The Role of the Financial Cycle[1] in Macro-Prudential Policy Decision-Making: When to Accumulate or Reduce Counter-Cyclical Buffers

*By Refiloe Tšephe**

Abstract

THE CREDIT-TO-GDP gap is used as a tool for macroprudential policy making. However, in Lesotho GDP data is only available on an annual basis. Therefore, the purpose of this study is to find an appropriate proxy for the credit-to-GDP gap. The study follows Karfakis (2013) and utilizes three methods to reach its aim, namely; cross-correlations, in-sample Granger causality, and the VAR model. The study uses annual bank credit to private sector, M2 and trade-deficit as a percentage of GDP data covering the period from 1973 to 2013. The study examines the relationship between the credit cycle and credit-to-GDP gap and discovers that the credit cycle is synchronous with the credit-to-GDP gap in Lesotho. In addition, the relationship between the M2 cycle and credit-to-GDP gap is explored and it is established that the M2 cycle leads the credit-to-GDP gap by one (1) year and can suitably be used as a proxy for the credit-to-GDP gap. In addition, there is a bi-directional causality between M2 cycle and credit-to-GDP gap. The study recommends the use of the credit cycle as a proxy for credit-to-GDP gap in line with empirical evidence found, and also recommends the use of M2 cycle on the basis of empirical evidence found in this study.

Keywords: Credit-to-GDP gap, Counter-cyclical buffer, Credit Growth
JEL classification: G18, G21, E32, E51

[1] The financial cycle in this paper refers to the expansion and contraction of credit and M2 over time.

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The Role of the Financial Cycle[1] in Macroprudential Policy Decision-Making: When to Accumulate or Reduce Counter-Cyclical Buffers

Refiloe Tšephe

1 INTRODUCTION

THE CENTRAL BANK OF LESOTHO (CBL) is mandated to promote the stability and soundness of the financial system in Lesotho. It attains this objective through delivering its core functions, notably: achieving and maintaining price stability; fostering liquidity, solvency and proper functioning of a stable market-based financial system; promoting safe and sound development of the financial system; and promoting efficient operations of the payments system. Different tools and approaches are used to this effect. Analysis of the financial soundness indicators (FSIs) and stress testing are some of the tools that are used in assessing the stability of the financial sector. In an effort to better understand the soundness of the financial sector, arrays of tools are explored to help assess the stability of the financial sector. Moreover, the 2007 – 2009 global financial crisis (GFC) has unveiled the need for better macroprudential policies and frameworks that will lead to effective macroprudential oversight. The Financial Stability Board (FSB), International Monetary Fund (IMF) and Bank of International Settlements (BIS) (2011), defined macro-prudential policy as a policy which focuses on system wide financial risk, detects and limits financial imbalances, risk concentrations and builds countercyclical buffers to smooth out the economic cycle.

[1] The financial cycle in this paper refers to the expansion and contraction of credit and M2 over time.

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A well designed macroprudential policy framework should have clearly defined objectives and instruments or tools that are used to achieve the objectives. Credit-to-GDP gap is one such tool developed as the reference point to address risk build-up in the economy and address the procyclical nature of banking institutions, whereby banks ride the economic cycle, thus exacerbating the booms and bursts episodes in the economy. Credit-to-GDP gap is derived as the difference between credit-to-GDP ratio and its long-term trend, and it is used as a guide for setting countercyclical capital buffers (CCB) to prevent procyclicality in credit extension. This measure acts as an early warning indicator. However, in Lesotho, the problem arises in attempting to deploy the credit-to-GDP gap tool in analyzing the systemic build-up of risk in the economy because GDP data is only available on an annual basis[2]. Therefore, the purpose of this study is to explore a high frequency variable that is highly correlated with credit-to-GDP gap that can be used as a credit-to-GDP gap proxy. Borgy *et al.*, (2009), FSB, IMF & BIS (2011) and Anusha (2015) among others have shown that there is a robust relationship between the real and financial sectors of the economy, with credit booms and bursts leading financial crises. Anusha (2015) further elucidates that it is vital to determine the cyclical properties of credit and its nexus with economic activity in order to establish early warning indicators for financial imbalances and macroeconomic policies. Moreover, Banerjee (2011) attributes the boom and burst phases of the business cycle to the procyclical nature of credit.

Following this introduction, the rest of the study is structured as follows; section two will be a brief description of the literature review and section three will detail the methodology adopted. Section four discusses the results while section five covers the recommendations of the study.

2 LITERATURE REVIEW

The credit-to-GDP gap sanctions broad credit to the household and private non-financial corporate sector, including non-banks and lending from abroad. Credit in each quarter is divided by rolling GDP sum of last four (4) quarters, commonly referred to as annualised credit-to-GDP ratio Basel committee on banking supervision (BCBS) (2010) and Bonfim and Monteiro (2013).

[2] The study did not use interpolation methods because as has been stated in the literature, interpolated data suffers from serial correlation (Chen, 2007). Moreover, interpolated high frequency data series does not correctly fit the old low frequency data (Pavia-Miralles, 2010).

BCBS has proposed that banks hold additional capital at times when the ratio of private sector credit-to-GDP grows more quickly than its long-run trend. The need for a countercyclical buffer arises due to the realization that in different phases of the business cycle, for instance in an economic upswing, the financial system tends to be overexposed to aggregate risk through ample credit availability, rapid increases in asset prices, leverage and maturity mismatches. Therefore, the financial system should build adequate buffers in these risky times so that when the cycle turns, the downside does not induce financial distress resulting from rationing of credit extension and significant deleveraging (FSB, IMF and BIS, 2011). In other words, the buffer is a stabiliser during both the expansion and contraction phases of the financial cycle.

There are three ways in which cycles can be determined; *classical or business cycles*, which are described as oscillations in the level of an economic variable; *deviation cycles*, the difference between the level and long run permanent component of an economic variable and growth rate cycles which are measured by the growth rates of level variables. However, deviation cycles are more favoured for empirical investigations (Egert and Sutherland, 2012). There are two different strands of theory on business cycle and the role of money in influencing real economic activity. *Monetary–business-cycle theory* argues that money has a fundamental role in determining real economic activity, with changes in the growth of money in circulation causing output growth. However, the *real-business-cycle theory* views money supply as a dormant factor as establishments in the real economy will influence the agents' financial decisions thus influencing the quantity of money demanded (Ahmed, 1993). Moreover, there are three main transmission channels through which credit feeds into economic activity. First, through the *borrower's balance sheet channel*, where negative financial shocks induce borrowers to reduce their demand for credit thus creating an environment of lower spending and lower economic activity. Second, there is the *bank balance sheet channel* which shows that monetary policy decisions affect the cost and availability of credit. Last, there is the liquidity channel, through which liquidity shortages can compel a fire-sale of assets by banks and create a solvency problem for banks (BCBS, 2011). The first two channels are referred to as the *financial accelerator channel* as they exacerbate the shocks from endogenous developments in credit markets to the real economy.

Banerjee (2011) used Granger causality test and cross coefficients methodology to establish the relationship between credit cycles and GDP cycles in India. Due to structural changes in the Indian economy, the data was broken into three episodes: first 1950-51 to 1979-80, a period characterised by import substituting industrialization when credit was evidently observed to have significantly Granger-caused growth. Second, 1980-81 to 1990-91, there was no apparent causality as well as cross correlations between the two variables and last, 1991-92 to 2010-11 a period characterised by causality from output to credit cycles. In general, the direction of causality has changed overtime from credit leading output to output leading credit. In the liberalized phase, post 1992, there was more evidence of interconnectedness between financial institutions and the real economy in India.

In addition, Banerjee (2011) declares that procyclicality of credit is deemed as a vital factor influencing amplitudes of output cycles and intensifying the economic cycles. Moreover, analysis of the nexus between financial and real economy has established that credit booms precede financial crises (Anusha, 2015). Using a bivariate Markov switching model and a sample of 103 banking crises, Serwa (2008) could not find any lead-lag relationship between credit and output in both tranquil and crises periods, with the relationship being regime-dependent. The European Banking Federation (EBF) (2011) deploying cross correlations in 11 euro area countries and the US, with quarterly data covering a period from the first quarter of 1980 to the last quarter of 2010 established that credit cycles are vastly independent on business cycles with regard to both amplitude and synchronicity. The volatility of the credit cycle has been on average 2.5 times higher as compared to the business cycle. However, EBF further noticed that there has been a reduction in amplitude of the credit cycle in the late part of the 1990's, implying that there is more alignment between credit creation and the real economy. In terms of the lead-lag relationship, it was established that real GDP growth leads real credit growth. Furthermore, a feed-back relationship from credit to economic activity was observed though the observation is not the same across all countries.

Ricardo *et al* (2010) used standard deviation methods, state-of-the-art panel Granger causality tests and panel regressions for a sample of 144 countries over the period 1990 to 2007 to investigate the short-term relationship between credit changes and output changes. They established that Granger causality runs from GDP to credit in most of the countries, whereas the reverse holds true for a few countries in the sample under study. Moreover, their panel regressions reveal a more robust effect of GDP growth on credit growth than the opposite. Percic (2013) deployed quarterly data on real GDP and total credit to non-banking private sector from 10 European countries covering the period from the first quarter of 2000 to the

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last quarter of 2012 and the results were mixed for the sampled countries. In 40 percent of the countries, it was discovered that economic activity led credit whereas 30 percent of the countries exhibited Granger-causality from credit expansion towards economic growth, with the remaining 30 percent showing no causal lead-lag relationship. In addition, credit cycle and real GDP have shown a synchronized relationship between the two cycles in about 40 percent of the countries, implying the affiliation of credit expansion to the real economy.

Investigating the cyclical relationship between credit and growth in India and US covering the period 1994 to 2013 in the frequency domain, Anusha (2015) discovered that credit cycles and output cycles are analogous in duration of almost 3 years. Moreover, Anusha found evidence of a lead-lag relationship between real credit and real output in both India and the US, with real credit leading output in the US and exhibiting robust synchronization while the reverse holds for the Indian economy. However, Zhu (2011) studied the nexus between the credit and business cycles using various methodologies and discovered that business cycle frequencies show a weak correlation between US credit variables and real activity and credit leads output by about 2 quarters. Moreover, Granger causality is indecisive about the direction of causality or whether it actually exists. In the euro area, bank credit was found to lag output by 2 quarters. Looking into the credit and business cycle nexus in Italy from 1861 to 2013, Bartoletto *et al* (2015) deployed a local turning-point dating algorithm and found evidence pointing to credit and business cycles being poorly synchronized in the medium term, and periods in which real contractions overlapped resulted in severe recessions. Moreover, there was insignificant evidence of credit leading output in both medium and short term fluctuations.

Gomez-Gonzalez *et al* (2015) used a sample of 33 developed and emerging market economies (EME) in the frequency domain and discovered that there is a high probability of cycle interdependence in medium and long-term frequencies. Moreover, they also established bi-directional Granger-causality between the two cycles with 88 percent of the countries showing greater correlation between credit and GDP. In addition, cross correlation between credit lags and contemporaneous output is positive with the relationship between the two cycles more robust with inclusion of lags. Last, they conclude that credit cycle peaks were found to precede booms in output, while peaks in output cycle precede troughs in the credit cycle. Classens, Kose and Terrones (2011) investigated the level of synchronization between business and financial cycles applying the concordance statistic on a database of over 200 business and 700 financial cycles in 44 countries, covering the period from the first of quarter 1960 to the last quarter of 2007. They discovered that there is a robust level of synchronization between credit and output cycles, with both cycles in the same phase approximately 80 percent of the time. Moreover, developed economies show a higher degree of synchronicity relative to their EME counterparts, with financial downturns associated with slower economic activity while the reverse holds for financial upswings.

Egert and Sutherland (2012) study the nature of financial and real business cycles in OECD countries deploying annual, quarterly and monthly economic indicators. The study used the concordance indices to determine the degree of the cycles overlapping once turning points were established. The study established that the amplitude of the real business cycle was narrowing during the great moderation with asset price cycle becoming more impulsive. Moreover, they identified that access to bank credit and capital markets exacerbate movements in the real economy and at the same time, there was feedback effect from the real economy to bank lending. Chang (2016) examines the linkage among cycles and their lead-lag relationship. The hypothesis of the study is that, theoretically, credit cycle is viewed as one of the reasons driving the business cycle. Chang used the concordance index to examine the degree of synchronization among cycles and discovered that credit cycles do indeed serve as one cause of business cycles. In addition, Chang (2016) used probit estimation and regressed 12 financial soundness indicators (FSI's) to determine the source of credit cycle. The main finding from the estimation was that short-term credit and changed level in loan to business and individuals have a higher concordance with real estate price index cycle and business cycle.

Karfakis (2013) studied the relationship between real output and real credit at business-cycle frequencies with 3 empirical methods; cross correlation, regression and simulation analysis in Greece between the first quarter of 2000 to the first quarter of 2011 and established that real credit Granger-causes movements in real output. The in-sample Granger causality tests portrayed that the "…real credit cycle has information content that helps predict movements in the real output cycle" (Karfakis, 2013: 26). This implies that an increase in the credit cycle or credit above long term trend is associated with a real output expansion. Moreover, Karfakis (2013) indicated that the history of business cycles in Greece does not Granger cause the

[3] http://data.worldbank.org/country/lesotho?view=chart.

cycles of real credit at a 5 percent significance level. Cross correlation results indicated that real credit cycle leads real output cycle by one quarter, with the relationship between the two cycles being strongly procyclical. On the other hand, real credit growth rate was established to have led real output growth rate by three quarters with the relationship between the two variables robustly procyclical.

3 METHODOLOGY

3.1 Data sources, type and sample

The study uses annual bank credit data to the household and private non-financial corporate sectors, including non-banks and lending from abroad, real gross domestic product (GDP), broad money (M2) and trade deficit to GDP ratio covering the period from 1973 to 2013. The data were extracted from the World Banks' world development indicators (WDI) database[3].

3.2 Description of Analytical tools

3.2.1 Descriptive Statistics

The study uses cross-correlations to determine the cyclical relationship between credit-to-GDP gap and credit as well as M2 cycles at various leads and lags established by looking at the Schwarz Bayesian Criterion (SBC)[4]. The credit and M2 cycles can lead the credit-to-GDP gap by $\boldsymbol{j}$ years, synchronous, or lag behind it by a similar period, corr($\boldsymbol{y_t}$, $\boldsymbol{x_{t-j}}$), corr($\boldsymbol{y_t}$, $\boldsymbol{x_t}$), corr($\boldsymbol{y_t}$, $\boldsymbol{x_{t+j}}$), respectively. $\boldsymbol{y_t}$ is the credit-to-GDP gap and $\boldsymbol{x_t}$ is the real credit cycle or M2 cycle. A statistically negative and positive significant value implies that real credit or M2 cycle is countercyclical and procyclical, respectively. Values close to zero (0) indicate that the two variables are uncorrelated while values close to one (1) show that the variables are synchronous.

[3] http://data.worldbank.org/country/lesotho?view=chart.

[4] Schwartz information Criterion provides more parsimonious models relative to the Akaike Information Criteria (Enders, 2010).

3.2.2 Econometric techniques

3.2.2.1 In-sample Granger causality (backward-looking aggregate demand specification)

The study uses the Augmented Dickey-Fuller (ADF)[5] test to examine the unit root properties of the data. On the basis of the outcome of the unit root test, the data is used to estimate the following model (aka Karfakis, 2013):

$$y_t = \alpha + \beta y_{t-1} + \vartheta x_{t-1} + \pi z_{t-1} + \mu_t \qquad (1)$$

Where $\boldsymbol{y_t}$ is the credit-to-GDP gap, $\boldsymbol{x_t}$ can either be the real credit cycle or M2 cycle, $\boldsymbol{z_t}$ trade deficit to GDP ratio, and $\boldsymbol{\mu_t}$ is the error term. The trade deficit ratio is incorporated to capture the effects of external factors on aggregate demand. Focus is on the causal effect of the credit cycle and M2 cycle as the predictor variable(s) in equation 1. The causal effect is determined by deploying an in-sample Granger causality F-test[6] for testing the null hypothesis that $\vartheta_t = 0$, using heterosckedasticity and autocorrelation (HAC) consistent standard errors. Temporal stability in equation 1 is tested using the sup-wald statistic.

3.2.2.2 Credit-output relationship in terms of vector autocorrelation regression (VAR)

In order to check for robustness of the results obtained from Granger-causality, the study also deploys the following VAR model:

$$Y_t = A + B(L)y_t + \theta \boldsymbol{z_{t-1}} + \boldsymbol{w}_t \qquad (2)$$

Where $\boldsymbol{Y_t} = (\boldsymbol{y_t}, \boldsymbol{x_t})$ is a 2*1 vector of endogenous variables, $\boldsymbol{A}$ is a 2*1 vector of constant terms, $\boldsymbol{B\ (L)}$ is a 2*2 matrix polynomial in the lag operator $\boldsymbol{L}$, θ is a 2*1 vector of parameters,

[5] "··· [Dickey-Fuller] DF, [Augmented Dickey-Fuller] ADF and [Phillips-Peron] (PP) tests have comparable accuracy when it comes to detecting stationarity. Also, the unit root test seems to give slightly better results than the KPSS test when larger samples are used, whereas the opposite occurs for smaller samples." (Vlad-Metes, 2005; 22).

[6] Alternatively, $\vartheta_t = 0$ can be estimated using out-of-sample Granger causality test. The predictive ability of Equation 1 is compared to its restricted version, which will exclude real credit. If the mean squared prediction error (MSPE) in Eq. (1) is smaller than the MSPE of the restricted version, then this will imply that real credit Granger causes real output.

$\boldsymbol{z_t}$ exogenous variable and $\boldsymbol{w_t}$ is a 2*1 vector of white noise error terms with covariance matrix $\sum w$.

After establishing whether credit can be a lead indicator for GDP, credit can be used to compute the countercyclical capital buffer (CCB) as follows: The credit-to-GDP ratio is used as a reference point and is intended to help the authorities analyse whether or not to activate or increase the required counter-cyclical capital buffer. The long term trend is calculated using the Hodrick-Prescott (HP) filter, using a smoothing parameter of λ = 400 000, with the low and upper bounds being 2 and 10, respectively. When the one-sided HP gap is less than two percentage points, the buffer add-on is set to zero. If the gap exceeds 10 percentage points, the add-on is set at its maximum of 2.5 percent. The buffer add-on is calculated as (gap - 2) * (0.3125) percent between extremes {2 < gap < 10}. For trend estimation, it is essential to use sufficiently long-time series (at least 30 years for annual data) to arrive at meaningful estimates.

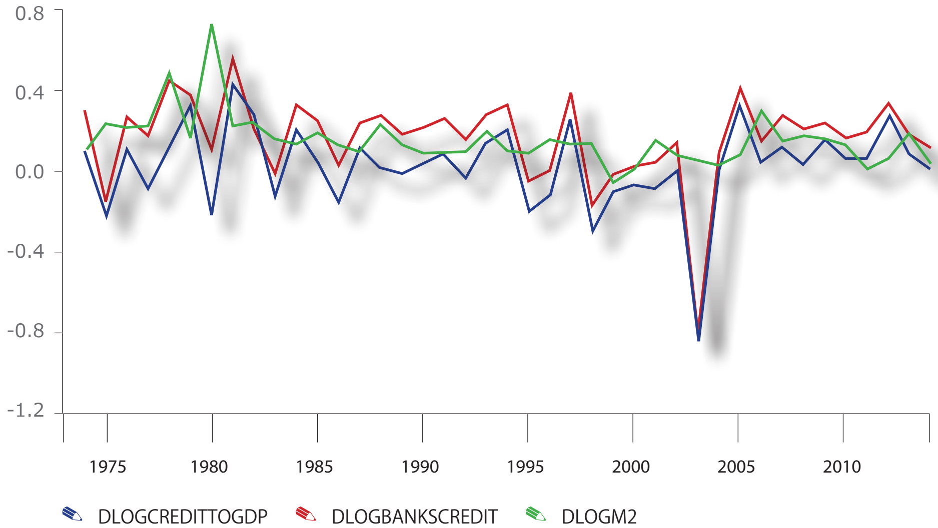
4 DATA ANALYSIS

4.1 Relationship between credit-to-GDP Growth, credit growth and M2 Growth

It is evident from Figure 1 that M2 growth moves first while credit-to-GDP[7] growth follows, inferring that M2 growth leads credit-to-GDP growth. On the other hand, credit growth mimics credit-to-GDP gap moving synchronously.

[7] Growth rates defined as differences in logs in M2 and credit to GDP ratio.

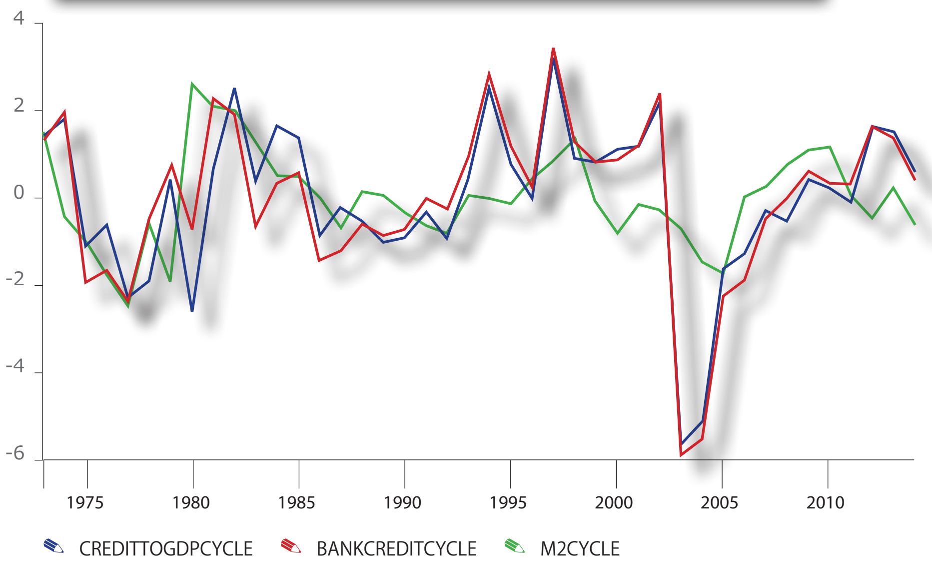
Figure 1 Credit-to-GDP gap, credit and M2 growth



Source: Word Development Indicators, 2016

Figure 2 shows the graphical relationship of credit-to-GDP gap, credit and M2 cycles in Lesotho. M2 cycle also moves first and then credit-to-GDP gap follows. The Credit cycle moves very closely to the credit-to-GDP gap showing a greater association between the two variables.

Figure 2 Credit-to-GDP gap, credit and M2 cycles



Source: Word Development Indicators, 2016

4.2 Analysis of M2 and credit cycles as lead indicators for credit-to-GDP gap[8]

4.2.1 Unit root test results

The study uses the ADF test with intercept, with only trade deficit ratio and credit-to-GDP gap tested using ADF with trend and intercept[9] to establish their stationarity. Table 1 show that M2 cycle, output cycle, credit cycle and credit-to-GDP gap are all stationary at a 5 percent significance level, while M2 growth, credit growth and output growth are all stationary at a 1 percent significance level. The trade deficit to GDP ratio is first difference stationary at a 1 percent significance level.

[8] Results on credit cycle are deferred to Appendix 2 because there is no lead-lag relationship found.

[9] Credit cycle and Credit-to-GDP gap graph in Figure 2 show a sharp decline in 2003, however, upon conducting the Chow-break point test, the there is no evidence found supporting structural breaks as shown in appendix 1. TDR shows a rising trend. Furthermore, impulse response functions in Appendix 2 show no evidence of structural breaks in the data used.

Table 1	ADF test statistic	
Variables[10]	T-statistic	Decision
M2 cycle	-3.65 (0.01)**	Stationary
Output cycle	-3.34 (0.02)**	Stationary
Credit cycle	-3.83 (0.01)	Stationary
M2 growth	-4.90 (0.00)*	Stationary
Output growth	-5.38 (0.00)*	Stationary
Credit growth	-6.06 (0.00)*	Stationary
TDR#	-0.64 (0.85)	Non-stationary
d(TDR)	-6.15 (0.00)*	Stationary
Credit-to-GDP gap#	-4.12 (0.01)**	Stationary

Critical values -3.60, -2.94 and -2.61. (*), (**) and (***) denote 1%, 5% and 10% level of statistical significance with p – values in parenthesis (). ADF with intercept and trend (#), critical values -4.21,-3.53 and -3.19 (*), (**) and (***) denote 1%, 5% and 10% level of statistical significance. (#) denotes ADF with intercept and Trend.

4.2.2 Lead-lag relationship between credit-to-GDP gap, M2 and credit cycles

The co-movement of credit-to-GDP gap and M2 cycle using correlation analysis is displayed in Table 2a. The study establishes a lead-lag relationship between credit-to-GDP gap and M2 cycle with M2 cycle leading credit-to-GDP gap by one (1) year and M2 growth also leading credit-to-GDP growth by one (1) year, displaying a procyclical relationship between the variables. Table 2b shows no lead-lag relationship between credit-to-GDP gap and credit cycle, with the two variables strongly associated in current periods. Credit growth is also established to be strongly synchronous with credit-to-GDP gap.

[10] Variables are in nominal terms.

Table 2A Cross correlations (Credit-to-GDP gap and M2 cycle)

Credit-to-GDP gap	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t-1}	x_{t-2}	x_{t-3}
$\bar{y}_t, \dot{x}_t$	0.27	0.28	**0.50**	0.35	0.34	-0.01	-0.35
	(0.10)	(0.09)	**(0.00)**	(0.02)	(0.03)	(0.94)	(0.03)
$\bar{\bar{y}}_t, \dot{x}_t$	0.18	0.04	**0.38**	0.01	0.35	0.07	-0.21
	(0.28)	(0.80)	**(0.02)**	(0.96)	(0.03)	(0.69)	(0.21)

Where $\bar{y}_t, \dot{x}_t$ is the cross correlation between credit-to-GDP gap and M2 cycle. Whereas the notation $\bar{\bar{y}}_t, \dot{x}_t$ refers to the growth rates of the credit-to-GDP gap and M2, respectively. Probability values are in parenthesis and largest absolute significant correlations are bold.

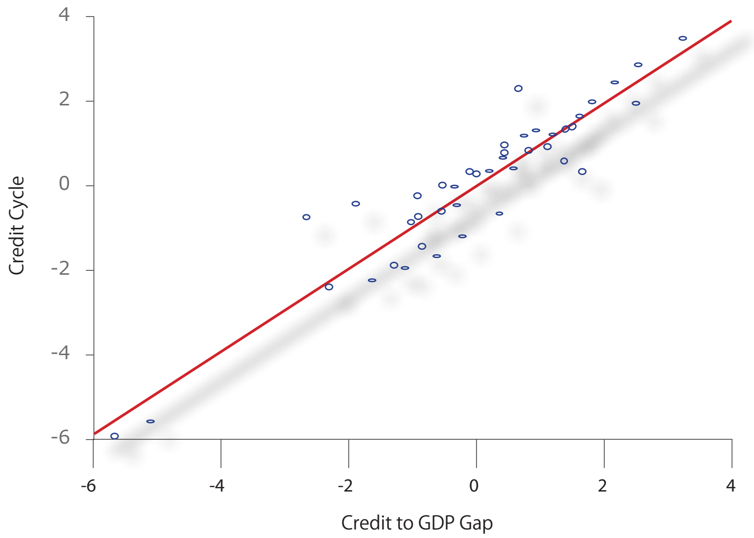
Table 2B Cross correlations (Credit-to-GDP gap and credit cycle)

Credit-to-GDP gap	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t-1}	x_{t-2}	x_{t-3}
$\tilde{y}_t, \tilde{x}_t$	0.21	0.16	0.45	**0.94**	0.34	0.02	0.004
	(0.19)	(0.32)	(0.00)	**(0.00)**	(0.03)	(0.89)	(0.98)
$\grave{y}_t, \grave{x}_t$	0.31	-0.09	-0.01	**0.94**	-0.07	-0.05	0.27
	(0.06)	(0.60)	(0.96)	**(0.00)**	(0.65)	(0.75)	(0.11)

Where $\tilde{y}_t, \tilde{x}_t$ is the cross correlation between credit-to-GDP cycle and credit cycle. Whereas the notation $\grave{y}_t, \grave{x}_t$, refers to the growth rates of the credit-to-GDP and credit, respectively. Probability values are in parenthesis and largest absolute significant correlations are bold.

Figure 3 shows how much credit-to-GDP gap is explained by credit cycle and about 87 percent of variation in credit-to-GDP gap is explained by credit cycle (R^2 = 0.87). This figure implies a high association between credit-to-GDP gap and the credit cycle in Lesotho also as indicated in Figure 3.

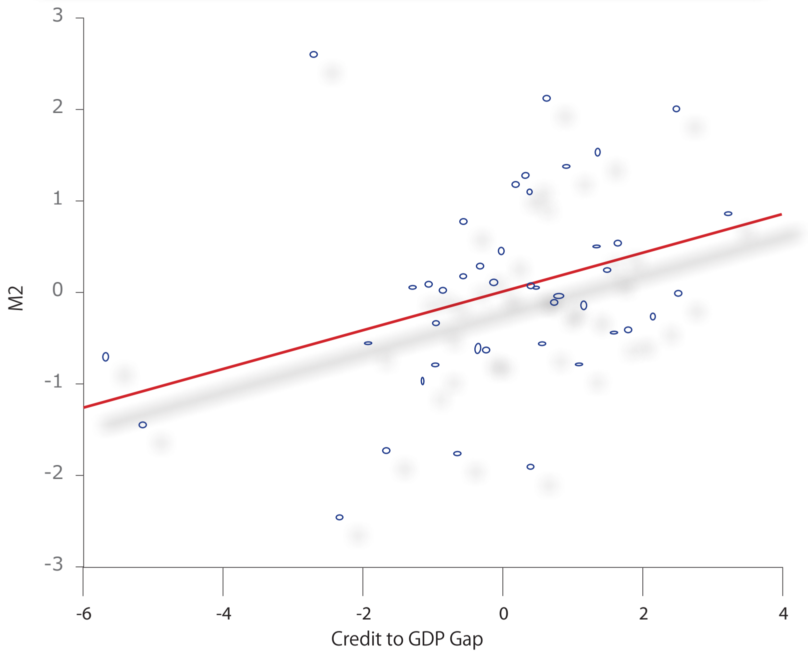
Figure 3 Credit-to-GDP gap and credit cycle



Source: Word Development Indicators, 2016

Figure 4 shows low degree of association between credit-to-GDP gap and M2 cycle. In other words, 12 percent of movements in the credit-to-GDP gap can be explained by the M2 cycle.

Figure 4 Credit-to-GDP gap and M2 cycle



Source: Word Development Indicators, 2016

4.2.3 The VAR relationship between credit-to-GDP gap and M2cycle

Table 3a shows that M2 cycle explains about 66 percent of the variations in credit-to-GDP gap. Moreover, 49 percent of the variation in M2 cycle is explained by lagged M2 cycle, with the relationship between the two variables positive and statistically significant. The information criteria variables all indicated two (2) lags; therefore Table 3b shows the VAR relationship with two (2) lags. However, credit-to-GDP gap is significant up to lag one (1) only, with other variables insignificant in explaining variations in credit-to-GDP gap. Also, only the first lag of M2 cycle is significant in explaining the movements in M2 cycle.

Table 3A	(Credit-to-GDP gap-M2 Cycle; 1 lag)		
Regressors	Credit-to-GDP gap	M2 cycle	Trade deficit ratio
$\bar{y}_{t-1}$	0.25 (1.73)	0.11 (1.32)	0.36 (0.45)
$\dot{x}_{t-1}$	0.66 (2.69)	0.49 (3.37)	-3.78 (-2.87)
dz_{t-1}	0.04 (1.52)	-0.01 (-0.89)	0.002 (0.01)

AIC, FPE, SIC and HQ select two (2) lags, diagnostics of the system: Serial correlation LM test: χ^2 (9) = 7.04 [0.63], Heteroskedasticity Test (whites' test with cross terms): χ^2 (2162) = 173.60 [0.17]. Moreover, all the inverse unit roots fall inside the unit circle, implying that the VAR is stationary.

Table 3B	(Credit-to-GDP gap-M2 Cycle; 2 lags)		
Regressors	Credit-to-GDP gap	M2 cycle	Trade deficit ratio
$\bar{y}_{t-1}$	0.25 (1.73)	0.11 (1.32)	0.36 (0.45)
y_{t-2}	0.66 (2.69)	0.49 (3.37)	-3.78 (-2.87)
$\dot{x}_{t-1}$	0.66 (2.69)	0.49 (3.37)	-3.78 (-2.87)
$\dot{x}_{t-1}$	0.66 (2.69)	0.49 (3.37)	-3.78 (-2.87)
dz_{t-1}	0.66 (2.69)	0.49 (3.37)	-3.78 (-2.87)
dz_{t-2}	0.04 (1.52)	-0.01 (-0.89)	0.002 (0.01)

AIC, FPE, SIC and HQ select two (2) lags, diagnostics of the system: Serial correlation LM test: χ^2 (9) = 22.09 [0.01], Heteroskedasticity Test (whites' test with cross terms): χ^2 (54) = 63.82 [0.17]. Moreover, all the inverse unit roots fall inside the unit circle, implying that the VAR is stationary.

4.2.4 Granger causal relationship between credit-to-GDP gap and M2 cycle

4.2.4.1 Simple Granger causality

Table 4 shows the estimated output equation with credit-to-GDP and M2 cycles obtained using the HP filter with a smoothing parameter of 100. There is a statistically significant positive relationship between lagged M2 cycle and credit-to-GDP gap, with lagged M2 cycle explaining about 66 percent of variations in the credit-to-GDP gap. In addition, Table 4 shows simple in-sample Granger-causality test and demonstrates that there is bi-directional Granger-causality between M2 cycle and credit-to-GDP gap. On the other hand, there is uni-directional Granger causality between M2 growth and credit-to-GDP growth.

Table 4	Credit-to-GDP gap-M2 cycle				
Regressors	*Coefficient*	*St. Error*	*T-statistic*	*In-sample test of Granger Causality*	
y_{t-1}				Null	F-test (Prob)
$\bar{y}_{t-1}$	0.26	0.14	1.79 (0.08)	$\dot{x} \neq> \dot{y}$	4.23 (0.02)
$\dot{x}_{t-1}$	0.66	0.24	2.72 (0.01)	$\dot{y} \neq> \dot{x}$	3.38 (0.05)
dz_{t-1}	0.04	0.03	1.54 (0.13)	$\ddot{x} \neq> \ddot{y}$	4.08 (0.03)
				$\ddot{y} \neq> \ddot{x}$	1.05 (0.36)

Adj. R^2 = 0.27; SEE = 0.15; Heteroskedasticity, white's test = F(9,30) = 1.02 (0.45), Breusch-Godfrey Serial Correlation LM Test: F(2,34) = 1.66 (0.21), Jarque-Bera test: 87.30(0.00), Ramsey-reset test: F(2,34) = 0.38 (0.69).

Where $\bar{y}_t$ is credit-to-GDP gap, $\bar{\bar{y}}_t$ is credit-to-GDP growth, $\dot{x}$ is M2 cycle, x is M2 growth and z is trade deficit ratio (% of GDP), probability in parenthesis. $\dot{x} \neq> \bar{y}_t$; Means M2cycle does not Granger-cause credit-to-GDP gap, $\ddot{x} \neq> \bar{\bar{y}}_t$; means M2 growth does not Granger cause credit-to-GDP growth.

4.2.4.2 VAR Granger causality

For robustness checks, the study uses VAR Granger causality tests. The results are displayed in Table 5. VAR Granger causality test confirms the results from the simple Granger causality tests that there is bi-directional Granger-causality between M2 cycle and credit-to-GDP gap. On the other hand, there is no Granger causality between M2 growth and credit-to-GDP growth..

Table 5	In-sample Granger causality	
Null	F-statistic	Prob.
$\dot{x} \neq> y_t$	4.23	0.02
$\bar{y} \neq> x$	3.38	0.05
$\ddot{x} \neq> y$	4.08	0.03
$\bar{\bar{y}} \neq> x$	1.04	0.36

Where $\bar{y}$ is credit-to-GDP gap, $\bar{\bar{y}}$ is credit-to-GDP growth, $\dot{x}$ is M2 cycle, x is M2 growth.

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5 CONCLUSION AND RECOMMENDATIONS

5.1 Key findings

The study investigates the lead-lag relationship between M2 cycle and credit-to-GDP gap and discovered that M2 cycle leads credit-to-GDP gap by one (1) year with the relationship procyclical. Moreover, simple OLS Granger-causality test indicates a bi-directional causality between M2 cycle and credit-to-GDP gap. Conversely, there is uni-directional evidence of Granger causality from M2 growth to credit-to-GDP growth. VAR Granger-causality test also corroborates the simple OLS results. The relationship between the credit cycle and credit-to-GDP gap was examined and the results show a strongly synchronous association between the two variables. On the other hand, the study investigated the relationship between real credit and real output cycles[11] and had anticipated that real credit cycle will mimic real output cycle, as availability of money will lead to increased investment and thus increase economic activity. However, the results of the study portray a different picture from our *a priori expectations*. First, the cross correlation between real output cycle and real credit cycle shows no significant lead-lag relationship between the two variables, there is cross correlation between real credit cycle and real output cycle only in the current period of the credit cycle. Similar results were established using the growth rates for both the real output and real credit. Second, using the simple OLS regression, the relationship between real credit cycle and real output cycle is negative and insignificant. The only significant relationship is found between real output cycle and its lagged value. Last, using the VAR regression for robustness checks, there is no relationship between real output cycle and real credit cycle. In addition, Granger causality tests were conducted on both the OLS and VAR regression models, the results confirm that neither real credit cycle nor real output cycle Granger-causes each other. Real output growth and real credit growth also displayed no Granger-causality between them. The results could imply several issues, for instance, it could mean changes in output are as a result of other variables except the availability of credit to the private sector or it could be as a result of mis-specification in the models used in the study.

[11] Refer to Box 1.

Additionally, the study also used the broad money supply (M2) as an alternative to credit to private sector as M2 has been used in the literature as a proxy for financial development like in Chang and Caudill (2005), Handa and Khan (2008), Akomolafe (2014) and Marbua (2013). M2 cycle was computed using the HP filter using a smoothing parameter of 100. The study investigated the relationship between M2 cycle and output cycle in order to establish whether M2 cycle can be used as a lead indicator for the output cycle[12]. The study discovered that M2 cycle leads the output cycle in Lesotho by 3 years, with the relationship countercyclical. Therefore, broad money can be used as a lead indicator for the output cycle in Lesotho. On the other hand, it was established that there is no lead-lag relationship between M2 growth and output growth[13]. Using simple OLS granger-causality, it was discovered that there is uni-directional causality from M2 cycle to output cycle while there is no Granger-causality between M2 growth and output growth.

5.2 Recommendations

The study proposes the following recommendations based on both the theoretical and empirical evidence discovered in the study, as a proposed way forward to develop the counter-cyclical buffers in Lesotho.

- Credit extension to the household and private non-financial corporate sector, including non-banks and lending from abroad is limited in influencing real output in Lesotho. According to the CBL (2012) economic review, dimness in private sector credit extension can be attributed, amongst others; to commercial banks' risk aversion[14] coupled with low credit demand by the private sector. Consequently, because of the empirical evidence found in this study, credit cycle can be used as a proxy for credit-to-GDP gap in Lesotho.

- M2 cycle can also be used as an instrument for the macroprudential policy framework on the basis of empirical evidence that suggests its' suitability as a leading indicator for the credit-to-GDP gap.

[12] Refer to Box 1.
[13] Calculated as first difference in logs.
[14] CShown by a high risk premium in Lesotho relative to other common monetary area (CMA) countries - CBL, Financial stability watch, March 2015.

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- Credit-to-GDP gap is computed by taking credit in each quarter and dividing it by a rolling GDP sum of last four (4) quarters, commonly referred to as annualised credit-to-GDP ratio. Therefore, the last quarter value coincides with annual GDP value which can be used to perform a reality check on the validity of the proxies.

- The study recommends that for stress testing, shocks to the NFA should be conducted to determine how they affect the macro-financial stability and financial deepening factors as it represents a big part of broad money in Lesotho.

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BOX 1

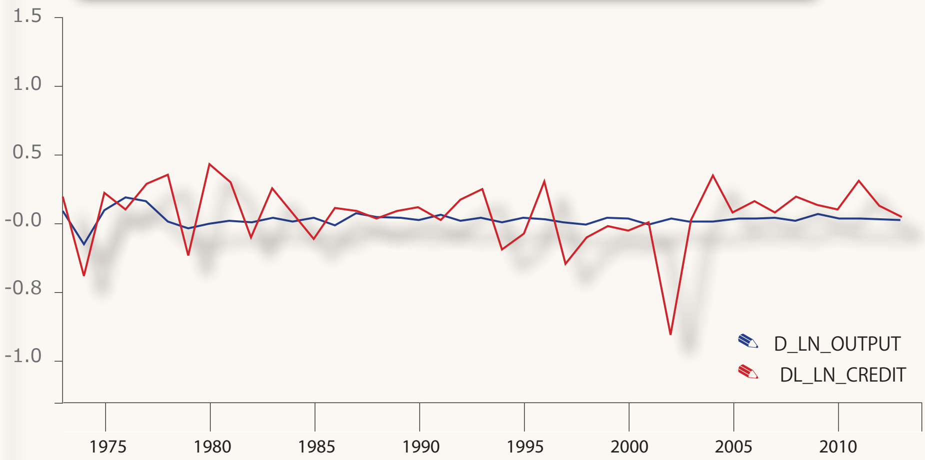
Box 1 Application of credit and M2 to output

1. Relationship between real GDP growth and real credit growth

Figure 1 shows the growth rates of real GDP and real credit, calculated as difference in logs in real GDP and real credit in Lesotho. Through visual inspection, real GDP growth rate appears to be more stable across the sample period while real credit growth tends to deviate from its mean in some periods. Commercials banks performance in Lesotho was weak and characterised by inadequate management, extension of credit disregarding prudent lending practices and excessive political intervention for one of the state owned banks', which was eventually closed in 1998 (Motelle and Masenyetse, 2012; Borotho, 1998). Two of the state owned banks were experiencing limited lending capacity in late 1990s as a result of insolvency and being illiquid and resulted in low investment environment, which transpired in recessionary conditions in 1998 (Borotho, 2000) and subsequently led to the privatisation of Lesotho bank (Motelle and Masenyetse, 2012). This period was coincidentally aligned to the Asian banking crises, which for some countries extended to the early 2000s'. In 2001, the AGOA initiative was signed into law and resulted in Asian businesses locating to Lesotho to enjoy this duty free environment for exports to the US market. In an attempt to boost the export market, the Central Bank of Lesotho (CBL) in 2002 signed a memorandum of understanding (MOU) with commercial banks to advance credit to eligible exporters. In 2004, two additional players were introduced in the banking sphere and this resulted in banks aggressively competing for loans and thus relaxing their credit standards (CBL, 2004). The 2007 global financial crisis had an impact on the global market and Lesotho was no exception. The land administration act (LAA) was introduced in 2010, where households could use land as collateral to access credit from banks (CBL, 2012). These developments explain the rather sporadic movement in real credit growth. Since credit exerts a small influence in creating more output in Lesotho due to limited extension to the private sector, the developments which transpired in the credit environment have shown not to have impacted the real output growth as it is shown to be smooth in the period under review.

Box I Application of credit and M2 to output (continued)

Figure 1 Real GDP growth and real credit growth



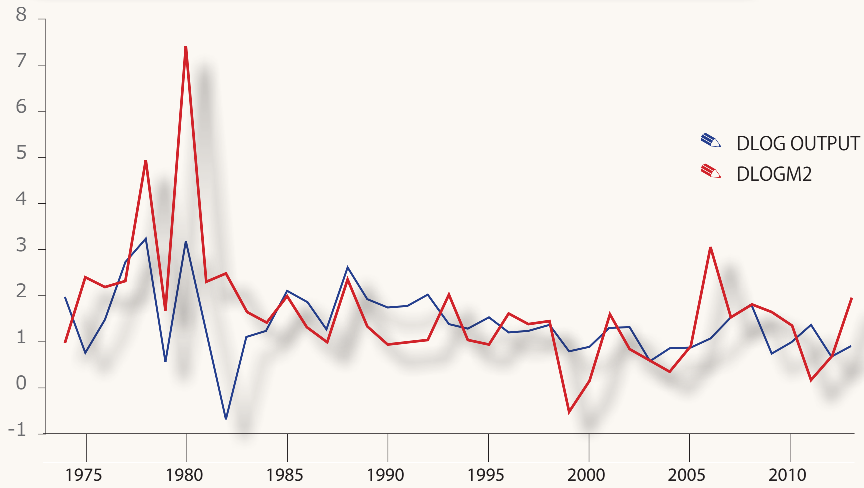
Source: World Development Indicators, 2016

2. Relationship between GDP growth and M2 growth

Alternatively, the study investigated the relationship between the growth rates of GDP and M2 as showed in Figure 2, calculated as difference in logs in GDP and M2 in Lesotho. Through visual inspection, there seems to be correlation between GDP growth rate and M2 growth in the period under review as the two growth rates look to be moving closely to each other with M2 growth looking to move first then output growth following.

Box 1 Application of credit and M2 to output (continued)

Figure 2 Output growth and M2 growth

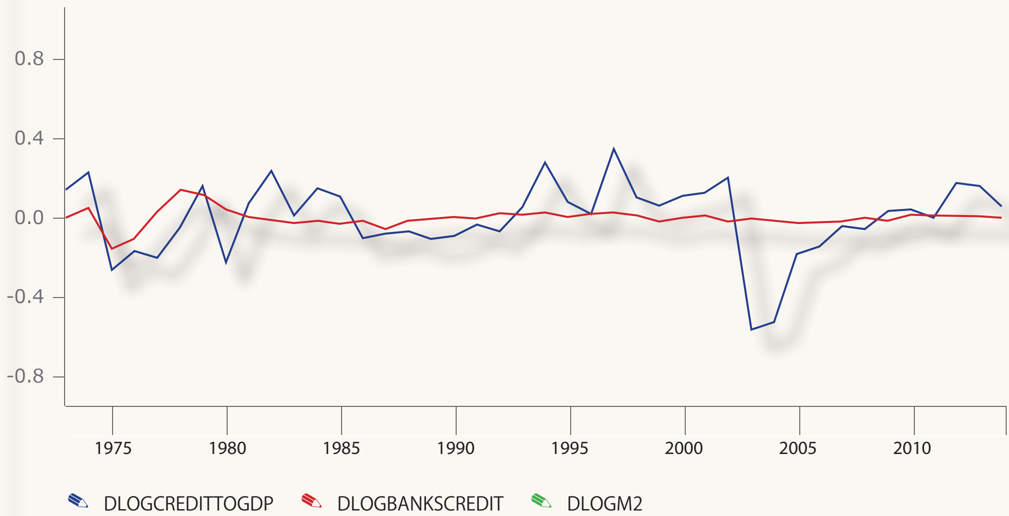


Source: World Development Indicators, 2016

Figure 3 plots the real output and real credit cyclical components (in logarithms). The cycles were derived using the Hodrick-Prescott (HP) filter with an annual smoothing parameter of 100. Notably, there seems to be a structural break in 2003 for the real credit cycle. The Chow break-point test was conducted to formally test whether the observed structural break is statistically significant. The test confirms that there is a structural break in 2003. The findings on the test are reported in Appendix 1.

Box 1 Application of credit and M2 to output (continued)

Figure 3 GDP and credit cycles

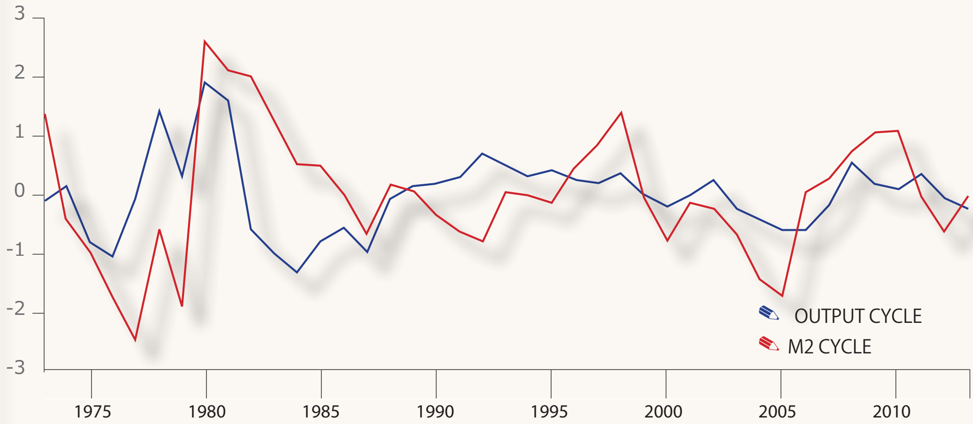


Source: World Development Indicators, 2016

Figure 4 plots the output and M2 cyclical components (in logarithms). The cycles were derived using the HP filter with an annual smoothing parameter of 100. From the visual inspection of the Figure 4, it is evident that the M2 cycle graph leads the output cycle graph, as peaks and troughs of M2 cycle are followed by peaks and troughs of the output cycle graph.

Box 1 Application of credit and M2 to output (continued)

Figure 4 Output and M2 cycles



Source: World Development Indicators, 2016

3. Credit cycle and M2 cycle as lead indicators for the output cycle

3.1. Unit root test results

The apparent structural break in 2003 for real credit cycle prompted the stationarity test to be conducted on the variable employing an ADF test with an intercept and trend. Also, trade deficit to GDP ratio exhibits a rising trend and ADF test with an intercept and trend was used to determine the stationarity of the variable. However, for the remaining variables, the ADF test with intercept was used. Table 1 shows that real credit cycle and real output cycle are stationary at a 5 percent significance level, while real credit growth and real output growth are stationary at a 1 percent significance level. The trade deficit to GDP ratio is stationary at a 10 percent significance level. Table 1 shows that M2 cycle and output cycle are stationary at a 5 percent significance level, while M2 growth and output growth are both stationary at a 1 percent significance level. The trade deficit to GDP ratio is first difference stationary at a 1 percent significance level

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Box 1	Application of credit and M2 to output (continued)

Table 1: ADF Test

Variables	T-static	Decision	Variables	T-statistic	Decision
Real credit cycle#	-4.15 (0.01)**	Stationary	M2 cycle	-3.65 (0.01)**	Stationary
Real output cycle	-3.86 (0.01)**	Stationary	Output cycle	-3.34 (0.02)**	Stationary
Real credit growth	-6.70 (0.00)*	Stationary	M2 growth	-4.90 (0.00)*	Stationary
Real output growth	-5.93 (0.00)*	Stationary	Output growth	-5.38 (0.00)*	Stationary
TDR#	-3.36 (0.07)***	Stationary	TDR#	-0.64 (0.85)	Non-stationary
			d(TDR)	-6.15 (0.00)*	Stationary

Critical values -3.60, -2.94 and -2.61. (*), (**) and (***) denote 1%, 5% and 10% level of statistical significance with p – values in parenthesis. () ADF with intercept and trend (#), critical values -4.21, -3.53 and -3.19 (*), (**) and (***) denote 1%, 5% and 10% level of statistical significance.

3.2 Lead-lag relationship between GDP, credit and M2 cycles

The results reported in Table 2a show that there is no lead-lag relationship between real output cycle and real credit cycle, as the largest significant value in absolute terms is at the current observation of real credit cycle. Although insignificant, there is evidence suggesting that the real credit cycle is pro-cyclical to real output cycle in the lead periods, and it is counter-cyclical in the lagging periods. In other words, the results imply that real output cycle is explained by the current level of real credit cycle. When examining the real growth rates, it is evident that real output growth is also explained at the current rate of real credit growth. In contrast, there is evidence suggesting that real credit growth is counter-cyclical to real output growth in the lead periods, and pro-cyclical in the lag periods with an exception noted in year x_{t-3}. This was a period where growth in credit was fuelled by the reduction in borrowing costs due to low domestic and global interest rates.

The co-movement of output cycle and M2 cycle using correlation analysis is also displayed in Table 2b. The study establishes that M2 cycle is countercyclical with the output cycle, and M2 cycle leads output cycle by 3 years. Moreover, the relationship between M2 cycle and output cycle changes in the lead periods and turns procyclical. Moreover, Table 2b displays that the relationship between M2 cycle and output cycle turns procyclical in the lead periods with the correlations statistically significant.

Box I Application of credit and M2 to output (continued)

Table 2 A: Cross Correlations (Output cycle and credit cycle)

$\tilde{y}_{t}, \tilde{x}_{t}$	x_{t-3}	x_{t-2}	x_{t-1}	x_{t}	x_{t+1}	x_{t+2}	x_{t+3}
	-0.24	-0.27	-0.01	**0.30**	0.23	0.15	0.11
	(0.15)	(0.10)	(0.95)	**(0.06)**	(0.14)	(0.35)	(0.50)
$\grave{y}_{t}, \grave{x}_{t}$	-0.07	0.04	0.06	**0.34**	-0.03	-0.16	-0.10
	(0.70)	(0.80)	(0.71)	**(0.03)**	(0.87)	(0.33)	(0.65)

Where $\tilde{y}_{t}, \tilde{x}_{t}$ is the cross correlation between real output cycle and real credit cycle. Whereas the notation $\grave{y}_{t}, \grave{x}_{t}$ refers to the growth rates of both the real output and real credit. Probability values are in parenthesis. The highest significant correlations are in bold.

Table 2 B: Cross Correlations (Output cycle and M2 cycle)

$\dot{y}_{t}, \dot{x}_{t}$	x_{t-3}	x_{t-2}	x_{t-1}	x_{t}	x_{t+1}	x_{t+2}	x_{t+3}
	-0.60	-0.52	-0.15	0.31	0.31	0.43	0.30
	(0.00)	(0.00)	(0.35)	(0.05)	(0.05)	(0.01)	(0.06)
$\ddot{y}_{t}, \ddot{x}_{t}$	0.03	-0.07	0.03	**0.51**	0.05	0.35	0.15
	(0.88)	(0.67)	(0.85)	**(0.00)**	(0.78)	(0.03)	(0.38)

Where $\dot{y}_{t}, \dot{x}_{t}$ is the cross correlation between output cycle and M2 cycle. Whereas the notation $\ddot{y}_{t}, \ddot{x}_{t}$ refers to the growth rates of both the output and M2. Probability values are in parenthesis. The highest significant correlations are in bold.

3.3 The VAR relationship between GDP, credit and M2 cycles

Table 3a displays GDP-credit cycles VAR estimation output with endogenous variables lagged once. The results indicate that in all three systems of equations, the left hand side variables are only explained by their own lagged variables and the rest of the variables are statistically insignificant. Looking at the output regression, about 50 percent of the variance in real GDP cycle is caused by lagged real GDP value, while the lagged credit cycle explains about 34 percent of the current credit cycle movements and lastly, only 2 percent of the current movement in trade deficit to GDP ratio is explained by its lagged value. However, Looking at Table 3b, about 67 percent of the variance in output cycle is caused by lagged output cycle value, while the lagged M2 cycle explains about 24 percent of the variation in output cycle and bearing a countercyclical effect.

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Box 1 Application of credit and M2 to output (continued)

Table 3 A: Estimating VARs (Output-credit cycles; 1 lag)

Regressors	Output cycle	Credit cycle	Trade deficit ratio
$\tilde{y}_{t-1}$	0.50 (3.26)	0.54 (0.83)	0.99 (0.64)
$\tilde{x}_{t-1}$	-0.04 (-1.07)	0.34 (2.12)	-0.33 (-0.87)
z_{t-1}	-0.002 (-0.55)	-0.003 (-0.22)	0.02 (26.96)

AIC, FPE and HQ select three (3) lags, while SIC select one (1) lag, diagnostics of the system: Serial correlation LM test: χ^2(9) = 8.09 [0.53], Heteroskedasticity Test (whites' test with cross terms): χ^2(36) = 54.69 [0.02]. Moreover, all the inverse unit roots fall inside the unit circle, implying that the VAR is stationary.

Table 3 B: Estimating VARs (Output-M2 cycles; 1 lag)

Regressors	Output cycle	M2 cycle	Trade deficit ratio
$\dot{y}_{t-1}$	0.67 (4.63)	0.36 (1.46)	-0.17 (-0.38)
$\dot{x}_{t-1}$	-0.24 (-2.78)	0.47 (3.27)	-0.65 (-2.40)
dz_{t-1}	-0.003 (-0.07)	-0.12(-1.37)	0.04 (0.25)

AIC, FPE and HQ select three (3) lags, while SIC select one (1) lag, diagnostics of the system: Serial correlation LM test: $\chi^2(9)$ = 8.09 [0.53], Heteroskedasticity Test (whites' test with cross terms): $\chi^2(36)$ = 54.69 [0.02]. Moreover, all the inverse unit roots fall inside the unit circle, implying that the VAR is stationary.

Moreover, the AIC, FPE and HQ information criterion variables indicate three (3) lags in the GDP-credit cycle VAR regression model and two (2) lags for output cycle and M2 cycle in Table 4a and 4b. Table 4a shows real output cycle lags are significant up to two lags, with the second lag being negative. Moreover, when looking at the real credit cycle regression, lagged real output cycle explains about 2 percent of movements in real credit cycle. Lagged real credit explains about 39 percent of movements in real credit cycle up to lag one (1). Trade deficit to GDP ratio explains about 20 percent of movements in real credit cycle lagging real credit cycle by three (3) years. Lagged trade deficit to GDP ratio explains about 76 percent of movements in the current trade deficit to GDP ratio. Table 4b displays GDP-M2 cycle VAR estimation output with 2 lags, 64 percent of variation in output cycle is explained in the first lag of the output cycle while 23 percent is explained by the second lag of the M2 cycle with a countercyclical effect. When looking at the M2 cycle regression, lagged M2 cycle explains about 62 percent of movements in the current M2 cycle while 20 percent of the variation is explain in lag 2 of the trade deficit ratio. Lag one of M2 cycle explains about 81 percent of the variation in Trade deficit to GDP ratio with a countercyclical effect.

Box 1 Application of credit and M2 to output (continued)

Table 4 A: Estimating VARS with multiple lags (GDP-credit cycles; 3 lags)

Regressors	Real output cycle	Real credit cycle	Trade deficit ratio
$\tilde{y}_{t-1}$	0.81 (5.71)	2.02 (2.06)	2.06 (1.15)
$\tilde{y}_{t-2}$	-0.37 (-2.79)	0.45 (0.50)	-0.79 (-0.47)
$\tilde{y}_{t-3}$	-0.08 (-0.75)	0.11 (0.15)	-4.22 (-3.08)
$\tilde{x}_{t-1}$	-0.04 (-0.00)	0.39 (2.38)	-0.03 (-0.11)
$\tilde{x}_{t-2}$	-0.02 (-0.64)	-0.12 (-0.69)	0.39 (1.21)
$\tilde{x}_{t-3}$	0.01 (0.39)	0.22 (1.28)	0.08 (0.25)
z_{t-1}	-0.01 (-1.09)	-0.11 (-1.30)	0.76 (4.90)
z_{t-2}	0.00 (0.15)	-0.09 (-0.83)	0.34 (1.81)
z_{t-3}	0.01 (0.68)	0.20 (2.46)	-0.13 (-0.91)

Akaike information criterion (AIC), Final prediction error (FPE) and Hannan-Quinn information criterion (HQ) select three (3) lags, while Schwarz information criterion (SC) selects one (1) lag, diagnostics of the system: Serial correlation LM test: $\chi^2(9) = 5.83$ [0.7560], Heteroskedasticity Test (whites' test with cross terms): $\chi^2(108) = 115.93$ (0.28). Moreover, all the inverse unit roots fall inside the unit circle, implying that the VAR is stationary..

Table 4 B: Estimating VARS with multiple lags (GDP-M2 cycles; 2 lags)

Regressors	Output cycle	M2 cycle	Trade deficit ratio
$\dot{y}_{t-1}$	0.67 (4.63)	0.36 (1.46)	-0.17 (-0.38)
$\dot{y}_{t-2}$	-0.24 (-2.78)	0.47 (3.27)	-0.65 (-2.40)
$\dot{x}_{t-1}$	0.67 (4.63)	0.36 (1.46)	-0.17 (-0.38)
$\dot{x}_{t-2}$	-0.24 (-2.78)	0.47 (3.27)	-0.65 (-2.40)
dz_{t-1}	-0.24 (-2.78)	0.47 (3.27)	-0.65 (-2.40)
dz_{t-2}	-0.003 (-0.07)	-0.12(-1.37)	0.04 (0.25)

AIC, FPE and HQ select two (2) lags and SIC select one (1) lag, diagnostics of the system: Serial correlation LM test: $\chi^2(9) = 20.18$ [0.0.02], Heteroskedasticity Test (whites' test with cross terms): $\chi^2(162) = 174.09$ [0.24]. Moreover, all the inverse unit roots fall inside the unit circle, implying that the VAR is stationary.

Box 1 Application of credit and M2 to output (continued)

3.4 Granger causal relationship between GDP, credit cycle and M2 cycle

3.4.1 Simple Granger causality

Looking at the in-sample Granger-causality test, we fail to reject the null hypothesis that real credit cycle does not Granger-cause real output cycle. Moreover, the null hypothesis that real output cycle does not Granger-cause real credit cycle is accepted. While examining the growth rates, real output growth does not Granger-cause real credit growth, with real credit growth also not Granger causing real output growth. On the other hand, Table 5b shows the estimated GDP-M2 cycle output equation with the cycles obtained using the HP filter. The in-sample Granger-causality test shows that we reject the null hypothesis that M2 cycle does not Granger-cause output cycle. Moreover, we fail to reject the null hypothesis that output cycle does not Granger causes M2 cycle. Moreover, there is no Granger-causality between output growth and M2 growth.

Box 1 Application of credit and M2 to output (continued)

Table 5 A: Estimated real output equation (GDP-credit cycle)

Regressors	*Real output cycle*	*Real credit cycle*	*Trade deficit ratio*	*In-sample test Granger Casuality*	
				Null	*F-test (Prob)*
$\tilde{y}_{t-1}$	0.50	0.15	3.26 (0.00)	$\tilde{x} \neq> \tilde{y}$	1.10 (0.30)
$\tilde{x}_{t-1}$	-0.04	0.04	-1.07 (0.29)	$\tilde{y} \neq> \tilde{x}$	0.70 (0.41)
z_{t-1}	-0.002	0.004	-0.51 (0.61)	$\dot{x} \neq> \dot{y}$	0.09 (0.91)
				$\dot{y} \neq> \dot{x}$	0.53 (0.59)

Adj. R^2 = 0.17; SEE = 0.04; Heteroskedasticity, Breusch-Godfrey test = F(3,36) = 1.72 (0.18), Breusch-Godfrey Serial Correlation LM Test: F(2,34) = 1.96 (0.16), Jarque-Bera test: 98.55 (0.00), Ramsey-reset test: F(2,34) = 1.89 (0.17).

Where $\tilde{y}$ is real output cycle, $\dot{y}$ is real output growth, $\tilde{x}$ is real credit cycle, $\dot{x}$ is real credit growth and is trade deficit ratio (% of GDP), probability in parenthesis. $\tilde{x} \neq> \tilde{y}$; Means real credit cycle does not Granger-cause real output cycle, $\dot{x} \neq> \dot{y}$; means real credit growth does not granger cause real output growth.

Table 5 B: Estimated real output equation (GDP-M2 cycle)

Regressors	*Real output cycle*	*Real credit cycle*	*Trade deficit ratio*	*In-sample test Granger Casuality*	
				Null	*F-test (Prob)*
$\dot{y}_{t-1}$	0.67	0.15	4.63 (0.00)	$\dot{x} \neq> \dot{y}$	6.32 (0.00)
$\dot{x}_{t-1}$	-0.23	0.09	-2.78 (0.01)	$\dot{y} \neq> \dot{x}$	2.35 (0.11)
dz_{t-1}	-0.003	0.05	-0.07 (0.95)	$\ddot{x} \neq> \ddot{y}$	0.38 (0.69)
				$\ddot{y} \neq> \ddot{x}$	2.03 (0.15)

Adj. R^2 = 0.38; SEE = 0.05; Heteroskedasticity, Breusch-Pagan-Godfrey test = F(9,29) = 4.89 (0.00), Breusch-Godfrey Serial Correlation LM Test: F(2,33) = 1.33 (0.28), Jarque-Bera test: 2.67 (0.99), Ramsey-reset test: F(2,33) = 0.72 (0.49).

Where $\dot{y}$ is output cycle, $\ddot{y}$ is output growth, is $\dot{x}$ M2 cycle, $\ddot{x}$ is M2 growth and z is trade deficit ratio (% of GDP), probability in parenthesis. $\dot{x} \neq> \dot{y}$; Means M2 cycle does not Granger-cause output cycle, $\ddot{x} \neq> \ddot{y}$; means M2 growth does not granger cause output growth.

3.4.2 VAR Granger causality

For robustness checks, the study uses VAR Granger causality tests in Table 6[1]. Looking at the in-sample Granger-causality test, we fail to reject the null hypothesis that real credit cycle does not Granger-cause real output cycle. In addition, real output cycle does not Granger cause real credit cycle. While examining the growth rates, real output growth does not Granger-cause real credit growth and real credit growth does not Granger cause real output growth either as evidenced in Table 6a and 6c.

Moreover, the study uses VAR Granger causality tests in Table 6b for GDP-M2 relationship. VAR Granger-causality confirms results that M2 cycle does Granger-cause output cycle. In addition, output cycle does not Granger-cause M2 cycle. Moreover, there is no Granger-causality between M2 growth and output growth.

Box 1 Application of credit and M2 to output (continued)

Table 6 A: In-sample Granger causality (GDP-credit cycles; 1 lag)

Null	*F-statistic*	*Prob.*
$\tilde{x} \neq> \tilde{y}$	1.10	0.30
$\tilde{y} \neq> \tilde{x}$	0.70	0.41
$\grave{x} \neq> \grave{y}$	0.10	0.76
$\grave{y} \neq> \grave{x}$	0.32	0.57

Table 6 B: In-sample Granger causality (GDP-M2 cycles: 2 lags)

Null	*F-statistic*	*Prob.*
$\dot{x} \neq> \dot{y}$	7.05	0.01
$\dot{y} \neq> \dot{x}$	1.33	0.26
$\ddot{x} \neq> \ddot{y}$	0.14	0.87
$\ddot{y} \neq> \ddot{x}$	0.74	0.49

Table 6 C: In-sample Granger causality (GDP-credit cycles; 3 lags)

Null	*F-statistic*	*Prob.*
$\tilde{y} \neq> \tilde{x}$	7.05	0.01
$\tilde{y} \neq> \tilde{x}$	1.33	0.26
$\grave{y} \neq> \grave{x}$	0.14	0.87
$\grave{y} \neq> \grave{x}$	0.74	0.49

Where $\tilde{\mathbf{y}}$ is real output cycle, $\grave{\mathbf{y}}$ is real output growth, $\tilde{\mathbf{x}}$ is real credit cycle, $\grave{\mathbf{x}}$ is real credit growth. Where $\dot{\mathbf{y}}$ is output cycle, $\ddot{\mathbf{y}}$ is output growth, $\ddot{\mathbf{x}}$ is M2 cycle, is M2 growth. $\overline{\mathbf{y}}$ is credit-to-GDP gap, $\overline{\overline{\mathbf{y}}}$ is credit-to-GDP growth.

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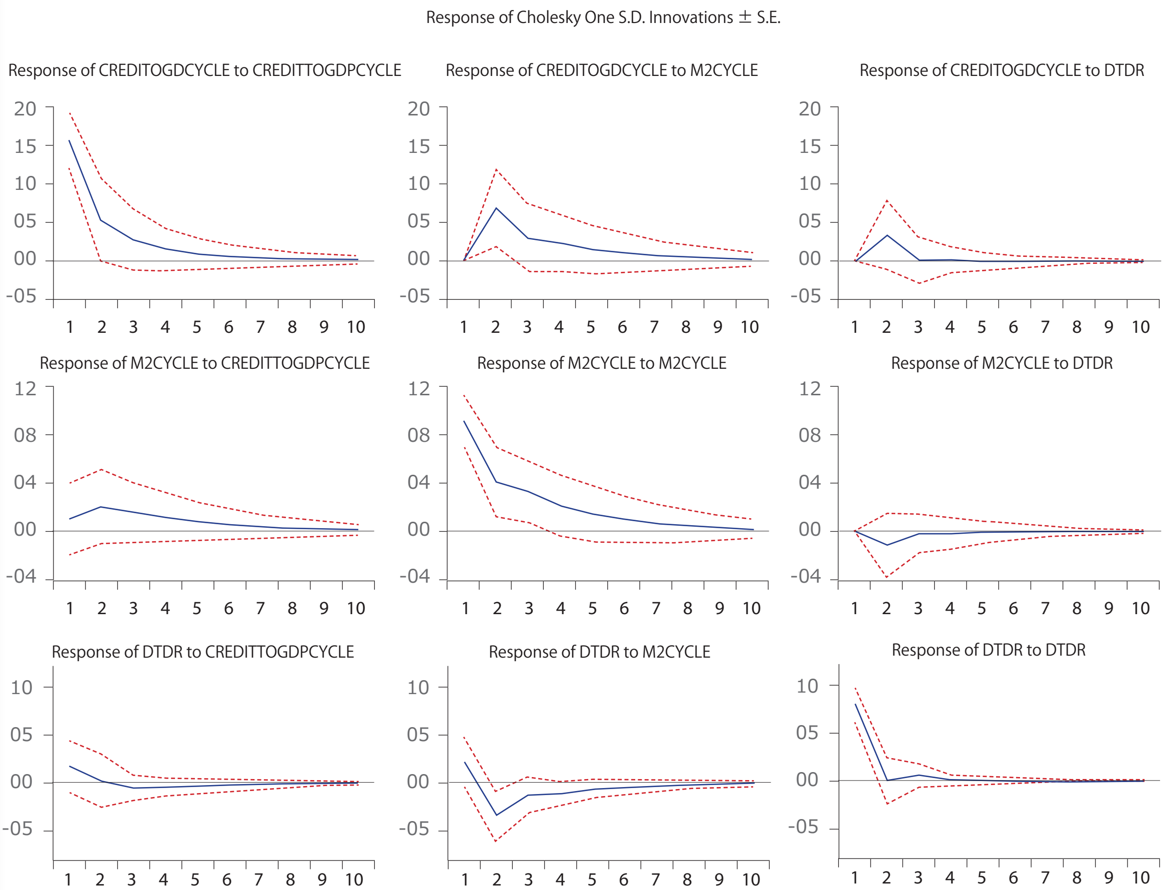
APPENDIX 1

Table 1	Chow breakpoint test	
	Value of the test Statistic	Probability value
F-Statistic	1.00*	Prob. F(4,31) = 0.42
Log likelihood ratio	4.72**	Prob. Chi-square(4) = 0.32
Wald Statistics	3.99**	Prob. Chi-square(4) = 0.41
Ho: No breaks at specified breakpoints, (*) F-statistic, (**) Chi-square Statistic.		

Figure 4 Impulse response function



Source: Word Development Indicators, 2016