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The Bank Lending Channel:
Identifying Asymmetries in Belizean Domestic Bank Reactions to Policy Signals

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This research paper investigates whether the characteristics of a bank affect its response to monetary policy signals in Belize. The study examines the bank lending channel of monetary policy transmission by using a Generalized Method of Moments estimation on a panel of six domestic banks in Belize. The findings provide empirical evidence that monetary policy has a direct impact on domestic banks' credit supply, as an increase in the reserve cash ratio leads to a reduction in loan growth. Furthermore, domestic banks' responses to monetary policy signals vary depending on their liquidity holdings and asset size, but not on their level of capitalisation.

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1.0 Introduction

Researchers have established that "there is a distinct lending channel" through which monetary policy transmission is effective (Kayshap & Stein, 1994). In this view, a reduction in bank reserves has a consequential impact on the real sector, based on critical micro-foundation assumptions. Therein, a reduction in bank reserves should lead to a falloff in investment and spending by households and firms. However, it has also been widely held that the effectiveness of the lending channel is influenced by several factors, including the characteristics of financial institutions' balance sheets involved in intermediating loans. Assessing the impact of these factors on a country level is important to understand better and predict the impact of a central bank's monetary policy changes on the real economy.

Recent studies found that the lending channel of monetary policy transmission in Belize is significant in the long run (CERT, 2019; Arana, 2020). However, responses to monetary policy impulses were largely weak to non-existent within the country's highly concentrated and underdeveloped banking system. Belize's financial system is dominated by a few domestic banks, which provide a majority of credit to the economy since there is no formalised capital market infrastructure in place. This phenomenon raises the question of whether bank characteristics matter in the transmission of monetary policy in Belize. To the author's knowledge, no previous empirical investigation has assessed the role of bank characteristics in determining the efficacy of monetary policy changes in Belize. This is of primary importance to the Central Bank of Belize (Central Bank), given its statutory objective to promote "credit and exchange conditions conducive to the growth of the economy of Belize."

This study aims to fill this gap by conducting a bank-level analysis to measure the response of credit to the Central Bank's monetary policy changes through the bank lending channel based on three characteristics: size, liquidity, and capital. The research will add to the literature on monetary policy transmission by providing insights into how balance sheet factors influence bank credit to the private sector in a small economy with a fixed exchange regime.

Following Díaz and Rocabado (2018), the study uses a Generalized Method of Moments (GMM) regression on an unbalanced panel of six Belizean banks on data from 2000Q1-2021Q4. It seeks to measure the distributive effects of monetary policy adjustments on the real economy through the bank lending channel. The results showed that monetary policy was effective through the bank lending channel when utilising the cash reserve ratio as a monetary policy tool but not when using the Treasury-bill (T-bill) rate as an instrument. In addition, the coefficients of two balance sheet characteristics, bank liquidity and asset size, were aligned with a priori expectations, meaning both were statistically significant and carried the expected sign. This implied that larger, more liquid banks were less responsive to changes in reserve requirements than smaller, less liquid ones within the Belizean banking system. Furthermore, the coefficient for bank capital was negative and not statistically significant across models, which was not in alignment with a priori expectations.

The rest of this paper is divided into five sections. Section 2 reviews the literature on the monetary policy transmission mechanism, focusing on the bank lending channel. Section 3 traces the evolution of monetary policy in Belize. Section 4 describes the data and empirical method used in the study. Section 5 presents the panel estimation results. Section 6 closes with the main takeaways of the findings, including the resulting policy implications.

2.0 Literature Review

2.1 Theoretical Underpinnings

Many central banks' primary function is to manage price fluctuations. To evaluate their effectiveness, researchers study the tools central banks utilise and the main channels through which they operate. Mishkin (1996) identified four main channels of monetary policy: the interest rate, credit, exchange rate, and asset price channels. Although more channels have been identified, these four are the main cornerstones of research on this matter. These monetary policy transmission channels have been assessed frequently in developed nation settings (see Sims, 1972; Christiano & Eichenbaum, 1995; Bernanke & Gertler, 1995; Kuttner & Mosser, 2003; Gertler & Karadi, 2015). More recently, evaluations in the developing nation context have also picked up steam (see (Mishra et al., 2010; Valdes & Valle, 2018; Bustamante et al., 2019).

The interest rate channel is known as the traditional channel of monetary policy. Through this mechanism, an increase in key policy rates leads to a rise in short-term market rates, resulting in higher real interest rates and capital costs for individuals and businesses, slowing consumption and investment. Bean et al. (2002) show that higher interest rates, indeed raise capital costs to borrowers, the required rate of return for business investments, the cost of private expenditures to households, and, in a floating exchange regime, cause volatility in the exchange rate.

The combined effects of a rise in interest rates reduces investment by firms, consumption, price competitiveness, and net exports, leading to lower aggregate demand, output, and prices. However, seminal works like that of Bernanke and Gertler (1995) exhibited that this channel alone could not explain large fluctuations in aggregate demand and output. This research prompted a new wave of studies into what is now known as the credit channel of monetary policy.

Under the credit channel, the effect of monetary policy is propagated to the real economy in two ways—the balance sheet channel and the bank lending channel (Bernanke & Gertler, 1995). In the balance sheet channel, contractionary monetary policy increases real interest rates and reduces borrowers' net cash flows and the value of assets that can be used as collateral in financing operations. As a result, firms would have to pay higher premiums to access finance in money markets and endure increases in the cost of credit and the required rate of return to investments.

This stymies investments in the economy, which reduces real economic growth and lowers the general price level. Ananchotikul and Seneviratne (2015) added that "the balance sheet channel, also referred to as the

broad credit channel or financial accelerator, is based on the theoretical prediction that the external finance premium facing a borrower should depend on the debtors' financial position, and it is the endogenous pro-cyclical movements in borrowers' balance sheets that act to propagate monetary policy shocks." There is limited data on the debtors' balance sheet in Belize to conduct a country study of this nature. Hence, an analysis of this nature would not be possible.

The main idea of the bank lending channel is that contractionary monetary policy changes reduce banks' available reserves to offer new loans. A reduction in the supply of loanable funds should result in lower consumption and investment, and, in turn, reduce aggregate demand. Furthermore, if banks cannot obtain alternative sources of funds, demand will exceed supply in the loan market. Higher demand for loans would lead to higher interest rates and a further reduction in investment, consumption, and output. The monetary policy changes will be propagated to the real economy more effectively in a financial system dominated by domestic banks (Ehrmann et al., 2003). In addition, the bank lending channel operates on two key assumptions—monetary policy actions can impact bank loan supply, and there are no perfect substitutes for bank lending available to borrowers.

For monetary policy to impact the supply of loanable funds, banks' liability structure must be skewed towards deposits with limited access to alternative funding sources. Deposits provide the most convenient source of funds for intermediation. However, in the presence of a contractionary policy stance, a bank with easy access to other sources of funds could lessen the impact of monetary policy changes—the substitution effect. These sources may include external loans, deposits from parent banks, and liquidating securities (Díaz & Rocabado, 2018). If banks cannot easily source funds under a restrictive policy stance, the level of available reserves and their loan supply will be reduced. The effectiveness of policy changes would then depend on the banks' characteristics in the system.

A restrictive change in monetary policy will not impact individual banks with sufficiently high levels of excess liquidity if they have a large enough buffer to withstand these effects. They could absorb the policy change and provide the market with credit, unlike a bank that is closely managing its liquidity position. Likewise, larger banks with higher capitalisation levels would be more insulated from monetary policy changes because these institutions would face lower financing costs. However, the smaller, less capitalised banks would have more difficulty borrowing in the money market to compensate for the reduction in liquidity since they would face higher borrowing costs. Accordingly, the theory implies that smaller, less capitalised banks with lower levels of liquidity would be more responsive to changes in monetary policy within the economy. These individual characteristics are most frequently evaluated in studies of this sort and will be the focus of this research.

Additionally, the bank lending channel would be more effective if borrowers did not have alternative funding sources apart from banks. In this instance, when the supply of intermediated funds tightens, businesses and households will be forced to reduce their investment and consumption activities. If economic agents have access to alternative sources of loans, like from development banks and credit unions who are not directly

affected by monetary policy changes, or if banks were able to obtain funding from abroad, then the policy changes would have a lesser impact on aggregate demand. The Belizean economy is bank based, with other intermediaries accounting for a smaller portion of the financial system. Furthermore, the country has an underdeveloped capital market, limiting potential borrowers' ability to obtain funding from non-bank sources.

2.2 Empirical Evaluations

A further review of the literature shows that the earliest tests of the existence of the bank lending channel were carried out by Bernanke and Blinder (1992), utilising a reduced-form loan supply equation on aggregate data. However, the work was criticised for identification issues, implying that changes in macroeconomic variables could not be readily attributed to either the effects on loan demand or supply. They found that monetary policy in the United States had mixed effects on bank lending growth dependent on bank size and liquidity. Their results went according to a priori expectations as the larger banks with more liquidity did not respond as readily to monetary policy as their smaller and less liquid counterparts. Kishan and Opiela (2000) also evaluated the mechanism using asset size and bank capital as distinguishing characteristics and found that more capitalised banks respond less to monetary policy. Ehrmann et al. (2003) evaluated a credit supply model that incorporated the monetary policy tool, individual bank characteristics, and sources of loan demand within the system. Their results indicated that more liquid banks in Germany, France, Italy, and Spain did not react significantly to monetary policy. However, bank size and capitalisation were not statistically significant in the evaluation.

Empirical work on developing countries often found that the most important transmission channel is the credit channel. Mishra et al. (2010) observed this outcome in their evaluation of monetary policy channels in Latin America and the Caribbean, Asia and the Pacific, and the Middle East and North Africa, among other economic areas. Primus (2016) found that in the small open Caribbean economies, there is a weak pass-through from interest rates to macroeconomic variables. However, reserve requirements proved useful in impacting excess reserves, credit, and stabilised exchange rate pressures. These evaluations were conducted on macro-level data and could have the same identification problems as in Bernanke and Blinder (1992). Ananchotikul and Seneviratne (2015), in an IMF evaluation of Asian economies using micro-data, found heterogeneity in banks' reactions to monetary policy depending on the characteristics evaluated, including bank liquidity, ownership type, and financial position. They implied that this heterogeneity in bank reaction could explain the relatively weak effect of the bank lending channel at the aggregate level in the economies.

Farinha and Marques (2001) applied panel cointegration techniques on microdata to analyse the Portuguese economy. They found a heterogeneous reaction in the bank lending channel based on capital levels. Similar panel evaluations of the Malaysian economy by Karim et al. (2011) found that the bank lending channel is effective, and that there are differences in the banks' reactions based on their capitalisation and liquidity. Bustamante et al. (2019), also using a panel of banking data, found that the credit supply in Peru is impacted by bank-specific characteristics such as size, liquidity, capitalisation, and profitability. Raising reserve requirements was an effective tool in reducing credit in that economy. Finally, Díaz and Rocabado (2018)

evaluated the effectiveness of monetary policy on bank lending in Bolivia, utilising GMM and fixed effects models on panel data for the domestic banks in that country. They tested for the existence of a bank lending channel, while evaluating the institutions by size, liquidity, and level of capitalisation. Their results indicated that smaller commercial banks with less capital are more affected by monetary policy changes.

The literature shows how the evaluation of the bank lending channel using micro-level data can measure the direct impact of monetary policy tools against banking characteristics through interaction terms. Like Díaz and Rocabado (2018), this study will employ a GMM model, originally proposed by Arellano and Bond (1991), to analyse the reaction of Belize's domestic banks to monetary policy based on several characteristics. GMM models are suited for addressing endogeneity problems in dynamic unbalanced panel data sets with large cross sections and small time series, akin to the data set used in this study. Furthermore, the methodology has been robust in providing unbiased estimates, regardless of the characteristics of the data set. Thus, the model should provide a good framework for stable panel estimation and reliable coefficient estimates.

3.0 Historical Review

3.1 Monetary Policy and Tools

The Monetary Authority of Belize was established in 1976, operating under the mandate to "stimulate the economy, control inflation, and maintain balance of payment stability"[1]. This body was authorised to use several monetary policy tools, including interest rate controls, cash reserves, liquid asset ratios, and credit controls. Belize pegged its currency to the United States dollar in 1976 (BZ$2.00 to US$1.00), linking its monetary policy to the US. The Central Bank was established in 1982 under the Central Bank of Belize Act. It was mandated to foster "monetary stability, especially as regards stability of the exchange rate, and promoting credit and exchange conditions conducive to the growth of the economy of Belize" (Central Bank of Belize Act, revised 2011). The Central Bank can set key interest rates and use credit controls, among other monetary policy tools. However, changing reserve requirements has been its main tool of monetary policy. More recently, the Central Bank has attempted to incorporate the T-bill rate into its policy toolkit. Central Bank policymakers have used the rate to influence domestic banks' demand for short-term securities to absorb or release cash liquidity, thereby reducing or increasing the supply of loanable funds. Conversely, banks may increase or decrease their T-bill holdings to reduce or expand their loan portfolio, depending on their prevailing risk appetite.

The reserve requirements are composed of the liquid asset requirements, the cash reserve requirements, and the securities requirement. At the end of December 2021, these requriements stood at 21.0%, 6.5%, and 0.0%, respectively. The Central Bank created a Monetary Policy Committee (MPC) to develop a market-oriented monetary policy strategy in 2009. As one of their first moves, the MPC liberalised the T-bill rate from a fixed position of 3.2% that year and implemented the third tier of the reserve requirements, the securities requirement. This new tier was last changed in October 2011, when it was lowered from 6.5% to 0.0% of the average deposit liabilities.

[1] See https://www.centralbank.org.bz/financial-system/monetary-policy.

There were 15 changes in the reserve requirements between 1990 and 2010—six expansionary and nine contractionary episodes. An expansionary monetary policy change in the form of a reduction in reserve requirements is expected to boost bank liquidity and, in turn, loan growth. The credit expansion should lead to an increase in aggregate demand, output, and prices, while applying downward pressure on foreign reserves. The opposite is expected during monetary contractions. Of the changes in reserved requirements made since 1990, loan growth (60.0%), statutory liquidity (60.0%), and cash liquidity (86.0%) responded in line with a priori expectations in most instances. In contrast, changes in gross reserves (47.0%) and output (25.0%) responded as expected in less than half of the cases. The low pass-through of policy changes to the real economy could be partially explained by the Government's impact on the economy (Alvarez, 1986). However, another underlying reason could be the heterogeneity of bank responses to monetary policy signals.

4.0 Data and Econometric Methodology

4.1 Variables and Data Sources

The panel estimation of the bank lending channel uses quarterly data from 2000Q1 to 2021Q4 on a cross-section of six domestic banks. The study employs a GMM estimation with seven endogenous variables. These are (i) credit to the private sector (CRED), (ii) real gross domestic product (GDP), (iii) the consumer price index (CPI), (iv) banking liquidity (LIQ), (v) bank capital (LCAP), (iv) bank assets (SIZE), and (vii) a measure of monetary policy (TBR or RCR), as shown in Table 1.

Table 1: Variables for Panel Estimation: Definition and Sources

Variables	Definition	Source
GDP	Real Gross Domestic Product (2014 prices)	Statistical Institute of Belize
CPI	Consumer Price Index (2011 = 100)	Statistical Institute of Belize
TBR	Belizean 91-day Treasury bill rate	Statistical Digest: Table 24: Selected Comparative Bank Rates and Treasury Bill rates
RCR	Required cash reserves as a percentage of deposit liabilities	Central Bank of Belize
CRED	Domestic Bank Net Credit to the private sector	Central Bank of Belize
LIQ	Domestic Bank Cash Liquidity Holdings	Central Bank of Belize
LCAP	Domestic Bank Capital Holdings	Central Bank of Belize
SIZE	Domestic Bank Asset Base	Central Bank of Belize

The policy variables were identified as the Central Bank's primary monetary policy tools and, as such, will be evaluated in this empirical assessment. The model is estimated using quarterly data expressed in logs and transformed following the specifications provided in Díaz and Rocabado (2018). All panel variables will undergo a within transformation for the least squares dummy variable (LSDV) estimation, which differences the actual observations from their mean over the time series. In addition, the GMM and fixed effects estimation techniques will utilise variables in their log differences. The variables that will identify the banking characteristics used across all three models are constructed as follows:

$$size_{it} = Log(A_{it}) - \frac{1}{N_t} \sum Log(A_{it})$$

Where $size_{it}$ is the relative size of $bank_i$ at time t; A_{it} is the total assets of $bank_i$ at time t; N_t is the number of banks in time t.

$$Liq_t = \frac{Lq_{it}}{A_{it}} - \frac{1}{T}\sum\left[\frac{1}{N_t}\sum\frac{L_{it}}{A_{it}}\right]$$

Where Liq_t is the relative liquidity of a bank; Liq_{it} is the liquid assets of bank i at time t; N_t is the number of banks in time t; and A_{it} is the total assets of bank i at time t.

$$Cap_{it} = \frac{C_{it}}{A_{it}} - \frac{1}{T}\sum\left[\frac{1}{N_t}\sum\frac{C_{it}}{A_{it}}\right]$$

Where Cap_{it} is the relative capitalisation of a bank; C_{it} is the capital of bank i at time t; N_t is the number of banks in time t; and A_{it} is the total assets of bank i at time t.

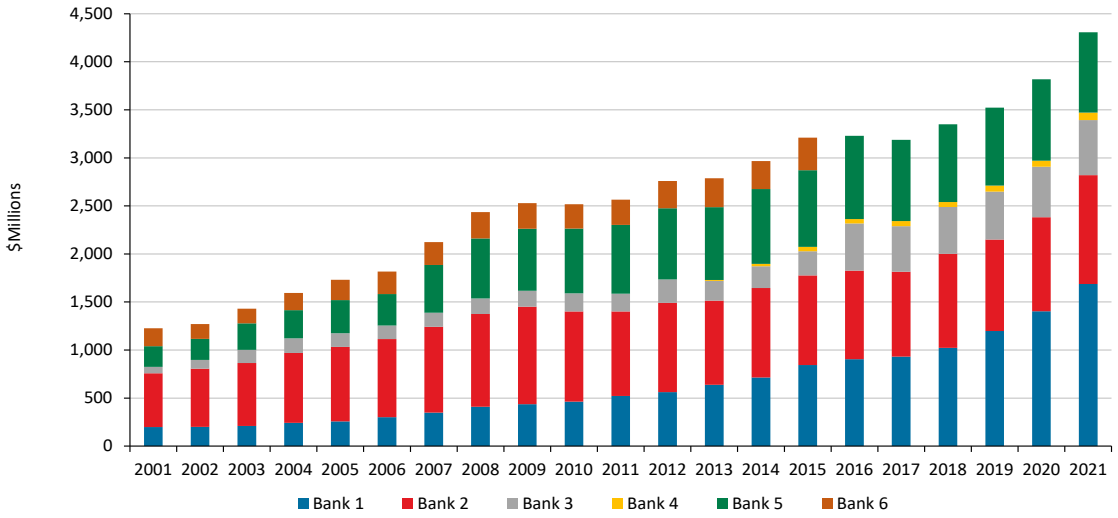
4.2 Banks' Characteristic Variables

The subsections below describes the data of the three bank characters investigated in this study.

4.2.1 Asset Size

Between 2000 and 2021, six licensed commercial banks operated domestically, of which foreign owners controlled five, and the Government wholly owned one. During this period, aggregate asset holdings by banks nearly quadrupled from $1,126.0mn in 2000 to $4,306.6mn in 2021, mainly reflecting significant expansions in their loan portfolios and Government securities holdings. Domestic banks' loan portfolios more than tripled from $695.4mn at the end of 2000 to $2,315.0mn at the end of 2021. Over the same period, their Government securities holdings nearly quadrupled from $86.2mn to $325.8mn. Although banks' asset holdings have risen appreciably, the distribution of assets within the banking system has remained heavily skewed. At the end of

Figure 1: Banks by Asset Size

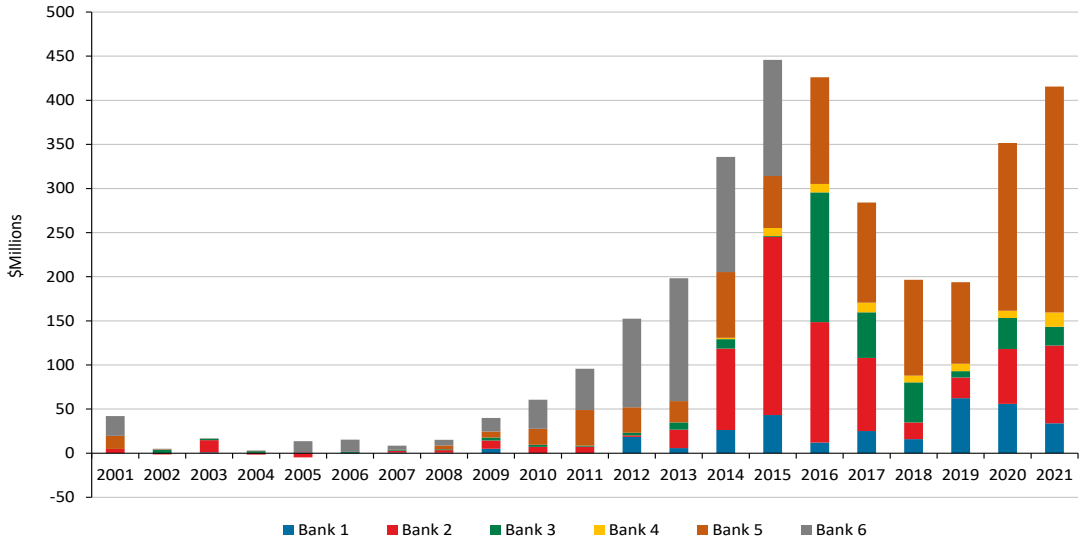


2021, the largest bank accounted for 39.2% of the market share. In comparison, the smallest bank had only 1.8%. Furthermore, two bank acquisitions occurred during the period—one in 2015 and the other in 2020.

4.2.2: Liquidity

The distribution of cash liquidity remained uneven throughout the review period. It was not usual for a single bank to hold over 50.0% of the entire system's excess cash balances. For example, at the end of 2021, one bank accounted for 61.6% of the system's excess cash reserves. Even in periods of high liquidity, some banks had to borrow funds on the interbank market to alleviate liquidity shortfalls. Between 2001 and 2011, excess cash level growth was moderate, averaging $28.0mn. Since 2012, there has been a marked rise in aggregate liquid balances. Excess cash holdings soared to an average of $300.0mn from 2012 to 2021. The significant increase in domestic banks' cash holdings during that period was attributable to several factors. The

Figure 2: Excess Cash Liquidity Distribution Amongst Banks



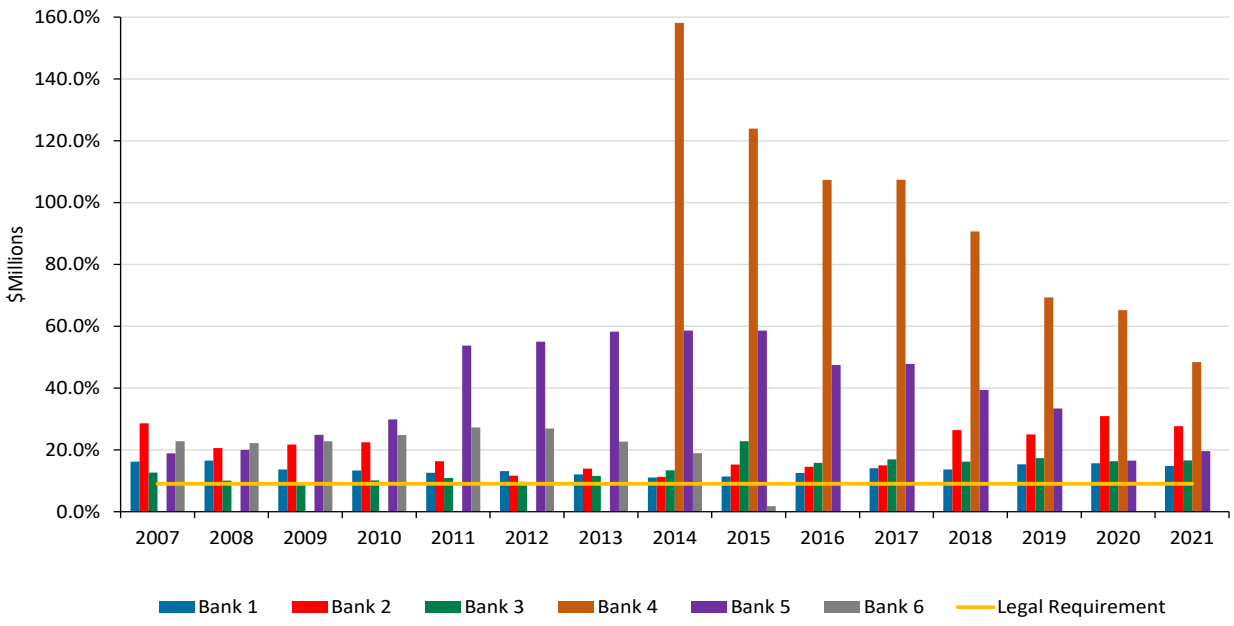
chief contributors to the build-up in cash reserves from 2012 to 2015 were: (i) subdued loan growth, as some banks sought to stabilise their balance sheets in the face of high non-performing loans; (ii) expansionary fiscal policy, particularly in 2014 and 2015 when the Government's deposit accounts at banks rose sharply; and (iii) heightened foreign currency sales to the public and the Central Bank. However, cash conditions tightened from 2016 to 2019 due to: (i) large-scale purchases of Government securities, which had been issued to help fund the nationalisation of a utility company; (ii) greater short-term T-bill investments by more risk-averse banks; and (iii) a ramp-up in lending by the more risk-tolerant banks. The COVID-19 pandemic reversed the downward trend as cash liquidity shot back up since 2020, as funds from the Government's social support programmes, such as conditional cash transfers, entered the commercial banking system.

4.2.3: Capital

Domestic commercial banks in Belize have remained well capitalised over the review period as the Central Bank requires all domestic banks to maintain a 9.0% minimum capital adequacy ratio (CAR) in line with the Basel II/III framework. The capital adequacy ratio is the quotient of a bank's eligible capital base divided by its total risk-weighted exposures. Most banks in Belize have majority foreign ownership. These banks can receive capital injections from their shareholders abroad in times of distress.

A newly established bank stood out with a very high CAR of 158.2% at the end of 2014. However, by 2021,

Figure 3: Capital Adequacy Ratios Across Banks



this ratio has fallen to 48.4% as the bank's risk-weighted assets grew with an increase in its loan portfolio. Meanwhile, the other banks had CARs ranging between 14.8% and 27.7% at the end of 2021. Only one domestic bank slipped below its CAR in 2015, as it wound down its operations and sold its assets to another bank.

Though banks have remained solvent and capitalised over the period, most were significantly affected by the Central Bank's implementation of new loan loss provisioning standards in late 2011 between 2012 and 2017. Banks were required to set aside loan loss provisions of 100.0% (of the loan value) for unsecured loans and 70.0% (later reduced to 50.0%) for fully secured loans which had been non-performing for over a year. The effect of the increase in these provisioning expenses reduced banks' profitability and capital.

4.3 Methodology

The study will evaluate the bank lending channel of monetary policy on a micro level, using a panel of the six banking institutions within the economy. The literature on the transmission mechanism in small states indicates that the characteristics of these economies skew the mechanism towards this channel (Mishra et al., 2010). The model utilised will test the efficacy of policies on the bank lending channel through its impact on a loan supply model and evaluate if there are differences in the banks' reactions to monetary policy based on three characteristics—bank size, capitalisation, and liquidity. The empirical model employed by Díaz and Rocabado (2018) will be utilised, namely a GMM estimation. The model is specified as follows:

$$\Delta Log(L_{it}) = \sum_{j=1}^{n} A_j \Delta Log(L_{it-j}) + \sum_{j=0}^{n} B_j \Delta Log(MP_{t-j}) + \sum_{j=0}^{n} C_j \Delta Log(Y_{t-j}) + \sum_{j=0}^{m} (D_j \Delta CPI_{t-j} + E_j X_{it-j}) + \sum_{j=0}^{m} F_j X_{it-1} \Delta Log(MP)_{t-j} + \mu_{it} \quad (1)$$

Where i is the individual bank (i = 1 to 6); t represents time (t = 1 to T); Δ is the first difference operator; L_{it} is the loan balance of bank i at time t; MP_t is the monetary policy variable at time t; Y_t represents GDP at time t; ΔCPI is the inflation rate; X_{it} is the individual characteristic of bank i at time t (size, liquidity, capitalisation); and μ_t is the total error.

The GMM model, proposed by Arellano and Bond (1991), is generally viewed to correct any bias present in OLS estimations. The possible endogeneity in this process would be addressed by adding lagged values of the variables in equation (1) above as GMM-type instruments with the model expressed in first differences to eliminate the fixed effects over time. The autocorrelation of the residuals in the dynamic models must

be evaluated. In the GMM (differenced) estimation, it is accepted in the literature that there should not be any second-order autocorrelation in the model's residuals, which will evaluated using Arellano and Bond autoregressive tests. The Arellano-Bond methodology was designed to estimate models with large cross sections (number of banks in this case) over a relatively short period.

An alternative estimation procedure would be to use OLS on static panel data with fixed effects applied within the transformation. However, this would not be ideal given that equation (1) has lagged values of the dependent variable in the model. Because the model calls for a dynamic specification, the OLS method can be augmented by adding cross-section dummy variables to the estimation to correct the violation of the strict exogeneity rule. This methodology, known as the Least Squares Dummy Variable (LSDV) model, applies OLS to the model expressed in deviations from the mean of each unit in the panel with respect to time (within transformation). Nickell (1981) showed that the LSDV might be biased and inconsistent when the number of cross sections (N) is large and the time series (T) is short. This bias is not reduced by adding explanatory variables or increasing N and is corrected only by increasing T. In models designed for larger financial systems, this posed a huge problem as the number of financial institutions operating in these markets was large, and data was available for only a short period. This is not an issue for Belize as the panel of six banks is being regressed over a time series spanning twenty-one years of quarterly data. In addition, the bias evaluated by Nickell (1991) would not be present in the Belizean economy, and the LSDV estimates would provide BLUE estimators. In this study, the LSDV and the fixed effects models were both used for robustness checks[2].

The coefficients that will be analysed are those that capture the impact of the monetary policy shock, Bj, and those of the interaction terms, Fj, that attempt to capture the heterogeneity in bank responses to monetary policy. The response of loans to monetary policy, Bj, depends on the monetary policy variable utilised, as the responses to changes in the cash ratio reserve and the T-bill rate are expected to have a negative coefficient. The differences in bank reactions to monetary policy changes will be captured in the significance of the coefficients, Fj, which should show that banks that are smaller, less liquid, and have lower capital levels will react more to changes in monetary policy, identifying the asymmetries in domestic bank reactions (Kashyap & Stein, 2000). If the coefficient on the interaction terms is insignificant, this implies homogeneity in the policy transmission, as the characteristics identified would not impact the mechanism.

5.0 Results

5.1 Bank Response to Monetary Policy

The bank lending channel was established by Arana (2019) as the most crucial channel of monetary policy transmission, so a micro-level analysis was carried out to assess how bank-level characteristics could affect the mechanism because its impact was relatively low. The GMM methodology (Arellano & Bond, 1991) was the main estimation method utilised for the study. Both fixed effects and the LSDV methodology were employed to test the robustness of the GMM model. One lag of the dependent variable was used, along with the current value, and one lag of the independent variables. The instruments utilised in the GMM estimation were the

[2] Further robustness checks include estimation at different time intervals and estimating models with the different characteristics separately.

lagged values of the variables mentioned above in levels. Two monetary policy variables were assessed: (i) the cash reserve ratio and (ii) the 91-day T-bill rate. Increases in both are viewed as a contractionary policy change, and their coefficients are expected to carry a negative sign in the model estimation. On the other hand, theory also dictates that the signs of the interaction terms in the money supply equation should be positive for both models, implying that larger, more capitalised, and liquid banks respond less to monetary policy changes than their counterparts.

The long-term coefficients on the monetary policy variables were used to test the significance of these policies on bank lending. Meanwhile, the long-term coefficients on the interaction terms were used to analyse the heterogeneity of bank responses to changes in monetary policy. Finally, all long-run coefficients were calculated as the sum of their contemporaneous coefficient and their lags, divided by one minus the sum of the lagged dependent variable coefficients. The significance of the long-term coefficient was tested using the Wald test, as in Díaz & Rocabado (2018). Results for the long-run money supply model estimation can be found in Table 2, and for the short-term coefficients, in the appendix; see Tables A.4, A.5, and A.6.

Table 2: Long-term Coefficients of Panel Estimation of Monetary Policy Impact of RCR on Bank Loans

Long-Term Coefficient of:	GMM	LSDV	Fixed Effects
Δ Loans $_{t-1}$	0.236	0.213	0.206
	(0.000)***	(0.000)***	(0.000)***
Δ RCR	-0.221	-0.219	-0.227
	(0.0526)*	(0.020)**	(0.0075)***
Capitalization*Δ RCR	-1.652	-1.317	-0.982
	-0.206	(0.0948)*	-0.183
Size*Δ RCR	0.336	0.293	0.233
	(0.0125)**	(0.0035)***	(0.0008)***
Liquidity*Δ RCR	0.063	0.106	0.109
	(0.003)***	(0.000)***	(0.000)***

Notes: Probabilities are below coefficient estimates in parenthesis.
*** , **, *, next to a number indicates statistical significance at the 1, 5, and 10 percent level, respectively.

The results show that the change in loan supply in the banking system is positively impacted by its lagged value and presents evidence of persistence in loan growth within the economy. This value was significant in all three models assessed at the one percent level. The monetary policy indicator, the change in the reserve cash ratio, has a significant negative impact on the provision of loans in the banking system. This result align with economic theory and shows that an increase in the reserve cash ratio reduces loan growth. In all models assessed, a 1.0% increase in the monetary policy variable causes an approximate 0.2% fall in loan supply, all being significant at the ten percent level. This result further solidifies the use of the cash reserve ratio as a monetary policy tool and validates the existence of the bank lending channel of monetary policy.

Some similarities were found when the model was augmented to include the T-bill rate. The evidence of persistence in loan growth remains, with a 1.0% loan growth in the previous quarter, causing about a 0.2% loan expansion in the current quarter across all models. However, the coefficient on the T-bill rate as the monetary policy indicator (see Table 3) does not present the expected sign and was only statistically significant in the LSDV model. This implies that the T-bill rate is not effective as a monetary policy instrument in the nascent history of open market operations of the Central Bank.

5.2 Response of Balance Sheet Characteristics in the Bank Lending Channel

Domestic bank liquidity and its' interaction with the cash reserve ratio (see Table 2) is significant in all three models analysed at the one percent level. The coefficient in the GMM specification of the model is positive and statistically significant at the one percent level. This outcome aligns with the theory that less liquid banks respond more to monetary policy changes than banks holding higher liquidity.

Similarly, the results indicate that the asset size of banks impacts the bank lending channel, as the variable was statistically significant and positive. The sign implies that larger banks are less responsive to monetary policy than smaller ones, attributable to the availability of alternative sources of loanable funds, including proceeds from parent banks, borrowing on the money market at a low rate, and having assets to liquidate. In practice, banks with larger assets tended to hold more foreign assets and government securities that could be liquidated if needed. In Belize, one bank was a local subsidiary of a foreign bank. Theoretically, this bank should have no issue in sourcing funds from its head office abroad. Lastly, the coefficient on bank capitalisation was not statistically significant and carried the wrong sign. This implies that banks' response to monetary policy changes would be similar regardless of their level of capitalisation.

Table 3: Long-term Coefficients of Panel Estimation of Monetary Policy Impact (T-Bill rate) on Bank Loans

Long-Term Coefficient of:	GMM	LSDV	Fixed Effects
Δ Loans t – 1	0.234	0.213	0.206
	(0.000)***	(0.000)***	(0.000)***
Δ TBR	2.421	5.442	4.421
	-0.371	(0.0200)**	-0.324
Capitalization*Δ TBR	1.902	23.333	17.922
	-0.965	-0.185	-0.589
Size*Δ TBR	5.142	1.388	0.312
	-0.910	-0.298	-0.294
Liquidity*Δ TBR	2.416	-2.609	-2.817
	-0.477	(0.000)***	(0.000)***

Notes: Probabilities are below coefficient estimates in parenthesis.
*** , **, *, next to a number indicates statistical significance at the 1, 5, and 10 percent levels, respectively.

6.0 Conclusion

The study evaluated the bank lending channel of monetary policy using a GMM estimation technique on a panel of six domestic banks in Belize. The main assumptions of the existence of a bank lending channel were that borrowers depended on bank loans and that monetary policy could affect loan supply. The estimation established a direct bank lending channel as the cash reserve ratio proved statistically significant in the models analysed. In contrast, the T-bill rate, a more recent monetary tool, was not statistically significant in two of the three models. The cash reserve ratio carried the a priori negative sign since an increase would reduce the supply of bank loans to the economy. However, the impact of changes in cash reserve ratios depended on the liquidity and asset size of the domestic banks rather than their capital structure. Furthermore, less liquid and smaller banks tended to respond more to monetary policy, limiting the effectiveness of monetary policy tools in the system. The study implies that the authorities should pay attention to differences in the characteristics mentioned above when predicting the outcome of monetary policy changes. To that end, empirical evaluations may have to take a ground-up approach for the true impact of monetary policy to be revealed, as macro-level analysis may be insufficient and overstate the system's response.

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8.0 Appendix

Table A1: Financial System Structure

	2016	2017	2018	2019	2020	2021
Number of Institutions						
Domestic Banks	5	5	5	5	5	5
International Banks	5	5	4	3	3	3
Credit Unions	11	8	9	9	9	9
Domestic Insurance Companies	10	10	10	10	11	11
Other Financial Institutions	1	1	1	1	1	1
Financial System Assets ($mn)	5,574.4	5,623.3	5,400.5	5,439.8	5,794.9	6,425.7
Domestic Banks	3,230.0	3,187.4	3,349.7	3,519.1	3,816.9	4,266.3
International Banks	1,061.2	1,094.9	602.7	416.8	376.7	445.0
Credit Unions	906.8	943.4	1,045.0	1,096.6	1,141.6	1,189.2
Domestic Insurance Companies	271.8	289.0	293.8	299.9	345.1	389.1
Other financial Institutions	104.7	108.6	109.2	107.3	114.6	136.2
Assets as Percent of Total Financial System (%)						
Domestic Banks	57.9	56.7	62.0	64.7	65.9	66.4
International Banks	19.0	19.5	11.2	7.7	6.5	6.9
Credit Unions	16.3	16.8	19.4	20.2	19.7	18.5
Domestic Insurance Companies	4.9	5.1	5.4	5.5	6.0	6.1
Other financial Institutions	1.9	1.9	2.0	2.0	2.0	2.1
Assets as Percent of GDP (%)	123.4	123.0	116.6	112.5	139.3	128.9
Domestic Banks	71.5	69.7	72.3	72.8	91.7	85.6
International Banks	23.5	23.9	13.0	8.6	9.1	8.9
Credit Unions	20.1	20.6	22.6	22.7	27.4	23.9
Domestic Insurance Companies	6.0	6.3	6.3	6.2	8.3	7.8
Other financial Institutions	2.3	2.4	2.4	2.2	2.8	2.7

Table A2: Financial Soundness Indicators

Percentages

	2016	2017	2018	2019	2020	2021
Capital Adequacy						
Regulatory Capital to Risk Weighted Assets	24.0	24.2	24.6	22.8	19.8	19.2
Primary Capital to Risk-Weighted Assets	23.0	23.2	23.6	21.7	18.6	18.2
Non-Performing Loans (Net of Specific Provisions) to Regulatory Capital	14.4	11.1	11.7	11.4	23.9	14.9
Large Exposure to Capital	128.5	117.5	96.5	94.5	139.3	153.6
Asset Quality						
Non-Performing Loans to Total Gross Loans	10.4	6.4	6.2	5.1	7.7	5.3
Non-Performing Loans (Net of Specific Provisions) to Total Gross Loans	3.0	2.4	2.7	2.4	4.4	2.8
Loan Loss Coverage	79.8	77.6	72.3	71.9	57.3	66.0
Profitability/Efficiency						
Return On Equity (Net Income to Average Capital)	4.8	9.2	19.8	13.3	3.2	5.7
Return On Assets (Net Income to Average Assests)	0.6	1.3	3.1	2.0	0.4	0.6
Interest Margin to Gross Income	68.7	68.1	66.9	65.5	69.2	66.0
Non-Interest Expenses to Gross Income	64.6	62.6	61.0	63.4	62.1	68.3
Liquidity						
Liquid Assets to Total Assets	32.7	27.3	25.8	24.3	28.1	33.8
Liquid Assets to Short-Term Liabilities	51.7	41.7	38.6	36.1	38.5	46.6
Customer Deposits to Total (Non-Interbank) Loans	132.3	130.4	127.8	128.4	138.1	155.1

Table A3: Banking Sector Indicators

	2016	2017	2018	2019	2020	2021
Loans and Advances	2,015.0	2,018.2	2,119.9	2,238.0	2,278.1	2,313.0
Of which: Private Sector	2,006.3	2,012.9	2,069.3	2,180.0	2,236.8	2,285.2
Total Liabilities	3,230.0	3,187.4	3,349.7	3,431.7	3,725.9	4,175.3
Of which: Deposits	2,666.5	2,631.8	2,708.8	2,874.1	3,146.8	3,587.8
Liquid Asset Requirement	613.7	599.8	622.8	653.3	652.5	743.7
Liquid Asset Holdings	1,057.3	868.9	863.4	854.0	1,072.8	1,442.1
Excess Liquid Assets	443.7	269.0	240.6	200.7	420.3	698.3
Cash Requirements	226.9	221.7	230.2	241.4	202.0	230.2
Cash Holdings	583.4	505.7	426.8	435.2	553.6	645.8
Excess Cash	426.0	284.0	196.6	193.8	351.9	415.6

Table A4: GMM Estimation of Loan Supply Model with Reserved Cash Ratio as Policy Instrument

Dependent Variable: Credit Growth			
	Coefficient	Std Error	Prob
LCRED(-1)	0.236	0.049	0.000
LRCR	-0.152	0.086	0.079
LRCR(-1)	-0.017	0.083	0.842
LGDPS	0.265	0.132	0.046
L_CAPITALIZATION	-2.949	1.870	0.116
L_SIZE	1.343	0.259	0.000
L_LIQUIDITY_CASH	0.115	0.116	0.321
L_CAPITALIZATION*LRCR	-1.209	0.035	0.152
L_CAPITALIZATION*LRCR(-1)	-0.052	0.985	0.220
L_SIZE*LRCR	0.059	0.944	0.956
L_SIZE*LRCR(-1)	0.197	0.082	0.472
L_LIQUIDITY_CASH*LRCR	0.028	0.063	0.002
L_LIQUIDITY_CASH*LRCR(-1)	0.020	0.050	0.571
J-statistic			7.369
Prob(J-statistic)			0.007

Table A5: LSDV Estimation of Loan Supply Model with Reserved Cash Ratio as Policy Instrument

Dependent Variable: Credit Growth			
	Coefficient	Std Error	Prob
LCRED(-1)	0.213	0.024	0.000
LRCR	-0.113	0.076	0.138
LRCR(-1)	-0.059	0.076	0.440
LGDPS	0.113	0.099	0.254
L_CAPITALIZATION	-2.376	1.525	0.120
L_SIZE	1.255	0.173	0.000
L_LIQUIDITY_CASH	0.207	0.052	0.000
L_CAPITALIZATION*LRCR	-0.405	0.869	0.642
L_CAPITALIZATION*LRCR(-1)	-0.632	0.852	0.459
L_SIZE*LRCR	0.041	0.064	0.518
L_SIZE*LRCR(-1)	0.189	0.051	0.000
L_LIQUIDITY_CASH*LRCR	0.026	0.030	0.387
L_LIQUIDITY_CASH*LRCR(-1)	0.058	0.027	0.031
C	0.009	0.003	0.001
R-squared	0.619		
Adjusted R-squared	0.607		

Table A6: Panel Fixed Effects Estimation of Loan Supply Model with Reserved Cash Ratio as Policy Instrument

Dependent Variable: Credit Growth			
	Coefficient	Std Error	Prob
LCRED(-1)	0.206	0.025	0.000
LRCR	-0.131	0.071	0.064
LRCR(-1)	-0.049	0.071	0.493
LGDPS	0.148	0.088	0.096
L_CAPITALIZATION	-1.768	1.440	0.220
L_SIZE	1.053	0.163	0.000
L_LIQUIDITY_CASH	0.216	0.050	0.000
L_CAPITALIZATION*LRCR	-0.474	0.828	0.567
L_CAPITALIZATION*LRCR(-1)	-0.306	0.819	0.709
L_SIZE*LRCR	0.021	0.060	0.727
L_SIZE*LRCR(-1)	0.164	0.047	0.001
L_LIQUIDITY_CASH*LRCR	0.030	0.028	0.289
L_LIQUIDITY_CASH*LRCR(-1)	0.057	0.025	0.026
C	0.010	0.003	0.000
R-squared	0.548		
Adjusted R-squared	0.528		

Table A7: GMM Estimation of Loan Supply Model with Treasury Bill Rate as Policy Instrument

Dependent Variable: Credit Growth			
Variable	Coefficient	Std Error	Prob
LCRED(-1)	0.234	0.040	0.000
LTB	8.495	4.420	0.055
LTB(-1)	-6.641	4.712	0.159
LGDPS	0.134	0.119	0.258
L_CAPITALIZATION	0.089	0.037	0.018
L_SIZE	0.615	0.073	0.000
L_LIQUIDITY_CASH	0.022	0.010	0.023
L_CAPITALIZATION*LTB	-0.038	0.029	0.189
L_CAPITALIZATION*LTB(-1)	1.495	33.172	0.964
L_SIZE*LTB	10.086	33.446	0.763
L_SIZE*LTB(-1)	-6.148	2.739	0.025
L_LIQUIDITY_CASH*LTB	7.996	2.921	0.007
L_LIQUIDITY_CASH*LTB(-1)	-6.146	2.863	0.032
J-statistic			4.846
Prob(J-statistic)			0.028