CREDIT PROCYCLICALITY AND FINANCIAL REGULATION IN SOUTH AFRICA[1]

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Abstract

This study assesses the behaviour of credit extension over the business cycle in South Africa for the period 2000 to 2012 and is motivated by the proposal of the Basel Committee on Banking Supervision (BCBS) to use credit extension over the business cycle as a reference guide for implementing countercyclical capital buffers. Using a logistic smooth transition autoregressive model, we find that credit extension in South Africa increases during the trough phase of the business cycle, while this relationship becomes insignificant during the peak phase. The study also finds that credit extension decreases during the expansion phase of the business cycle, while it increases during the contraction phase. Thus, unlike previous studies for South Africa, we do not find any evidence that credit extension is procyclical and that the common reference guide for implementing countercyclical capital buffers should therefore be used with caution. The reason is that the BCBS's proposed measure of credit extension would suggest implementation of capital buffers during contractionary economic conditions and their withdrawal during expansionary economic conditions, which could have adverse consequences for macroeconomic stability.

Key words: credit extension, procyclicality, financial regulation

JEL: C32, E32, 61, G21

1 Introduction

The 2008 global financial crisis highlighted the vulnerability of the financial system and its ability to generate economic instability through endogenous credit booms. The reason is that the willingness of financial institutions to lend tends to increase during periods of booming economic conditions and to decrease in periods of weakening economic conditions. This procyclical behaviour of credit extension can have adverse implications for economic activity by amplifying the fluctuations in the business cycle and considerably prolonging and deepening recessions (Borgy, Laurent & Jean-Paul, 2009; Jeong, 2009). Thus, excessive credit extension due to imprudent and relaxed lending standards by financial institutions is the foremost predictor of financial crises (Guo & Stepanyan, 2011; Schularick & Taylor, 2012; Taylor, 2012). The rapid, uncontrolled liberalisation and deregulation of the financial sector preceding the financial crisis consequently necessitated a range of initiatives relating to regulatory, macroprudential and accounting principles in order to mitigate systemic risk in the financial system (Schularick & Taylor, 2012).

The Basel III policy framework was introduced in 2010 to further strengthen the financial system, while the United States (US) also introduced the Dodd–Frank Wall Street Reform and Consumer Protection Act in the same year (BCBS, 2010a; BCBS, 2011; United States Congress, 2010). The Basel III framework was specifically intended to improve the quality and quantity of bank capital, enhance liquidity and leverage ratios, broaden risk coverage, and supplement

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financial systems' stress-testing approaches. Countercyclical capital buffers, detailed in the guide by the BCBS (2010b), were among the key macroprudential policy proposals of Basel III designed to ensure that financial institutions have adequate capital to maintain the flow of credit during periods of broader financial-system distress (BCBS 2010a; BCBS, 2011). They are expressed as a ratio of financial institutions' risk-weighted assets, where, for instance, a standardised credit risk weight of 0 per cent is assigned to cash and guaranteed securities, 100 per cent to unsecured residential-mortgage exposures, with high-volatility, commercial real-estate loans being assigned a credit risk weight of 150 per cent of financial institutions' assets.

The BCBS (2010b) outlined specific procedures and provided general guidelines on how to operate countercyclical capital buffers, which were to be fully implemented by 2015. The proposal was to use the difference between the ratio of aggregate private-sector credit to gross domestic product (GDP) from its long-term Hodrick–Prescott (1997) trend as a common reference guide for the implementation of countercyclical capital buffers. Countercyclical capital buffers are to be set within the range of 0 and 2.5 per cent of risk-weighted assets, in addition to the normal mandatory capital-conservation buffers of 2.5 per cent. They are to be implemented incrementally when the gap between private-sector credit as a percentage of GDP and its long-term trend is between 2.5 and 10 percentage points. Specifically, a countercyclical buffer of 0 per cent will apply when the gap between private-sector credit as a percentage of GDP and its long-term trend is less than 2.5 percentage points, whereas a countercyclical buffer of between 0 and 2.5 percent applies when it is between 2.5 and 10.0 percentage points. Their operation is to be left to the discretion of relevant national authorities, depending on whether they see the systemic financial risks increasing or decreasing.

This study assesses the behaviour of credit extension over the business cycle in South Africa. This is achieved using the logistic smooth transition autoregressive (LSTAR) model that distinguishes between the peak and the trough phases, as well as the expansion and the contraction phases, of the business cycle. The motivation is that the financial crisis of 2007/2008 had uncovered substantial gaps in theoretical and empirical frameworks for monitoring, analysing and regulating systemic risk in the financial system. Thus, there exists a significant gap in the macroprudential approach to financial regulation, and this gap is to understand the nature and behaviour of credit extension over the business cycle (Tan, 2012; Hollo, Kremer & Lo Duca, 2012). Although Akinboade and Makina (2009, 2010) and Fourie, Botha and Mears (2011) find evidence of procyclicality of credit extension in South Africa, they do not use the BCBS's (2010b) proposed credit-extension measure for determining the level of countercyclical capital buffers. Thus, identifying and appreciating the behaviour of credit extension over the business cycle, whilst paying special attention to the proposals of the BCBS (2010b), are a high priority for researchers and policymakers and will provide important policy insights for future implementation of the capital buffers for financial institutions in South Africa.

The remainder of this paper is organised as follows. In the next section (Section 2), we discuss related literature. The data are discussed in Section 3. Section 4 outlines the econometric methodology. Section 5 discusses the empirical results, while Section 6 concludes the discussion.

2 Related literature

Empirical evidence on procyclicality of credit is mixed with the majority of studies finding evidence that credit extension is indeed procyclical across a number of developed and emerging economies and across different financial crises. Bouvatiery, Lopez-Villavicencioz and Mignonx (2014) investigate credit procyclicality using a two-regime, smooth-transition regression model that distinguishes between economic peaks and troughs for a sample of 17 Organisation for Economic Co-operation and Development (OECD) countries. They find that credit extension is procyclical in extreme peaks and troughs in the business cycle in Canada, the United Kingdom (UK) and the US, while it is not procyclical in one or both regimes in Australia, Belgium, France, Finland, the Netherlands, Norway, and Spain. Other studies that find evidence of credit procyclicality include those by Jeong (2009) in respect of Korea, Angelini and Panetta (2009) for six major developed economies, and Jorda, Schularick and Taylor (2011) for 14 advanced countries. In a similar manner, Huidrom, Kose and Otrok (2010) find evidence of credit procyclicality in the G7 countries, Xu (2012) in 33 advanced and emerging-market economies, Guo and Stepanyan (2011) in emerging-market economies, and Repullo and Saurina (2011) in seven developed economies, including France, Germany, Japan, the US and the UK. However, in contrast, no evidence of credit procyclicality is found by Bebczuk, Burdisso, Carrera and Sangiacomo (2011) in 144 developing and advanced countries, by Bertay, Demirguç-Kunt and Huizinga (2012) in high-income countries, and by Drehmann and Tsatsaronis (2014) across a panel of 53 advanced and emerging countries between 1980 and 2013.

Empirical evidence supporting the view that credit extension increases during business-cycle peaks that are followed by financial crises can be found in Taylor (2012) as well as in Goodhart and Hofmann (2008) for industrialised countries, and in Schularick and Taylor (2012) and Jorda et al. (2011) for 14 advanced countries. There are several studies that conclude that the use of the BCBS's (2010b) proposed gap between the ratio of aggregate private-sector credit to GDP and its long-term trend as a common reference guide for countercyclical capital buffers for financial institutions may not be appropriate. These include the studies by Gersl and Jakubik (2010), Repullo and Saurina (2011) as well as Giannone, Lenza and Reichlin (2012) in respect of developed countries, Edge and Meisenzahl (2011) for the US, Gersl and Seidler (2012) for the Czech Republic, and Nigam (2013) for Uganda. However, these findings are in contrast with those of Borio, Drehmann, Gambacorta, Jiminez and Trucharte (2010) and Borio, Drehmann and Tsatsaronis (2011), on the one hand, and Andersen, Giese, Bush, Castro, Farag and Kapadia (2013), on the other, who conclude that the proposed reference guide performed best in capturing the systemic vulnerabilities that consequently led to financial crises in 36 countries and the UK, respectively.

Akinboade and Makina (2009, 2010) and Fourie et al. (2011) find evidence of procyclicality of credit extension in South Africa. However, these studies have a limitation in that they do not use the gap between the ratio of credit as a ratio of GDP and its long-term Hodrick–Prescott (1997) trend, which is the BCBS's (2010b) proposed measure to determine the level of countercyclical capital buffers. Thus, these studies cannot be used to establish whether the BCBS's (2010b) proposed measure to determine the level of countercyclical capital buffers is indeed procyclical or not.

Using a descriptive analysis, the South African Reserve Bank's (SARB) (2011) Financial Stability Review concludes that the BCBS's (2010b) prescribed credit-to-GDP extension measure should be used with care and not exclusively or in a uniform way. Related studies that do not necessarily examine the behaviour of credit extension over the business cycle include those by Burrai, De Jongh, Raubenheimer, Van Vuuren and Wiid (2015), who conclude that the proposed credit-extension measure has weak properties as an early-warning signal for financial crises. Van Vuuren (2012) and Farrell (2014) conclude that the mechanical application of the proposed credit-extension measure is not advisable for South Africa given the BCBS's (2010b) proposed use of the Hodrick–Prescott (1997) filter, which has limitations in that it is sensitive to the ex-post revision of many macroeconomic variables and has the so-called end-point problem. The use of the Hodrick–Prescott (1997) filter is also questioned by Gersl and Seidler (2012) for selected Central and Eastern European countries, by Edge and Meisenzahl (2011) for the US, and by Kelly, McQuinn and Stuart (2013) for Ireland.

3 Data description

Monthly data are used in this study. They are sourced from the SARB and span the period January 2000 to December 2012. They comprise the BCBS's (2010b) proposed ratio of private-sector credit to GDP and South Africa's coincident business-cycle indicator. The gap between the ratio of private-sector credit to GDP and its long-term trend is constructed on the basis of detailed, step-by-step guidelines proposed by the BCBS (2010b). Step 1 involves calculating aggregate private-sector credit as a percentage of GDP, and Step 2 involves calculating the deviation of credit as a percentage of GDP from its Hodrick–Prescott (1997) trend. The BCBS (2010b) suggests using a smoothing parameter of 400 000 for quarterly data, which is equivalent to 3 600 000 for monthly data. Twelve additional data points were forecasted at the end of the data series in order to circumvent the end-point problem, as proposed by Mise, Kimand and Newbold (2005). Thus the unit of measurement of this variable is percentage points.

In line with the credit-gap measure, the business cycle is measured as the difference between the coincident business-cycle indicator and its Hodrick–Prescott (1997) trend using the normal smoothing parameter of 14 400 for monthly data. Thus this variable is measured in percentage points. Often, the difference between GDP and its Hodrick–Prescott (1997) trend is used to measure the business cycle. However, in South Africa, GDP data are not available monthly. The SARB constructs the coincident business-cycle indicator monthly by combining various equally weighted indicators of economic activity. These include the aggregate indicators of production, sales, income and employment.

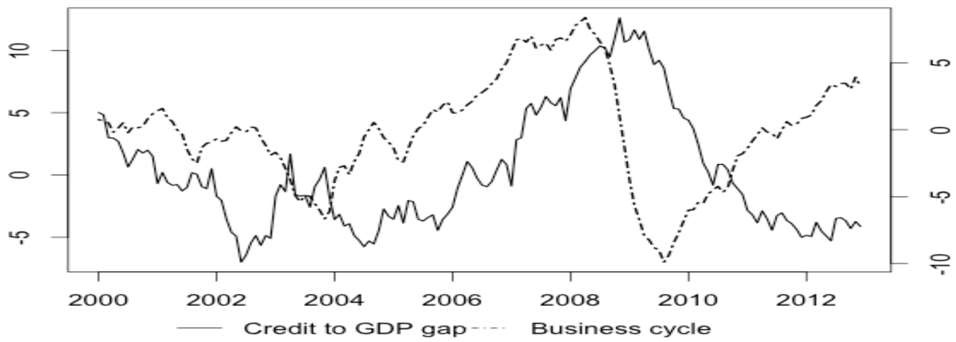
The descriptive statistics in respect of the gap between credit as a percentage of GDP and its long-term trend and the South African business cycle are presented in Table 1, while the evolution of the gap is depicted in Figure 1.

Table 1
Descriptive statistics

	Credit-to-GDP ratio gap	Business cycle
Mean	0.33	−0.10
Median	−0.86	0.04
Maximum	12.63	8.37
Minimum	−7.01	−9.90
Standard deviation	4.84	4.08
Jarque Bera	19.14	0.61
Probability	0.00	0.74

Notes: Own calculations based on data from the SARB database.

Figure 1
Evolution of the main variables



4 Econometric methodology

The stylised observed behaviour of many macroeconomic variables, such as output growth and investment, et cetera, is that they exhibit asymmetric features by displaying abrupt changes and dramatic breaks in their behaviour over time. Hamilton (2005) provides evidence of dramatic breaks in the behaviour of macroeconomic indicators during financial crises. Sims and Zha (2004) and Davig (2004) provide evidence of abrupt changes in the behaviour of macroeconomic indicators due to shifts in government policy. According to Van Dijk, Terasvirta and Franses (2002), Hamilton (2008), and Borio et al. (2011), fluctuations in macroeconomic variables tend to be different during periods of expansions and contractions, with the expansions in these variables tending to be gradual and protracted, while the contractions are abrupt and dramatic. For instance, in Figure 1, the expansion in the business cycle started in early 2004 to mid-2008, thus spanning more than four years, while the contraction started in mid-2008 to mid-2009, therefore spanning only one year. To capture this stylised observed behaviour, the LSTAR Model introduced by Terasvirta (1994, 1998) is estimated.[2] This model allows for regime-switching behaviour when the transition variable (here, the business cycle) reaches a particular threshold. In this particular instance, the LSTAR Model will allow the regime-switching variable, which is credit extension, to behave differently over the different phases of the business cycle. In line with the NBER (2012), the different phases of the business cycle are peaks and troughs, as well as expansions and contractions.

Specifically, assuming two regimes for credit, the LSTAR Model used in our analysis is specified as follows:

$$Y_t = \begin{cases} \beta_L + \beta_{L1} Y_{t-d} + \ldots + \beta_{Lm} Y_{t-(m-1)d} \left(1 - G\left(Z_t, \gamma, \theta\right)\right) + \varepsilon_t, & Z_t \le \theta \\ \beta_H + \beta_{H1} Y_{t-d} + \ldots + \beta_{Hm} Y_{t-(m-1)d} \left(G\left(Z_t, \gamma, \theta\right)\right) + \varepsilon_t, & \theta < Z_t \end{cases} \tag{1}$$

where

$$G = P(Z_t, \gamma, \theta) = \left(1 + \exp - \gamma\left(Z_t - \theta\right)\right)^{-1} \tag{2}$$

and

$$Z_t = \phi_1 X_t + \phi_2 X_{t-1} + \ldots + \phi_m X_{t-(m-1)d} \tag{3}$$

Here, Y_t is credit extension, which is the regime-switching variable, X_t is the business cycle and the transition variable, while G is the monotonic transition function that is bounded between 0 and 1, specified as a logistic function with a threshold variable Z_t. The smoothing parameter γ determines the speed and smoothness of transition between regimes. It is determined via grid search and takes a value close to zero in the case of an abrupt speed of adjustment between regimes and a high one otherwise.[3] θ measures the threshold location. The model parameters are the βs, while the threshold parameters are the $\emptyset$s. m is the embedding dimension and d is the time-delay parameter.[4] The subscripts L and H indicate the low- and high-credit regimes, respectively, while ε_t is the error term.

The LSTAR Model can take different forms, depending on how the logistic function $G(Z_t, \gamma, \theta)$ is specified, resulting in different types of regime-switching behaviour. In the event that the transition variable is in levels $Z_t = X_{t-d}$, the model distinguishes between periods of positive and negative values of the transition variable; hence, in terms of our analysis, the model allows credit extension (the regime-switching variable) to behave differently during peaks and troughs in the business cycle (the transition variable). Enders and Granger (1998) also suggest that the model can distinguish between periods of upturns and downturns in the transition variable when the transition variable is defined in terms of *first differences* $Z_t = \Delta X_{t-d}$; then the model allows credit extension to behave differently when the business cycle is expanding or contracting.[5]

Here, the LSTAR Model is specified as follows:

$$\begin{aligned} CRT\_Gap_t = &\left(\beta_L + \beta_{L1} CRT\_Gap_{t-d} + \ldots + \beta_{Lm} CRT\_Gap_{t-(m-1)d}\right)\left(1 - G\left(Z_t, \gamma, \theta\right)\right) \\ &+ \left(\beta_H + \beta_{H0} CRT\_Gap_{t-d} + \ldots + \beta_{Hm} CRT\_Gap_{t-(m-1)d}\right)\left(G\left(Z_t, \gamma, \theta\right)\right) + \varepsilon_{t+s} \end{aligned} \tag{4}$$

where CRT_Gap_t is the deviation of the ratio of credit to GDP from its long-term trend. The following transition functions are specified: The first transition function is specified as $G = (1 + \exp - \gamma(ECN\_CY_t - \theta))^{-1}$, where the transition variable is the *state* of the business cycle, that is, the *level* of the gap between the coincident business-cycle indicator and its long-term trend, ECN_CY_t. The second transition function is specified as $G = (1 + \exp - \gamma(\Delta ECN\_CY_t - \theta))^{-1}$, where the transition variable is the *change* in the gap between the coincident business-cycle indicator and its long-term trend, $(\Delta ECN\_CY_t$. As discussed above, the first transition function distinguishes between the peak and the trough phases of the business cycle.[6] The second transition function distinguishes between the expansion and the contraction phases of the cycle. Thus, the study will establish how the gap between the ratio of aggregate private-sector credit to GDP and its long-term trend behaves during the peak and the trough, as well as during the expansion and the contraction phases of the cycle.

5 Empirical results

The estimation of the Smooth transition autoregressive models proceeds in accordance with the following steps as detailed in Terasvirta (1994) and Van Dijk et al. (2002). The first step involves testing the linearity of the full-order autoregressive model at different values of the time-delay parameter.[7] Table 2 presents the results for the test of linearity of the full-order autoregressive model at different values of the time-delay parameter. The reason for the linearity test is to ascertain asymmetry in the main variables. Linearity in the full-order LSTAR model is rejected for both the peaks and troughs model and the expansions and contractions model, with the rejection being most significant when the time-delay parameter is 2.[8]

Table 2
Non-linearity test and the optimal time-delay parameter

	Peaks and troughs model		Expansions and contractions model	
	Spec test	*P-Value*	*Spec test0*	*P-Value*
$d = 1$	23.67	0.01	12.29	0.04
$d = 2$	27.39	0.00	14.79	0.03
$d = 3$	20.61	0.01	12.18	0.04
$d = 4$	16.93	0.01	10.01	0.05

Notes: Spec_test is the test for linearity of the full-order LSTAR model against full-order Autoregressive model, which is the F-test with associated p-values. This test also doubles as the test for the optimal time-delay parameter, $d = 1,2,..,n$, which is determined where the test for linearity is rejected most significantly. The details on how to carry out these tests can be found in Terasvirta (1994) and Van Dijk et al. (2002).

Additional tests to choose between the LSTAR Model and the exponential smooth transition autoregressive (ESTAR) model were not performed in this study. The reason is that the transition functions in the LSTAR model and the ESTAR model adjust differently to the deviations of the regime-switching variable around the threshold level. The LSTAR model is more appropriate given its ability to allow credit extension to adjust differently in various phases of the business cycle (expansion, contraction, peak and through). Additionally, the estimation results show statistically significant asymmetries in the behaviour of credit extension over the business cycle, which favours the use of the LSTAR model over the ESTAR model.

As can be seen from equations (1) to (3), the LSTAR model is specified in an autoregressive manner necessitating the determination of the number of lags. The lags selection criteria used are the Akaike Information Criterion, the Bayesian Information Criterion and the Hannan Quin Information Criterion. They all point to the lag order of 2 in the autoregressive model. However, the lag order of 1 was used in the estimation because the coefficients for the lag order of 2 were consistently statistically insignificant in estimation across all the models. To determine the threshold location of the LSTAR Model, a grid search was implemented.[9] According to Aznarte, Di Narzo and Stigler (2008), the grid search involves estimating the model for a grid of different values of the threshold variable and taking the best fit as the threshold estimate. The location of the thresholds with respect to transition variables, the business cycle, and the change in the business cycle were determined endogenously by fitting the LSTAR Models to possible threshold values between the 0.1 and 0.9 quantile of observations in each of the high and low regimes. The threshold values that deliver the best fit in respect of the specified LSTAR Models based on some criteria, in this case the Akaike Information Criterion, were selected.

Additionally, the following tests for model adequacy were implemented to assess the robustness of the estimated LSTAR Models. These included the test of residual variance, the Akaike Information Criterion and the Mean Absolute Percentage Error for forecasting accuracy, as well as the model-misspecification tests for no remaining non-linearity and parameter constancy. The results of the measures of model adequacy are presented in Table 3. The Akaike Information Criterion, the Mean Absolute Percentage Error, and the test for residual variance chose the LSTAR Model with the second transition function, which distinguishes between periods of expansion and contraction in the business cycle as the best model among the specified alternatives. The null hypotheses of no remaining non-linearity and parameter constancy are accepted for the peaks and troughs model as well as the expansions and contractions model.

The estimated results of the two variants of the LSTAR Models are also presented in Table 3. As discussed above, the first transition function is specified as $G = (1 + \exp - \gamma(ECN\_CY_t - \theta))^{-1}$, , where the transition variable is the gap between the coincident business-cycle indicator and its long-term trend, ECN_CY_t . This transition function distinguishes between periods of peaks and troughs in the transition variable. The second transition function is specified as $G = (1 + \exp - \gamma (\Delta ECN\_CY_t - \theta))^{-1}$, where the transition variable is the *change* in the gap between the coincident business-cycle indicator and its long-term trend. The second transition function thus distinguishes between periods of expansion and contraction in the economy. Accordingly, the transition variable in this instance is the first difference of the gap between the coincident business-cycle indicator and its long-term trend or the change in business cycle.

Table 3

Logistic smooth transition autoregressive models results

	Peaks and troughs model		Expansions and contractions model	
	Coefficient	Standard error	Coefficient	Standard error
β_L	−1.76	0.44***	−0.18	0.15
β_{L1}	0.74	0.06***	0.99	0.03***
β_H	6.27	2.06***	0.12	0.26
β_{H1}	−0.03	0.17	−0.14	0.06**
γ	0.56	0.26**	102.18	135.26
θ	2.94	1.13***	0.09	0.02***
AIC	179		129	
$MAPE$	200		171	
$Resid\_Var$	2.92		2.12	
Mod_test1	38.5	0.18	1.48	0.23
Mod_test2	21.4	0.32	1.15	0.23

Notes: The Peaks and Troughs Model is specified as $G = (1 + \exp - \gamma(ECN\_CY_t - \theta))^{-1}$, *where the transition variable is the gap between the coincident business-cycle indicator and its long-term trend,* ECN_CY_t. *The expansions and contractions model is specified as* $G = (1 + \exp - \gamma(\Delta ECN\_CY_t - \theta))^{-1}$, *where the transition variable is the change in the gap between the coincident business-cycle indicator and its long-term trend (*ΔECN_CY_t. *Statistical-significance codes: *** = 1 per cent, ** = 5 per cent, and * = 10 per cent.* AIC *is the Akaike Information Criterion.* $MAPE$ *is the Mean Absolute Percentage Error.* $Resid\_Var$ *is the variance of the residuals.* Mod_test1 *and* Mod_test2 *are the model-misspecification tests for no remaining non-linearity and parameter constancy, respectively, and their associated p-values, with details in Terasvirta (1994) and Van Dijk et al. (2002).*

For the LSTAR Model with the first transition function, the grid search finds a statistically significant threshold of 2.9, so that the credit gap behaves differently when the gap between the coincident business-cycle indicator and its Hodrick–Prescott (1997) trend is greater than 2.9 compared with when it is below or equal to this threshold level. The deviation of the ratio of credit to GDP from its long-term trend increases by a statistically significant 74.4 per cent relative to its recent past in the low regime, or when the business cycle is below 2.9. In the high regime, or when this gap is above 2.9, the deviation of credit to GDP ratio from its long-term trend decreases by 2.6 per cent relative to its recent past.[10] However, this is statistically insignificant. This means that there is no meaningful relationship between the business cycle and credit extension during the peak phase of the cycle. The parameter that measures the speed and smoothness of transition between regimes in the threshold variable is 0.56 and is statistically significant. This implies a relatively smooth and slow speed of adjustment between the high and the low regimes.[11]

Credit extension is supposed to be procyclical according to the BCBS (2010a, 2011). Hence the gap between the ratio of aggregate private-sector credit to GDP and its long-term trend was expected to increase during periods of peak phases of the business cycle and to decrease during periods of trough phases of the business cycle. However, here, the empirical results reveal a statistically significant and positive relationship in respect of the gap between the ratio of aggregate private-sector credit to GDP and its long-term trend relative to its recent past during the trough phases of the business cycle or when the gap between the coincident business-cycle indicator and its long-term trend is below or equal to 2.9. However, such a relationship cannot be ascertained during the peak phases of the cycle or when the gap between the coincident business-cycle indicator and its long-term trend is above 2.9. This implies that the relationship between the deviation of the ratio of aggregate private-sector credit to GDP and its long-term trend is countercyclical during the business-cycle troughs, while it becomes statistically insignificant during the peak periods in the business cycle. Thus the hypothesis that the gap between the ratio of aggregate private-sector credit to GDP and its long-term trend increases during expansions in the business cycle, with the opposite being true during contractions in the business cycle, is not satisfied. The BCBS (2010b) proposes the use of credit extension as a reference guide for implementing countercyclical capital buffers based on the assumption that credit is procyclical. However, our results imply that the proposed measure of credit extension suggests implementation of capital buffers during contractionary economic conditions and their withdrawal during expansionary economic conditions. Thus, in this manner, the implementation of capital buffers would be procyclical instead of countercyclical.

According to the results pertaining to the second transition function, which are also reported in Table 3, the grid search finds a statistically significant threshold when the *change* in the gap between the coincident business-cycle indicator and its long- term trend is 0.09. Thus the deviation of the credit-to-GDP ratio from its long-term trend behaves differently when the change in the gap between the coincident business-cycle indicator and its long-term trend is greater than the threshold level of 0.09, which signals periods of economic expansion, compared with when it is below or equal to this threshold level, which signals periods of economic contraction. The credit gap increases by a statistically significant 99.3 per cent relative to its recent past in the low regime, or when the change in the gap between the coincident business-cycle indicator and its long-term trend is below or equal to 0.09. In the high regime, or when the change in the gap between the coincident business-cycle indicator and its long-term trend is above 0.09 per cent, the deviation of the credit-to-GDP ratio from its long-term trend decreases by a statistically significant 13.7 per cent relative to its recent past. The parameter that measures the speed and smoothness of transition between regimes in the threshold variable is 102.2, implying a possible and relatively high and abrupt speed of adjustment between the high and the low regimes. However, it is statistically insignificant.

Thus the empirical results generally point to the fact that credit extension in South Africa is not procyclical. This is because credit extension *increases* during the trough phases of the business cycle, while a statistically significant relationship between credit extension and the cycle cannot be established during the peak phases. Furthermore, credit extension *decreases* during periods of expansion, while it *increases* during periods of contraction. Thus the use of credit extension as per the BCBS (2010a, 2011) as a common reference guide to determine the level of the countercyclical capital buffers for financial institutions may not be appropriate for South Africa. It would tend to increase capital requirements during periods of economic contraction, which would exacerbate the procyclicality of credit extension and result in dire consequences for the economy. This finding is consistent with Repullo and Saurina (2011) and Giannone et al. (2012), among others, for developed economies, with Drehmann and Tsatsaronis (2014) across a panel of 53 countries, and with Bouvatiery et al. (2014) for a sample of 17 OECD countries. Akinboade and

Makina (2009, 2010) and Fourie et al. (2011) find evidence of procyclicality of credit extension in South Africa. However, these studies do not use the BCBS's (2010b) proposed measure of credit extension and therefore cannot be used to establish whether the BCBS's (2010b) proposed measure is indeed procyclical or not.

6 Conclusion

The purpose of this study was to examine the behaviour of credit extension over the business cycle in South Africa in order to assess its usefulness as a reference guide for implementing countercyclical capital buffers for financial institutions. The study was motivated by the suggestions on the part of the BCBS (2010a, 2011) at the Bank for International Settlements, which has identified credit extension as one of the major causes of financial crises. As a result, the BCBS (2010b) has proposed the implementation of countercyclical capital buffers for financial institutions using credit extension as a common reference guide so as to limit credit procyclicality and its associated systemic and economic risks. The behaviour of credit extension over the business cycle was analysed using the LSTAR Model, which distinguishes between the peak and the trough phases, as well as the expansion and the contraction phases, of the business cycle.

The study found that credit extension increases during the trough phase of the business cycle, while its relationship with the business cycle is insignificant during the peak phase. It also found that credit extension decreases during the expansion phase of the business cycle, while it increases during its contraction phase. Thus the study did not find evidence of procyclical behaviour in respect of credit extension in South Africa over the business cycle; hence the BCBS's (2010a, 2010b, 2011) proposed reference guide for implementing countercyclical capital buffers should be used with caution and not as a mechanical rule. The reason for caution is that this proposed measure with respect to credit extension suggests application of capital buffers during the contraction phase of the business cycle in South Africa. The opposite is true during its expansionary phase, thereby undermining financial institutions' ability to extend credit during recessions, while amplifying it during booms – which could have adverse consequences for macroeconomic stability.

Future research could examine the behaviour of disaggregated components of credit extension over the business cycle, together with other economic aggregates over and above the aggregate measure of credit extension.

Endnotes

1 We are grateful for comments by two anonymous referees. Financial support from Economic Research Southern Africa (ERSA) is gratefully acknowledged.

2 The choice of the LSTAR Model is motivated by its ability to allow asymmetrical adjustment of the regime-switching variable around the threshold level. Alternative models such as the exponential smooth transition autoregressive (ESTAR) model do not allow this feature. More details can be found in the section on empirical results.

3 It measures the steepness of the associated logistic sigmoid or "S"-shaped curve.

4 Simply put, the embedding dimension and the time-delay parameter jointly determine the appropriate lag length to be used in estimation. In the present case, we are estimating the LSTAR Model with two regimes. This means that the embedding dimension is 2, while the time delay can assume any value. But, based on lag selection criteria (see Table 1), the time delay is 2. However, we opted for one lag for reasons given in the results section.

5 For a more detailed discussion on specification and the various forms of threshold autoregressive models, see Terasvirta (1994, 1998), Van Dijk et al. (2002), Van Dijk, Terasvirta, Stefan and Lundbergh (2003), and Aznarte et al. (2013).

6 The phases of the business cycle are defined in line with the NBER (2010) Business Cycle Dating Committee as expansion, contraction, peak and through. The economic-cycle expansions (contractions) start at the peak (trough) of a business cycle and end at the trough (peak).

7 In the event that the null hypothesis of linearity is rejected, the next step involves performing additional tests to choose between the LSTAR Model and the ESTAR Model. However, it must be noted that the choice between the LSTAR Model and the ESTAR Model can also be done as a post-estimation exercise through the use of model evaluation criteria.

8 Although not reported here, Terasvirta's neural network test of non-linearity, as reported in Granger, Lin and Terasvirta (1993), also pointed to non-linearity in both the gap between the credit-to-GDP ratio and its long-term trend and the business-cycle measure.

9 Alternatively, when the threshold value of the transition variable is known, it can be inputted directly into the LSTAR Model. Otherwise, the threshold value of the transition variable can be determined using a grid search and then plugging into the LSTAR Model.

10 We are estimating an LSTAR Model. Thus the model compares the current value of the regime-switching variable (credit extension) with the one(s) that precedes it, at different levels of the threshold variable (business cycle).

11 The statistical significance of this parameter is often not a concern and is frequently allowed to be dimension-free, as suggested Terasvirta (1994), given that its size points to the various forms of the transition function.

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