}{\theta}\right) * \left([(1-\rho)\alpha H_{ij} f(FIN)^{\frac{1}{1-\alpha}} * \alpha^{\frac{1+\alpha}{1-\alpha}}] / \eta_{ij} - \rho \right) \quad (5)$$

The equation (5) states that all the variables in the model grow at the constant rate given by Gr.

3.2 Threshold and Dynamic Asymmetric Model

Following Eberhardt and Presbitero (2013) and Shin et al. (2014), we extended the Shin et al. (2013) NARDL to the panel Threshold-ARDL model. The modelling approach begins with the following:

$$y_t = \beta^+ x_t^+ + \beta^- x_t^+ + u_t \qquad (6)$$

$$\Delta x_t = u_t$$

whereas y_t and x_t are integrated variables I(1) and x_t is broken into the negative and positive components $(x_t = x_t^+ + x_t^-)$ of the partial sums of the changes in x_t:

$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} \max(\Delta x, d)\,, x_t^- = \sum_{j=i}^{t} \Delta x_j^- = \sum \min(\Delta x, d),$

and d is non-zero exogenously determined threshold.

In line with Shin *et al.* (2014) model (6) can be modified to include non-threshold exogenous variables:

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + \lambda^T z_t + u_t \qquad (7)$$

w_t is the vector of non-threshold variables

The more general form of (7) can be modified into TARDL (pqq) :

$$\Delta y_t = \rho y_{t-1} + \beta^+ x_{t-1}^+ + \beta^- x_{t-1}^- + \theta_z z_{t-1} + \sum_{i=1}^{p-1} \vartheta_i \Delta y_{t-i} + \sum_{i=0}^{p} \left(\pi_i \Delta x_{t-i}^+ + \pi_i \Delta x_{t-1}^- + \pi_i \Delta z_{t-i} \right) + u_t \qquad (8)$$

The level stationary or first-order integrated and are mutually co-integrated series can be used to obtain the coefficients of the model (8), and the precise inference can be drawn (Pesaran and Shin, 1999).

The OLS estimators of the parameters β^+ and β^- are asymptotically distributed as:

$T(\beta - \beta) \overset{\alpha}{\sim} MN(0, V)$

where $V = P \lim T \to \infty T^2 (X^T X)^{-1} \sigma_u^2$ is the centered asymptotic normality and it is non-perfectly collinear. Therefore, the inference can be made in a standard fashion using Wald statistic (Shin et al., 2014) and the test of asymmetry can also be conducted. Finally, the corresponding t-value of these parameters can be used in testing the threshold hypothesis (Lombardi et al., 2017).

According to (8) we present our panel-TARDL model as below:

$$\Delta lGDP_t = plGDP_{t-1} + \beta^{+}Credits_{t-1}^{+} + \beta^{-}Credits_{t-1}^{-} + \theta_z HC_{t-1} + \sum_{i=1}^{p-1}\vartheta\,\Delta lGDP_{t-i} + \sum_{i=0}^{p}(\pi_i\Delta Credits_{t-i}^{+} + \pi_i\Delta Credits_{t-1}^{-} + \pi_i\Delta HC_{t-i}) + u_t \quad (9)$$

$$CR_t^{+} = \sum_{j=1}^{t}\Delta Credits_j^{+} = \sum_{j=1}^{t}\max(\Delta Credits, d),\ CR_t^{-} = \sum_{j=i}^{t}\Delta Credits_j^{-} = \sum\min(\Delta Credits, d)$$

Where CR_t^{+} a positive partial sum is i.e. the values of credits above the given threshold, and CR_t^{-} is the negative partial sum i.e. the values of credits below the given threshold. These values are used to determine the growth effect for accumulated incremental credit (moving along the higher segment), and accumulated effect on growth due to credit reductions (moving along the lower segment), and d is the exogenously fixed credit threshold. Following (Eberhardt and Presbitero, 2013; 2015; Lombardi et al., 2017) we set the private credit to GDP (in its level form) corresponding to (38% and 58% of GDP) as a threshold around which we break the credit series into two and labeled it as positive and the negative credit (the codes are adopted from Eberhardt and Presbitero (2015).

3.3 Panel Data Analysis

3.3.1 The Mean Group Estimator

In a case where the parameters are completely heterogeneous, the MG estimator of Pesaran and Smith (1995) is the appropriate technique. The procedure estimates the individual countries' parameters and their averages are taken to obtain consistent and efficient estimates. However, if these parameters are not truly heterogeneous, the resulting estimates are inefficient (Pesaran and Shin, 1999).

3.3.2 The Pool Mean Group Estimator

This is a hybrid model, that is, it has an element of fixed effect model in the long run by imposing the homogeneity to the cross-countries parameters while the short-run parameters including the intercepts and error correction terms are all allowed to follow heterogeneous manner. These short-run averages of PMG are consistent estimates of the short-run parameters and error correction (Pesaran and Shin, 1999).

3.3.3 The Dynamic Fixed Effect Estimator

On the other end is the DFE model. In DFE, the assumption of heterogeneity is completely ruled out except in the case of intercept term. The long and short-run slopes and the error term are all forced to be the same across countries. This procedure yields an efficient estimate only if these restricted parameters are truly homogeneous (Pesaran and Smith, 1995; Pesaran and Shin, 1999). However, the homogeneous models both DFE and GMM can hardly produce unbiased estimates in the dynamic model, because as sample size T increases so the number of the instruments and this consumes the degree of freedom (Roodman, 2006).

Having focused on the BRICS countries, and given that they are all emerging economies, we should expect the long-run growth rate of all or at least their subset to converge to the same equilibrium path. However, the rate of convergence may be different, depending on the institutional, political and economic set up of each country. With this, we expect the long-run parameters to be homogeneous and that the PMG procedure yields consistent estimators. In addition, the MG estimator is likely to suffer from a degree of freedom given the sample size of this study. Nonetheless, the selection between the two procedures is done using the Hausman's statistic (Pesaran and Shin, 1999; Abdu et al., 2021) based the hypothesis given as: H0: MG and PMG are not significantly different and Hi: the difference between the two estimators is significant. Acceptance of null is tantamount to the acceptance of PMG as against MG. The same comparison can also be made between DFE and PMG using the same test statistics.

Using PMG or MG will circumvent the difficulties associate with the techniques adopted in the aforementioned studies. In the first place, our datasets consist of large T and so fit the techniques that will account for the stationarity of the series and subsequently the possible co-integration; secondly, the endogeneity imposed by the lag dependent variable cannot be controlled by fixed-effect or GMM type of techniques if the model violates the assumption of parameter homogeneity, lastly, the panel-

TARDL enables us to test both the threshold and dynamics asymmetry at the same time.

The common problem associated with the panel time-series datasets is that of cross-sectional error dependency. It is often emanate because of inter-relationship among the global economies in such a way that the shocks from one country can be transmitted into another e.g. the famous global financial crisis of 2007-2008 and just a recent covid-19 pandemic. Although they are seen to have a common source, their impact may differ across the economies resulting in the dependency problem in the cross-countries datasets (Pesaran 2006; Chudik and Pesaran 2015). Any model in which such dependency is ignored is likely to produce an inconsistent parameters' estimates (Chudik et al., 2017). In this study, we account for the cross-sectional error in any stage of analysis where doing so is possible.

3.3.4 Peseran (2004) Cross-Sectional Dependence Test

This the test applies to the heterogeneous non-stationary datasets. The test can also handle the model containing unbalanced datasets and the series with the broken trend. It is based on the coefficient of correlation from the given ADF model.

$$CD = \sqrt{\frac{2T}{N(N-1)}\left(\sum_{i=1}^{N-1}\sum_{k=i+1}\hat{\rho}_{ik}\right)} \rightarrow N(0.1) \tag{10}$$

The null for no against the presence of a cross-sectional correlated error is given by model (10) and the distribution of the test follows CD ~ N (0,1) asymptotic statistics.

3.3.5 Pesaran, Yamagata (2008) Test for the Slopes Heterogeneity

This test provides the guide for model selection so as avoid an arbitrary imposition of slope heterogeneity or homogeneity. The procedure offers the test statistics for the null of homogenous slopes against the heterogeneous ones. The procedure also provides two statistics i.e. the Swamy (1970) and its standardized version that account for dependency among the cross-sectional errors. Consequently, the tests as given in (11) and (12) apply to a small and large sample accordingly.

$$\tilde{\Delta}_{ij} = \sqrt{N}\left(\frac{N^{-1}\tilde{s}-k}{\sqrt{2k}}\right) \tag{11}$$

$$ad\tilde{j}\Delta_{ij} = \sqrt{N}\left(\frac{N^{-1}\tilde{s}-E\left(\tilde{z}_{l\tau}\right)}{\operatorname{var}\sqrt{\tilde{z}_{l\tau}}}\right) \tag{12}$$

3.3.6 Stationary Test

This paper conducted the panel stationary test using Maddala and Wu (MW, 1999) and the Pesaran (CIPS, 2007) Tests MW is the first generation procedure that is applied to the cross-sectional independent datasets, its ADF-type statistic is given in (13) below:

$$\Delta y_{it} = \alpha_i + \rho_i y_{it-1} + \sum_{j=0}^{k} \delta_{ij} y_{it-1} + e_{it} \tag{13}$$

The combination of p-values from several tests are used in this procedure, and the statistical distribution of the null is asymptotic as (14).

$$MW_{ADF} = -2\sum_{j=0}^{k} \log\left(\tau_j\right) \rightarrow x_2^2 N \tag{14}$$

$MW_{ADF} = \tau_j$ is the combined unit root tests.

CIPS Test is consider as a second-generation test, it is a cross-sectionally augmented IPS test. It is augmented-ADF statistics given by (15):

$$\Delta y_{it} = \alpha_i + \partial_i y_{it-1} + \beta_i \bar{y}_{it-1} + \sum_{j=0}^{k} \lambda_{ij} \Delta \bar{y}_{it-1} + \sum_{j=0}^{k} \delta_{ij} y_{it-1} + e_{it} \tag{15}$$

The null of unit root is checked by CIPS statistic below:

$$CIPS_{ADF} + \frac{1}{N}\sum_{i-}^{N} t_i(N,T) \tag{16}$$

$t_i(T,N)$ is the cross countries ADF statistic for a t-statistic of parameter ∂_i .

3.3.7 Bootstrapped Error-correction based Co-integration Test (Westerlund, 2007)

This is cross-countries error dependency robust test for co-integration. The hypothesis is tested for the absence of significant error-correction term using bootstrapped group-statistic (G_τ) and the bootstrapped panel statistics (P_τ) from the below equations (17-19):

$$\Delta Y_{it} = \delta_i^{'} d_{it} + \alpha_i Y_{it-1} + \lambda_i^{'} X_{it-1} + \sum_{j=1}^{\rho i} \alpha_{ij} \Delta y_{it-1} + \sum_{j=0}^{\rho i} \gamma_{it-1} \Delta X_{it-1} + \mu_{it} \tag{17}$$

The two-equation in (16), give the group statistics where the hypothesis is tested against the alternative of the significant error term in at least one of the countries datasets.

$$G_\tau = \frac{1}{N} \sum_{i=1}^{N} \frac{\hat{\alpha}_i}{SE(\hat{\alpha}_i)} \quad G_\tau = \frac{1}{N} \sum_{i=1}^{N} \frac{T\hat{\alpha}_i}{\hat{\alpha}_i(1)} \tag{18}$$

The two-panel statistics are in (17), the null of the absence of error correction is tested against the alternative of its presence for the whole panel.

$$P_\tau = \frac{\hat{\alpha}}{SE(\hat{a})} \quad P_\alpha = T\hat{\alpha} \tag{19}$$

These statistics are unaffected by the problems of dependent errors, the small sample properties and size distortions.

3.4 Types and Sources of Data

The study is based on the datasets of five BRICS (Brazil, Russia, India, China and South Africa) members, from 1980 to 2018. The variables observed are GDP per capita measure in USD, which we obtained from the United Nation Conference of Trade and Development (UNCTAD) website, the credit to private sector % of GDP which was collected from WDI and the human development index which is extracted from Penn world table 9.0. The GDP is the dependent variable and served as economic growth, the credits to private sector is the measure of financial development and served as the main explanatory variable and, the human development index as a human capital served as a control variable. The selection of private credit as a measure of financial development follows its relevance in the literature particularly for the developing countries (see, Gregorios and Guiditto, 1995; Samargandi et al., 2015).

4. Results Presentation and Discussion

We begin by reporting the results of various panel data pre-estimations tests discussed in section 3, namely: Peseran (2004) Cross-Sectional Dependence Test, Pesaran, Yamagata (2008) test for the slopes heterogeneity, Maddala and Wu (1999) and Pesaran (CIPS) (2007) stationarity tests, the Bootstrapped version of Westerlund (2007) error-correction based Co-integration test. The descriptive statistics are also reported in Table 1 of this section.

Table 1. Descriptive Statistics

country	variables	unit	mean	sd	min	max	Xnorm
All	lGDP	Log level	13.267	1.184	10.99	16.88	6.77(0.00)
All	H/capital	%	2.188	0.538	1.128	3.403	14.12(0.00)
All	Credits	% of GDP	58.63	32.36	13.60	156.81	33.18(0.00)
Individual means	Brazil	Russia	India	China	South Africa		
Credits	49.311	37.09	33.37	107.04	60.74		

Source: Research finding.

Note: Xnorm is the Jaquar-Bera statrtistic. The individual country's means of Credits are presented at a bottom of the table.

Table 2 reports the cross-sectional error dependency test, the results revealed the rejection of the possibility of independent cross-country's errors by the CD statistic.

Table 2. Cross-sectional Dependency Test

Statistics	lGDP	Human Capital	Credits
avgρ	0.87	0.97	0.54
Avg/ρ/	0.87	0.87	0.54
CD-test	17.18***(0.00)	19.06***(0.00)	10.72***(0.00)

Source: Research finding.

Note: HO: the variables are strictly cross- sectional independents; p-values in bracket; *** indicates that null is rejected at 1% level of significance.

The next is the homogeneous slope test. According to both delta and adjusted delta statistics as shown in table 3 the slope homogeneity is rejected.

Table 3. Slope Homogeneity Test

	Delta-Statistics	p-values
$\tilde{\Delta}_{ij}$	2.14	0.03**
$\widetilde{adj}\Delta_{ij}$	2.30	0.02**

Source: Research finding.

Note: H0: slopes are homogenous; ** indicates rejection of H0: at 5 % significance level.

Table 4 reported the results of the unit root test. The left side of the table is the MW test and it is revealed that lGDP is I(1) and both human capital and the credits are I(0), and from the right side of the table, the CIPS test have shown that lGDP is stationary at I(0) while both human capital and credits variables are I(1).

Table 4. Panel Unit Root

		MW with constant			CIPS with constant	
lGDP	2	64.831***(0.000)	I(1)	1	-2.694***(0.004)	I(0)
Human capital	1	33.348***(0.000)	I(0)	2	-3.314**(0.014)	I(1)
Credits	1	23.176**(0.010)	I(0)	2	-1.587***(0.000)	I(1)

Source: Research finding.

Note: p-values in parenthesis ***, and **, means significance at 1% and 5% respectively.

The results for Westerlund (2007) co-integration test is reported in the Table5, both bootstrapped and non-bootstrapped p-values of the panel statistic Pt rejected the null of no co-integration if the trend is included in the model. However, only the non-bootstrapped p-value of panel statistic Pα supported the existence of significant error correction once the trend is excluded from the model.

Table 5. Westerlund (2007) Panel Co-integration Test based on bootstrapped p-Values

Stats.	Values	Z-stats.	P-val	boots-p	stats	Value	Z-val	P-val	Boots-p
Gt	-2.03	1.32	0.91	0.65	Gt	-1.48	1.36	0.91	0.68
Gα	-15.51	-0.57	0.28	0.97	Gα	-2.83	2.24	0.99	1.00
Pt	-5.07	-0.05	0.52	0.00***	Pt	-3.62	0.21	0.58	0.05**
Pα	-17.15	-2.21	0.014**	0.95	Pα	-6.68	-0.33	0.37	0.85

Source: Research finding.

Note: H0: no error-correction, *** and ** indicate significance level at 1% and 5% respectively.

Tables 6 and 7 report the results from Panel-TARDL model as estimated using three techniques; PMG, MG and DFE. We conducted the

Hausman's test to decide on the more efficient estimator among the three. From the results, the threshold variable is a credit to the private sector expressed as a percentage of GDP. The threshold points are selected exogenously (Eberhardt and Presbitero, 2013; 2015). In search of the appropriate thresholds, we consider the means of credits for each of the individual country, Brazil (49%), China (107%), India (33%), Russia (37%), South Arica (60%) and their combined group mean (58%). Based on the corresponding t-values of the resulting thresholds, we focus on those values at which the private credit is around 38% and 58% of GDP (Lombardi et al., 2017) as they produced significant thresholds. We further assume these thresholds to be homogeneous across the sampled countries (Chudik et al., 2017; Lombardi et al., 2017). Chudik et al. (2017) also assumed homogeneous thresholds within the groups.

Table 6 column 1 reported the results from the DFE model. It revealed that human capital has a positive and significant effect on GDP in the long run and the short-run effect is insignificant. Both the short run and the long run linear terms of credit are found not significant. We find the positive significant effect of credit only below the 38% threshold and afterwards it is negative and significant, and the short-run coefficient is negative and significant above the threshold. However, the Hausman statistic of 15.15 does not favor the DFE model. The MG estimator in column 2 reported insignificant results for all the explanatory variables. This is not surprising given its sensitivity to the degree of freedom (Samargandi et al., 2014) and based on the value of Hausman statistic 12.16, the PMG is more efficient estimator than MG.

Table 6. Threshold Effect and Dynamic Asymmetry, Credits to Private Sector<= 38% of GDP

Models	**(1) DFE**	**(2) MG**	**(3) PMG**
Variables			
Const.	3.045***(0.008)	9.479(0.111)	2.716**(0.013)
Human Capital			
Lr	4.501***(0.000)	1.25(0.397)	3.724***(0.000)
Shr	-6.401*(0.204)	-1.021(0.875)	-11.034(0.043)-
Credits			
Lr	0.471(0.150)	-2.00(0.146)	1.105***(0.0001)
Shr	0.095(0.164)	0.336(0.683)	0.242(0.630)

Models	**(1) DFE**	**(2) MG**	**(3) PMG**
Credits>38%ofGDP			
Lr	-0.003(0.582)	0.034(0.296)	-0.178***(0.004)
Shr	-0.004***(0.007)	-0.032(0.367)	0.003(0.770)
Credits<=38%ofGDP			
Lr	0.073***(0.000)	0.053(0.307)	0.025***(0.004)
Shr	-0.001(0.940)	-0.029(0.373)	0.0003(0.690)
ECM			
lGDP(-1)	-0.372***(0.006)	-0.462**(0.017)	-0.357**(0.010)
HAUSMAN TEST			
PMG vs DFE	**15.15***(0.000)**		
MG vs PMG		**12.66**(0.005)**	
ASYMMETRY TEST			
LR asym			**18.87***(0.000)**
SR asym			**0.003*(0.086)**

Source: Research finding.

Note: *, **, *** means 10%, 5% and 1% level of significant in that order.

According to PMG results reported in Table 6 column 3, both the human capital and the linear term of credit reported significant positive long-run coefficients. However, the short run coefficient of human capital is negative and significant and that of credit is negative and insignificant. Below the 38% threshold, the credits significantly improve the economic growth of BRICS and the effect is negative when the credits is above the 38% of GDP, conversely, these effects are insignificant in the short run. The error correction term is significant and correctly signed in all the three models.

Table 7. Threshold Effect and Dynamic Asymmetry, Credits to Private Sector>58% of GDP

Models	**(1) DFE**	**(2) MG**	**(3) PMG**
Variables			
Const.	2.745**(0.016)	7.547***(0.004)	2.720**(0.012)
Human Capital			
Lr	4.657***(0.000)	1.612(0.162)	3.503***(0.000)
Shr	-6.730(0.162)	-1.170(0.851)	-10.63(0.061)
Credits			
Lr	0.300(0.362)	0.052(0.184)	1.165***(0.001)
Shr	0.044(0.633)	0.032(0.982)	0.350(0.826)
Credits>58%ofGDP			
Lr	-0.005(0.342)	0.052(0.184)	-0.019***(0.004)
Shr	-0.005***(0.002)	-0.024**(0.050)	-0.0004(0.990)
Credits<=58%ofGDP			

Models	**(1) DFE**	**(2) MG**	**(3) PMG**
Lr	-0.010**(0.032)	-0.004(0.921)	-0.022***(0.001)
Shr	-0.002(0.381)	-0.002(0.956)	-0.015(0.647)
ECM			
lGDP(-1)	-0.313**(0.011)	-0.467**(0.012)	-0.364**(0.010)
HAUSMAN TEST			
PMG vs DFE	**31.78***(0.000)**		
MG vs PMG		**7.86*(0.08)**	
ASYMMETRY TEST			
LR asym			**1.56(0.211)**
SR asym			**1.06(0.302)**

Source: Research finding.

Note: Lr and Shr means long and short run parameters respectively. *, **, *** means 10%, 5% and 1% level of significant in that order.

Our findings for threshold is supported by series of literature suggesting the view that excessive finance is not healthy for the economy (Cecchetti and Kharroubi, 2012; Beck et al., 2014; Law and Singh, 2014; Samargandi et al., 2014; Adeniyi et al., 2015), except Olufemi and Ibrahim (2020) who found that the minimum requirement of credits must be attained for a country to have any positive result from financial development. However, our finding on threshold point is not in line with these studies, while the threshold values we fixed is greater than 8.1% obtained in Olufemi and Ibrahim (2020) for Sub-Sahara Africa and 0.433% in Samargandi et al. (2014) for lower-middle-income countries. It is, however, less than 88% and 80% obtained in Law and Singh (2014) and Beck et al. (2014), respectively. These may resulted from specification issues associated with these studies as highlighted in section 1.

The implications of our findings are: if the financial system achieved higher advancement, it may be that a considerable amount of private credits will be used for consumptions, and time may come, where the greater portion of the income of the households will be devoted to the credits repayments. This will eventually affect the private consumption expenditure negatively and, as result, the growth will be contracted. Similarly, faulty tax policy may induce the corporate bodies to turn to bank credit for their capital financing and encourage the taking of mortgage loans by the households.

The asymmetric test is conducted for the magnitude of these effects and the chi-sqr values and their associated probability of 18.87(0.00) and 0.030(0.086) revealed the existence of the long run asymmetric effect of credit to private sector at 1% level of significance and that the short-run asymmetry is insignificant even at 10% level. This signifies that the growth effect of financial development is not at the same magnitude as its negative growth effect. In addition, these have an important policy implication, especially when the authorities decide to review the tax policy with the view to checkmate the credit bias for both the household and corporate bodies.

Column 1 in the Table 7 reported the results from the DFE model where it revealed that the coefficient of human capital has a positive and significant sign in the long run and that the short-run coefficient is insignificant. The private sector credits reported insignificants coefficients for both the short run and long run segment. The results also shown that the coefficient of credit is negative in both the segments of the 58% threshold and the effect is insignificant in the upper segment. The short-run coefficient of credit is negative and significant at above the threshold. However, the Hausman statistic of 31.78 does not favor the DFE model. Going by column 2 of the table, the MG estimator reported significant results for only ECM term and negative short-run effect of the credit at the upper regime of a threshold. These MG results may be in connection with the reason stated above. The Hausman statistic of 7.86 also fails to consider MG as an efficient estimator. From column 3, the PMG results revealed that human capital and linear term of credit have a positive significant long run and insignificant short-run effect on economic growth. The credit has shown a negative and significant effect at both segments of the 58% threshold. The ECM term for all the models is satisfactory. The WALD test did not support the asymmetry in both the short run and the long run. This means that at any threshold above 38%, the credits will yield the same magnitudes of negative consequences on growth.

5. Conclusion

The finance-growth effect has been subject to debate ranging from the direction of the relationship to the modelling issues. In this study, we introduce to the literature the fresh evidence from Panel Threshold-ARDL, which is estimated using the PMG model. Our analysis accounts for the stationarity of the datasets, the parameter heterogeneity and the endogenous regressor's problem. The flexibility of this model also allows us to not only exogenously determine the threshold but also test for the asymmetric effect of financial development.

The overall results supported the notion of "too much finance" in that, below the threshold of 38% level of credit to GDP, the financial development affect the BRICS economies positively, and this effect becomes negative afterwards. These negative and positive effects above and below the threshold are of different magnitude. Policymakers should take appropriate micro and macro-prudential policies to check the excessiveness of private credits taken by individuals and corporate bodies. This can be achieved through tax reforms.

Various thresholds levels have been reported in the literature about the finance-growth nexus and this may be in connection with the modelling approach used. In this paper, we came up with a different approach in which we considered many issues, which are previously ignored; however, our sample size still limits our chance of considering the cross-sectional dependency. Hence, there is still a need to extend the sample coverage of this study to consider the inclusion of more countries that is left for further study.

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