Can bank capital adequacy changes amplify the business cycle in South Africa?

Foluso Akinsola and Sylvanus Ikhide

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Can bank capital adequacy changes amplify the business cycle in South Africa?

Foluso Akinsola[1] and Sylvanus Ikhide[2]

Abstract

Financial globalisation and financial innovation have increased most banks' appetite for risk and therefore engendered financial fragility in the financial system. This paper examines the relationship between regulatory bank capital adequacy and the business cycle in South Africa using Vector error correction model (VECM). This paper employed quarterly data from South Africa Reserve Bank (SARB) for the period 1990 to 2013. The Johansen Cointegration approach was used to ascertain whether there is indeed a long-run co-movement between capital adequacy and the business cycle. Results from the tests and VECM model show that there are significant linkages among the variables, especially between capital adequacy and the business cycle. The impulse analysis result shows that the response of the business cycle to one standard deviation shock of capital adequacy is negative and persistent for over 25 quarters before stabilizing. This shows the procyclicality effect of the business cycle. In other words, the imposition of a capital adequacy requirement can amplify the business cycle in South Africa. The result shows that fluctuation in the business cycle can be amplified by the bank capital adequacy requirements in South Africa.

Keywords: Bank capital, Procyclicality, business cycle, Basel Accord

JEL Classification: G21, E32, G28

[1]Doctoral Graduate of Development Finance. University of Stellenbosch Business School, South Africa and Lecturer, Department of Economics, University of Lagos, Nigeria. All correspondence should be directed to akinfolu@yahoo.com or akinsfa@unisa.ac.za

[2]Professor of Development Finance. Sylvanus.Ikhide@usb.ac.za, University of Stellenbosch Business School, PO Box 610, Bellville, Cape Town, South Africa.

1. INTRODUCTION

Financial globalisation and financial innovation have increased most banks' appetite for risk and therefore engendered financial fragility in the financial system (Goodhart *et al.*, 2004; Drumond, 2009; Mishkin, 2010). Therefore, prudential regulations in the form of the International Basel Accord (Basel I and II) were introduced to curtail systemic risk and ensure stability in the banking system. However, the introduction of the capital requirement in the form of Basel I and Basel II may have amplified the business cycles. A number of studies (Berger and Udell, 1994; Blum and Hellwig, 1995; Jackson, 1999; Santos, 2000; Stolz, 2002; Goodhart *et al.*, 2004) have drawn attention to the procyclicality of bank capital regulation.

According to the literature on the bank capital channel and balance sheet channel, the presence of financial frictions and imperfect markets necessitates the regulation of the financial market. However, the introduction of bank capital regulations may amplify financial shocks to the real sector. Most studies are either focused on supply-side credit (banks and regulators) procyclicality or demand-side credit (household and investors) procyclicality. However, this study has gone further to delineate these two schools of thought and establish the link between prudential regulation and business downturn in South Africa. The article is one of the few papers that have established this link. Against this background, it will be interesting to examine the co-movement between the business cycle and bank capital adequacy requirements in South Africa. What role does financial regulation play in promoting a financial crisis and hence accentuating the business cycle in South Africa? To answer these questions, this study employs quarterly data from the South African Reserve Bank (SARB) using Vector Autoregressive modelling from 1990 to 2013. The paper is organised as follows: section 2 presents the overview of capital regulation in South Africa. Section 3 examines the theoretical foundation of bank capital procyclicality. The methodology and result are discussed in sections 4 and 5 while section 6 concludes the study.

2 THEORETICAL ISSUES IN BANK CAPITAL PROCYCLICALITY

2.1 Capital requirements and bank portfolio behaviour

Bankers are usually seen as custodians and handlers of portfolios of assets, hence the major goal of bankers is to decide on the optimal asset ratio that will maximise their profit and at the same time cater for the depositors' funds and maintain the shareholders market value. VanHoose (2007) explained the rationale behind the portfolio theory by assuming that banks as “managers of portfolio of assets” usually respond to any constraint in capital requirement by modifying their selection of asset portfolio or their “portfolio leverage (asset-capital) ratio” (VanHoose, 2007: 3682). For instance, a binding capital requirement on a bank’s portfolio usually constrains the leverage ratio of the bank which ultimately impacts the “bank’s efficient asset investment frontier”. The bank will respond to this tightening in leverage ratio by manipulating the mix of assets in its “portfolio per unit of capital” (VanHoose, 2007). VanHoose further explained that portfolio selection is usually determined by the degree of “risk aversion” across banks.

It is important to establish that banks’ behaviour and their response to the restrictions of capital requirements is also dependent on the level of risk each bank allows on their balance sheet. However, for capital requirements to influence banks’ portfolio selection and reduce the level of risk taken by the banks, the underlying bank must be exposed to asset regulation (Kahane, 1977). It is interesting to note that Basel I was introduced to tame and influence most banks’ portfolio selection by imposing risk weights for different levels of banks’ assets. However, studies have shown that increases in capital requirements do not necessarily result in a reduction in banks’ high-risk assets. Some of the major seminal works of Sharpe (1978), Santomero and Watson (1977), Koehn and Santomero (1980) and Kim and Santomero (1988) have established the effect of binding capital regulation on the behaviour of banks in terms of increasing their portfolio risk. They further agreed that most banks will respond to higher capital requirements by choosing a riskier “portfolio of asset mix” prior to the increase in capital requirement. Consequently, such action by the banks can render the intentions of capital regulation futile and at the same time create instability in the financial system.

Giovanoli (2009: 82) observed that most financial and international regulation was established as a “child of crisis”. He observed that the “modern banking supervision” was developed after the “Great Depression” of the 1930s; similar cases were the Euromarkets after the collapse of the Bretton Woods system and then the establishment of the BCBS after the collapse of the Herstatt Bank in 1974. The International Financial Architecture (IFA) was established in 1999 after the 1998 Asian Crisis. The FSB was formed by the G20 in response to the global financial crisis of 2008 and 2009. It appears that after every circle of crisis, there is a new regulation. It can be observed that banks’ behaviour regarding capital requirements and their effectiveness in maintaining stability on the banking system is dependent on banks’ affinity to take on riskier assets.

The introduction of strict capital requirements could make some banks respond by investing in safer assets, while other banks could invest in riskier assets. Hence, the response of banks is not homogenous. Some choices will make the system stable, while others leave it unsecured (VanHoose, 2007). A bank that likes to take risks will choose a riskier portfolio of assets that will be detrimental to the net worth of the bank. Koehn and Santomero (1980) considered a mean variance method of portfolio selection to determine whether capital requirement would augment the risk conduct of banks. They believe that an increase in capital requirement reduces the profit of the banks and might induce banks to invest in riskier assets. This is usually called “the expected income effect” (Koehn and Santomero, 1980: 1235). Kim and Santomero (1988) used a mean variance model to examine the effect of capital asset ratio on the risk propensity of banks but in their case they considered the role of an “inefficiently priced” deposit insurance and how it promotes risk-taking behaviour of banks because it ignores the individual banks’ optimal capital structure (Kim and Santomero, 1988: 1231). Santos (2000) established that “deposit insurance” is effective in preventing bank runs and protecting depositors funding. However, deposit insurance companies also encourage banks to invest in risky assets which elicit more problems of moral hazard from the banks (Santos, 2000: 16). Merton (1977), Pyle (1986), Kane (1990) and Keeley and Furlong (1990) have also all established deposit insurance deficiency as reducing moral hazard from the banks. Deposit insurance firms are usually insensitive to risk-taking by banks. This emanates from having an “unfairly priced deposit insurance premium” that encourage the arbitrage of banks to take on more risk. The weakness of deposit insurance has generated argument on the issue of “too big to fail” or “too interconnected to fail” justification of bailing out large banks who deliberately invest in risky assets in the hope that public bailout will be available when they become insolvent. Deposit insurance is not relevant to this study because South Africa has not established deposit insurance as a requirement for banks in South Africa, hence this study does not examine the role and impact of deposit insurance.

Furlong and Keeley (1989) have a different view about the impact of capital regulation on banks’ behaviour. They criticised Koehn and Santomero (1980) for using an incompatible mean-variance framework for measuring banks’ returns in times of crisis. Their analysis shows that capital regulation ratios can reduce the risk incentive of the banks by integrating the value of deposit insurance into the state preference model. They argue that an increase in capital should be an added incentive for bankers to be prudent in asset selection because banks will have to provide for the loss of capital when they default. Furlong and Keeley(1989) also examined the balance sheet impact of capital regulation and concluded that in the presence of efficiently valued deposit insurance, capital regulation will cause banks to diversify their portfolio and ultimately reduce risk conduct of banks. Gennotte and Pyle (1991) concluded that the effect of capital regulation and deposit insurance on a bank's portfolio behaviour is usually equivocal when the bank's marginal costs rise as the portfolio of assets (which is a combination of safe and riskier assets) increases. But if the bank responds by investing more in risky investments then the capital tightening will have an increased tendency to for the bank to go bankrupt (Furlong and Keeley, 1989: 889; Flannery, 1989: 256; Gennotte and Pyle, 1991: 820; VanHoose, 2010: 143). The exact nature of the relationship between bank regulation and portfolio behaviour is inconclusive and this research attempts to shed more light on the debate.

2.2 Capital requirement and incentives

The school of thought on capital regulation and incentives examined the way banks weigh the benefits of lending and making profits against the costs of breaking the capital regulatory rules on banks' balance sheet. They consider different options before adhering to the capital regulation. Most of the models assume that banks are "forward looking optimizers" (VanHoose, 2007: 3685). However, capital regulation usually keeps a close watch on banks and penalties are levied on banks that default on capital regulation rules.

Diamond and Rajan (2000: 43) asserted capital requirements can implicitly affect the credit flow and even make the bank riskier especially when bank take some radical actions meet all obligations, these can later escalates to induce credit crunch in the real sector . Milne (2002:9) believes that prudential bank supervision has a limited capacity to "monitor banks continuously", hence can only impose some strict penalties on banks. However, these strict penalties are only used as an "incentive mechanism" to encourage banks to adhere to rules of capital regulations. Milne further argued against previous studies that view capital regulators as "strictly binding" on banks. He believes that prudential bank supervision can only influence the portfolio choice of banks in reducing the "expected future cost on debt" and equity finance of the banks. He gave examples of how some banks will shift their portfolio choice in lending to large corporate organisations such as the OECD government bond compared to giving loans to small and medium scale enterprises (Milne, 2002: 2-9). However, Blum (1999) using a dynamic model confirmed that capital adequacy will encourage excess risk-taking by banks because most bankers are more interested in maximising profit.

Estrella (2004b) examined a model where the regulators follow three stages to ensure banks adhere to the minimum capital rules. The higher a bank's capital, the easier it becomes for the banks to meet the regulator's mandate. In the first stage, the regulator applies public information and quantitative capital requirements to determine whether banks meet the minimum capital requirement. Therefore, at this stage most banks are focused on adhering to the minimum capital requirement. The model further assumes that banks' capital can be raised both internally through retained earnings and externally through the financial market. At this stage, any bank that defaults from the minimum capital benchmark is closed. In the second stage, most banks that passed the first stage can implicitly raise capital to invest in risky investment assets given their limitation to meet the minimum capital requirement. In the final stage, the banks should report to the regulator "voluntarily" whether they have adhered strictly to the minimum capital rules or have failed. At this stage, it is left to the banks to decide on the information they may share with the regulator whether it is veracious or not. Implicitly at these three stages, some banks might be able to meet the minimum capital requirement and use their funding to invest in risky investments while some banks might close due to insufficient funding (Estrella, 2004b: 146–147).

Estrella's model believes that banks have the incentives to adhere strictly to regulators' rules based on the strict penalties and tight market surveillance from the regulator. However, during business downturns, when most banks are faced with low solvency ratios, there are usually high levels of defaulters and liquidity problems which might create a crisis and render the Basel rules ineffective due to information asymmetry and voluntary disclosure from the banks.

3 METHODOLOGY

3.1 Model specification

The model attempts to capture the relationship between bank regulation and the business cycle following Berger and Udell (1994), Stolz (2007), VanHoose (2010) and Drumond (2010). It is assumed that capital buffers force banks to hold equity that they would otherwise not hold to enhance financial stability and prevent banks from taking "excess risk" that can lead to bank crises which may accentuate a business cycle. However, the cost of capital to most banks is drastic because its increase may accentuate the procyclical tendencies of the banking sector. The model estimated in this work tries to capture the co-movement of banks' capital regulation and the business cycle by modifying the empirical works of Watanabe (2005) and Seo (2013). The model is designed for the verification of the procyclicality hypothesis. The Vector Autoregressive model and Vector Error correction model (VAR/VEC) are adopted in this study because a contemporaneous relationship might exist between the business cycle and capital adequacy in the analysis and this model provides an avenue for resolving such a relationship. The risk-based capital (RBC) standard bank capital regulation played a predominant role in Watanabe's (2005) framework[3].

The model estimated is of the form:

Equation 1

$$\text{In}COIN_t = \propto_o + \propto_1 InCOIN_{t-1} + \beta CAR_{t-1} + \gamma\, DUM_{crisis} + \partial \text{M3}\_GDP_{t-1} + \propto_3 X_t + \varepsilon_t \qquad \ldots..1$$

Where the dependent variable $(COIN_t)$ is the coincident business cycle index, (CAR_{t-1}) captures the book-based ratio value of the Capital Asset ratio at time t-1 while (M3_GDP_{t-1}) measures the money supply to GDP at time t-1, (money supply to GDP is included based on previous studies and estimations where monetary policy is established to affect the business cycle). (DUM_{crisis}) represents dummy variables that captures crisis periods (mainly the global financial crisis of 2008 and 2009) while other control variables are captured by (X_t).

Co-integration analysis and VEC models accompanied by impulse responses and variance decomposition were employed in the analysis of interaction between capital regulation and the business cycle. The data set for the study covers 23 years from 1990Q1 to 2013Q4. This period was covered because at least two of the banking crises are included in the period (Asian Crisis, 1997–1998 and Global Financial Crises, 2007–2009) and to incorporate the introduction of the Basel regulations in South Africa. The financial variables and control variables were obtained from SARB.

Figure 1 shows a stylised picture of the movement between the business cycle index and capital adequacy ratio in South African banks. One can observe a correlated movement in the coincidental index and the regulatory Tier 1 capital to risk-weighted assets.

[3] The effect of capital regulation on credit crunch is investigated in another paper. This study will focus mainly on capital regulation, the business cycle and banking instability.

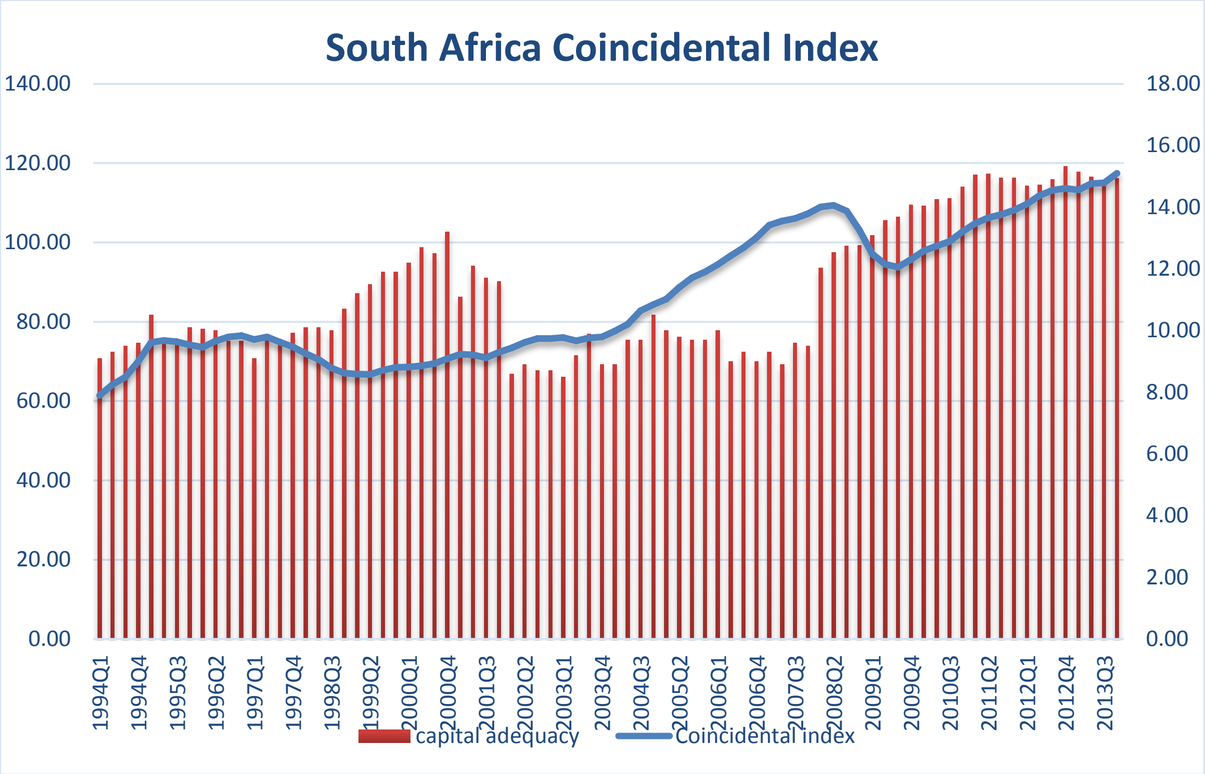

Figure 1: Trends showing the relationship between the business cycle index and capital adequacy regulation in South Africa

Source: SARB (2014)

Table 1 :Definition of Variables

VARIABLES	A PRIOR EXPECTATION	DEFINITIONS AND SOURCES
Business Cycle Proxies	(+/-): We expect the business cycle to vary with capital regulation.	The South Africa Composite coincident index captures the business cycle in South Africa (SARB).
Consumer Price Index (CPI)	(-): We expect inflation and the business cycle to move in opposite directions.	CPI inflation index captures increase in general price level of goods and services in South Africa.
Financial condition Index (FCI)	(+): We expect financial condition index to move directly with the business cycle.	The Financial Condition index is a composite of five-time series: real effective exchange rate, earning yield on shares, real interest rate, money supply growth and yield curve for South Africa.
Capital Adequacy ratio (CAP_ADE)	(+): We expect the capital adequacy ratio to move with the business cycle.	CARt captured the regulatory element Book based ratio (Tier 1 measure in the Basel Accord) for South Africa.
Operating expenses	(-): We expect operating expenses and the business cycle to flow in opposite directions because operating expense will affect profit adversely.	Operating expenses captured the total operating expense to total assets in South Africa commercial banks. The variable is pertinent to measure the significance of transaction and monitoring cost in the banking system.
Net interest margin	(-): We expect net interest margin and the business cycle to flow in opposite directions because a negative net interest margin will affect profit adversely.	Net interest margin is a performance meter that examines the success of banks' investment and earnings.
M3 to GDP	(+/-): We are interested in the co-movement of the business cycle and money supply.	The ratio of money supply(M3) to GDP in South Africa

4 MODEL ESTIMATION AND DISCUSSION

This study employed the VAR based co-integration and VEC models accompanied by impulse response and variance decomposition. In estimating the VAR, this study considers the fact that most macroeconomic variables are usually non-stationary at level, hence we employ VAR based co-integration test using the methodology developed by Johansen (1995).

The purpose of cointegration tests in this study is to measure whether a long-run relationship exists between financial regulation and the business cycle. Similarly, we also want to ascertain whether periods of financial crises coincide with periods of financial regulation in South Africa. Co-integration will also be tested to determine the need to use a VEC model.

Table 2 shows the pair-wise contemporaneous correlation matrix for the residuals of the variables. The largest observed correlation is between the FCI and money supply to GDP ratio which is (-0.36). There is a negative relationship between the crisis period dummy variable and the business cycle showing -0.1590 in Table 2. It is also worth noting that there is a positive and strong correlation between capital adequacy and the business cycle (0.1750). The correlation matrix further strengthens the evidence that there is apparently a relationship between the business cycle, capital adequacy and financial crisis periods. This shows that there may be some common trends driving these variables.

Table 2: Residual Correlation Matrix

Variable	**INCOIN_INDEX**	**CAP_ADE**	**M3_GDP**	**OPE_EXP**	**DUMMY1**	**CPI**	**INFCI**
INCOIN_INDEX	1.0000	0.1750	-0.2144	0.0477	-0.1590	-0.0427	0.0068
CAP_ADE	0.1750	1.0000	-0.2317	-0.0115	0.0664	0.1967	-0.0411
M3_GDP	-0.2143	-0.2317	1.0000	-0.1762	0.0690	-0.1569	-0.3601
OPE_EXP	0.0477	-0.0115	-0.1762	1.0000	0.1217	0.1447	0.2295
DUMMY1	-0.1590	0.0664	0.0690	0.1217	1.0000	0.0381	0.0994
CPI	-0.0427	0.1967	-0.1569	0.1447	0.0381	1.0000	-0.3036
INFCI	0.0068	-0.0411	-0.3601	0.2295	0.0994	-0.3036	1.0000

Source: Author’s computation

Covariance analysis exemplifies the linear association between two variables: in other words, how a change in one variable can be linearly connected with a change in another variable. Covariance analysis is essential in this case because of the contemporaneous correlation between the macroeconomic variables, especially the relationship between capital adequacy and business cycle variables. The Covariance Analysis depicts the covariance, t-statistics and p-value between two variables. The t-statistics and p-values are designed to measure the extent of the correlation between two variables. In other words, if the p-value is 0.01 then one can be 99% confident and conclude that there is a correlation between two variables.

Table 3: Covariance Analysis

Covariance Analysis: Ordinary shows Covariance, t-Statistic, Probability values consecutively							
	CAP_ADE	CPI	DUMMY1	INCOIN_INDEX	INFCI	M3_GDP	OPE_EXP
CAP_ADE	4.778529						

CPI	-0.842036	7.453326					
	-1.258700	-----					
	0.2119	-----					
DUMMY1	0.008475	0.356135	0.174375				
	0.082001	**2.904309**	-----				
	0.9349	**0.0048**	-----				
INCOIN_INDEX	0.236634	-0.043554	-0.012020	0.035115			
	6.250288	-0.754639	-1.372921	-----			
	0.0000	0.4527	0.1737	-----			
INFCI	-0.034901	-0.054118	0.000592	-0.006826	0.004304		
	-2.215901	**-2.799323**	0.190729	**-5.895523**	-----		
	0.0296	**0.0065**	0.8492	**0.0000**	-----		
M3_GDP	0.553009	-0.143514	-0.015063	0.060880	-0.012392	0.120383	
	9.409192	-1.353718	-0.923221	**23.55856**	**-5.731660**	-----	
	0.0000	0.1797	0.3587	**0.0000**	**0.0000**	-----	
OPE_EXP	-0.871130	0.292978	0.017834	-0.108043	0.024390	-0.224346	0.500175
	-6.023822	1.355828	0.534313	**-12.43288**	**5.457375**	**-19.93234**	-----
	0.0000	0.1791	0.5946	**0.0000**	**0.0000**	**0.0000**	-----

Source: Author's computation

Table 3 shows the covariance analysis between two variables. There is a high correlation between the capital adequacy and the business cycle (t-statistics value is 6.25). There is also a negative and high correlation relationship between the FCI, capital adequacy and the business cycle (t-statistics:-2.21,-2.79 and -5.89) respectively (see Table 3). Covariance analysis further strengthens the evidence that apparently there is an association between the business cycle, capital adequacy and financial crisis periods.

4.1 Unit root tests

The KPSS test is presented in Table 4. The KPSS test and Ng-Perron stationary test are improved versions of unit root test. They are more powerful tools in testing whether unit roots exist in variables of interest. However, under KPSS tests, the data usually appear stationary by default if there is little information in the sample (Brooks, 2008: 331). Both Ng-Perron and KPSS tests were conducted to ascertain the unit root properties of the variables in the model. Maddala and Kim (1998) suggested that an important way of overcoming the problem of failing to reject a null hypothesis when it is false is to use different tests and compare them. The result of KPSS and NG Perron unit root tests are given in Tables 4 and 5.

Table 4: KPSS Stationarity test result

Variables	Levels		First Difference	
N zaresther	Intercept	Intercept & Trend	Intercept	Intercept & Trend
M3_GDP	1.244324	0.296383	0.508676**	0.115903***
INFCI	0.814908	0.034554**	0.039611***	
COINCIDENT_ INDEX	1.128096	0.201531	0.241803***	0.052158***
CPI	0.728035	0.198394*	0.198394*	0.025776***
CAP	0.674726**	0.195646**	0.113248	0.071354
INT_MARGIN	0.274496**	0.293988		
OPE_EXP	1.131878	0.112481***	0.500000***	

For KPSS: Null hypothesis is stationary. (*, **, *** is not significant at 1%, 5% and 10% respectively)

Source: Author's computation

Table 5: NG Perron stationarity test

Variables	**Levels**		**First Difference (MZa)**	
	Intercept	**Intercept & Trend**	**Intercept**	**Intercept & Trend**
M3_GDP	1.94721	-1.73179	-26.9034***	-33.9228***
INFCI	-7.37848*	-160.084***		
CAP_ADE	-0.96209	-5.89478	-37.8720***	-37.7116***
OPE_EXP	-1.17010	-5.89478		-37.7116***
INT_MARGIN	-11.8124**	14.9019*		
CPI	-2.14865	-26.2613***	-17.6831***	
COINCIDENT_INDEX	-0.47803	-0.47803	-21.9067***	-24.8510***

Note: *, **, *** implies significance at 10%, 5% and 1% level using Modified Philips Peron test (MZa)

Source: Author's computation

The unit root tests conducted revealed all variables have unit root in their levels except operational expenses which is I (0), thus these I(1) variables have to be differenced to ensure stationarity. This result is confirmed by using KPSS and NG Perron tests.

4.2 Optimal lag length selection

Table 6: VAR Lag Length Selection Criteria Results

VAR Lag Order Selection Criteria Endogenous variables: INCOIN_INDEX CAP_ADE INFCI M3_GDP CPI						
Lag	LogL	LR	FPE	AIC	SC	HQ
1	440.4850	NA	7.84e-12	-11.38315	-10.59875*	-11.07055
2	484.1994	75.45227	4.73e-12	-11.89587	-10.32707	-11.27068*
3	507.1675	36.49730	5.11e-12	-11.84021	-9.486994	-10.90241
4	532.7252	37.11111	5.25e-12	-11.85548	-8.717869	-10.60509
5	576.9785	58.19608*	3.33e-12*	-12.38297*	-8.460952	-10.81998
6	591.6847	17.32519	4.95e-12	-12.10095	-7.394528	-10.22536
7	621.1882	30.71599	5.18e-12	-12.22434	-6.733508	-10.03615

Source: Author's computation

Having tested for unit roots, the next step is to conduct the cointegration test to establish whether a long-term relationship exists among our variables of interest. However, the Johansen cointegration test requires that we first determine the optimal lag length for the model. The choice was made by examining the lag structure in an unrestricted VAR originally specified using maximum number of lags (7) and using VAR lag order selection criteria.

The widely-used information criteria are the AIC, SIC, HQIC, FPE and LR tests. More fundamental is the fact that lag length selected must conserve degrees of freedom. Table 6 shows that LR, AIC and FPE choose lag 5 while SC and HQ choose lag 1 and lag 2 respectively. We choose the optimal lag length 5 after checking each lag length for stability and ensuring that lag length 5 meets all the criteria.

Table 7 summarises the stability test for the VAR residual test for the model when lag 5 was picked. The probability result for LM serial correlation test for lag 5 is 0.7729. We can reject the null hypothesis that there is serial correlation in the model because the probability value is less than 0.05. Similarly, in the case of the joint residual heteroskedasticity test, the result shows a probability of 0.2024. We can also reject the null hypothesis that there is heteroskedasticity in the model (in other words the residuals are jointly correlated). The model also passed the normality test given the probability value of 0.1115.

Table 7: VAR Residual Stability Test

Stability test for VAR Residual	Probability Result
Residual Serial correlation LM Test	0.7729
Residual Joint Heteroskedasticity Test	0.2024
Residual Joint Normality Test	0.1115

Source: Author's computation

4.3 Cointegration analysis

We are interested in the co-movement of capital regulation and the business cycle. We also want to ascertain whether there is a long-run relationship between capital adequacy requirement, financial crisis and the business cycle. Cointegration analysis is a good tool that will help us to investigate the long-run relationship among these non-stationary variables. This study employs Johansen and Juselius's (1990) cointegration approach to examine the long-run relationship. The model considers the effect of the intercept and trend. The result of the Trace and Max-Eigenvalue statistics are reported in Table 8.

Table 8: Johansen Cointegration Trace Test results

Hypothesized No CE(S)	Max Eigenvalue Statistics	Critical values (5%) Trace	Hypothesized No CE(S)	Trace Statistics	Critical values (5%) Trace
None**	44.31348	33.87687	None**	84.92212	69.81889
At most 1**	23.43228	27.58434	At most 1**	40.60864	47.85613
At most 2**	10.71235	21.13162	At most 2**	17.17636	29.79707

*(**) denotes rejection of the hypothesis at the 5% level
Trace test indicates 1 cointegrating equation at 5% level
Source: Author's computation

Trace value: Using a sequential testing procedure in Table , r=0 (no cointegrating vector) against the alternative of at most one cointegration vector (r≤1), the trace test statistic is 84.922, which is greater than the 95% critical value of 69.819, thus we reject the null hypothesis of no cointegrating vectors. We now move on to the next row, the trace test statistics (40.608) are less than the critical values of (47.856), so that the null hypothesis of at most one cointegrating vector is not rejected.

Eigen value: Using a sequential testing procedure in Table 8, r=0 against the alternative of at most one cointegration. The test statistic 44.313 is greater than 33.877 at 95% critical value, thus we reject the null hypothesis of no cointegrating vectors. We now test the null hypothesis of at most one cointegration vector, where eigen values test statistics (23.432) is greater than (27.5843). The null hypothesis of at most one cointegrating vector is accepted. We accept that there is at least one convector. The result shows that at least one cointegrating equation was reported by both trace test and maximum eigenvalues statistics. This result further supports that there is a long-run relationship among the variables and also suggests the suitability of using the VECM. A stability test is required to ensure that the residuals of the model are not serially correlated in the long run. We further conducted a robustness test to avoid spurious regression in the model. Table 9 summarises the stability test for the VEC residual test. The probability result for the LM serial correlation test is 0.2537. We can reject the null hypothesis that there is serial correlation in the model because the probability values are less than 0.05. Similarly, in the case of the joint residual heteroskedasticity test, the result shows a probability of 0.6699. We can also reject the null hypothesis that there is heteroskedasticity in the model.

Table 9: VEC Residual Stability Test

Stability Test for VEC Residual	Probability Result
Residual Joint Normality Test	0.3427
Residual Serial correlation LM Test	0.2537
Residual Joint Heteroskedasticity Test	0.6699

Source: Author's computation

We tested the VAR for heteroskedasticity, normality and serial correlation to ensure that our model is stable and the residuals of the model are not serially correlated in the long run.

4.4 Vector Error Correction Model

We estimated a Vector error correction model (VECM) and normalized[4] on coincident index where we express the business cycle (coincident index) as a function of the remaining variables. The result shows that capital adequacy has a positive and significant long-run impact on the business cycle. FCI is also found to be positive but not significant in the long run.

Table 10: Vector Error Correction Estimates

Vector Error Correction Estimates **Standard errors in ( ) & t-statistics in [ ]**							
Cointegrating Eq:	**INCOIN_ INDEX (-1)**	**CAP_ADE (-1)**	**INFCI(-1)**	**M3_GDP(-1)**	**CPI(-1)**	**@TREND(90Q1)**	**C**
CointEq1	1.000000	-1.045590	-2.357023	-4.020617	0.857822	0.147473	-9.603842
		(0.26030)	(9.98440)	(5.52832)	(0.32447)	(0.09727)	
		[-4.01682]	[-0.23607]	[-0.72728]	[2.64379]	[1.51616]	
Error Correction:	**D(INCOIN_INDEX)**	**D(CAP_ADE)**	**D(INFCI)**	**D(M3_GDP)**	**D(CPI)**		
CointEq1	-0.003887	-0.134412	0.013814	0.000220	-0.115593		
	(0.00159)	(0.07621)	(0.00285)	(0.00123)	(0.11073)		
	[-2.44047]	[-1.76362]	[4.84898]	[0.17954]	[-1.04389]		

Equation 2:

The long-run regression is provided in Equation 5.2.

$$\mathrm{INCOIN_t} = 9.604 - 0.147\, TREND_t\ [1.52] + 1.046\, CAP_t [4.02]$$

$$- 0.858\, CPI_t [-2.64] + 4.020 M3\_GDP_t [0.73] + 0.232 INFCI_t [0.24] \qquad \text{....2}$$

Note: t values in [ ] square brackets.

The indication from the cointegration relation is that capital adequacy has a significant long-run impact on the business cycle. This is indicated by the reported coefficient 1.046 and the t statistics test of 4.017. The coefficient of the error correction terms is interpreted as the speed of adjustment to the long-run equilibrium. The coefficient of the error correction term of the business cycle is negative, which implies that any disequilibrium to the composite coincident index might be persistent for some time. The speed of adjustment of coincident index to its

[4] For more details on the VECM approach and normalisation see Endresz (2011) and Harris and Sollis (2003)

own long-run equilibrium is slow, as shown by the adjustment coefficient. Every quarter just over 0.3% of the disequilibrium in the business cycle is adjusted back to equilibrium. The stability of the VECM is checked again after identifying our model to ensure there is no serial correlation and heteroskedasticity problem.

Tables 13 and 14 show the dynamic causal interaction between the business cycle and capital regulation in a VEC form. This allows us to access the causality from one variable to the other using the chi-square test of the lagged first differenced terms. The weak exogeneity test allows us to ascertain the direction of causality in the VECM framework. The weak exogeneity test was carried out following Demetriades and Hussein (1996) and Arestis and Demetriades (1997), where restrictions are placed on each variable in the system to determine which is endogenous. In the business cycle model, the causality between the business cycle and capital adequacy was assessed and established. There is a bidirectional relationship between bank capital adequacy and the business cycle in South Africa, which indicates that there are significant linkages between capital adequacy and the business cycle in the long run.

4.5 Impulse response analysis

Impulse response functions also show the dynamic responses of a dependent variable in this case coincident index to a one-period standard deviation shock to the innovations of each variable determinant, in particular the capital adequacy. To investigate the potential dynamic impact of the capital regulation shock, impulse response analysis is conducted. These impulse response functions show the dynamic response of the coincident index ratio to a one-period standard deviation shock to the innovations of the system and also indicate the directions and persistence of the response to each of the shocks over a 10-quarter period. We applied the generalized impulses which builds an “orthogonal set of innovations that does not depend on the VAR ordering” where the ordering of variables is not very sensitive to the choice of ordering.

Figure 2A shows the effect of capital adequacy shock on the business cycle in South Africa. Figure 2A shows that the response of the business cycle to one standard deviation shock of capital adequacy is negative and persistent for over 25 quarters before stabilising. This vividly shows the procyclicality effect of the business cycle.

Figure 2B shows that the response of the business cycle to one standard deviation shock of FCI is positive and persistent for over 20 quarters before steadying. The impulse analysis also supports the volatility in the financial system in South Africa when there is a global financial crisis. The effect of the response of capital adequacy to one standard deviation shock of FCI is also negative and persistent for 20 quarters, as is depicted in Figure 2C. Figure 2D shows the response of the business cycle to one standard deviation shock of consumer price index is also negative and tenacious.

The results of the impulse response test show that the impact of capital adequacy shock is persistent and lasting. This result further confirms the assertion in theory that capital adequacy amplifies the business cycle. The focus of this study is not just on the capital adequacy but also in the relationship between crisis periods and business cycle variables. The impact of the FCI is significant and persistent. Shocks to the FCI might reflect an increase in fragility or financial crisis by the business cycle variable. In addition, we also tested for the relationship between price stability, the business cycle and financial crisis period. There are a number of reason shocks to FCI might reflect an increase in fragility by the business cycle. First, financial fundamentals are vulnerable to fluctuation in money value and economic condition. Similarly, any case of asset price misalignment or excessive growth boom will ultimately amplify the business cycle. South Africa went through a period of turmoil after the global finance crisis of 2008 where there was a concomitant reduction in private credit to GDP and money supply. The result is also shows that the "risk taking" channel and the credit channel play a vital role in the transmission of monetary policy in South Africa.

Figure 2A: Response of INCOIN_INDEX to Generalized One S.D. CAP_ADE Innovation

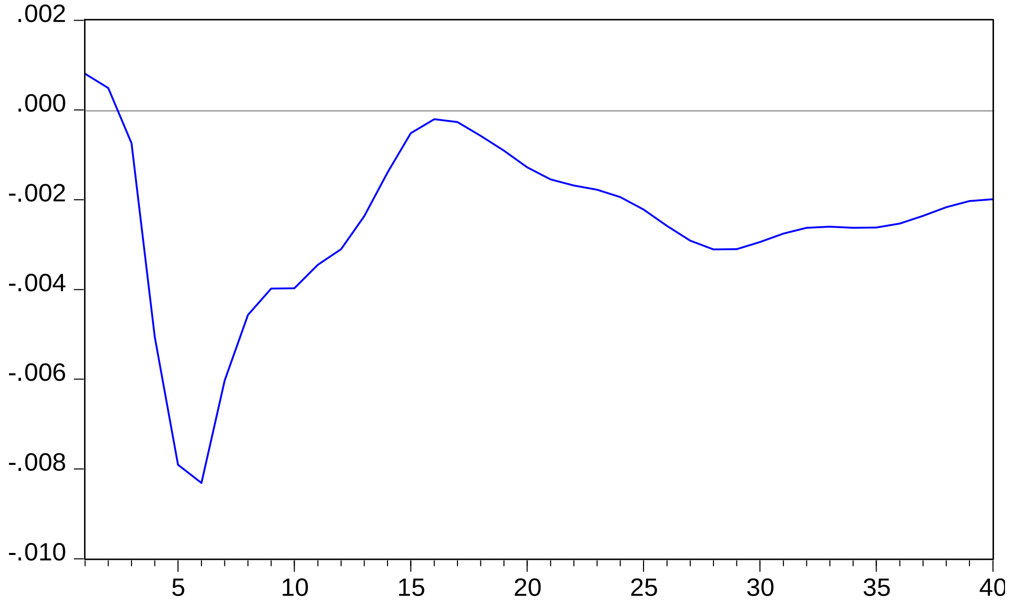

Figure 2B: Response of INCOIN_INDEX to Generalized One S.D. INFCI Innovation

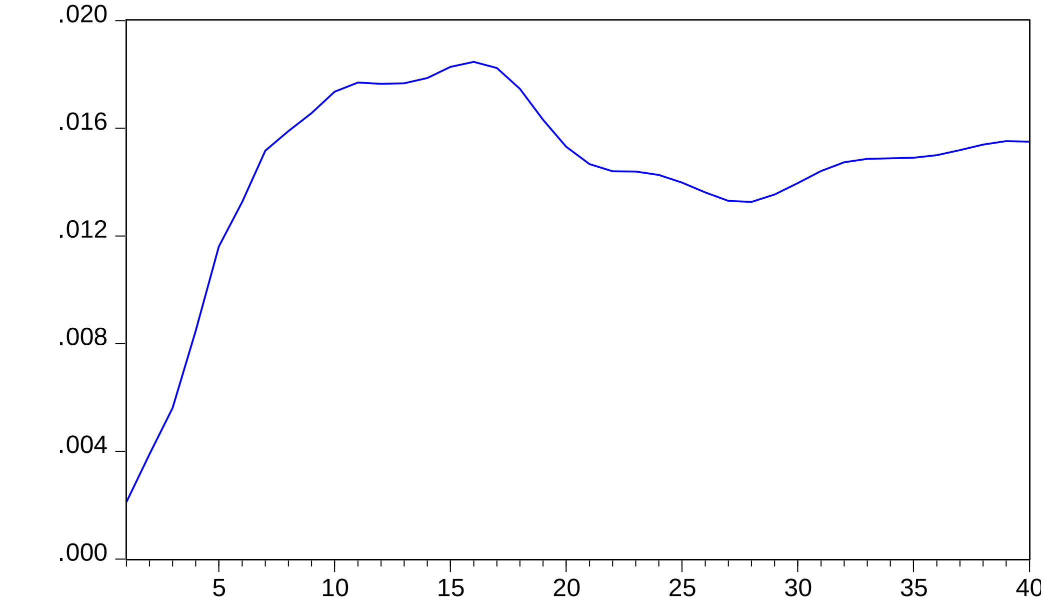

Figure 2C: Response of CAP_ADE to Generalized One S.D. INFCI Innovation

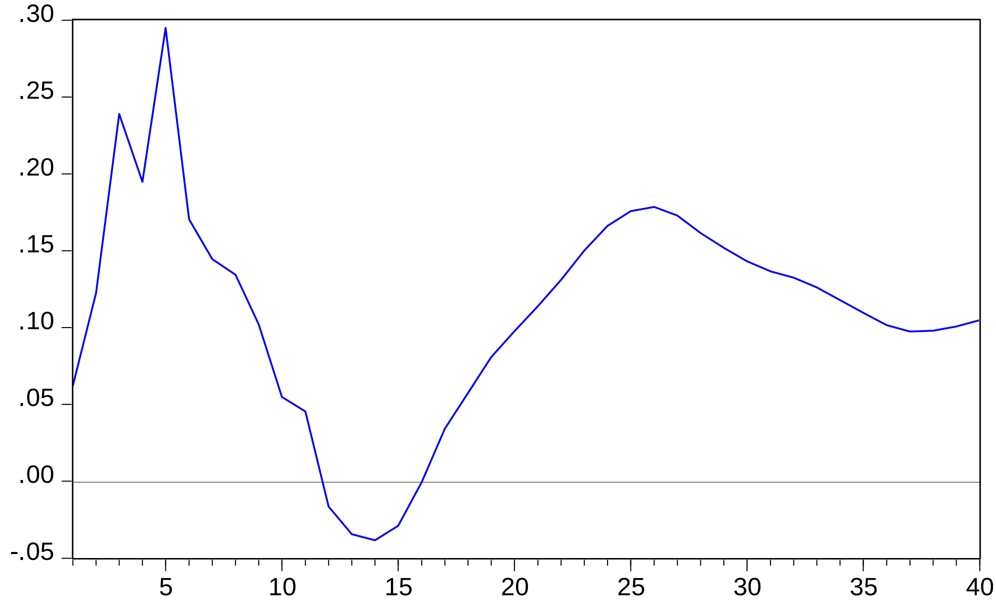

Figure 2D: Response of INCOIN_INDEX to Generalized One S.D. CPI Innovation

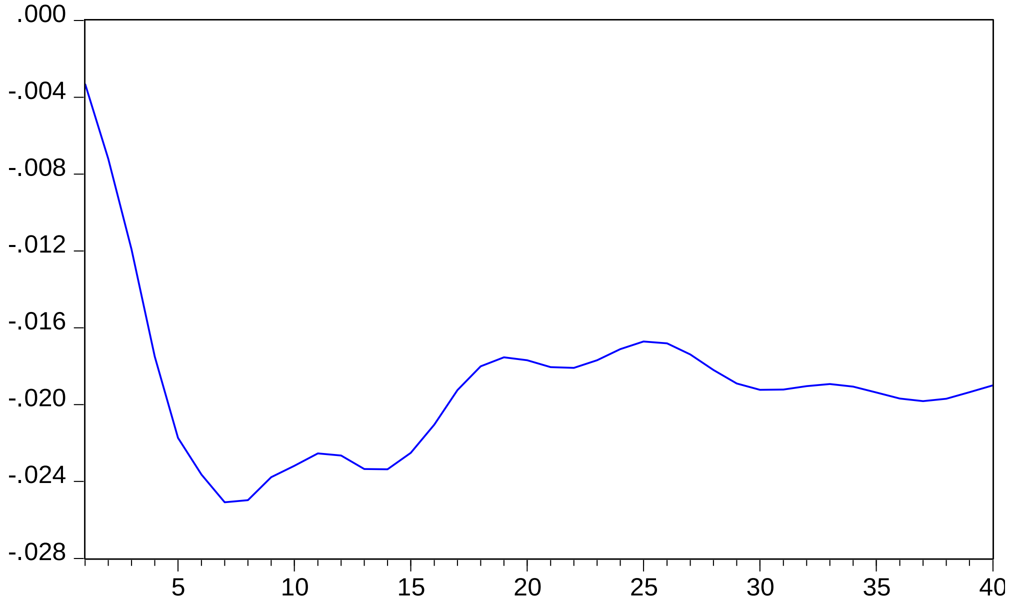

Figure 2: Response of the business cycle to a one period shock to capital regulation and Financial Condition Index

Source: Author's computation

4.6 Variance Decomposition

Variance decomposition measures the forecast error variance of any variable, explained by innovations to each explanatory variable over a series of time horizons to a system when a shock is applied. In summary, this technique shows the relative importance of each random innovation to each explanatory variable over a series of time horizons. Variance decompositions performed on the VECM may provide some information on the relative importance of shocks to the independent variables in explaining variations in the dependent variable. In the context of this study, it therefore provides a way of determining the relative importance of shocks in explaining variations in capital adequacy and the business cycle. The results of the variance decomposition analysis are presented in Table 11 and show the proportion of the forecast error variance in the business cycle explained by its own innovations and innovations in its determinants.

Table 11: Variance Decomposition of business cycle, capital adequacy using the model with financial condition index and money supply

Variance Decomposition of INCOIN_INDEX						
Period	**S.E.**	**INCOIN_INDEX**	**CAP_ADE**	**INFCI**	**M3_GDP**	**CPI**
1	0.011960	100.0000	0.000000	0.000000	0.000000	0.000000
5	0.060090	86.68579	4.408034	1.850746	0.554043	6.501386
10	0.104348	79.43401	4.259616	5.975657	0.800418	9.530298
15	0.129976	74.64613	3.275929	9.268657	2.403288	10.40600
20	0.146748	71.56248	2.689276	11.50455	4.285665	9.958024
Variance Decomposition of CAP_ADE						
Period	**S.E.**	**INCOIN_INDEX**	**CAP_ADE**	**INFCI**	**M3_GDP**	**CPI**
1	0.572291	0.454263	99.54574	0.000000	0.000000	0.000000
5	1.222972	0.618425	80.45437	9.031647	5.690129	4.205428
10	1.681480	0.515338	70.25536	6.341431	15.09267	7.795205
15	2.123023	2.036998	51.47734	4.528151	33.01747	8.940045
20	2.573328	8.094486	38.68980	3.179431	43.44952	6.586761
Variance Decomposition of INFCI:						
Period	**S.E.**	**INCOIN_INDEX**	**CAP_ADE**	**INFCI**	**M3_GDP**	**CPI**
1	**0.021392**	**3.137463**	**0.941891**	**95.92065**	**0.000000**	**0.000000**
5	0.050352	2.194213	2.836395	47.64169	37.91571	9.411994
10	0.077204	8.717981	19.35428	22.11807	30.78752	19.02215
15	0.094600	7.092378	33.02272	17.47956	23.15303	19.25231
20	0.105610	5.863492	41.06146	14.31616	21.57053	17.18837

Source: Author’s computation

In the first quarter, all the variance in the coincident index is explained by its own innovations (shocks). Coincident index explains about 100 per cent of its variation, however, after a period of 6 quarters, the coincident index explains about 80 per cent of its own variation, while its determinants explain the remaining 20 per cent. The influence of the capital adequacy, FCI and inflation index increased gradually to about 24 per cent after a period of 13 quarters, explaining the largest component of the variation in the business cycle. Thus, the FCI explains the largest component of the variation in the business cycle, followed by the CPI. The result also shows evidence of a link between financial instability and price stability in South Africa.

Similarly, with both capital adequacy and FCI variance in the first quarter, 99 per cent of all the variance in the capital adequacy and dummy variance is explained by its own innovation (shocks). However, after 10 quarters the influence of the money supply, inflation and the business cycle increased drastically to about 30 per cent, showing that the business cycle influences bank capital adequacy. South African banks tend to change their behaviour during upturns and during downturns and procyclicality of South African banks tend to be associated with the function of the monetary policy, banks' monitoring costs and capital adequacy.

The result shows evidence of a link between financial instability and price stability in South Africa which is similar to the result of Blot *et al.* (2015). The result shows that the business cycle influences bank capital adequacy.

5 CONCLUSION AND POLICY RECOMMENDATION

The phenomenon of bank regulation procyclicality requires careful examination for both regulatory bodies and supervisory authorities given the salient role of the financial sector as an engine of growth to the real sector. Consequently, policies and regulations should be formulated in a way that will not hinder the financial deepening of the markets. Regulatory measures that promote excessive risk-taking during a crisis could have severe implications for the procyclical behaviour by most banks. We suggest that the South African economy needs forward-looking policies that will mitigate the flow of credit to the real sector and at the same time ensure financial stability.

The aim of this study was to examine the extent of linkages between the business cycle and capital adequacy requirements in South Africa employing the VECM framework. We want to understand the extent to which the imposition of capital adequacy can accentuate and deepen the business cycle in the financial system. The Johansen Cointegration approach was used to ascertain whether there is indeed a long-run co-movement between capital adequacy and the business cycle, but first we tested the stationarity of our series under the NG–Perron and KPSS framework, where we established that all the series were I(1), a property essential for cointegration analysis. Results from the tests and VECM model show that there are significant linkages among the variables, especially between capital adequacy and the business cycle. The impulse analysis result shows that the response of the business cycle to one standard deviation shock of capital adequacy is negative and persistent for over 25 quarters before stabilising. This shows the procyclicality effect of the business cycle. In other words, the imposition of a capital adequacy requirement can amplify the business cycle in South Africa. The result shows that fluctuation in the business cycle can be amplified by the bank capital adequacy requirements in South Africa. In other words, the imposition of a capital adequacy requirement can amplify the business cycle in South Africa.

Appendix

Table 12: Summary statistics of data employed, 1990q1 to 2013q

	INCOIN_INDEX	CAP_ADE	INFCI	M3_GDP	CPI	OPE_EXP
Mean	4.442427	11.31400	5.686373	0.653532	6.391250	3.574625
Median	4.344426	10.10000	5.693362	0.560254	6.116667	3.600000
Maximum	4.766155	15.33000	5.799658	1.245269	13.40000	5.000000
Minimum	4.117953	8.500000	5.549805	0.201373	0.433333	2.340000
Std. Dev.	0.188572	2.199777	0.066020	0.349152	2.747303	0.711692
Skewness	0.229124	0.553668	-0.293830	0.349031	0.155635	0.062083
Kurtosis	1.552067	1.812468	2.016208	1.596689	2.873911	1.875441
Jarque-Bera	7.688342	8.788083	4.377303	8.188580	0.375959	4.266831
Probability	0.021404	0.012351	0.112068	0.016668	0.828632	0.118432
Sum	355.3942	905.1200	454.9098	52.28255	511.3000	285.9700
Sum Sq. Dev.	2.809188	382.2823	0.344337	9.630637	596.2661	40.01399
Observations	80	80	80	80	80	80

Source: Author's computation

Table 13: Weak Exogeneity test

Variables	Chi-square	Probability	Outcome of the Variables
Coincident index	24.77407	0.000004	endogenous
Cap_ade	5.412031	0.066802	endogenous
M3_GDP	7.268079	0.026409	endogenous
INFCI	11.47413	0.003224	endogenous
Crisis Dummy	0.511877	0.774189	exogenous
CPI	1.433204	0.488409	exogenous

Note: We imposed restrictions on α (alpha restriction of the VECM) to be able to identify the endogenous variables and ascertain the robustness of our model.

Source: Author's computation

Table 14: Block Exogeneity Granger Causality Results based on VECM

Dependent Variable	Independent Variables χ-Statistics of lagged 1^{st} differenced term (p-value)						ECT$_{t-1}$ Coefficient (t-ratio)
	Δ In_Coin	**Δ M3_GDP**	**Δ Cap_ade**	**ΔFCI**	**Δ CPI**	**Δ Dummy**	
Δ In_Coin	--	8.999** (0.0611)	**14.626** (0.0055)**	9.590** (0.0479)	23.594** (0.0001)	21.295** (0.0003)	(-6.5196)]
Δ Cap_ade	**5.683** (0.2240)**	5.069** (0.2803)	--	20.156** (0.0002)	3.121 (0.5377)	3.238 (0.5188)	-
Note that ** denotes 5 % significant level and […] represents p-value.							

Source: Author's computation

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