Investigating the Interactions between Capital Buffers, Credit and Output Growth:

Evidence from the Jamaican Banking Sector

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Abstract

This paper applies the Arellano-Bover GMM technique to an unbalanced panel of banks from the Jamaican banking sector to test the hypothesis that banks' capital buffers intensified rather than tempered the cyclical behaviour of loans over the period 2000 to 2012. The results revealed that capital buffers are procyclical in nature in that it amplifies cyclical loan fluctuations via changes in the output gap. This result is reinforced when high quality capital is examined. In addition, a panel Granger causality test used to examine the causal relationship between buffer capital and loan growth revealed that buffer capital "Granger causes" loan growth. This finding serves as a validation to the procyclical behaviour of capital buffer. Overall, these results have important implications for the development of macroprudential policy tools for the Jamaican banking system.

Keywords: Procyclicality, Capital Buffers, Business Cycle, Macroprudential policy

JEL Classification: E320, G21, G28

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[*] The views expressed are those of the author and do not necessarily reflect those of the Bank of Jamaica.

1. Introduction

Financial crises have wide scale implications for an economy. As the quintessential example, the global financial crisis of 2007/2008 negatively impacted the financial systems of most developed economies and seriously threatened those of emerging economies, like Jamaica. Although the Jamaican financial system was somewhat insulated from the direct impact of the financial crisis, some financial institutions were indirectly affected. In this regard, the Bank of Jamaica implemented a suite of tools aimed at augmenting the supply of foreign currency and facilitating the flow of credit to alleviate the impact from the international environment. This was in addition to measures taken to ease liquidity constraints on domestic financial institutions which resulted directly from the impact of margin calls from international financial institutions.

Though the Jamaican economy was spared the full blunt of the international financial crisis, the system remains vulnerable to possible economic stresses as the lag effects of the global economic downturn and recession permeates through segments of the local economy. The global crisis underscored the fact that the performance of the economy has implications for the earnings potential of financial institutions and vice versa. As such, the decision of these institutions to hold excess reserves influences economic activity. For example, if a buildup in buffer capital results in amplifying business cycle fluctuations, then this has the potential to increase economic instability, suggesting procyclicality of financial system variables.[1] These concerns have

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[1] Procyclicality of the financial system can be defined as amplification of swings in the economic cycle caused by financial sector activities.

intensified the interest in strengthening the macroprudential orientation of existing policy structures to enhance the financial system and overall macroeconomic stability.[2]

The banking sector is highly regulated globally and the rules that regulate this sector have severe implications for the financial stability of any economy. Countercyclical policy tools, particularly countercyclical capital buffer (CCB), is a macroprudential tool proposed in the new regulatory framework of Basel II by the Basel Committee on Banking Supervision.[3] Its main objective, as stated in a Bank of International Settlements (BIS) consultative paper (2010), is to protect the banking sector from periods of excessive aggregate credit growth that have often been associated with the build-up of system-wide risk.

This paper is motivated by Langrin and McFarlane (2012) that assessed the ability of specific macroeconomic and commercial bank-level variables in reflecting the risk build-up in the banking system in Jamaica. This paper builds on Langrin and McFarlane (2012) in two main areas. First, the paper includes all deposit taking institutions (DTIs). The inclusion of BOJ licensees under the Financial Institutions Act (FIA licensees) and building societies allowed for a broader scope in examining the procyclicality of the banking system. Second, the paper examines the role of bank capital in explaining fluctuations in loan growth. Specifically, the paper follows Coffinet *et al*. (2011) in assessing the links between bank capital buffers, credit and economic growth. It also examines the cyclical nature of capital buffers as this has

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[2] Macroprudential regulation characterizes the approach to financial regulation aimed at mitigating the risks of the financial system as a whole. It evaluates the soundness and vulnerabilities of the financial system.

[3] Countercyclical policy tools are used to reduce or dampen business cycle fluctuations. The Basel framework is a set of banking regulations implemented by the Basel Committee on Bank Supervision, which regulates finance and banking internationally.

implications for the implementation of macro-prudential policy. The study is also motivated by the fact that the typical credit channel via monetary policy becomes inefficient, especially in crisis or stressed periods. As such, macro-prudential policy tools would provide that ‘second instrument’ to propel the economy.

The literature on the cyclicality of capital buffers provides no clear indication of whether capital buffers are generally procyclical or countercyclical in nature. For example, Coffinet *et al*. (2011) assessed the extent to which capital buffers intensify rather than reduce the cyclical behavior of credit for French banks over the period 1993-2009. After accounting for loan stock threshold and double counting of loans outstanding, a total of 98 banks were left as a representation of the French banking system. It was shown that bank capital buffers exacerbate the cyclical credit fluctuations arising from output gap developments. Another interesting finding from this study was that a causal relationship exists between capital buffers and loan growth. Hence, the overall empirical results gave support to a countercyclical financial regulation that aims at smoothing loan growth.

Deriantino (2001) demonstrated empirically that there is strong evidence of procyclicality in capital buffers among banks in ASEAN countries.[4] The study showed that loan growth was reduced when the economy contracted due to the impaired lending capacity as a result of the need to increase capital buffer to mitigate credit riskiness.

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[4] Evidence of this procyclicality came from 63 commercial banks from five countries within the Association of Southeast Asian Nations (ASEAN) during the period 1997-2009.

Tabak *et al.* (2011) also provided evidence on the procyclicality of capital buffers. The authors analyzed the relationship between economic cycle and capital buffers held by banks in Brazil. They estimated a loans growth equation to assess the relationship between lending and buffer capital. Feasible Generalized Least Squares estimation was used on an unbalanced panel of 134 banks in Brazil from 2000 to 2010. The results revealed that the economic cycle negatively affects surplus capital and that buffers have a negative impact on loans. This implies that high bank capitalization is associated with reduced loans in crisis periods. In addition to the direct fall in loans, banks may also reduce their loans as a way to increase their capitalization during economic downturns.

In addition, Repullo and Suarez (2009) provide evidence of the cyclical nature of bank capital regulation. The study assessed the procyclical effects of bank capital regulation in a dynamic equilibrium model of relationship lending where banks are unable to access the equity markets every period. They found that under cyclically-varying risk-based capital requirements, banks hold larger buffers in expansions than in recessions. However, these buffers were not sufficient to prevent a significant contraction in credit growth at the beginning of the recession.

A later study by Repullo and Saurina (2011) argued that a mechanical application of the buffer would reduce capital requirements when there is an expansion and increase them when there is a contraction in the economy, so it may end up exacerbating the inherent procyclicality of risk-sensitive bank capital regulation.

Jokipii and Milne (2006) found that the relationship between capital buffers and the output gap is negative and largely dependent on the size of the bank under examination. Using a panel of 486 banks in a cross section of countries over a seven year period (1997-2004), they found that the capital buffers of larger banks exhibited a countercyclical relationship with the output gap. As for smaller banks, the converse was true, capital buffers rise with the economic cycle. They attribute their findings to the ability of smaller banks to respond to changes in expansions by increasing their loans and as such their capital buffers increase because loan assets rise more slowly than larger banks.

Another set of literature focused on the calibration of macro-prudential policy tools. For example, Langrin and McFarlane (2012) identified conditioning variables at one year and three month horizons that policymakers can use in the design of countercyclical capital buffers. The paper focused on commercial banks in Jamaica over the period 1990-2012. The results from the study indicated that variables such as one-sided HP-filtered: credit-to-real GDP gap, credit plus investment-to-real GDP gap, private and public sector credit-to-real GDP gap all have significant predictive value for the accumulation phase at one year, three month and contemporaneous horizons.

The discussion on the procyclicality of the financial system showed that developments in the financial system can bring about disturbances in the macroeconomy that inevitably lead to financial instability. Therefore sound and effective use of macro-prudential tools should be put in place to better protect the financial system from crisis.

The paper is organized as follows. In the next section, a description of the data used and a brief discussion of the descriptive statistics are presented. The models to be estimated are presented in section 3. Section 4 provides the econometric results. Section 5 analyses the causality between capital buffer and credit growth. Section 6 summarizes and provides some policy implications.

2. The Dataset

2.1 Description of the data

A confidential database provided by the Bank of Jamaica (BOJ) is used to construct the sample of banks. An unbalanced monthly panel data is used which consists of 15 banks (7 commercial banks, 4 building societies, and 4 FIA licensees) and covers the period 2000 to2012.[5]

In order to assess the cyclicality of capital buffers, idiosyncratic as well as macroeconomic independent variables are employed in a buffer equation and a loans growth equation. The explanatory variables utilized in these two equations are defined as follows. As a proxy for cost of capital, the monthly return on equity, *ROE,* was used. The size of banks, *Size,* was measured by the total assets of each individual bank minus the average total assets of all banks (both in logarithmic form). Using this measure for *Size*, reduces the possibility of spurious correlation resulting from time trends in banks' assets. As a measure of the banks' internal measure of risk, the ratio of total provisions for loan to total loans, *Prov,* was used. The ratio of liquidity, *Liq,* was

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[5] The unbalanced panel is comprised of banks that would have ceased being in existence or merged over the sample period.

measured by the ratio of liquid assets to total assets. The bank capital buffer, CB, used to test for procyclicality in the loan growth equation and its lagged value,$CB_{i,t-1}$, was used to account for the expected time varying behavior of capital in the banks' capital buffer equation. As it relates to the macroeconomic series, output gaps are calculated using the Hodrick-Prescott (HP) filter, which is used to derive estimates of potential output.[6] The 30-day Government of Jamaica Treasury bill rate was used as the main refinancing rate.

2.2 Descriptive Statistics

The monthly data, for the period 2000-2012, indicates that banks generally hold more prudential capital than that required by regulators (see Table A1). The capital buffer as a ratio to regulatory capital of the selected banks varied from negative 519.0 per cent to positive 366.0 per cent.[7] The median capital buffer for the system is approximately 22.0 percent of regulatory capital, while the average is around 30.0 percent. Several reasons have been put forward to explain why banks hold excess capital. Tabak (2004), laments that banks generally will tend to assess their risks differently than regulators, for example, using their own internal economic capital models. Therefore appropriate bank-specific capital levels will be set according to their own assumptions and risk behavior. As capital ratios affect the ability of banks to collect loans in a non-monotonic way, a bank may be forced to exceed capital requirements (Dietrich and Vollmer, 2005). Banks may also need to hold excess capital in order to signal some level of soundness to the market and

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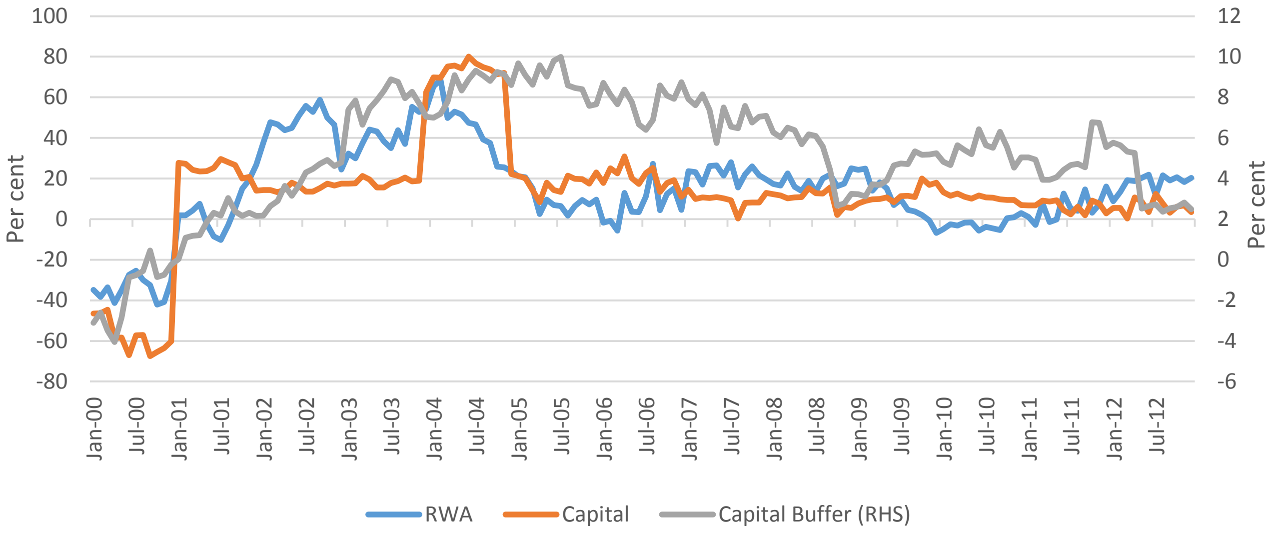
[6] The output gap as a measure of economic activity, is the difference between actual and potential output. The construction of the output gap is difficult because, among other problems, potential output is an unobserved variable. Therefore, potential output was estimated using the Hodrick-Prescott (HP) filter which decomposes GDP into growth and cyclical components. This decomposition assumes that GDP does not contain any seasonality.

[7] Let the buffer capital and regulatory capital held by banks be K_{it} and K_{it}^{r} , respectively. The capital buffer ratio is then defined as $\frac{K_{it}-K_{it}^{r}}{K_{it}^{r}} \times 100$.

satisfy the expectations of rating agencies (Jackson *et. al*., 1999). Concerning the data for higher quality capital (Tier1 capital buffer), the median was 0.03 percent of regulatory capital and the average was approximately 0.15 percent.

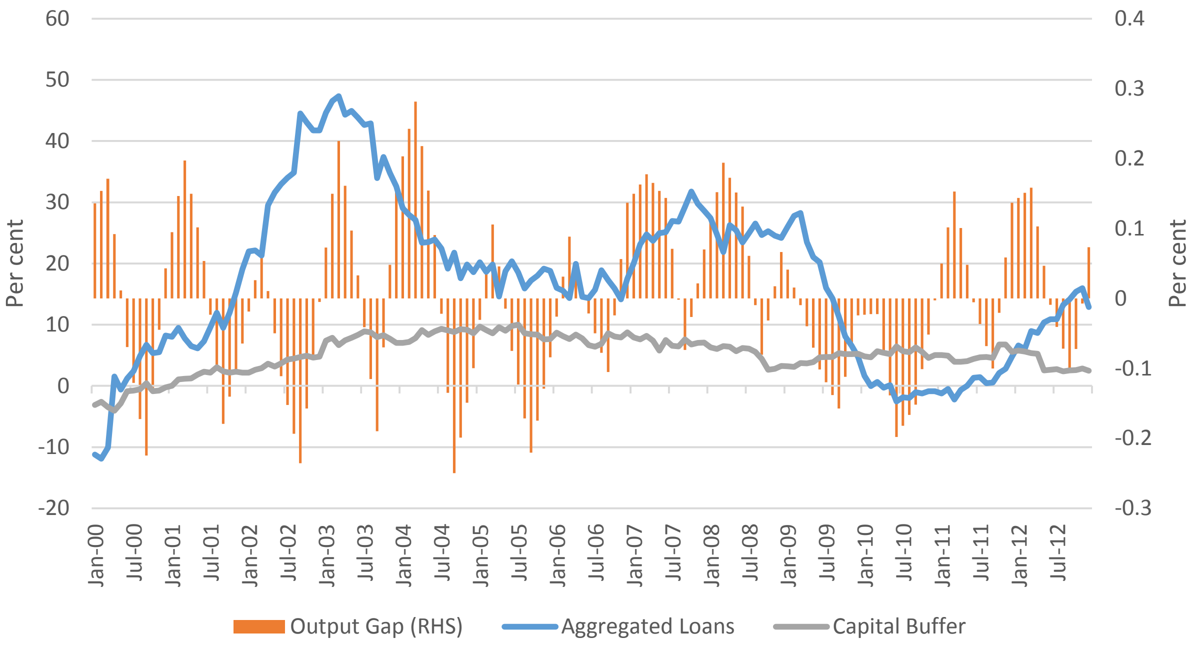
Over the sample period, capital buffer accumulation was quite volatile (see Graph 1). This suggests that there was no fixed target for buffer capital, as capital evolution did not correlate very strongly with risk weighted assets. As such changes in total capital as well as changes in risk weighted assets impacts the accumulation of capital buffer.

Graph 1: Time plot of the (unweighted) mean of bank variables



Cyclical patterns can be identified in the evolution of capital buffer and loan growth over the sample period (see Graph 2). There appears to be a slightly positive co-movement between loan growth and the business cycle. This is in line with the expectation that banks will increase loans when risks are perceived to be weak, i.e. in an expansionary phase. On the contrary, loans growth would decline during an economic contraction phase. For the sample period, there is an initial period where the growth in loan leads the expansionary phase in the cycle. However, the relationship reverses in a contraction phase, where changes in loan growth lag the cycle. Movements in buffer capital seems relatively independent of the cycle. This goes against *a priori* expectations where buffer capital is expected to be built up during recessions. Hence, an empirical investigation will seek to provide a better analysis of this relationship.

Graph 2: Cyclical developments in capital buffers and loan growth



3 Empirical model

The aim of this study is to identify whether bank capital buffers amplify the cyclical pattern of loan growth. In other words, it seeks to understand if capital buffer behaves pro-cyclically. To test this hypothesis, two equations are specified. The first equation explores whether the output gap significantly explains variation in capital buffers, while the second equation examines the effect of capital buffer on loan growth, after controlling for the output gap. The procyclical effect of capital buffer will be seen if a negative relationship is found between the output gap and buffer capital in the first equation, and subsequently between loan growth and buffer capital in the second equation.

3.1 Capital buffer equation

The general model is expressed as follows:

$$CB_{it} = \varphi_0 + \sum_{m=1}^{M} \varphi_m X_{m,i,t} + \varepsilon_{i,t} \qquad (1)$$

Capital buffer ($CB_{i,t}$) is defined as the difference between economic capital and regulatory capital as a ratio to regulatory capital. The intercept is denoted by φ_0 and φ_m m=1…..M, denotes the M coefficients common to all banks on the independent variables, $X_{m,i,t}$. Finally, $\varepsilon_{i,t}$ represents the residuals of the equation, which are assumed to be independent and identically distributed. The specific model to be estimated over the panel of banks is expressed as follows:

$$\Delta CB_{it} = \varphi_0 + \varphi_1 CB_{it-1} + \varphi_2 Gap_{t-1} + \varphi_3 ROE_{it-1} + \varphi_4 Size_{it-1} + \varphi_5 Prov_{it-1} + \varepsilon_{it} \qquad (2)$$

To avoid the possible endogeneity of banking variables, all explanatory variables were lagged. The variable of interest in the model, $Gap_{t,}$, was used to determine whether the business cycle has an effect on bank capital buffer (see equation 2). A negative sign on the coefficient for the gap variable would suggest precautionary savings during economic downturns, while a positive sign would indicate a build-up of capital during good times to smooth activities across the cycle.

The other variables are control variables. It is expected that the ROE_t will be negatively correlated with capital buffer as higher level of earnings can substitute for capital against unexpected losses. A negative sign is expected on *Size* given the premise is that big banks have less incentives to constitute capital buffers due to a lower risk aversion, in line with the *too big to fail* hypothesis. In addition, given their higher ability to diversify risks as well as their ability to access funding, larger banks generally have little incentive to maintain significant capital buffers (Coffinet et al., 2011). Since *Prov* is considered a proxy for the risk of bank assets, a positive sign is expected for the coefficient on this variable in the capital buffer equation. As for the lagged dependent variable, a positive sign is expected.

The Arellano-Bover (1995) Generalized Method of Moments (GMM) technique was used to model the cyclicality of capital buffers (see equation 2). This estimation technique was chosen specifically to account for several characteristics of the panel such as: (i) possible endogeneity of the bank explanatory variables; (ii) the presence of fixed effects possibly correlated with the explanatory variables; (iii) the presence of the lagged dependent variable may give rise to autocorrelation; (iv) and the possibility of heteroskedasticity. To account for the possible endogeneity of any of the explanatory variables instrumental variables were included in the model. In particular, instruments employed in the differenced equation were two to three lags of *ROE*, one to two lags of *Size*, and one to four lags of *Prov*. For the gap variable, 1 to 6 lags were used to account for seasonal patterns in the business cycle. To ensure a robustly estimated model, a post-estimation diagnosis test, the Sargan test, was used to check the validity of the instruments.

3.2 Loan growth equation

To take into account the banks' lending behavior in the study of the cyclical behavior of capital buffer, the effect of each institutions' capital buffer on credit growth was considered. The model includes a set of bank-specific explanatory variables as well as macroeconomic variables used to assess the cyclicality of capital buffers (see equation 2).

Again, using the Arellano-Bover GMM technique, the following specification is estimated:

$$Loan_{it} = \delta_0 + \delta_1 Loan_{it-1} + \delta_2 Size_{it} + \delta_3 \Delta RR_t + \delta_4 Gap_t + \delta_5 Liq_{it} + \delta_6 CB_{it} + u_{it} \qquad (3)$$

The lagged dependent variable is meant to assess the autocorrelation of loan growth (see equation 3). The *a priori* expectation is that bank size, *Size*, should have a positive relationship with loan growth. This hypothesis was supported by Kashyap and Stein (1995) which found that small banks' lending is more sensitive to Fed-induced deposit shocks and external shocks than that of large banks. Regarding the output gap, *Gap*, a positive sign on the coefficient is also expected as banks tend to increase loans when the economy is expanding. During this boom period, risks are perceived to be lower than when the economy is in a recession. A positive sign is expected on the coefficient of the liquidity variable, *Liq*. This *a priori* expectation is against the background that various studies, including Coffinet *et al*., (2011) have shown that banks' liquidity and solvency is positively correlated with their loan supply. The variable of interest in the loan model is, CB_{it}. The sign on this variable's coefficient will determine whether the procyclicality hypothesis holds (see equation 3). The coefficient on central bank's refinancing rate, *RR*, is expected to have a negative sign since it represents the cost of bank refinancing.

4 Empirical Results

4.1 Capital buffer equation

The results of the capital buffer model appears broadly consistent with the results of Tabak *et al*., (2011), Coffinet *et al*. (2011) and Deriantino (2001) (see Table A3). The coefficient on the variable of interest, the output gap, is statistically significant at all levels and has a negative sign. This negative coefficient on the *GAP* indicates that a worsening of the real economy implies build up in capital buffers. This would suggest that banks increase their precautionary reserves in bad times. It is worth mentioning that if this increase in capital buffers intensify the cyclical slowdown of loan growth, then this would signal a procyclicality in capital buffers. As it relates to the control variables, the coefficient on *Size* is negative and statistically significant suggesting that larger banks hold less buffer capital. This is consistent with the *too big to fail* hypothesis. Both the *ROE* and *Prov* were found to be statistically significant. The negative sign on the return on equity may suggest that increased profitability would imply decreased expected losses, thus requiring less reserves and hence less capital. In contrast, there was a positive sign on the loan loss provision coefficient which implies that a higher loan loss provisions rate reflects more cautious lending behaviour of banks. This trend would influence increases in total buffer capital and thus has implications for the cyclicality of capital. The negative coefficient on the lagged dependent variable suggests that banks do not immediately build up buffer capital in the short-term. However, at extended lag periods, the coefficient becomes positive. The results further suggest and confirm that banks tend to increase buffer capital over a longer period, say one year (see Table A3).

To test the robustness of the capital buffer model, an additional estimation was carried out. The model was re-estimated, using higher quality (tier1) capital buffer as opposed to total capital buffer as the dependent variable. The same macroeconomic and bank-specific variables were used to test whether the same relationship holds for the purest form of capital. Tier1 capital buffer which is defined as the difference between tier1 capital and regulatory tier1 capital as a ratio to regulatory tier1 capital replaced the capital buffer variable in the previous model (see equation 1).[8] The regulatory minimum level of tier1 capital is 4.0 per cent of risk weighted assets (RWAs).

The results of the robustness check of capital buffer using tier 1 capital confirmed and reinforced the previously found results in the original buffer equation (see table A3). The output gap was negatively correlated with the tier 1 buffer, reiterating the procyclical effect. The coefficients on the other bank-specific variables were all significant and carried the same sign as was previously estimated, except for *ROE*. In this model with high quality capital (Tier 1), the coefficient on *ROE* was positive, which suggests that the existence of information asymmetry is more prevalent with high quality capital. When there are information asymmetries, a significant proportion of fluctuations in bank earnings are kept as retained earnings and increases in earnings will spark increases in capital (Fonseca and Gonzalez, 2006).

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[8] Let tier1k and $tier1k^R$ be tier1 capital and regulatory tier1 capital (calculated at 4% of RWA) respectively. The buffer is then $\frac{tier1k - tier1k^R}{tier1k^R} \times 100$

4.2 Loans equation

The results from the loans growth model suggest that buffer capital negatively impacts loan growth, with a coefficient of negative 0.034 (see Table A4). The impact of capital buffer becomes more significant when the purest form of capital (Tier 1 capital) is considered. The coefficient on tier1 capital, negative 7.8, suggests and stronger negative relationship between capital buffer and loan growth than when the total buffer capital was considered. Therefore when buffer increases, banks supply less loans, controlling for the output gap and the other bank variables. This result therefore confirms that capital buffers have a procyclical effect. The coefficient on the output gap is significantly positive whether total buffer or tier 1 buffer capital is used in the estimation of the model. All the other bank-specific variables were statistically significant and carried their expected signs. Once again, the model specification was justified by the Sargan test statistic.

5. Vector Autoregressive (VAR) & Granger Causality Analysis

To buttress the results that were established in the previous section, the existence of a causal relationship between capital buffers and loan growth was examined. Granger Causality tests were used to establish the ordering of the variables in the VAR. More importantly, the results from the Granger Causality tests will help in justifying the existence of procyclicality. If the results show that capital buffers Granger Cause the credit cycle, the procyclicality hypothesis would be validated. If a bi-directional causality is found, like in Coffinet *et al*. (2011), the procyclicality hypothesis would still hold, though one might suspect some level of multicollinearity. However, should the causality run in the opposite direction only, support would not be given to the procyclicality hypothesis from this test.

5.1 Methodology – Tests for causation

Under the standard assumptions of stationarity of series, the standard version of the model is expressed as:

$$y_t = \sum_{k=1}^{K} \alpha_k \, y_{t-k} + \sum_{k=1}^{K} \beta_k \, x_{t-k} + \mu + u_t \qquad (4)$$

where α_k, β_k and μ are parameters to estimate, K representing the optimal lag length in the regression and u_t the residual. The estimation of the Granger Causality is generally run as a bivariate vector auto-regression (VAR), to test for bi-directional causality simultaneously (see equation 4). The null hypothesis is that of no causality ($H_O\colon \beta_i = 0 \; \forall \; i \ldots, K$). The Wald test is generally used to test the nullity of the coefficients.

However, since this study utilizes panel data, individual tests of H_O is not the most suitable. Furthermore, when there is at least one parameter in the dynamics of the endogenous variable which is common to all individual tests, a panel Granger Causality test is more powerful than Granger Causality tests done with a standard time series (Hurlin, 2004). Hence, the panel-causality test proposed by Hurlin (2005, 2008) was employed. This test is expressed as:

$$y_t = \sum_{k=1}^{K} \alpha_{k,i} \, y_{i,t-k} + \sum_{k=1}^{K} \beta_{k,i} \, x_{i,t-k} + \mu_i + u_{it} \qquad (5)$$

where α_{ki}, β_{ki} and μ_i are parameters to estimate and varies across individuals, K representing the number of lags common to all individuals and μ_{it} the residuals from the model. Successful tests for stationarity on all variables allowed for the execution of the Granger Causality test. A test for homogenous non-causality proposed by Hurlin (2005), was subsequently performed. The null and alternative hypotheses of this test are expressed as:

$$H_o : \beta_i = 0, \forall\, i = 1, \ldots, N \tag{6}$$

$$H_1 : \beta_i \neq 0, \forall\, i = 1, \ldots, N \tag{7}$$

where β_i = ($\beta_{i1,\ldots,}\beta_{iK}$) is the vector of the coefficients. Given the specification for the null and alternative hypotheses, the mean Wald test for panel was computed as $\overline{W}_N = \frac{1}{N} \sum_{i=1}^{N} W_i$. This Wald statistic has a chi-squared distribution with K degrees of freedom.

The VAR is specified as follows:

$$CB_{it} = \sum_{k=1}^{K} \alpha_{1ik}\ CB_{it-k} + \sum_{k=1}^{K} \beta_{1ik}\ \Delta Loan_{it-k} + \mu_{1i} + u_{1it}$$

$$\Delta Loan_{it} = \sum_{k=1}^{K} \alpha_{2ik}\ CB_{it-k} + \sum_{k=1}^{K} \beta_{2ik}\ \Delta Loan_{it-k} + \mu_{2i} + u_{2it} \tag{8}$$

with the output gap being modelled as an exogenous variable.

5.2 Results – VAR

The panel-causality estimation is used to test for a causal relationship between banks' capital buffer, CB_{it}, and the growth rate of loan, $\Delta Loan_{it}$. For the procyclical hypothesis to hold, the causality would go from aggregate capital buffer to loan growth.

Tests for stationarity used the augmented Dickey-Fuller, Phillips Perron, as well as the Levin, Lin and Chu and the Im, Pesaran and Shin tests. All unit root tests produced similar results for all the variables (see Table A5). Of note, the *RR*, *Size*, and *ROE* were found to be non-stationary. All three variables became stationary after first differencing.

The Akaike criterion (AIC) statistic was used to determine the optimal lag length to use for the VAR. The results from the lag length criteria suggest that the optimal number of lags was 8. The results show that there is one-way causation, with causality running from capital buffer to loan growth over the whole panel (see Table A6). This finding is consistent with the *a priori* expectation and further confirms the procyclicality hypothesis. In addition, the coefficients in the VAR reinforced the negative relationship between buffer capital and loan growth. To test the robustness of the Granger Causality test, tier1 capital was substituted in the model. Results from the higher quality capital validated the existence of procyclicality of capital buffers.

The impulse response functions show that a one standard deviation shock to capital buffer would have an initial positive impact on loan growth (see in Figure 1). However, in the second period, there is a large negative impact, which is consistent with the results of the GMM model. Of note, the effect of the shock dies out after the third period. These innovations are also reflected in the variance decomposition (see Table A7). The variance decomposition also shows that loan growth makes little to no contribution to changes in capital buffer, while capital buffer accounts for up to 10 percent of the changes in loan growth. These findings validate the results from the GMM estimations and thus solidify the existence of the procyclicality of capital buffers.

6. Summary and Policy Implications

The main purpose of the study was to assess the interplay among bank capital buffers, lending and economic growth. As such the paper contributes to the financial-crisis banking literature on the procyclicality of the financial system by providing bank-level evidence from Jamaica for the period 2000 to 2012. This was accomplished through the estimation of a dynamic panel framework, using the Arellano-Bover (1995) GMM technique and the Hurlin (2005) panel Granger Causality test. Controlling for various determinants of capital buffers, the impact of the business cycle was analyzed and the results indicated that during economic downturn, DTIs in Jamaica raise the amount of capital buffers which limits their lending capacity. This was substantiated by the result that capitalization is negatively related to the loans level.

The paper revealed that capital buffers in Jamaica's financial system exhibits procyclical behavior. The Basel committee emphasizes that addressing procyclicality should be a key element of a sound macroprudential policy. In the current context, results from this study support the view that an efficient macroprudential regulation should aim at smoothing credit growth, with bank capital being an essential instrument. In this context, pursuing a countercyclical buffer capital macroprudential policy would augur well to offset the negative implications of procyclicality.

The April 2009 report by the Financial Stability Forum suggests various approaches that can be taken to address procyclicality in the financial system. One such suggestion is to develop mechanisms by which buffer capital are built up during periods of strong economic conditions and may be drawn down during periods of economic and financial stress. This will ensure financial stability through serving as a shock absorber, instead of transmitter of risk to the broader economy, thus functioning as an automatic stabilizer of boom-and-bust cycles. As is seen in this study and that of others, banks and other financial intermediaries demonstrate a highly procyclical behaviour, amplifying rather than mitigating business cycle fluctuations. With capital being one of the main drivers of this procyclicality, implementing the countercyclical capital buffer policy should be a priority.

Similar to what has been done at the Bank of Spain, dynamic provisioning can also be introduced. Dynamic provisions are macroprudential tools designed to enhance bank soundness and to help mitigate part of the procyclicality of the banking system. They allow for an earlier detection and coverage of credit losses in banks' loan portfolios, thereby allowing the build-up of a buffer in lending booms to be used in recessions. According to a 2012 BIS report, the underlying principle behind dynamic provisioning is that provisions should be set in line estimates of long-run, or through-the-cycle expected losses. This will help in mitigating procyclicality and creating countercyclical provision buffers.

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Appendix A

Table A1: Descriptive Statistics

	B_TIER1	CB	GAP	LIQ	LOAN	PROV	RR	ROE	SIZE
Mean	0.154	29.889	-0.001	0.256	1.038	0.0296	12.431	0.202	-0.395
Median	0.025	22.073	-0.010	0.233	0.009	0.017	12.950	0.192	-0.280
Maximum	6.625	366.129	0.281	0.881	2076.709	0.336	18.350	0.959	0.854
Minimum	-0.001	-519.532	-0.250	0.022	-0.100	0.000	6.250	-0.550	-2.772
Std. Dev.	0.607	75.914	0.118	0.153	45.138	0.044	3.205	0.158	0.733
Observations	2118	2118	2118	2118	2118	2118	2118	2118	2118

Table A2: Correlation Matrix

	B_TIER1	CB	GAP	LIQ	LOAN	PROV	RR	ROE	SIZE
B_TIER1	1	-0.357	-0.011	-0.059	0.003	-0.033	0.159	-0.139	-0.551
CB		1	0.010	0.115	-0.008	-0.262	-0.033	0.298	0.064
GAP			1	-0.040	-0.003	-0.031	0.016	0.048	0.007
LIQ				1	-0.026	-0.007	0.047	0.173	0.083
LOAN					1	-0.008	0.002	-0.003	-0.023
PROV						1	0.207	-0.061	0.162
RR							1	0.269	-0.248
ROE								1	0.083
SIZE									1

Table A3: Determinants of Bank’s Capital Buffer

		(1)	(1a)	(1b)
Explanatory Variables	Exp. Sign	Total Buffer GMM, System	Tier 1 Buffer GMM, System	Total Buffer GMM, System
$\Delta \boldsymbol{ROE_{it-1}}$	(-)	-10.318**	0.010***	-13.621**
		(4.528)	(0.001)	5.718
$\Delta \boldsymbol{Size_{it-1}}$	(-)	-7.313***	-0.011***	-8.897***
		(1.056)	(0.001)	0.838
$\Delta \boldsymbol{GAP_{t-1}}$	(?)	-18.235***	-0.046	2.708***
		(1.743)	(0.007)	0.959
$\Delta \boldsymbol{Prov_{it-1}}$	(+)	57.397***	0.020***	25.604
		(18.628)	(0.004)	28.071
$\boldsymbol{CB_{it-1}}$	(+)	-1.132***		-1.138***
		(0.005)		0.020
$\boldsymbol{CB_{it-12}}$	(+)			0.948***
				0.043
$\boldsymbol{Tier\_1_{it-1}}$	(+)		-1.199***	
			(0.001)	
Observations		2016	2016	1942
Number of Banks		15	15	15
Number of Estimated Coefficients		5	5	6
Sargan test (p-value)		0.23	0.45	0.25

Note: *** significant at the 1% threshold, **5%; * 10%; Standard errors are in parentheses

$$\Delta CB_{it} = \varphi_0 + \varphi_1 CB_{it-1} + \varphi_2 Gap_{t-1} + \varphi_3 ROE_{it-1} + \varphi_4 Size_{it-1} + \varphi_5 Prov_{it-1} + \quad \varepsilon_{it} \qquad (1)$$

$$\Delta Tier\_1_{it} = \varphi_0 + \varphi_1 CB_{it-1} + \varphi_2 Gap_{t-1} + \varphi_3 ROE_{it-1} + \varphi_4 Size_{it-1} + \varphi_5 Prov_{it-1} + \quad \varepsilon_{it} \qquad (1a)$$

$$\Delta CB_{it} = \varphi_0 + \varphi_1 CB_{it-1} + \varphi_2 Gap_{t-1} + \varphi_3 ROE_{it-1} + \varphi_4 Size_{it-1} + \varphi_5 Prov_{it-1} + \varphi_6 CB_{it-12} \quad \varepsilon_{it} \qquad (1b)$$

Table A4: Determinants of Bank's Loans

		(1)	(2)
Explanatory Variables	Exp. Sign	Total Buffer GMM, System	Tier 1 Buffer GMM, System
$\boldsymbol{Loans_{it-1}}$	(?)	-0.138***	-0.069***
		(0.005)	(0.003)
$\boldsymbol{Size_{it}}$	(+)	5.068***	-3.615***
		(0.561)	(0.527)
$\boldsymbol{\Delta RR_t}$	(-)	-15.652***	-18.002***
		(0.181)	(0.167)
$\boldsymbol{GAP_t}$	(+)	21.252***	11.485***
		(0.402)	(0.130)
$\boldsymbol{Liq_{it}}$	(+)	14.156***	7.624***
		(0.609)	(0.825)
$\boldsymbol{CB_{it}}$	(?)	-0.034***	
		(0.007)	
$\boldsymbol{Tier\_1_{it}}$	(?)		-7.787***
			(0.206)
Observations		2026	2026
Number of Banks		15	15
Number of Estimated Coefficients		6	6
Sargan test (p-value)		0.11	0.11

Note: *** significant at the 1% threshold, **5%; * 10%; Standard errors are in parenthesis

$$Loan_{it} = \delta_0 + \delta_1 Loan_{it-1} + \delta_2 Size_{it} + \delta_3 \Delta RR_t + \delta_4 Gap_t + \delta_5 Liq_{it} + \delta_6 CB_{it} + u_{it} \qquad (1)$$

$$Loan_{it} = \delta_0 + \delta_1 Loan_{it-1} + \delta_2 Size_{it} + \delta_3 \Delta RR_t + \delta_4 Gap_t + \delta_5 Liq_{it} + \delta_6 Tier\_1_{it} + u_{it} \qquad (2)$$

Table A5: Panel Unit Root tests

Series	Levin, Lin & Chu (t-stat)		Im, Pesaran and Shin (W-stat)		ADF (Fisher Chi-square)		PP (Fisher Chi-square)	
	H_0=common unit root		H_0= individual unit root					
	Stat.	p-value	Stat.	p-value	Stat.	p-value	Stat.	p-value
Buffer	-4.18625	0.0000	-7.59510	0.0000	147.665	0.0000	197.450	0.0000
Loan Growth	-24.3405	0.0000	-27.2947	0.0000	649.985	0.0000	1062.02	0.0000

Note: the null hypothesis is rejected when the p-value<0.05

Table A6: Granger Causality Tests on total capital buffer and loan growth

(1) **Null Hypothesis**	(2) **F-Stat**	(3) **Null Hypothesis**	(4) **F-Stat**
Capital Buffer does not Granger Cause Loan growth	12.830*** (0.000)	Tier 1 capital buffer does not Granger Cause Loan growth	5.139*** (0.000)
Loan growth does not Granger cause capital Buffer	0.356 (0.943)	Loan growth does not Granger Cause Tier capital buffer	1.048 (0.400)

Note: p-values are in parentheses.

Table A7: Variance Decomposition

	Variance Decomposition of CB:			**Variance Decomposition of ΔLOAN:**		
Period	**S.E.**	**CB**	**ΔLOAN**	**S.E.**	**CB**	**ΔLOAN**
1	15.65495	100.0000	0.000000	48.24465	2.242331	97.75767
2	19.53245	99.98414	0.015863	65.53074	7.970729	92.02927
3	22.13680	99.92222	0.077780	66.16179	9.705834	90.29417
4	24.69180	99.87369	0.126307	66.16917	9.703671	90.29633
5	27.09835	99.86528	0.134715	66.18456	9.743010	90.25699
6	29.19747	99.85939	0.140610	66.19632	9.755261	90.24474
7	31.15806	99.87371	0.126290	66.20252	9.754015	90.24599
8	32.76054	99.88002	0.119978	66.21256	9.752061	90.24794
9	34.29141	99.88245	0.117554	66.22070	9.752227	90.24777
10	35.71721	99.88417	0.115826	66.23510	9.751528	90.24847
11	37.01807	99.88426	0.115742	66.34519	9.733680	90.26632
12	38.21621	99.88304	0.116960	66.35065	9.748219	90.25178

Figure 1
Impulse Response Functions