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An Analysis of Private Sector Credit Growth in Belize: A VECM Approach

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Abstract:

This paper seeks to identify the long run determinants and short run dynamics influencing Belize credit growth performance during the period 1997 to 2016. Restrictions were applied to a vector error correction model to identify credit demand and credit supply behaviour. Key findings confirm the existence of a long run relationship between credit growth, domestic banks' equity and non-performing loans, indicative of implications for regulatory capital regimes and credit risk mitigation.

JEL Classification: G21, C32

[1] The views expressed in this paper are that of the author and do not necessarily represent that of the Central Bank of Belize.

1.0 Introduction

The protracted slowdown in private sector credit growth after the onset of the financial crisis in 2008 has been a source of concern for broader economic recovery and the medium-term profitability of Belize's domestic banking sector. Private sector credit growth averaged 11.1% over the period 1998 to 2008. However, after 2009, there was a clear downward shift as credit expansion averaged 1.9% annually between 2009 and 2016. The protracted slowdown in credit growth has been a source of concern for broader economic recovery and the medium-term profitability of Belize's domestic banking sector. This deceleration exacerbated the already poor performance of the domestic banking system during the high stress period after the dual crisis[2]. Despite commercial banks attempt to spur borrowing by reducing interest rates, aggregate credit growth has been below expectations. A by-product of this phenomenon was persistent and excessive liquidity in the system. Eight years after the global financial crisis, annual private sector credit growth at the end of 2016 stood at a mere 1.6%, while return on assets averaged less than 1% and one long standing bank withdrew from Belize in early 2016 mainly due to continued losses. The underlying factors affecting credit outcomes were unclear as below-trend credit growth persisted in the face of high, excess liquidity and declining lending rates.

Considering these issues, this paper seeks to: (i) identify the long-run binding constraints to credit growth in Belize i.e. demand or supply-driven phenomenon; (ii) determine whether the influence of these factors were altered after the impact of the crisis; and (iii) based on these findings, provide appropriate recommendations to address the slowdown in credit growth, if necessary. To achieve these objectives, this paper will attempt to disentangle the effect of credit demand and credit supply on credit growth.

A review of the literature identifies two main methodologies for dissecting credit demand and supply dynamics in one coherent framework: vector error correction model (VECM) with long-run restrictions (Hulsewig et al. (2001), de Mello & Pisu (2010) and Sun et al. (2010)) and the switching regression framework (Dumičić & Ljubaj (2017) and Everaert et al. (2011)). The former approach relies on an identification strategy to determine loan demand and supply equations based on apriori theory; while the switching regression framework detects periods of surplus or deficit credit demand and supply. Use of the restricted VECM was considered more appropriate since the purpose of the paper is to provide insight on the long run constraints to credit growth and identify the short run dynamics that converge to equilibrium. The study will focus on Belize's domestic banking system since it accounts for over 73% of the total domestic credit market.

Following the introductory section, the paper summarizes the literature related to the application of VECM modelling on credit growth, while section three examines the background facts associated with aggregate lending behaviour in Belize. Sections four and five present the methodology and findings of the model, while section six concludes with policy recommendations based on the key findings of the study.

[2] Belize experienced two significant shocks in mid to late 2000s. The first being a domestic crisis which culminated in debt restructuring in 2007 and the second being the international financial crisis originating in the United States in 2007.

2.0 Literature Review

Factors affecting credit demand can be grouped into three main categories: price, income levels and expectations. The lending rate is the key price variable applied, however, its method of aggregation is dependent on the availability of data and the scope of the analysis. Income levels are identified using macroeconomic factors such as GDP performance, fiscal activity and real effective exchange rate (Branch et al., 2015; Shijaku & Kalluci, 2013). Some studies have broadened income measures to include corporate performance, such as profitability of corporate assets (Kok, 2009). More recent studies have also included business confidence indicators (Dumicic & Ljubaj, 2017).

Similarly, credit supply factors can be classified into price and non-price incentives. The price incentive factor is mainly captured in the interest rate differential (Hulsewig et al., 2001; Shijaku & Kalluci, 2013) which is measured by the difference between commercial banks' lending and deposit rates. The availability of funding is another main determinant applied in credit supply models and is captured in the level of equity (Hulsewig et al., 2001) and deposits (Shijaku & Kalluci, 2013). Monetary variables affect credit growth by altering money supply, such variables include the inflation rate (de Mello & Pisu, 2010; Fritzer & Reiss, 2008) or required reserve ratio (Sun et al., 2010). Other studies also incorporate credit risk factors such as the non-performing loan ratio (Dumicic & Ljubaj, 2017) and default risk.

Approaches taken to model the link between loan demand and loan supply vary across the board. Both aggregate and panel methods have been applied at the country and regional levels, while the two main types of models involve the use of restricted VECM approach and regression-switching models. For this analysis, the literature review will focus on the restricted VECM.

One strand of literature focuses on the identification of demand functions to model credit growth. Calza et al. (2006) modelled aggregate credit growth for the private sector in the Euro area for the period 1980 to 1999. The results of the VECM revealed the presence of one cointegrating relationship such that long run real loans are positively linked to real GDP and negatively related to the real short term and long-term interest rates. Fritzer and Reiss (2008) adopted a similar approach for the household sector in Austria, using GDP as the proxy for economic activity and real interest rates as the proxy for the cost of credit. Their findings showed that GDP was the most significant contributor to real credit growth and unlike the rest of Europe, Austria did not experience loan overhangs or shortfalls within recent years leading to 2008.

Modelling credit growth purely on demand-side behaviour fails to isolate supply-side effects as these demand equations incorporate elements of supply effects as well (Fritzer & Reiss, 2008). To overcome these issues, Hulsewig et al. (2001) used separate demand and supply equations in a dynamic VECM system to model the bank lending channel in Germany. Demand side factors were consistent to those employed in demand-focused studies i.e. activity/income-based variable, GDP, and the long-term lending rate. Supply side factors included the interest rate differential and the level of banks' equity. Three cointegrating relationships were found and restrictions were imposed to identify demand, supply and equity relationships. Findings were consistent with the existence of a bank lending channel in Germany, with the supply of loans being positively linked to banks' equity and the interest rate margin.

Similar methodologies were used by de Mello and Pisu (2010) and Sun et al. (2010) for modelling private sector credit to Brazil and China, while Sorenson et al. (2009) and Plasil et al. (2013) estimated corporate lending to the Euro area and the Czech economy, respectively. Common to these studies, Johansen cointegration techniques were employed to identify the number of cointegrating relationships (CIs) and

restrictions are applied to the CIs in order to identify the respective supply and demand equations of the VECM model. De Mello and Pisu (2010) found evidence of a lending channel for monetary transmission since loan supply was negatively related to the interbank Certificate of Deposit rate. Hence, they concluded that monetary policy plays a role in restoring equilibrium in Brazil by affecting commercial banks' inter-bank borrowing rate. Sun at al. (2010) used both monthly aggregate data and disaggregated bank data by loan types to confirm the existence of a bank lending channel, interest rate channel and asset price channel.

In their 2009 study of corporate lending, Kok et al. (2009) included other sector-specific variables: investment levels, business' profitability and the cost of issuing debt and securities. The main findings showed that a long-term increase in the monetary policy rate and risk premium reduced lending. Plasil et al. (2013) also included credit risk measures, such as non-performing loans and the default rate. The study proved that in normal circumstances, supply and demand exhibited a high degree of interaction while credit supply adjusts to demand pressures. However, after the onset of the international financial crisis, the impact of significant credit restrictions by the banks increased the influence of credit supply and dampened credit growth.

Variations of this VECM framework are also applied to model credit growth. One example of such is the model used by Brissimis et al. (2014) to estimate consumer lending in Greece for the period 1990 to 2008. The model separately estimates two equations for demand and supply and its findings were consistent with the existence of a bank lending channel. Another approach was used by Shijaku and Kalluci (2013) to estimate long term credit determinants for Albania. This paper incorporated loan demand and supply factors in one equation. Findings positively linked long term lending to economic growth and exchange rate appreciation, while government borrowings were negatively related.

Early regional studies focused on explaining credit growth by identifying either the supply or demand functions, but have not been limited to the use of VECM models. Stowe et al (2010) applied a dynamic-panel autoregressive model to identify the loan supply function of the Eastern Caribbean Currency Union (ECCU). Findings revealed that an operative bank lending channel existed and was impacted by the level of banks' capitalization. Furthermore, past credit growth, deposit growth and profitability have also had a significant impact on private sector credit growth. Downes et al. (1997) modelled the demand function for private sector credit in Barbados for the period 1973 to 1995 applying a Vector Autoregression model. The study concluded that over the long run, the effect of disposable income on personal consumer credit was positive, while the effect of inflation was negative. Additionally, disposable income and inflation had significant negative effects in the short term, while interest rates were only significant in the long term.

More recent contributions to credit growth analysis in the region sought to determine if credit behaviour was demand following or supply leading. Ramlogan and Mitchell-Ryan (2010) used a VECM model to test for causality between credit and investment in Trinidad and Tobago over the period 1970 – 2008. The study concluded that while credit was demand following for the aggregate economy, there were select sectors where credit was supply following as loan supply led to higher output. Branch et al. (2015) examined the causal relationship between economic growth, government expenditure and private sector credit. The study employed Granger Causality tests after estimating an Ordinary Least Squares model and establishing the existence of cointegrating relationships among the variables. Their findings showed that both economic growth and government expenditure influenced private sector credit.

3.0 Background: Aggregate Credit Behaviour

Belize's domestic financial system is largely influenced by the domestic banking sector which accounted for 71% of market share in 2016. This sector is predominantly foreign-controlled, as four of the five banks have external linkages. Due to the small number of banks and the lack of diversity in the financial system, the system tends to be highly concentrated: institutional investors, including credit unions and insurance companies, hold large deposits in a few institutions; while, large loans are also concentrated among a few banks. Foreign operational policy along with inherent characteristics lends itself to the specialization in specific markets.

Trends in lending were largely influenced by economic activity, as periods of higher economic growth and expansionary fiscal stimulus were accompanied by double-digit credit growth, while for periods of low economic activity, credit growth remained subdued. After taking into account the effects of the international and domestic crises, this analysis examines credit growth patterns in three distinct time periods: pre-crisis (1999 – 2003), early crisis (2004 – 2008) and late to post-crisis (2009 – 2016).

Pre-crisis phase (1999 – 2003)

In 1999, central government adopted an expansionary fiscal stance to boost economic growth by increasing public sector investment, actively encouraging private sector investment and increasing home ownership. From 1999 to 2003, central government's primary deficit averaged $61.5mn (3.4% of GDP), while real GDP growth hit peaks of 13% in 2000 and 9.3% in 2003. At the same time, private sector credit ramped up from an annual average of 7.5% between 1993 and 1997 to around 10.9% from 1999 to 2003.

Early crisis phase (2004-2008)

The expansionary fiscal stance was untenable during this period. Pressures on foreign reserves and unsustainable debt levels led to central government's debt restructuring exercise in 2007. Subsequently, the fiscal stance was reversed, which generated a primary surplus averaging $68.3mn, 2.6% of GDP, between 2004 and 2008. During the period, annual GDP growth was considerably lower, ranging between 1% and 5%. The rapid swing in the fiscal outturn and income levels in 2004-05 was initially accompanied by a dip in credit growth. However credit growth rebounded in 2006, and overall annual growth averaged 11.2% from 2004 to 2008.

Late to Post-crisis phase (2009 – 2016)

In late 2008/early 2009, the initial impact of the crisis was mainly felt in the real sector as tourism earnings fell by 7.9% in 2009. At the same time, Central Government's need to meet external debt payments led to continued fiscal consolidation efforts which intensified the slowdown. With the exception of 2015[3], the government maintained a primary surplus of around 1.0% of GDP between 2010 and 2016, while GDP growth for the entire period averaged 2.1%. During this period of subdued macroeconomic performance, credit growth averaged 1.9%, while domestic banks simultaneously undertook intensive clean-up of their balance sheets.

[3] 2015 was discounted from the analysis since the $184.6mn deficit was due mostly to government's compensation payments (to foreign shareholders for nationalized utilities) which was repatriated.

In the years following the early phase of the crisis, critical balance sheet repairs coincided with the slowdown of credit growth. The rapid deterioration in asset quality was primarily a reflection of poor lending practices and weak balance sheet positions for some commercial banks in the prior years. This was evidenced by the commercial banks need to reclassify several large loan facilities which were subject to covert ever-greening until the Central Bank enhanced its supervisory regime in 2008. From 1998 to 2007, NPLs averaged $62.2mn. However, within one year, NPL levels doubled from $109.2mn in 2007 to $221.1mn in 2008 and the gross NPL ratio[4] climbed from 6.8% to 12.7%.

By December 2011, Central Bank required commercial banks to set aside 70%[5] provisioning for loans that had been non-performing for more than one year; and granted the banks three to five years to achieve full compliance. To this end, NPL write-offs between 2011 and 2016 amounted to $240.9mn. During this time, annual provisioning expenditure averaged $48.7mn, being significantly higher than the $15.7mn average of the previous three years. These factors severely constrained banks' profitability and capital growth. The latter averaged 3.5% from 2008 to 2016, which was substantially lower than the 18.4% ten-year annual average prior to 2008.

In summary, between 1999 and 2003, government's expansionary phase supported sizeable growth in economic activity and commercial banks' lending. Increasing pressures on foreign exchange reserves and unsustainable debt levels led to fiscal consolidation during 2004 to 2008. Nevertheless, lending continued to be buoyant despite dampened economic growth. The onset of the global financial crisis in late 2008 coincided with Belize's own internal banking crisis. In 2009 and thereafter, fiscal consolidation efforts, low economic growth and intensive commercial banks' balance sheet repairs via provisioning and NPL write-offs shaped new lending patterns for Belize's economy.

[4] Ratio of total non-performing loans to gross loans.
[5] This was later revised to 50% in 2013

Chart 1. Relationship between credit growth, real output and fiscal activity

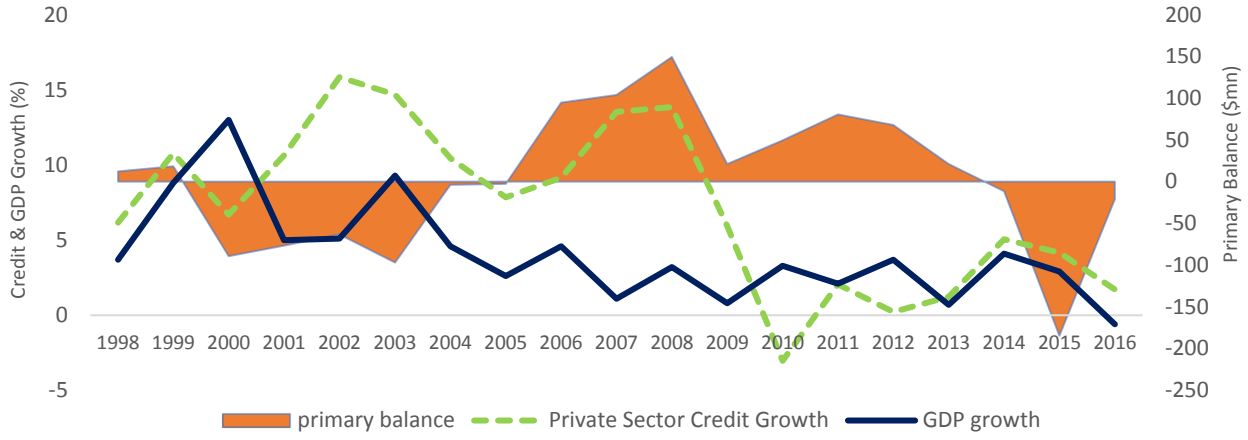
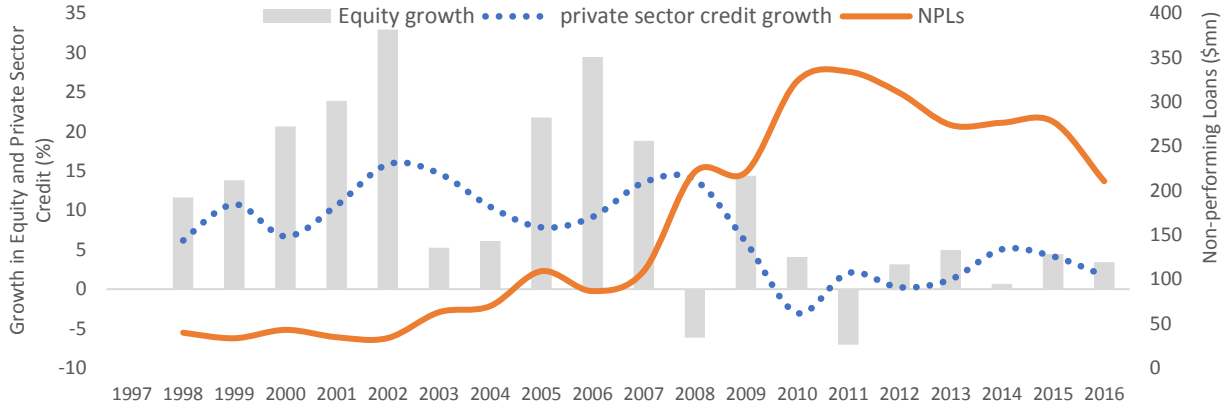


Chart 2. Relationship between Credit Growth, NPLs and Equity Growth



4.0 Methodology and Data

4.1 Variable Selection

The econometric model seeks to identify the long run determinants of credit growth in Belize and assess the short run dynamics to explain the shift in lending patterns after the onset of the international crisis. The application of the VECM simultaneously estimates long run and short run elements of the model by running through a system of equations, which reduces problems of endogeneity, omitted variables and serial correlation (Shijaku & Kalluci, 2013). Of the VECM approaches, the most appropriate method requires the identification of supply and demand relationships through the imposition of restrictions (Hulsewig et al., 2001; de Mello & Pisu, 2010; Sun et al., 2010). Although the application was one used for more developed and larger economies, the price incentives and behavioural expectations are assumed to hold for Belize.

The VECM model of private sector credit growth assumes that the expansion of credit is based on economic activity, as well as the capacity to grant and obtain credit (Shijaku & Kalluci, 2013). Hence, the variables used in this model are grouped into supply side and demand side factors. The supply side factors include: commercial banks' capital (*Equity*), interest rate differential and minimum liquidity reserve requirement (*LRR*). The factors used in the demand equation are constant GDP growth (*GDP*) and weighted average lending rate ($IR_{LENDING}$).

Commercial banks' capital (E*quity*) is a key source of asset growth since better capitalized banks have a higher capacity to lend. Thus, a positive relationship between capital and loan supply is expected. In addition to being a source of loan funding for Belize, approval must be obtained from regulators for loans that exceed 25% of the bank's capital. These high concentration risk loans amounted to 128.5% of regulatory capital and 26.9% of the total loan base at the end of 2016. Deposits were not used in the model, since persistent excess liquidity is a common feature in Belize's domestic banking system at the aggregate level[6].

The interest rate differential represents the difference between the weighted average lending rate ($IR_{LENDING}$) and the weighted average deposit rate ($IR_{DEPOSIT}$). An increase in the spread motivates banks to increase lending, suggesting a positive relationship between the spread and loan supply. Two factors affect the interest rate differential, the weighted average deposit rate ($IR_{DEPOSIT}$) and the weighted average lending rates ($IR_{LENDING}$). A reduction in the weighted average deposit rate, reduces commercial banks' cost of funding, increases the interest rate spread and thus spurs banks to lend more. An increase in the weighted average lending rate should lead to higher spreads and increased lending. Hence, loan supply is expected to be negatively related to deposit rates and positively related to lending rates.

The minimum liquidity reserve requirement[7] (*LRR*) is the main monetary tool used by the Central Bank of Belize and was actively applied from the mid-eighties to mid-2000s. The lower pace of lending after 2009

[6] During the eleven-year period from 1998 to 2008, excess liquidity in the domestic banking system was on average 30% higher than required; whereas from 2009 to 2016, the ratio of excess liquidity to the minimum requirement averaged 56%.

[7] Banks are required to hold a minimum of 23% of average deposit liabilities in liquid assets, which include the cash reserve requirement and other approved liquid assets.

supressed the authorities' need to use reserve requirements while commercial banks actively used Treasury bills to manage their liquidity. Changes in *LRR* is expected to be inversely related to the supply of credit. The inflation rate was not used in the model since inflation targeting is not a monetary policy tool used in Belize due to the country's fixed exchange rate regime.

Non-performing loans (*NPL*) provide a measure of credit risk in the banking system and are expected to be negatively related to capital growth. An increase in NPLs will require higher provisioning expenditure, which constrains the growth in retained earnings. NPLs are also expected to have a negative relationship with GDP growth and a positive relationship with lending rates.

4.2 Model Specification

Similar to the model used by de Mello and Pisu (2010), an aggregate model of loan demand ($Loan_{DEMAND}$) and loan supply ($Loan_{SUPPLY}$) was applied. For the Belizean economy, loan demand is a function of economic activity (*GDP*) and the weighted average lending rate ($IR_{lending}$). While loan supply depends on interest rate spread ($IR_{LENDING}$ - $IR_{DEPOSIT}$), the level of equity (*Equity*) and the minimum reserve requirement (*LRR*). Thus, the model can then be written as:

$Loan_{SUPPLY} = Loan_{SUPPLY}$ (*Equity*, $IR_{LENDING}$, $IR_{DEPOSIT}$, *LRR*), and

$$Loan_{DEMAND} = Loan_{DEMAND}\,(GDP,\ IR_{lending}) \qquad (1)$$

Identification of the loan demand and loan supply functions are based on the presence of cointegrating relationships. Loan supply is differentiated from loan demand based on this sign carried by the weighted average lending rate, such that loan supply is expected to be positively related to lending rates while loan demand is negatively related to lending rates.

The interaction among the variables are evaluated based on the VECM, which can be defined as:

$$\Delta Y_t = A(L)\Delta Y_t + \Pi Y_{t-1} + \varepsilon_t$$

where, y_t is a vector of included variables such that Y =[*Loans, GDP,* $IR_{LENDING}$, $IR_{DEPOSIT}$, *Equity, NPL, LRR*], L is the lag operator, and ε is an error term. Π is the product of two matrices, α_{ij} and β_{ij} of dimension 7 x 4. β is a vector of the cointegration relationships and the loading matrix, α, defines the speed of adjustment to the long run equilibria;

4.3 Data, Variable Inclusion and Misspecification Tests

Quarterly data was used for all variables from 1997Q1 to 2017Q1. All variables were expressed in natural logs. The variables, as aforementioned, include: private sector credit growth (*Loans*), constant GDP growth (*GDP*), domestic banks' capital growth (*Equity*), non-performing loans (*NPL*), weighted average lending rate ($IR_{lending}$), weighted average deposit rate ($IR_{deposit}$) and the minimum liquidity reserve requirement (*LRR*). Appendix 1 contains a list of all variables used, their definitions and sources.

All variables were subject to individual unit root tests, the Augmented Dickey-Fuller (ADF) and Philips Perron (PP). Five of the seven variables were non-stationary in levels, but stationary in their first difference form (see Table 2 of Appendix 2). When choosing the optimal length, tests of the VAR Lag Order Selection (see Table 3 of Appendix 2) revealed conflicting results: Schwarz Information Criterion (SIC) and Hannan-Quinn Information Criterion (HQ) suggested one lag, while Akaike Information Criterion (AIC) suggested seven lags. These tests were compared against the Lag Exclusion Wald Tests (see Table 4 of Appendix 2) which revealed that both one lag and seven lags were jointly significant for the model at the 1% level. For quarterly vector autocorrection (VAR) models, Ivanov and Kilian (2005) recommend using the SIC since the sample size contains less than 120 data points. Thus, the SIC with one lag was chosen. For the purpose of a VECM, the optimal lag level would be one less than the optimal lag length for the VAR, as such zero lags will be applied to this model.

Johansen tests were used to determine if the system was cointegrated. At the 5% probability levels, four cointegrating relationships were found to exist among the variables from both trace and maximum eigenvalue tests (see Table 5 of Appendix 2). On this basis, the Vector Error Correction Model (VECM) would be most appropriate for this condition. After specifying the model, residual tests of autocorrelation were performed. Portmanteau and Lagrange Multiplier tests failed to reject the presence of no autocorrelation (see Table 6 of Appendix 2). Model stability was confirmed, with the findings of the AR Roots test showing no roots existed outside of the unit circle (see Table 1 of Appendix 2). Dummy variables were included to take into account shifts in credit growth and non-performing loans.

4.4 Identification

For the identification of the cointegration vectors, 18 restrictions were imposed: one equality restriction and 17 exclusion restrictions based on the behavioural assumptions of loan demand, loan supply, equity and non-performing loans. The loan demand and supply equations were normalised by *Loans*, while the equity and NPL equations were normalized by *Equity* and *NPL*, respectively. Appendix 3 explains the identifying assumption and the respective restrictions.

The loan supply equation positively relates growth in loans to interest rate margin ($IR_{LENDING}$ - $IR_{DEPOSIT}$) and equity (*Equity*). An increase in the interest rate margin is expected to spur banks willingness' to lend, while banks' capital levels determine the capacity to lend. Equity is solely a constraint on loan supply and does not affect loan demand. The minimum liquidity reserve requirement is negatively related to credit growth and will only be included in the supply equation. GDP is excluded from the supply function, since its impact is expected to be much smaller than on loan demand. Thus based on these expectations, a zero restriction is imposed on the long-run coefficient of GDP, and an equality restriction is imposed such that the long run coefficient for the weighted average lending rate is negatively related to that of the weighted average deposit rate.

The growth in demand for loans is expected to be positively related to income (as measured by GDP) and negatively related to lending rates. Growth in loan demand is expected to increase when income levels increase, which in our model is measured by constant GDP growth. On the other hand, an increase in lending rates should cause a reduction in loan demand. Deposit rates, equity and the liquidity reserve

requirement is not expected to have a long run relationship with loan demand, hence zero restrictions are placed on the long run coefficients of these variables.

The third equation links equity growth with NPLs and credit growth. Increases in NPLs are expected to have a negative long run impact on equity by increasing provisioning, reducing profitability and constraining the level of retained earnings; while an increase in loan growth is expected to increase long run profitability due to the growth in performing assets. The fourth equation links NPL levels with growth in income, *GDP,* and lending rates, $IR_{lending.}$ NPLs are assumed to be negatively related to GDP and positively related to lending rates.

4.5 Tests of Weak Exogeneity

Tests of weak exogeneity were performed on the unrestricted model to determine if all variables should be treated as endogenous. If any variables are determined to be weakly exogenous to the system, the system can be re-specified to exclude those weakly exogenous short-term coefficients (α_{ij}). According to Juselius(2006), the weakly exogenous variables does not contain information about the long run parameters, thus by conditioning on weakly exogenous variables, a partial model can be obtained with more stable parameters than the full system. Hulsewig et al. (2001) carried out two types of tests of weak exogeneity: (i) without imposing restrictions on β; and (ii) imposing simultaneous over-identifying restrictions on β. Weak exogeneity is rejected if the empirical significance level is smaller than 10%.

To check if the parameters have become more stable after conditioning on the weakly exogenous variable, the results of the misspecification tests of the full model should be compared with those of the partial model. Results from the tests of weak exogeneity for both test (i) and (ii), reveal that the null hypothesis of weak exogeneity cannot be rejected for the liquidity reserve requirement and weighted average lending rates. However, tests of normality improved marginally when the partial model was estimated, thus the full model was used.

5.0 Results

5.1 Long run equations

The results of the cointegrating vectors of the restricted VECM are provided in Table 1. Based on the Likelihood Ratio (LR) test statistic of χ^2 (3) = 2.05999 and a p-value of 0.5600, we fail to reject the null hypothesis which states that the restrictions imposed on the cointegrating vectors are valid. Additionally, all signs in the model were found to be in line with theory.

Table 1. Identified Cointegrating Vectors (β_{ij}) [1]

	LOANS	*GDP*	*Equity*	*NPL*	$IR_{lending}$	$IR_{deposit}$	*LRR*
β_1	1	0	-0.078 [-38.424]	0	-0.022 [-7.084]	0.022 [7.084]	0.005 [1.334]
β_2	1	-0.0850 [-8.650]	0	0	0.061 [3.248]	0	0
β_3	-0.134 [-0.852]	0	1	0.041 [2.023]	0	0	0
β_4	0	7.3975 [8.008]	0	1	-0.163 [-0.104]	0	0

(1) t-statistics are in [ ]

The results reflect the long-run determinants of supply and demand for credit, as follows:

$$Loan_{SUPPLY} = 0.022\,(IR_{LENDING} - IR_{DEPOSIT}) + 0.078\,Equity - 0.005\,LRR \quad (1.1)$$

$$Loan_{DEMAND} = 0.085\,GDP - 0.061\,IR_{LENDING} \quad (2.1)$$

Equation 3.1 describes the long-run relationship between the level of banks' capital, non-performing loans and credit growth, while equation 4.1 reflects the long-run relationships between GDP growth and lending rates:

$$Equity = 0.134\,Loans - 0.041\,NPL \quad (3.1)$$

$$NPL = -7.398\,GDP + 0.163\,IR_{LENDING} \quad (4.1)$$

In line with apriori expectations, the supply equation shows that a long run positive association exists between growth in credit supply, interest rate margins and banks' equity, while the liquidity reserve requirement is negatively related. Equity is the most significant factor and has the largest impact on loan supply, such that a 1% increase in banks' equity will increase credit growth by 0.08%.

The impact of the liquidity reserve requirement on credit supply was relatively small, thus confirming the difficulty of using this monetary policy tool to influence long term credit behaviour. Garcia et al. (2008) documented the inability to curb loan growth by increasing the reserve requirement during the early 2000s. The IMF (2008) refers to the ineffectiveness of the reserve requirement to manage the seasonal

build-up of liquidity in Belize, as an increase in the requirement produces a one-off effect, after which liquidity accumulation in the system resumes.

A long relationship exists between credit growth, equity growth and non-performing loans. Equation 3 shows that a 1% increase in non-performing loans is expected to result in a 0.04% reduction in equity growth, as a pick-up in NPLs would reduce profitability and retained earnings. At the same time, equity growth is positively linked to credit supply, thus long run changes in NPL will reduce long term credit supply. Similarly, findings by Gross et al. (2016) on the study of 28 EU economies, suggest that those banks which compress asset growth during periods of capital shortfalls in order to meet capital requirements, risk dampening economic activity further by restricting credit supply.

On the demand-side, long-term growth in credit demand was found to be positively linked to GDP growth levels and negatively linked to lending rates. Both GDP growth and lending rates were found to be significant to long term credit demand. The income elasticity of demand was estimated at 0.085 suggesting that a 1% increase in long-run GDP growth will result in a long-term increase in credit demand of 0.09%. These findings are lower than income elasticities found by Shijaku and Kalluci (2013) for Albania (range of 0.165 – 0.220) and Saito et al. (2014) for Latin American and Caribbean (LAC) countries (0.287). While income elasticities for more developed economies are found to be close to unity or higher (Hulsewig et al., 2001; Calza et al., 2006; Dumicic & Ljubaj, 2017; Iossifov & Khamis, 2009; de Mello & Pisu, 2009), those of some developing economies were considerably lower, ranging between 0.165 and 0.287 (Downes et al., 1997; Shijaku & Kalluci, 2013; Saito et al., 2014).

The differences in income elasticity levels may be attributable to varying levels of access to formal financing sources. Economies with low access to formal financing will not experience a proportionate increase in lending when income levels rise since segments of the population may not be able to qualify for loans despite the increase in earnings. A comparison of high income OECD countries against LAC shows that for the former region, access to formal financing is higher with 94.0% of the population over 15 years holding accounts at formal financial institutions compared to 51.1% for the LAC countries. At the same time, the proportion of the population borrowings from financial institutions were higher[8] for OECD economies at 18%, compared to 11% in LAC countries. In contrast, borrowings from informal private lenders were higher for the LAC at 5%, compared to less than 1% for OECD economies.

The impact of long term lending rates on credit demand was estimated to be relatively smaller than economic activity, as a 1% increase in the weighted average lending rates is expected to cause a 0.06% decline in credit demand. When compared to regional studies, Belize appears to have a relatively inelastic price demand[9]. Countries exhibiting lower price elasticities of demand suggest that lower sensitivity could be attributed to the lack of price competition among banks, or bank-dominated financial systems with little alternative source of financing. This underscores that, for Belize, access to finance takes precedence over pricing from a borrowers' perspective.

[8] Based on the World Bank's Global Findex Database

[9] Downes et al (1997) estimated an interest rate elasticity of 0.282 for Barbados, while Branch et al. (2016) estimated an elasticity of 0.75 for Bahamas.

5.2 Short term dynamics

The loading matrix evaluates the short run dynamics of the model by identifying the variables' speed of adjustment towards the long-run equilibrium if deviations occur. Comparing the signs of the coefficients of the loading matrix ($\boldsymbol{\alpha}_{ij}$) with those of the normalized restricted cointegrating vectors ($\boldsymbol{\beta}_{ij}$) can determine which variables are converging towards equilibrium (Juselius, as cited in de Mello and Pisu, 2010). If the signs are the same for the variables of $\boldsymbol{\alpha}_{ij}$ and $\boldsymbol{\beta}_{ij}$, then the variable *i* adjusts towards the equilibrium defined by the cointegrating relationship *j*. Based on the loading matrix (Table 2) and the identified cointegrating vectors (Table 1), loan supply and equity equations will converge to long run equilibrium via adjustments in deposit rates and NPL levels, respectively.

Table 2. Loading Matrix (α_{ij}) [1]

	$LOAN_{supply}$	$LOAN_{demand}$	*Equity*	*NPL*
Credit Growth	0.0652 [0.043]	-1.0657 [-0.697]	0.0422 [0.353]	-0.0137 [-0.808]
GDP Growth	-6.9457 [-1.058]	7.3572 [1.113]	-0.6266 [-1.211]	-0.0286 [-0.390]
Equity Growth	-2.1098 [-0.255]	-0.5784 [-0.069]	-1.2826 [-1.966]	-0.0087 [-0.094]
NPL	16.5589 [2.937]	-16.0303 [-2.822]	1.1598 [2.610]	-0.1693 [-2.693]
$IR_{lending}$	1.6670 [2.739]	-1.6532 [-2.706]	0.1304 [2.775]	-0.0188 [-2.897]
$IR_{deposit}$	4.9185 [4.096]	-4.8944 [-4.032]	0.3927 [4.065]	-0.0580 [-4.137]
LRR	-0.3219 [-0.161]	0.2326 [0.116]	0.0162 [0.103]	0.0028 [0.124]

1. Values of T-statistics in parenthesis

Short-term disequilibrium in loan supply will correct itself mainly through adjustments in deposit rates with a relatively high speed of adjustment. For example, when short run credit growth falls below long-term equilibrium levels, banks will cut deposit rates to increase the interest margin on loans. Increased margins will make it more attractive to lend, thereby spurring commercial banks' loan supply. Short term disequilibrium in commercial banks' equity will be adjusted via changes in credit risk measures, as reflected in the level of non-performing loans. If equity growth were to fall below long-term equilibrium, banks will adjust NPL levels by tightening credit policy.

5.3. Detangling the Impact of Loan Demand and Loan Supply on credit growth

To assess the underlying factors that affected credit growth, the results of the forecast error variance decomposition (FEVD), impulse response functions (IRFs) and the historical decomposition of the model were examined. The FEVD decomposes the variance of the forecast error of each endogenous variable into a number of periods ahead. Thus when predicting the performance of the variable, the FEVD tells what portion of the forecast error variance is due to the structural shocks of other variables. The IRF shows the endogenous variables response to a unitary change in a structural shock. In other words, the IRF traces the effect of a shock on the adjustment path of the variable. Both the FEVD and the IRF assesses how a shock to the economic variable affects the system.

The historical decomposition also explains how the structural shock pushes the variable away from the equilibrium values. However, unlike the FEVD and the IRF, the historical decomposition provides an explanation over what has actually occurred over the historical period, in terms of recovered values of the structural shocks and observed paths (Ocampo & Rodriguez, 2011). Further, it facilitates the analysis of simultaneous shocks and addresses the relative importance of the shocks over a period of time. According to Ocampo and Rodriguez (2011), historical decomposition differs from the FEVD and IRFs, since the latter two only examines the possibility if a hypothetical shock occurs in the absence of any other disturbance.

(i) Impulse Response Function

The impulse response of private sector credit growth to shocks in equity growth has the largest immediate impact of 0.6% in quarter 2 but dies off by quarter 4. Shocks to GDP growth are the second largest at 0.2% and is only sustained for quarter 2. At the same, the response of credit growth to shocks in NPLs are much smaller but is sustained to the end of the period.

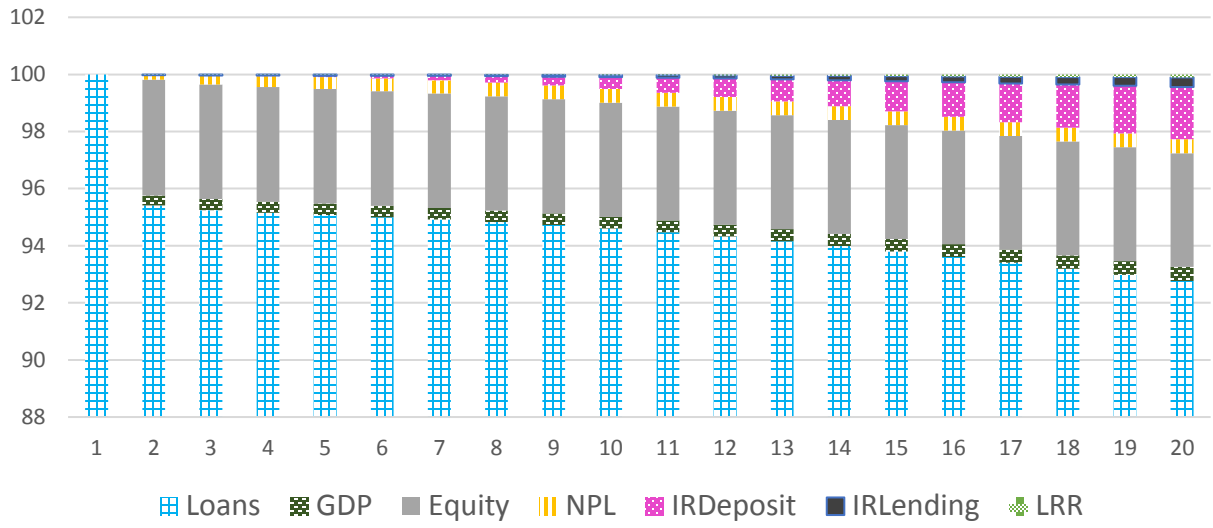
Table 3. Impulse Response Function of Private Sector Credit Growth

One standard deviation shock in each endogenous variable:						
Period	GDP	Equity	NPL	$IR_{Deposit}$	$IR_{Lending}$	LRR
2	-0.2%	0.6%	0.0%	-0.1%	0.0%	0.0%
4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
12	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%
20	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%

(ii) **Variance Decomposition**

The variance decomposition of private sector credit growth indicates that the short run dynamics are explained mostly by its own fluctuations, followed by equity. Within the first year, equity growth accounts for 4.0% of the variation in credit growth. By the medium term (within 15 quarters), respective variations in equity growth and deposit rates account for 3.99% and 1.06% of variances in credit growth. These dynamics are sustained thereafter and account for around 5.8% of the forecast error variance by the end of year 5.

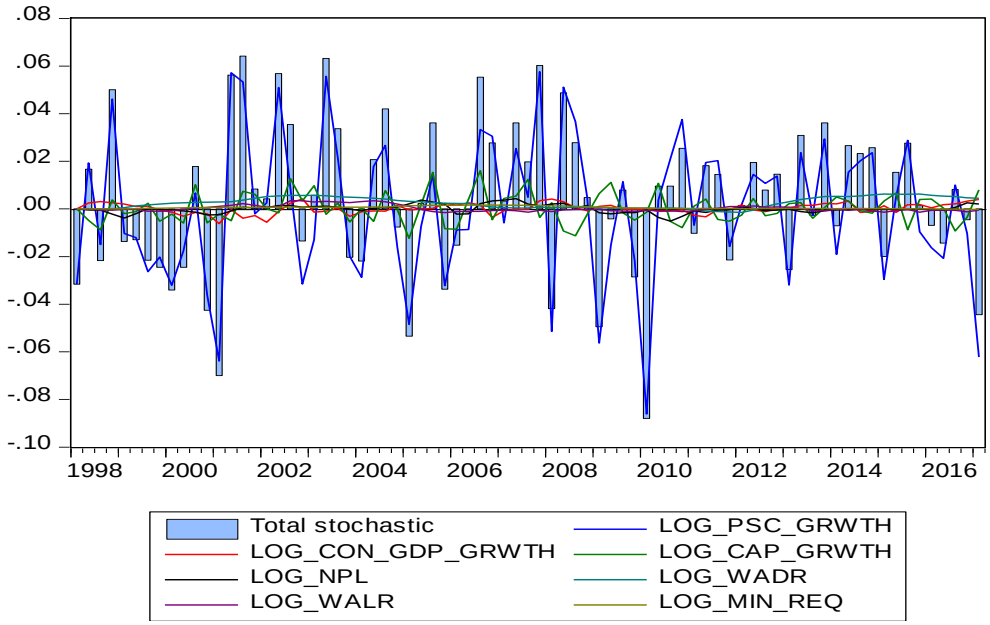
Chart 3. Forecast Error Variance Decomposition of Private Sector Credit Growth (%)



(iii) Historical Decomposition

The historical decomposition of a variable breaks down the forecast errors of the said variable into identified structural shocks of other component variables based on its historical trends. From the historical decomposition graph, there is no one identifiable shock which can consistently explain historical shocks to private sector credit.

Chart 4. Historical Decomposition of Private Sector Credit Growth



To obtain a numerical measure of the contribution of the shock of each variable to private sector credit we use the root mean squared errors (RMSE). The RMSE measures the difference between the values of the series predicted by the model and the values that are observed. Thus, a smaller RMSE value means that the predicted values are closer to the observed values. By comparing the RMSE of each series, we can determine which variables produce shocks that are closest to actual private sector credit growth. To obtain a comprehensive view of how these shocks have changed over time, the RMSE is calculated for the entire period, and then for three identifiable periods under review.

Between 1999 and 2008, equity shocks are best able to explain shocks to private sector credit growth. However, after 2008, shocks to deposit rates become more significant in explaining private sector credit shocks. Both factors, equity and deposit rates, are supply-side factors and their relative importance in explaining credit growth shocks is consistent with short-run dynamics.

Table 4. Summary RMSE Statistics of Historical Decomposition of Private Sector Credit Growth

	Base Projection	Base Projection Plus Accumulated Effects of Shock in:					
		GDP	*NPL*	*EQUITY*	*WALR*	*LRR*	*WADR*
1998 -2016	0.0316	0.0315	0.0312	*0.0309*	0.0313	0.0314	0.0313
1999-2003	0.0373	0.0371	0.0365	*0.0356*	0.0364	0.0371	0.0364
2004 - 2008	0.0334	0.0334	0.0327	*0.0315*	0.0336	0.0330	0.0333
2009 - 2016	0.0252	0.0253	0.0253	0.0261	0.0252	0.0252	*0.0247*

Prior to the crisis, low NPL levels induced banks to increase their risk appetite and loosen lending policy. The expansion in lending facilitated the increase in profitability and subsequent build up in equity. Hence, shocks to equity growth were in tandem with private sector credit shocks during this period. After 2008, however, commercial banks' reclassification of non-performing loan facilities reduced income levels. Deposit rates were cut to compensate for this loss in earnings, as evidenced in the results of the short run dynamics of the model.

6.0 Conclusions and Policy Recommendations

The long run association between domestic banks' equity, non-performing loans and GDP suggest that determinants of long run credit growth are multi-dimensional. The empirical evidence shows that the long run behaviour of loan supply and loan demand did conform to theoretical underpinnings, however supplementary cointegrating relationships provided further insight. The strong and significant long-term relationship between GDP growth and NPLs models the linkages between real sector activity and asset quality in the financial sector. At the same time, the interrelated nature between credit growth and equity have clear policy implications for capital regulations.

The short run dynamics indicate that imbalances in credit growth will converge to long run equilibrium through changes in deposit rates and banks' credit risk stance (as reflected by NPL levels). These findings are corroborated through the results of the historical decomposition. Prior to the crisis, shocks to equity were best able to explain shocks to credit growth, which was evidenced by low NPL levels which facilitated the build-up of capital through accumulated retained earnings. This growth in capital consequently fed the rise in credit supply, which in turn boosted profitability and capital growth.

This dynamic changed during the late crisis period, as the historical decomposition between 2009 and 2016 indicated that shocks to deposit rates closely mirrored shocks to credit growth. Thus, in the short-run when credit supply fell below the long-term equilibrium levels, banks cut deposit rates to compensate for the loss in income by reducing their cost of funding. However, in the long run, the simultaneous increase in NPLs and the reduction in credit growth restricted equity growth. This dynamic is evidenced by the decline in equity growth after the crisis, which fell from an average of 18.4% (between 1998 and 2007) to 3.5% (between 2008 and 2016).

Three main issues arise from the findings of this paper: (i) the need for a comprehensive framework to improve credit risk quantification for the financial sector; (ii) the implementation of dynamic capital regime to moderate systemic shocks; and (iii) financial market development to support the productive sector's access to finance and improve their resilience to shocks and economic cycles.

Improving lending institutions' capacity to assess credit risk can be achieved by the implementation of a credit risk bureau. Transparent credit information is important for risk management and can be used by lending agencies to screen borrowers and monitor the risk profile of an existing facility. Credit bureaus also facilitates the build-up of "reputational collateral" as persons' credit worthiness can be assessed even if they lack financial history with the specific lending institution.

The implementation of a dynamic capital regime can contain the amplification of the feedback effects between credit growth and capital. Two main tools applied under such a regime are countercyclical capital buffers and dynamic provisioning. The former requires banks to accumulate capital (conservation buffer) during the economic upswing, so that it can be drawn down during periods of stress. This conservation buffer is only activated during periods of excessive credit growth. Similarly, dynamic provisioning requires banks to increase generic loan loss reserves during the upswing, so that it can be applied to cover increased specific provisioning needs linked to declining asset quality during the downturns.

Gross et al. (2016) recommends that the authorities provide clear guidance on the manner in which macroprudential policies are implemented depending on the measure being used, the phase of the business cycle and its purpose. They recommend that during expansionary periods, dampening the

financial cycle of banks can be achieved by compressing asset growth in order to meet capital requirements. In contrast, during recessionary cycles, improving the health of balance sheets via capital injections may be necessary to mitigate the impact of the downturn.

The relatively low long-run price and income elasticities of credit growth in Belize are indicative of financial access constraints. The high level of bank dominance engaged in traditional banking activities suggests that the domestic commercial sector has limited financing alternatives. According to Rojas-Suarez (2014), capital markets provide important benefits for emerging market economies by: complementing banks' financial intermediation role, improving economic agents' capacity to manage financial risks and increasing financial resilience during periods of shocks. The also foster financial integrity by enforcing market discipline and the need to comply with internationally accepted standards for accounting, transparency and governance. However, Rojas-Suarez advocate that the development of strong and stable financial markets in EMEs are based on four pillars: macroeconomic stability, sound banking systems, high institutional quality and an adequate regulatory and supervisory framework.

References

Branch, S., Cooper, Y., & Moxey, M. (2015). An Empirical Analysis of the Nexus between Private Sector Credit, Economic Growth, Government Expenditure, Interest Rate and Inflation: Case of the Bahamas (1989 - 2014). Retrieved from http://www.ccmf-uwi.org /files/ publications/conference/2015 /5_2-Branch_Cooper_Moxey-p.pdf .

Brissimis, S., Garganas, E., & Hall, S. (2014). Consumer credit in an era of financial liberalization: an overreaction to repressed demand? *Applied Economics*, 46(2), 139-152. doi.org/10.1080/00036846.2013.835482.

Calza, A., Sousa, J., & Manrique, M. (2006). Credit in the Euro Area: An empirical investigation using aggregate data. *The Quarterly Review of Economics and Finance*, 46(2), 211-226. Retrieved from https://www.journals.elsevier.com/the-quarterly-review-of-economics-and-finance/ .

Dananau, C. (2015). Non-governmental credit in Romania: a VECM-based approach. *Romanian Statistical Review, 63*(1), 87-106. Retrieved from https://econpapers.repec.org/RePEc:rsr:journl:v:63:y:2015:i:1:p:87-106.

De Mello, L., & Pisu, M. (2010). The Bank Lending Channel of Monetary Transmission in Brazil. *Quarterly Review of Economics and Finance*, 50(1), 50-60. doi:10.1016/j.qref.2009.09.006.

Downes, D., Craigwell, R., & Greenidge, K. (1997). A demand function for private individual credit in Barbados. *Central Bank of Barbados Working Paper Series*. Retrieved from http://www.centralbank.org.bb/ .

Dumičić, M., & Ljubaj, I. (2017). Delayed Credit Recovery in Croatia: Supply or Demand Driven? *Croatian National Bank Working Paper Series*, (45). Retrieved from http://www.hnb.hr/.

Everaert, G., Che, N., Geng, N., Gruss, B., Impavido, G., Lu, Y., Soborowski, C., Vandenbussche, J., & Zeng, L. (2015). Does Supply or Demand Drive the Credit Cycle? Evidence from Central, Eastern and Southeastern Europe. *International Monetary Fund Working Paper.* Retrieved from https://ideas.repec.org/p/hnb/wpaper/45.html .

Fritzer, F. & Reiss, L., (2008), An Analysis of Credit to the Household Sector in Austria, *Austria Financial Stability Report*, Issue 16, p. 122-134, https://EconPapers.repec.org/RePEc:onb:oenbfs:y:2008:i:16:b:4 .

Garcia, G., Novelo, A., & Vellos, C. (2013). The Evolution of the Financial Sector in Belize (1996 – 2007). In R. Ramseran (Ed.), *The Financial Evolution of the Caribbean Community* (pp. 180 -212). Caribbean Centre for Money & Finance: UWI, St. Augustine.

Gross, M., Kok, C., & Sochowski, D. (2016). The impact of bank capital on economic activity- Evidence from a Mixed Cross-Section GVAR model. *European Central Bank Working Paper Series,* (1888). Retrieved from www.ecb.europa.eu/pub/research/working-papers/ .

Hulsewig, O., Winker, P., & Worms, A. (2001). Bank Lending and Monetary Policy Transmission: A VECM Analysis for Germany. *Journal of Economics and Statistics*. 224. 511-529. doi:10.2139/ssrn.304457.

Ivanov, V., & Kilian, L. (2005). A Practitioner's Guide to Lag Order Selection for VAR Impulse Response Analysis. *Studies in Nonlinear Dynamics and Econometrics,* Issue 9(1). Retrieved from https://www.bepress.com/ .

Juselius, K. (2006). *The Cointegrated VAR Model: Methodology and Applications*. Oxford: Oxford University Press.

International Monetary Fund. (2008). *Belize 2008 Article IV Consultation: Staff Report.* Retrieved from https://www.imf.org/en/Publications/CR/Issues/2016/12/31/Belize-2008-Article-IV-Consultation-Staff-Report-and-Public-Information-Notice-on-the-21777.

Kok Sorenson, C., Marques-Ibanez, D., & Rossi, C. (2009). Modelling loans to non-financial corporations in the Euro Area. *European Central Bank Working Paper Series*, (989). Retrieved from http://www.ecb.europa.eu/.

Ocampo, S., & Rodriguez, N. (2011). An Introductory Review of a Structural VAR-X Estimation and Applications. *Borradores de Economia Banco de la Republica Colombia, 686*. Retrieved from http://www.banrep.gov.co/docum/ftp/borra686.pdf.

Plasil, M., Radkovsky, S., & Rezabek, P. (2013). Modelling bank loans to non-financial corporations. Czech National Bank Financial Stability Report. Retrieved from http://www.cnb.cz/.

Ramlogan, A., & Mitchell-Ryan, T. (2010). An Assessment of the Impact of the Sectoral Distribution of Commercial Bank Credit on Economic Growth and Development in Trinidad and Tobago. *Central Bank of Barbados Working Paper Series.*

Rojas-Suarez, L. (2014). Towards Strong and Stable Capital Markets in Emerging Market Economies. *BIS Working Paper, 75c*. Retrieved from https://ssrn.com/abstract=2474016.

Saito, A., Savoia, J., & Lazier, I. (2014). Determinants of Private Credit in OECD Developed, BRIC´s and LAC Countries. *American International Journal of Social Science, 3*(3), 21-35. Retrieved from www.aijssnet.com/journals/Vol_3_No_3_May_2014/3.pdf.

Shijaku, Gerti & Kalluci, Irini. (2014). Determinants of bank credit to the private sector: The case of Albania. . doi:10.13140/RG.2.2.19042.12485.

Stowe, R., Jack, J., & Richards, W. (2008). Identification of Loan Supply Function and Credit Growth. *ECCB Staff Research Paper*. Retrieved from www.ccmf-uwi.org/files/publications/conference/1008.pdf .

Sun, S., Gan, C., & Hu, B. (2010). Bank lending channel in China's monetary policy transmission: a VECM approach. *Investment Management and Financial Innovations*, 7(2). Retrieved from https://businessperspectives.org/journals/investment-management-and-financial-innovations/ .

Appendix 1

Table 1. Variables for Vector Error Correction Model: Definitions and Sources

Variables	Definition	Source
Loans	Private Sector Credit Loan Growth	Statistical Digest: Table 1.Monetary Survey
GDP	Constant GDP Growth	Statistical Institute of Belize
$IR_{lending}$	Weighted Average Lending Rate for the Domestic Banking Sector	Statistical Digest: Table 23. Domestic Banks Weighted Average Interest Rates
$IR_{deposit}$	Weighted Average Deposit Rate for the Domestic Banking Sector	Statistical Digest: Table 23. Domestic Banks Weighted Average Interest Rates
Equity	Log of Domestic Bank's Capital	BR1: Domestic Banks Balance Sheet, FEDM Database, Central Bank of Belize
NPL	Log of non-performing loans for the Domestic Banking Sector	Central Bank FEDM Database
LRR	Minimum Liquidity Reserve Requirement for Domestic Banking Sector	Statistical Digest: Table 12. Domestic Banks Statutory Liquidity

Appendix 2

Table 2: Unit Root Tests

	Levels		First Difference	
	ADF	PP	ADF	PP
Log Private Sector Credit Growth *(Loans)*	-2.188	-7.266***	-13.632***	-28.489***
Log Constant GDP Growth (*GDP*)	-5.277***	-7.591***	-6.430***	-16.199***
Log Capital Growth (*Equity*)	-3.968***	-13.232***	-15.266***	-35.021***
Log Non-Performing Loans (*NPL*)	-0.398	0.986	-7.342***	-7.313***
Log Weighted Average Deposit Rate ($IR_{DEPOSIT}$)	-0.662	-0.527	-4.731***	-4.685***
Log Weighted Average Lending Rate ($IR_{LENDING}$)	-0.675	-0.611	-6.590***	-6.578***
Log Minimum Liquidity Reserve Requirement (*LRR*)	-2.298	-2.324	-9.211***	-9.258***

Note. Significance at the 1%, 5% and 10% levels are denoted by ***, ** and *, respectively.

Table 3: VAR Lag Order Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	17.07272	NA	1.78e-09	-0.283739	-0.060658	-0.195026
1	794.9487	1380.456*	2.17e-18*	-20.81546	-19.03081*	-20.10576*
2	835.5140	63.99037	2.85e-18	-20.57786	-17.23164	-19.24718
3	867.9380	44.75419	5.04e-18	-20.11093	-15.20314	-18.15926
4	908.3513	47.81292	7.90e-18	-19.86905	-13.39970	-17.29639
5	956.1215	47.09741	1.18e-17	-19.83441	-11.80349	-16.64077
6	1022.987	52.73908	1.34e-17	-20.33767	-10.74518	-16.52304
7	1127.111	61.59414	8.09e-18	-21.89044*	-10.73638	-17.45482

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion

Table 4: VAR Lag Exclusion Wald Tests

	Loans	*GDP*	*Equity*	*NPL*	$IR_{DEPOSIT}$	$IR_{LENDING}$	*LRR*	*Joint*
Lag 1	4.760	9.712	4.858	30.628	73.518	52.847	40.313	230.264
	[0.6893]	[0.2055]	[0.6773]	[0.0001]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Lag 2	5.396	12.536	9.082	2.878	6.514	12.483	4.716	59.055
	[0.6118]	[0.0842]	[0.2468]	[0.8961]	[0.4812]	[0.0858]	[0.6946]	[0.1539]
Lag 3	5.147	5.033	6.397	5.334	2.594	5.304	5.453	39.232
	[0.6421]	[0.6559]	[0.4942]	[0.6193]	[0.9198]	[0.6229]	[0.6048]	[0.8395]
Lag 4	20.045	11.619	9.241	1.127	3.817	2.311	4.052	52.629
	[0.0055]	[0.1138]	[0.2358]	[0.9925]	[0.8006]	[0.9406]	[0.7738]	[0.3354]
df	7	7	7	7	7	7	7	49

Table 5: Johansen Cointegration Tests

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.650804	252.6772	125.6154	0
At most 1 *	0.568523	171.6639	95.75366	0
At most 2 *	0.478757	106.9423	69.81889	0
At most 3 *	0.326095	56.77379	47.85613	0.0003
At most 4	0.203362	26.38454	29.79707	0.4445
At most 5	0.101692	8.878251	15.49471	0.3845
At most 6	0.008027	0.620597	3.841466	0.8843

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.650804	81.01334	46.23142	0
At most 1 *	0.568523	64.72159	40.07757	0
At most 2 *	0.478757	50.16852	33.87687	0
At most 3 *	0.326095	30.38925	27.58434	0
At most 4	0.203362	17.50629	21.13162	0.6585
At most 5	0.101692	8.257654	14.2646	0.3053
At most 6	0.008027	0.620597	3.841466	0.8843

Table 6: Serial Correlation Tests

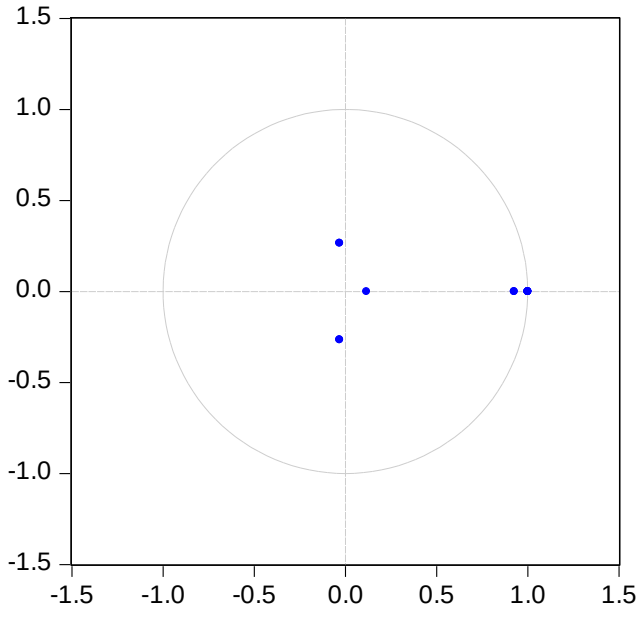
Portmanteau Tests for Autocorrelations

Lags	Q-Stat	Prob.*	Adj Q-Stat	Prob.*	df
1	38.86652	0.998	39.37792	0.997	67

Serial Correlation LM Tests

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	61.02871	49	0.1162	1.271226	(49, 298.9)	0.1185

Chart A1. Inverse roots of AR Characteristic Polynomial



Appendix 3

Table 7: Identifying Assumptions and Restrictions imposed on Model

Equation	Identifying Assumptions	Restrictions	Expected Signs
Equation 1: Loan Supply	Interest rate margin is positively associated with loan supply	$\beta_{1,5} = -\beta_{1,6}$	$(\beta_{1,5} - \beta_{1,6}) > 0$
	The impact of GDP on loan supply is negligible, compared to its impact on loan demand.	$\beta_{1,2} = 0$	None
	Equity is a constraint on loan supply, and an increase in equity leads to an increase in funds available for on-lending.	-	$\beta_{1,3} > 0$
	NPLs have an indirect impact on loan supply and would be accounted for in its impact on equity.	$\beta_{1,4} = 0$	
	Loan supply equation is normalized by the loan growth variable.	$\beta_{1,1} = 1$	
	Liquidity Reserve Requirement is expected to be negative.		$\beta_{1,7} < 0$
Equation 2: Loan Demand	Growth in demand is positively related to income or GDP.		$\beta_{2,2} > 0$
	An increase in lending rates leads to a decline in loan demand.		$\beta_{2,6} < 0$
	Equity, NPLs, deposit rates and liquidity reserve requirement do not affect loan demand.	$\beta_{2,3} = 0$, $\beta_{2,4} = 0$, $\beta_{2,5} = 0$, $\beta_{2,7} = 0$	
	Loan demand equation is normalized by the loan growth variable.	$\beta_{2,1} = 1$	
Equation 3: Equity	An increase in NPLs will result in the banks' need to increase provisioning resulting in a reduction in retained earnings and equity growth.		$\beta_{3,4} < 0$
	An increase in credit growth is expected to improve profitability and equity growth.		$\beta_{3,1} > 0$
	GDP, lending rates and liquidity reserve requirements are not directly linked to equity.	$\beta_{3,2} = 0$, $\beta_{3,5} = 0$, $\beta_{3,6} = 0$, $\beta_{3,7} = 0$	
	Equation is normalized by the equity variable.	$\beta_{3,3} = 1$	
Equation 4: NPL	An increase in GDP is expected to reduce the level of NPLs		$\beta_{4,2} < 0$
	An increase in lending rates is expected to increase the level of NPLs		$\beta_{4,6} > 0$
	Equity, private sector credit growth, interest rates are not directly linked to NPLs.	$\beta_{4,1} = 0$, $\beta_{4,3} = 0$, $\beta_{4,5} = 0$, $\beta_{4,6} = 0$, $\beta_{4,7} = 0$,	
	NPLs is normalized by the NPL variables	$\beta_{4,4} = 1$	

Appendix 4

Table 8: Tests of Weak Exogeneity

	$\chi^2(3)^1$	p-value	$\chi^2(4)^2$	p-value
Credit Growth	56.340	0.000	42.782	0.000
GDP Growth	33.213	0.000	29.787	0.000
Equity Growth	76.749	0.000	59.044	0.000
NPL	12.286	0.092	10.900	0.028
$IR_{deposit}$	8.316	0.306	6.361	0.174
$IR_{lending}$	15.561	0.029	11.351	0.023
LRR	5.315	0.622	3.514	0.476

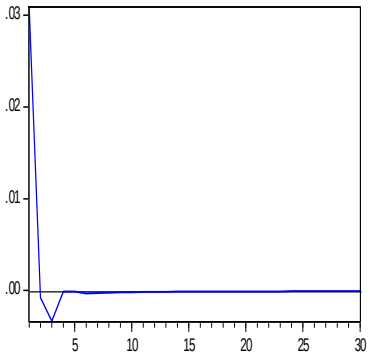
1 Refers to the likelihood ratio tests of joint restrictions on α with restrictions on β.

2 Refers to the likelihood ratio tests of joint restrictions on α without restrictions on β.

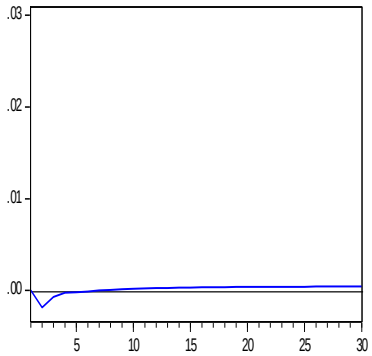
Appendix 5

Response to Cholesky One S.D. (d.f. adjusted) Innovations

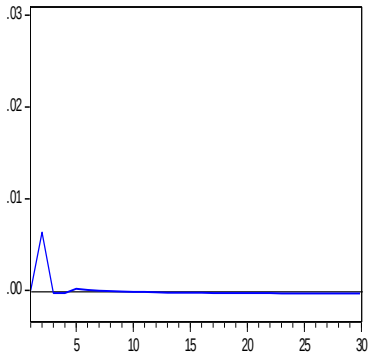
Response of LOG_PSC_GRWTH to LOG_PSC_GRWTH



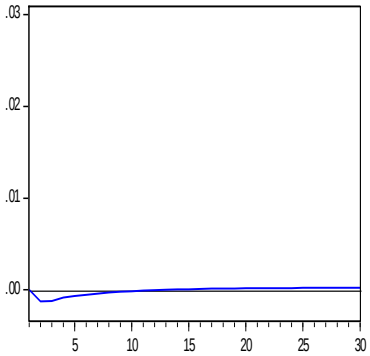
Response of LOG_PSC_GRWTH to LOG_CON_GDP_GRWTH



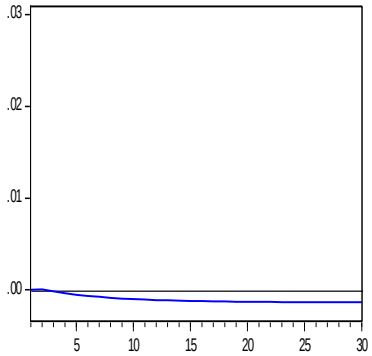
Response of LOG_PSC_GRWTH to LOG_CAP_GRWTH



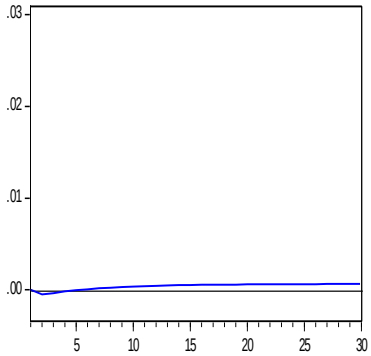
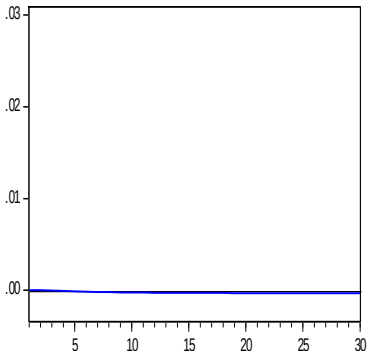
Response of LOG_PSC_GRWTH to LOG_NPL



Response of LOG_PSC_GRWTH to LOG_WADR



Response of LOG_PSC_GRWTH to LOG_WALR



Response of LOG_PSC_GRWTH to LOG_MIN_REQ