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Capitalization and profitability: applicability of capital theories in BRICS banking sector

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Abstract

The interrelationship between capitalization and profitability in banking sector of BRICS countries is studied with reference to existing five capital theories with the help of the ARDL and VECM/VAR models. These models are applied in the panel and individual settings on BRICS banking sector data from 2000 to 2020 to examine the presence of capital theories in the BRICS banking sectors. The study's long-term empirical findings hold up the signalling and the bankruptcy cost hypothesis for the BRICS, Brazil, Russia, and India. Capitalization appears to be having a detrimental effect on profitability in China and South Africa, the agency argument is upheld. Profitability appears to have a considerable positive long-run influence on capitalization, which is consistent with Myers and Majluf's (J Financ Econ 13:187–221, 1984) pecking order model for BRICS and Brazil. Profitability has a detrimental influence on capitalization in India and South Africa, corroborating the Modigliani and Miller (Am Econ Rev 48:261–297, 1958) and Miller (J Financ 32:1151–1168, 1977) notion. Although least significance is observed in most circumstances, the results of short-term prediction are comparable to those of long-run estimation. Both short-run and long-run evaluations of the capital-profitability link help in designing the "macroprudential" policies that demonstrate significance of our research.

Keywords: Capital theories, BRICS, Profitability, Banking, ARDL estimation, VECM models

JEL Classification: G21, C120

Introduction

Capitalization decisions are important to the success of modern institutions. Banks are expected to follow rigorous international and national standards in this connection. The aim of bank capital requirements is to ensure the stability and solvency of banking system in any country. By implementing several Basel Accords, regulators change capital requirements according to economic situations and adjust capital requirements time to time [20]. Capital adequacy defends against negative shocks and enhances the possibility of better earnings and profitability [3, 16, 35].

The capitalization-profitability nexus can be examined under the following hypotheses, namely the signalling hypothesis, the bankruptcy cost hypothesis, the Agency hypothesis, the pecking order hypothesis, and the Modigliani and Miller hypotheses and general theory of the cost of capital and capital structure (the Brusov-Filatova-Orekhova (BFO) theory) [9, 10, 11].

According to the signalling theory, increasing the capital of a bank conveys to the market favourable information about the bank's prospects and profitability which eventually increases the bank's business and leads to better profitability [13, 14, 15]. A well-capitalized bank, according to the bankruptcy cost hypothesis, is not relied on borrowing and has low credit and bankruptcy cost. This prevents the banks from bankruptcy while simultaneously increasing profitability. Some researchers, however, supported agency theory and claimed a negative association existed between capitalisation and profitability. They argued that equity is a costly source of funding due to high agency costs and higher returns required by shareholders which will affect profitability [6, 19]. According to agency theory, a greater capital ratio raises

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the agency cost, which limits managers' capacity to put more effort in creating shareholder value, resulting in poorer bank profitability.

Some researchers endorse the pecking order theory, including Annor, Obeng, and Nti [4], Mili, Sahut, Trimeche, and Teulon [30], Abusharba, Triyuwono, Ismail, and Rahman [1], Konishi and Yasuda [26], Saunders and Wilson [39], Keeley [24]. They argued that a profitable corporation could easily keep regulatory capital as needed. Internal funds, according to pecking order theory, are the least information-intensive source of funding,hence, a more prosperous corporation may maintain revenues to finance known investment prospects, resulting in better capital ratios.

Berger and Patti [7] and Williams [43] investigated hypotheses of reverse causation from profitability to capital and supported Modigliani miller model theory. According to their findings, profitable banks prefer lesser equity capital and prefer more leverage because increased efficiency reduces the cost of insolvency and financial turmoil (a substitution effect). Modigliani and miller's model assumes that in presence of tax, a corporation can opt for higher debt financing because it will reduce the overall cost of capital due to tax advantages. But increased use of debt increases the risk of insolvency in the business. However, if a bank is constantly earning profit, it can opt for more debt and lower capital. Modigliani and Miller proposed that more prosperous corporations may opt to keep lower capital ratios, and a negative relationship exists [31, 32]. Modigliani and Miller's preposition is supported by various research works undertaken in numerous industrialized and emerging nations [2, 8, 29].

The Brusov-Filatova-Orekhova (BFO) theory (the general theory of the cost of capital and capital structure) characterizes enterprises of any age. According to BFO theory, the assumption of corporate perpetuity in Modigliani and Miller's proposition leads to an underestimating of weightage average cost of capital, cost of equity, and firm capitalization. The Modigliani–Miller theory was expanded by the BFO theory, which developed a quantitative theory for evaluating essential parts of a company's financial activities over a short period of time. The application of BFO theory allows for the application of derived conclusions in actual economics, for firms with limited lifetimes, the introduction of a time component into theory, and the estimation of the conditions of companies with arbitrary lifetimes (or arbitrary age). We did not examine BFO theory in this study since banks are always focused on the long term and are not supposed to have an arbitrary life.

The interrelationship of capitalization and profitability is a contentious issue, and the available literature presents contradictory findings in many industries and situations, necessitating more research in this field. This study's contribution and novelty may be seen in numerous areas. This study investigated five main capitalization and profitability hypotheses (signalling hypothesis, bankruptcy cost hypothesis, Agency hypothesis, pecking order hypothesis, Hypothesis of Modigliani and Miller) that yet not been empirically tested by existing literature, contributing to the study's exclusiveness. This study investigated the interrelationship of capitalization and profitability across BRICS states where no earlier study has been conducted. The banking industry has aided the exceptional financial development of several emerging nations, notably the BRICS countries, which have seen significant economic upheavals in recent decades. To maintain a well-capitalized position, most countries, including the BRICS, require banks to hold the needed minimum capital. In terms of methodology, this study utilises two alternate capitalization and profitability measurements to provide precise finding on bank's capitalization and profitability nexus. We looked at two capital indicators: bank capital to total assets (CR) and bank regulatory capital to risk-weighted assets (CAR). We also used two profitability indicators to assess a bank's profitability: return on equity (ROE) and return on assets (ROA).

We are investigating the interrelationship between capitalization and profitability in BRICS nations from 2000 to 2020 utilizing yearly data for BRICS countries in the panel and individual settings. This study contributes to the existing range of evidence capitalization and profitability nexus by utilizing a variety of ideas, samples, procedures, time periods, and conditions. This study's empirical findings are drawn on the basis of more acceptable approach of the VECM/VAR Granger causality test and ARDL estimation, which delivers consistent and robust results. We anticipate that the results of our research will assist policymakers in making capitalization and profitability choices. Long-term empirical findings of the study corroborate the signalling and the bankruptcy cost hypothesis for the BRICS, Brazil, Russia, and India, implying a favourable influence on capitalization from profitability. Capitalization appears to have a significant adverse influence on profitability in China and South Africa, lending credence to the agency hypothesis, which claims that capitalization has a detrimental effect on profit. Profitability appears to have a significant positive long-run influence on capitalization, agreeing with pecking order argument of Myers and Majluf's [34] for BRICS and Brazil that increased profitability may support higher capital ratios since earnings are a source of capital. Profitability has a detrimental influence on capitalization in India and South Africa, supporting Modigliani and Miller's [32] conclusions (1977). In Russia and China,

profitability has no bearing on capitalisation. Although the significance is smaller in most situations, the short-term estimation results are comparable to the long-run ones.

We may also utilize our findings to make policy recommendations. Findings are relevant for BRICS bank regulators who are attempting to adjust capital requirements and help them in designing "macroprudential" regulations because our findings upheld that banks may enhance their profitability by increasing their capital ratios, and vice versa.

Literature review

Many nations have implemented the Basel capital requirements, recognizing the necessity of capital adequacy. However, some researchers are still conflicted on whether capitalization adds to banks' financial well-being.

The signalling and the bankruptcy cost hypothesis were proposed by Berger [6] as major explanations for capitalization's positive influence on bank profitability. According to Berger [6], increased equity in a bank communicates favourable information about the firm's prospects and profitability to the market. According to the bankruptcy cost theory, a bank with high capital ratio is not relied on the borrowed fund which led to less bankruptcy cost and ultimately boosts profitability. According to Dietrich and Wanzenried [12], banks with adequate capital ratios are lucrative, stable and profitable during market crises and relied less on borrowed funds. Almaqtari et al. [3] proved that banks may survive the negative impacts of increased non-performing loans caused by imprudent lending during economic inflationary times by strengthening their equity. Furthermore, they emphasised that a large quantity of regulatory capital suggests trustworthiness, which lowers borrowing costs. Belaid et al. [5] showed evidence that increasing the regulatory capital ratio lowers the chances of loan defaults. Pasiouras and Kosmidou [35] and Goddard et al. [16] identified a beneficial influence of capitalization on profitability in banks of countries of Europe. In addition, Berger [6] confirmed previous evidence of a positive influence of bank capitalization on profitability in the USA. Garca-Herrero et al. [19] argue that bank in the developing market should have high equity holding because it protects depositors in adverse macroeconomic scenarios by offering higher resilience to financial crises. The capital ratio, according to Zarrouk et al. [44], has a beneficial effect on the profits of 51 lending corporations in the MENA area.

Furthermore, according to Jensen and Meckling [22], a greater capital ratio, as per the agency theory, raises agency expenses and diminishes profit. High capital ratio may make banks to become more conservative and skipping out on opportunities and experience [16]. According to Martins et al. [28], the high capital ratio negatively affected the profits of 108 banks in the United Kingdom, Germany, and the USA. Tan and Floros [41] showed an association between a greater capital ratio and worse profitability in 101 Chinese banks. Increased capitalization in China's banking system, according to the authors, accompanies decreasing profit margins. The studies on this topic are extensive, and they have discovered an inverse relation between banks' capital and performance worldwide (see, for example, [12, 16]

Another group of researchers is looking at the effect of profit on capitalisation. According to the pecking order theory, internal funds are the least information-intensive source of funding; hence, a more prosperous corporation may maintain earnings to finance known investment prospects, resulting in better capital ratios [34]. Annor, Obeng, and Nti [4] investigated the drivers of capital decisions in a sample of Ghanaian commercial banks and discovered that ROA is favourably related to the capital ratio. Raising ROA enhances capital sufficiency while also allowing for the pursuit of riskier but more profitable activities. Banks are fully aware that raising their risk level increases the possibility of company failure but gives higher return. Hence, banks strive to increase their capital base so that they may take on greater risks [38, 40]. When studying the variables of the capital mix in the Indonesian Islamic banking sector, Abusharba, Triyuwono, Ismail, and Rahman [1] discovered that profitability has a positive link with capital. This showed that as earnings increase, Islamic banks may have a higher motivation to protect their owners' money.

Berger and Patti [7] and Williams [43] investigated hypotheses of reverse causation from profitability to capital. According to their findings, profitable banks prefer lesser equity capital because increased efficiency reduces the cost of insolvency and financial turmoil (a substitution effect). Gropp and Heider [18] explore the causes of leverage for the major USA and UK banks from 1991 to 2004. They include ROA and ROE multiplied by a regressor equal to 1 if the bank is close to attaining its regulatory standards. A more affluent bank may decide to keep a smaller precautionary buffer, knowing that it can rely on its reserves to reach the necessary levels in the future.

The BRICS banking industry has contributed to the country's remarkable financial development and has experienced substantial changes in banking laws such as capital requirements, liquidity requirements, licensing standards, foreign bank presence restrictions, and solvency considerations. Even though, no study has thoroughly focused on the capitalization and profitability in BRICS. Khan, Akhtar, and Akram [25] discovered

that banks in BRICS faced more constraints than banks in G7 countries in terms of licensing, capital sufficiency, admission of international banks, and supervision of banking operations. Mugova [33] used a GMM model to examine the influence of financial development on the growth of BRICS listed enterprises and discovered that financial development improves access to external funding and allows firms to alter their capital structure. Using panel data from 2007 to 2014, Hossain, Rahman, and Sadique [20] investigated the influence of Basel III on the Z score of banks in BRICS economies. The findings revealed that increased capital adequacy and leverage linked to increased BRICS bank resilience. Using GMM estimates, Jabra and Mighri [21] investigated the link between bank capital, risk, and profitability in the BRICS banking industry. The findings revealed that capital had a good influence on profit but a negative one on risk. However, these studies did not focus on the particular BRICS nations and did not investigate capitalization and profitability in the context of theories. Our analysis differs from others in that we focused on individual nations as well as the overall BRICS panel.

Research methodology

Econometric modelling and data description

Because capitalization and profitability are inextricably linked, our model explored the interrelationship between capitalization and profitability for the BRICS nations as a whole and each BRICS country.

The following general equations are used to empirically evaluate the long and short-run interaction between capitalization and profitability in the panel and individual county settings:

$$\text{Capitalization}_{it} = \alpha_{0+}\alpha_1 \text{Profitability}_{it} + F_i + \varepsilon_{it} \quad (1a)$$

$$\text{Capitalization}_{t} = \alpha_{0t+}\alpha_1 \text{Profitability}_{t} + \varepsilon_{t} \quad (1b)$$

$$\text{Profitability}_{it} = \alpha_{0+}\alpha_1 \text{Capitalization}_{it} + F_i + \varepsilon_{it} \quad (2a)$$

$$\text{Profitability}_{t} = \alpha_{0t+}\alpha_1 \text{Capitalization}_{t} + \varepsilon_{t} \quad (2b)$$

The relationship in Eq. 1a for the BRICS panel and Eq. 1b for individual countries might be positive or negative. Equations 1a and 1b, with a positive regression coefficient value, reflect the signalling and the bankruptcy cost hypothesis, respectively, since higher capital gives a positive indication about the position of banks and decreases the bankruptcy cost [6]. According to the agency theory, Eq. 1a and 1b with a negative regression coefficient value indicate agency theory because a greater capital ratio raises the agency cost, reducing profitability.

Profitability may have a bearing on capitalization in either a favourable or negative way. As a result, the BRICS panel's sign in Eq. 2a and individual states' sign in Eq. 2b may be positive or negative. Pecking order theory is represented by Eq. 2a and 2b with a positive regression coefficient value. Equation 2a and 2b with a sign indicates the Modigliani and Miller hypotheses, which proposed that more profitable banks may want to maintain lower capital ratios.

Two variables which are used to quantify capitalization are Capital Adequacy Ratio (CAR) and Capital Ratio (CR). CAR is taken as the percentage of regulatory capital in proportion to the risk-adjusted assets [42]. It is a percentage of total regulatory capital allocated to assets kept, weighted by the risk of those assets. The CAR is a regulatory case based on the BASEL principles that are aimed to monitor and improve the equity standing of banking organizations. CR is the percentage of bank equity and reserves to assets. Equity and reserves comprise all owner contributions, undistributed amount of profit, all kinds of reserves, contingencies, and value revisions. Assets encompass all assets in balance sheet. The bank's return on assets (ROA) and the bank's return on equity (ROE) are taken as profitability measures, both of which are widely used to assess the profitability of banks. ROA is the proportion of after-tax net income to total assets of a commercial bank, whereas ROE is the proportion of a commercial bank's after-tax net income to equity yearly.

The study empirically examined existing capital theories in the backdrop of BRICS banking sector in panel and individual settings. The analysis utilizes annual data on the four capitalization and profitability variables discussed above from 2000 to 2020. The data are extracted from global financial development indices provided by World Bank.

Methodology and estimation procedure

Unit root test

The stationary of the profitability and capitalization measures in the BRICS are assessed using unit root tests devised for panel data by Levin, Lin, and Chu (LLC). The null preposition states that every series has a unit root or that the series are not stationary, as opposed to the alternative preposition, which states that no series has a unit root or that the series is stationary. These statistics have the asymptotic distribution similar to a regular normal distribution [27]. The Augmented Dickey-Fuller test is used to assess the stationary property of variables in individual BRICS nations, using the null preposition of non-stationary series vs the alternative preposition of stationary series.

ARDL cointegration test

The next stage is to pursue cointegration after verifying that the series in our panel and member nations are integrated with a mixed order or stationary is observed at a different level. For that purpose, we use the ARDL bounds technique of Pesaran et al. [36] to investigate the long-term interaction effect. The null preposition of ARDL bound testing is that cointegration between variables does not exist, while the alternative preposition is that cointegration between variables exists.

If the F test value of ARDL bound testing is more than the upper value, the null preposition may be rejected. The null preposition, however, cannot be rejected if the F test value is within upper and lower critical values. Following the validation of co-integration, the conditional ARDL long-term model for capitalization and profitability will be calculated in the second step. This entails utilizing SIC to determine the ordering of ARDL models. In the third and last stage, the error correction model (ECM) was estimated using the statistics of long-run estimations to derive the short-run dynamic parameters. The method is suitable for three reasons. First, unlike other co-integration techniques such as Johansen [23], the bound test is simple. The Johansen [23] technique necessitates that all variables are integrated into the same order (I (1)) or stationary at same level, or else the predictive validity is compromised. The ARDL technique succeeds whether the model's regressor is I (0) or I (1). However, for I (2) series, the procedure will fail. Second, the ARDL test is substantially more efficient for small samples and datasets, such as those utilized our study. Third, ARDL model gives both short-run and long-run equilibrium.

Panel ARDL model

The panel ARDL PMG estimator is being used to identify the long- and short-term interactions between capitalization and profitability. Traditional estimating approaches do not allow for the examination of variable adaptations to both short- and long-term equilibrium circumstances. The Panel ARDL PMG estimator appears to be required for limiting heterogeneity in variable interaction while integrating the influence of independent variables [37]. The three most often used estimating methods of panel ARDL are the Pooled Mean Group (PMG), the Mean Group (MG); and the dynamic fixed effects (DFE). We has used the Hausman test that allows you to choose between the MG and the PMG on one side and the PMG and the DFE on the other (Result of the Hausman test is available on demand). Hausman test shows that PMG is more consistent and efficient for our analysis.

ARDL diagnostic tests

The robustness of the ARDL findings is ensured through diagnostic and stability testing. The Breusch Godfrey's serial correlation LM test, the Breusch–Pagan Godfrey's Heteroskedasticity test or the White test, and the Jarque–Bera' normality test are some of the techniques employed in this context. In addition, the Ramsey (RESET) estimate is used to assess the model's linear function or stability. Table 4 summarises the diagnostic statistics of the ARDL model. These statistics demonstrate the absence of serial correlation or heteroscedasticity in our model. The Ramsey (RESET) and Jarque Bera statistics were used to test the stability and normality of the derived model, which demonstrates that the model is stable and the data are normal.

VECM/VAR granger causality

The direction of causation after the cointegration test is determined by using the Granger causality analysis. Once the cointegration test indicates a long-run association, a Granger-type causality may be verified by adding a single period legged error correction term to the model [17]. Hence, the vector error correction model (VECM) is appropriate. If no cointegration between variables is observed, a vector autoregression (VAR) is appropriate. We employed VAR/VECM Granger Causality in both panel and individual settings because in some cases, there is the existence of cointegration, while in others, there is no cointegration (see Tables 2 and 3).

Empirical results and discussion

The statistical stationarity of the series is studied before proceeding with the ARDL and the VECM/VAR Granger causality test in a panel and individual context. The ADF (Augmented Dickey-Fuller Test) and LLC (Levin, Lin, and Chu) tests are used to evaluate the level of integration or the stationary characteristics of the series. Table 1 presents the outcomes of ADF estimations for individual countries as well as the LLC models for the panel of BRICS countries. The results of test statistics indicated that the series in our panel and individual countries are integrated in a mixed order or stationary at different levels; hence, the next stage is to check for the cointegration using ARDL models.

The ARDL bounds results on the basis of F value, as given in Table 2, present significant evidence for cointegration between variables for models 1–6 in Brazil, models 5–8 in Russia, all models in India, models 6–8 in China, and all models in South Africa except models 2, 4, 8.

After the bound test indicated long-run cointegration for individual countries, we constructed Tables 3 (ARDL Model) and 5 (VECM/VAR Granger causality

Table 1 Unit root tests results. *Source*: Authors' estimations using STATA

	Variables		Intercept		Trend and Intercept		None	
			Level (P values) I(0)	First Difference (P values) I(1)	Level (P values) I(0)	First Difference (P values) I(1)	Level (P values) I(0)	First Difference (P values) I(1)
BRICS	Levin, Lin & Chu test	CAR	0.188	0.000***	0.114	0.000***	0.627	0.000***
		CR	0.058*	0.000***	0.060	0.000***	0.971	0.000***
		ROA	0.060*	0.000***	0.766	0.000***	0.054*	0.000***
		ROE	0.050*	0.000***	0.110	0.000***	0.077*	0.000***
Brazil	Augmented Dickey-Fuller Test	CAR	0.058*	0.021**	0.197	0.045**	0.822	0.001***
		CR	0.177	0.000***	0.106	0.000***	0.400	0.000***
		ROA	0.084*	0.000***	0.157	0.001***	0.597	0.000***
		ROE	0.061*	0.000***	0.117	0.001***	0.572	0.000***
Russia	Augmented Dickey-Fuller Test	CAR	0.644	0.014**	0.124	0.045**	0.223	0.001***
		CR	0.451	0.000***	0.061*	0.003**	0.480	0.000***
		ROA	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
		ROE	0.406	0.000***	0.018**	0.000***	0.383	0.000***
India	Augmented Dickey-Fuller Test	CAR	0.388	0.049**	0.513	0.021**	0.904	0.005***
		CR	0.898	0.000***	0.367	0.002***	0.973	0.000***
		ROA	0.837	0.000***	0.605	0.000***	0.438	0.000***
		ROE	0.807	0.002***	0.474	0.004***	0.242	0.000***
China	Augmented Dickey-Fuller Test	CAR	0.772	0.084*	0.902	0.023**	0.822	0.022**
		CR	0.746	0.000***	0.187	0.003***	0.999	0.007***
		ROA	0.025	0.000***	0.543	0.023**	0.581	0.000***
		ROE	0.080*	0.000***	0.382	0.000***	0.629	0.000***
South Africa	Augmented Dickey-Fuller Test	CAR	0.639	0.000***	0.028**	0.000***	0.759	0.000***
		CR	0.221	0.000***	0.576	0.002***	0.576	0.000***
		ROA	0.021**	0.000***	0.054*	0.001***	0.132	0.000***
		ROE	0.156	0.003***	0.456	0.000***	0.654	0.000***

*, ** and *** denote significance at the 10%, 5% and 1% levels, respectively,

Null preposition: Every series has a unit root or series is non-stationary

Alternative preposition: Series are stationary or series have no unit root

model) to represent the variables' short-run and long-run interactions.

Table 3 displays that CAR and CR have a considerable positive effect on profitability for BRICS, Brazil, Russia, and India, corroborating the signalling and the bankruptcy cost theory, which presume a beneficial impact of capitalization on profit. This means that when capitalization rises, bank profitability rises as well. This might be because a bank's capital adequacy provides the market with positive signal about the bank's prospects and profitability. Bank with adequate capital does not rely on borrowed funds which reduces the cost of bankruptcy. While CAR and CR seem to have a considerable negative influence on profitability in China and South Africa, this validates the agency theory, which claims that capitalization has a detrimental effect on profit. Banking institutions with a greater capital ratio incur higher agency costs and operate more cautiously, perhaps missing out on growth opportunities.

While analysing the influence of profitability on capitalization, it has shown that ROE and ROA have a considerable and favourable impact on CAR and CR in BRICS and Brazil in all models from 5 to 8, as presented in Table 3. This supports the pecking order theory, which assumes that increased profitability may lead to better capital ratios since earnings are a funding source. Both profitability indicators have a detrimental influence on capitalization in India and South Africa across all models from 5 to 8 in Table 3, confirming the Modigliani and Miller theory's applicability in these countries. However, significance does not exist for the impact of ROE on capitalization in South Africa. Profitability does not have any influence on capitalization in Russia and China.

Table 3 also includes the findings of short-run estimation. The long-term coefficients sign is also persisted in the short-term. As a consequence, the short-run estimation within the ARDL framework also corroborated the positive influence of profitability on capitalization

Table 2 ARDL Bound Test. *Source*: Authors' estimations using STATA

Models	Variables	Statistics	Brazil	Russia	India	China	South Africa
Model 1	DV: CAR IV: ROA	Upper Bound	4.16	4.16	4.16	4.16	4.16
		Lower Bound	3.62	3.62	3.62	3.62	3.62
		F. Statistics	4.28**	2.97	4.568**	1.810	4.771**
Model 2	DV: CAR IV: ROE	Upper Bound	4.16	4.16	4.16	4.16	4.16
		Lower Bound	3.62	3.62	3.62	3.62	3.62
		F. Statistics	4.23**	4.006	4.652**	3.132	1.008
Model 3	DV: CR IV: ROA	Upper Bound	4.16	4.16	4.16	4.16	4.16
		Lower Bound	3.62	3.62	3.62	3.62	3.62
		F. Statistics	6.671**	0.895	4.214**	1.769	6.843**
Model 4	DV: CR IV: ROE	Upper Bound	4.16	4.16	4.16	4.16	4.16
		Lower Bound	3.62	3.62	3.62	3.62	3.62
		F. Statistics	6.167**	0.959	4.240**	1.927	1.558
Model 5	DV: ROA IV: CAR	Upper Bound	4.16	4.16	4.16	4.16	4.16
		Lower Bound	3.62	3.62	3.62	3.62	3.62
		F. Statistics	4.542**	4.72**	4.469**	5.228**	4.232**
Model 6	DV: ROE IV: CAR	Upper Bound	4.16	4.16	4.16	4.16	4.16
		Lower Bound	3.62	3.62	3.62	3.62	3.62
		F. Statistics	4.686**	4.833**	4.408**	4.947**	13.80**
Model 7	DV: ROA IV: CR	Upper Bound	4.16	4.16	4.16	4.16	4.16
		Lower Bound	3.62	3.62	3.62	3.62	3.62
		F. Statistics	2.005	4.940**	4.199**	4.749**	4.329**
Model 8	DV: ROE IV: CR	Upper Bound	4.16	4.16	4.16	4.16	4.16
		Lower Bound	3.62	3.62	3.62	3.62	3.62
		F. Statistics	1.505	5.405**	4.482**	4.143**	2.389
	Level of Significance (%)	5%	5%	5%	5%	5%	5%

*, ** and *** denote significance at the 10%, 5% and 1% levels, respectively,

DV represents Dependent variable and IV represents Independent variable

Null preposition: There is no cointegration among variables

Alternative preposition: There is cointegration

in BRICS, Brazil, and Russia, as shown in models 5–8 Table 3. Profitability negatively affected the capitalization in India and South Africa. Capitalization (CAR and CR) has no statistically significant association with profitability (ROA and ROE) in the short run across all models in Table 3. However, the positive value of the regression coefficient showed that capitalization has a favourable short-term impact on profitability.

Diagnostic and stability estimation are used to confirm the robustness of the ARDL results. Table 4 summarises the diagnostic test findings for the ARDL model. These findings revealed the absent of serial correlation or heteroscedasticity in our estimated model. The Ramsey RESET test and Jarque Bera test statistics were used to assess the results' stability and normality. The testing revealed that the calculated model was stable and that the data are normal. The reliability and validity of the ARDL estimations were validated by all of the estimated diagnostic test data.

VECM/VAR Granger causality is employed to assess the causal association of capitalization and profitability variables. Table 5 shows the causal connection between the CAR and the ROA, the CAR and the ROE, the CR and the ROA, and the CR and the ROE using VECM and VAR models.

The findings in Table 5 (VECM/VAR) are in line with those presented in Table 4. (ARDL). In many cases, there is evidence of a long-run Granger causal connection between the variables since a negative lagged error correction coefficient is found. The long-run estimation results using the VECM framework indicated the existence of a bidirectional causal connection between profitability and capitalization for the BRICS in panel estimation and Brazil, India, and South Africa in individual estimation. For Russia and China, a unidirectional association is observed from capitalization to profitability. In the short term, we observe that unidirectional causality runs from profitability to

Table 3 ARDL Model. *Source*: authors' estimations using STATA

Models	**Model 1**		**Model 2**		**Model 3**		**Model 4**		**Model 5**		**Model 6**		**Model 7**		**Model 8**	
Variables	**DV: ROA**		**DV: ROE**		**DV: ROA**		**DV: ROE**		**DV: CAR**		**DV: CAR**		**DV: CR**		**DV: CR**	
	IV: CAR		**IV: CAR**		**IV: CR**		**IV: CR**		**IV: ROA**		**IV: ROE**		**IV: ROA**		**IV: ROE**	
Statistics	**Coef.**	**Prob.**	**Coef.**	**Prob.**	**Coef.**	**Prob.**	**Coef.**	**Prob.**	**Coef.**	**Prob.**	**Coef.**	**Prob.**	**Coef.**	**Prob.**	**Coef.**	**Prob.**
Long run																
BRICS	0.037	0.000***	0.580	0.010**	0.060	0.016**	0.119	0.081*	1.877	0.000***	1.125	0.000***	1.966	0.000***	0.183	0.000***
Brazil	0.457	0.000***	4.440	0.003***	1.923	0.604	18.75	0.066*	1.823	0.006**	0.187	0.002**	1.817	0.000***	0.189	0.000***
Russia	0.030	0.065*	1.027	0.022**	0.036	0.024**	1.241	0.054*	4.291	0.191	0.086	0.325	0.437	0.769	0.106	0.641
India	0.091	0.059*	2.243	0.036**	0.444	0.024**	1.184	0.091*	− 1.048	0.048**	− 0.241	0.043**	− 1.362	0.021**	− 0.078	0.058*
China	− 0.085	0.058*	− 3.367	0.046**	− 0.064	0.029**	− 3.713	0.026**	49.24	0.981	2.072	0.337	1.179	0.867	0.102	0.551
South Africa	− 0.067	0.093*	− 3.016	0.000***	0.076	0.043**	− 1.831	0.031*	− 1.456	0.020**	− 0.254	0.072*	− 2.105	0.000***	− 0.281	0.049**
Short run																
BRICS	0.074	0.116	1.005	0.108	0.038	0.348	0.217	0.653	0.988	0.019**	0.086	0.034**	0.365	0.061*	0.018	0.017**
Brazil	0.431	0.114	5.052	0.116	0.353	0.247	3.461	0.299	1.163	0.014**	0.105	0.019**	0.402	0.094*	0.039	0.097*
Russia	0.031	0.649	0.580	0.011**	0.038	0.726	1.871	0.065*	0.114	0.079*	1.018	0.024**	0.125	0.766	0.030	0.618
India	0.016	0.788	0.226	0.815	0.112	0.183	2.452	0.099*	− 0.380	0.151	− 0.394	0.110	− 0.080	0.370	− 0.006	0.680
China	− 0.010	0.138	− 0.670	0.318	0.030	0.401	1.308	0.117	2.582	0.191	0.131	0.111	0.065	0.874	0.041	0.313
South Africa	− 0.760	0.100	− 0.273	0.234	0.073*	0.458	3.907	0.416	− 1.315	0.019**	− 0.084	0.024**	− 0.021	0.074*	− 0.398	0.043**

Notes:*, **, *** indicates the rejection of the null preposition at the 10%, 5% and 1% significance level

DV represents dependent variable and IV represents independent variable

Table 4 ARDL Diagnostic Test. *Source*: Authors' estimations using STATA

Models	Variables	Statistics	Brazil	Russia	India	China	South Africa
Model 1	DV: ROA IV: CAR	Normality J-B value	0.751 (0.686)	2.494 (0.287)	1.579 (0.453)	0.502 (0.777)	1.655 (0.437)
		Serial correlation LM test (F statistics)	0.351 (0.715)	0.679 (0.522)	0.582 (0.571)	1.487 (0.276)	0.141 (0.870)
		Heteroscedasticity test (Breusch-Pagan-Godfrey) (F statistics)	1.101 (0.4301)	0.333 (0.721)	0.477 (0.628)	0.506 (0.765)	0.364 (0.861)
		Ramsey reset test (F statistics)	0.933 (0.377)	1.522 (0.148)	0.379 (0.709)	1.872 (0.090)	0.308 (0.765)
Model 2	DV: ROE IV: CAR	Normality J-B value	0.571 (0.751)	0.598 (0.741)	0.359 (0.835)	0.944 (0.623)	1.390 (0.499)
		Serial correlation LM test (F statistics)	0.259 (0.777)	1.042 (0.396)	0.038 (0.962)	1.279 (0.336)	0.132 (0.877)
		Heteroscedasticity test (Breusch-Pagan-Godfrey) (F statistics)	0.773 (0.590)	0.906 (0.513)	0.541 (0.592)	1.639 (0.240)	2.719 (0.084)
		Ramsey reset test (F statistics)	0.975 (0.354)	0.359 (0.327)	0.435 (0.669)	0.091 (0.929)	1.012 (0.329)
Model 3	DV: ROA IV: CR	Normality J-B value	0.225 (0.893)	1.331 (0.513)	2.707 (0.258)	1.090 (0.579)	1.134 (0.567)
		Serial correlation LM test (F statistics)	1.921 (0.240)	0.784 (0.475)	0.772 (0.480)	0.351 (0.709)	1.268 (0.311)
		Heteroscedasticity test (Breusch-Pagan-Godfrey) (F statistics)	2.069 (0.176)	0.761 (0.483)	0.218 (0.806)	0.098 (0.906)	4.083 (0.036)
		Ramsey reset test (F statistics)	1.164 (0.288)	1.075 (0.316)	0.747 (0.466)	1.428 (0.590)	0.412 (0.685)
Model 4	DV: ROE IV: CR	Normality J-B value	0.147 (0.928)	0.032 (0.983)	2.025 (0.363)	0.363 (0.833)	7.094 (0.064)
		Serial correlation LM test (F statistics)	0.258 (0.782)	0.380 (0.695)	0.465 (0.637)	0.364 (0.703)	0.679 (0.522)
		Heteroscedasticity test (ARCH) Breusch-Pagan-Godfrey (F statistics)	1.217 (0.404)	0.981 (0.474)	1.109 (0.353)	1.608 (0.235)	3.260 (0.985)
		Ramsey reset test (F statistics)	1.595 (0.161)	2.073 (0.068)	0.197 (0.846)	0.163 (0.873)	1.298 (0.213)
Model 5	DV: CAR IV: ROA	Normality J-B value	0.264 (0.876)	3.080 (0.171)	3.866 (0.144)	0.734 (0.692)	0.191 (0.908)
		Serial correlation LM test (F statistics)	0.988 (0.418)	1.846 (0.212)	0.286 (0.755)	0.340 (0.719)	0.590 (0.574)
		Heteroscedasticity test (Breusch-Pagan-Godfrey) (F statistics)	0.488 (0.801)	0.276 (0.916)	2.770 (0.092)	0.490 (0.777)	0.970 (0.476)
		Ramsey reset test (F statistics)	0.576 (0.469)	0.683 (0.510)	1.376 (0.188)	0.373 (0.702)	0.710 (0.493)
Model 6	DV: CAR IV: ROE	Normality J-B value	0.322 (0.850)	8.788 (0.123)	3.592 (0.165)	1.826 (0.401)	0.419 (0.810)
		Serial correlation LM test (F statistics)	0.765 (0.500)	1.828 (0.141)	0.273 (0.764)	1.237 (0.319)	0.254 (0.782)
		Heteroscedasticity test (Breusch-Pagan-Godfrey) (F statistics)	0.456 (0.823)	0.573 (0.743)	2.727 (0.095)	0.927 (0.415)	3.085 (0.063)
		Ramsey reset test (F statistics)	0.841 (0.385)	0.857 (0.415)	1.206 (0.246)	0.490 (0.101)	1.092 (0.306)
Model 7	DV: CR IV: ROA	Normality J-B value	0.654 (0.720)	0.826 (0.661)	1.529 (0.465)	2.236 (0.326)	1.762 (0.414)
		Serial correlation LM test (F statistics)	0.005 (0.994)	0.230 (0.797)	0.733 (0.497)	0.062 (0.939)	2.129 (0.189)
		Heteroscedasticity test (Breusch-Pagan-Godfrey) (F statistics)	0.652 (0.666)	0.328 (0.724)	0.126 (0.882)	0.195 (0.936)	0.699 (0.657)
		Ramsey reset test (F statistics)	0.759 (0.465)	0.060 (0.952)	0.038 (0.970)	1.080 (0.302)	1.038 (0.329)

Table 4 (continued)

Models	Variables	Statistics	Brazil	Russia	India	China	South Africa
Model 8	DV: CR IV: ROE	Normality J-B value	0.599 (0.741)	1.433 (0.488)	1.507 (0.470)	2.638 (0.090)	1.960 (0.078)
		Serial correlation LM test (F statistics)	0.0131 (0.986)	0.407 (0.673)	0.683 (0.521)	0.103 (0.903)	0712 (0.507)
		Heteroscedasticity test (Breusch-Pagan-Godfrey) (F statistics)	1.193 (0.373)	0.062 (0.939)	0.094 (0.910)	0.565 (0.779)	0.206 (0.815)
		Ramsey reset test (F statistics)	0.697 (0.501)	0.003 (0.996)	0.060 (0.952)	0.805 (0.451)	0.469 (0.645)

*, ** and *** denote significance at the 10%, 5% and 1% levels, respectively

DV represents Dependent variable and IV represents Independent variable

capitalization for the BRICS in panel and Brazil, Russia, and South Africa in individual estimation.

Conclusions and policy implications

To sustain the banking sector's solvency, banking institution in the BRICS must maintain adequate capital. However, a prosperous entity can readily maintain regulatory capital as needed. Several studies have been undertaken to explore the effect of capitalization on profitability and vice versa. There are several hypotheses on the interrelationship between capitalization namely signalling hypothesis, bankruptcy cost hypothesis, Agency hypothesis, pecking order hypothesis, and hypothesis of Modigliani and Miller.

This research intends to add to the current literature by investigating capitalization and profitability nexus in the banking sector of five emerging countries of BRICS in both panel and individual settings from 2000 to 2020. The ARDL and Granger's causality test are used to study the interrelationship between capitalization and profitability in five BRICS nations. The empirical findings of the study in the long-term validate the signalling and the bankruptcy cost hypothesis, for the BRICS, Brazil, Russia, and India, all of which imply a favourable impact on capitalization from profitability.

While capitalization has a considerable negative effect on the profitability in China and South Africa, this lends credence to the agency hypothesis, which argues that capitalization has a major negative impact on profitability. Profitability positively influences the capitalization in long run and supporting the pecking order concept for BRICS and Brazil that is the increased profitability may support higher capital levels since earnings are a funding source. Profitability has a detrimental influence on capitalization in India and South Africa, validating the premise of Modigliani and Miller. In Russia and China, profitability has no bearing on capitalization. The short-run estimation findings are in line with the long-run results; however, the significance is lower in most cases.

We also utilize our findings to make policy recommendations. First, our findings are beneficial for BRICS bank regulators in deciding the capital adequacy norms. The short- and long-run implications of capital on profitability are crucial for the formulation of the so-called "macroprudential" strategies. Regulators should keep monitoring all banks' minimum capital requirements to enhance strength and viability. Regulators should have strict compliance for every bank and do not let banks to defray from maintaining minimum capital. Our findings suggest that banks can boost their profitability by raising their capital ratios.

Second, the study found that higher capitalization can impair the banking sector's profitability in some circumstances. Hence, before imposing any stated regulatory capitalization criteria, authorities should consider that capital amounts over a particular level might impair the banking industry's profitability. Third, this study also showed that banks with higher profitability can easily maintain adequate capital. Therefore, the regulators should consider bank profitability before imposing any stated statutory capitalization ratios. Banks with higher profit can retain profit to finance their investment opportunities rather than holding capital ratios beyond the required capital.

This study also has several limitations. First, owing to a lack of all essential data beyond 2020, the research period is from 2000 to 2020. Second, our study emphasises the banking system of the BRICS countries, but future research might provide similar data from other countries as well. Third, this study has not studied the general theory of the cost of capital and capital

Table 5 VECM/VAR Granger Causality Test. *Source*: Authors' estimations using STATA

Models	Model 1: CAR does not Granger Causes ROA		Model 2: CAR does not Granger Causes ROE		Model 3: CR does not Granger Causes ROA		Model 4: CR does not Granger Causes ROE		Model 5: ROA does not Granger Causes CAR		Model 6: ROE does not Granger Causes CAR		Model 7: ROA does not Granger Causes CR		Model 8: ROE does not Granger Causes CR	
Statistics	**Coef.**	**Prob.**	**Coef.**	**Prob.**	**Coef.**	**Prob.**	**Coef.**	**Prob.**	**Coef.**	**Prob.**	**Coef.**	**Prob.**	**Coef.**	**Prob.**	**Coef.**	**Prob.**
Long run																
BRICS	0.008	0.847***	0.006	0.349**	− 0.291	0.014**	0.039	0.025*	− 0.151	0.000***	− 1.121	0.000***	− 0.177	0.000***	− 0.122	0.000***
Brazil	− 0.277	0.064*	− 0.405	0.054*	0.227	0.0674*	0.139	0.081*	− 1.823	0.004**	− 1.370	0.004**	− 0.941	0.000***	− 0.888	0.000***
Russia	− 0.277	0.064*	− 0.405	0.054*	0.227	0.0674*	0.139	0.081*	1.355	0.104	1.370	0.104	0.941	0.105	0.888	0.111
India	− 0.130	0.039**	− 0.079	0.053*	− 0.389	0.048**	− 0.411	0.043**	− 0.522	0.039**	− 0.669	0.028**	− 0.178	0.017**	− 0.230	0.023**
China	− 0.742	0.055*	− 0.158	0.000***	− 0.469	0.104	− 0.338	0.002***	0.012	0.867	1.012	0.890	0.020	0.115	0.837	0.203
South Africa	− 0.065	0.030**	− 0.422	0.137	− 1.008	0.011**	− 0.415	0.021**	− 0.065	0.505*	− 0.422	0.0137**	− 1.008	0.011**	− 0.415	0.021**
Short run																
BRICS	2.419	0.298	2.242	0.325	3.839	0.146	0.402	0.817	0.233	0.089*	0.609	0.073*	7.222	0.027**	1.045	0.593**
Brazil	0.409	0.814	0.285	0.867	0.243	0.885	0.306	0.857	7.330	0.025**	8.138	0.017**	14.06	0.000***	13.58	0.001***
Russia	0.409	0.814	0.285	0.867	0.038	0.726	0.306	0.857	7.330	0.025**	8.138	0.017**	14.06	0.000***	13.58	0.1001
India	1.373	0.503	1.052	0.590	0.100	0.950	0.097	0.952	1.708	0.425	1.264	0.531	2.058	0.357	2.101	0.349
China	1.527	0.465	2.786	0.248	0.945	0.623	0.551	0.759	2.732	0.255	1.568	0.456	2.550	0.279	2.246	0.325
South Africa	5.128	0.070*	6.111	0.047**	1.850	0.396	1.825	0.401	5.128	0.077*	6.111	0.047**	1.850	0.039*	1.825	0.0401**

*, **, *** indicates the rejection of the null preposition at the 10%, 5% and 1% significance level

structure (the Brusov-Filatova-Orekhova (BFO) theory), which describes companies of arbitrary age.

Abbreviations
CAR: Bank regulatory capital to risk-weighted assets; CR: Bank capital to total assets; ROE: Bank return on assets; ROA: Bank return on equity; VECM: Vector error correction model; VAR: Vector autoregression; ARDL: Autoregressive distributed lag; LLC: Levin, Lin, and Chu test; ADF: Augmented Dickey-Fuller test; BRICS: Brazil, Russia, India, China, and South Africa.

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