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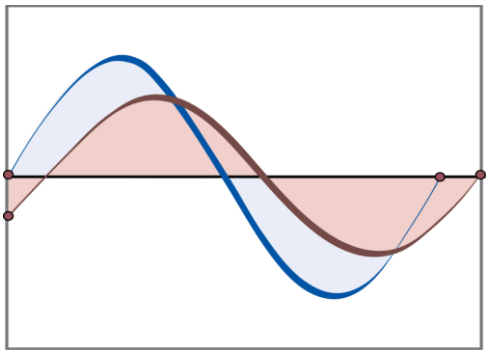

Using Reserve Requirements as a Macroprudential Tool

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One of the key lessons from the global financial crisis was that prevailing monetary policies were ill-suited for treating the financial imbalances associated with systemic risks. For many policymakers, the key challenge became how to design appropriate responses to enhance the stability of the financial system. In the absence of explicit formulas or estimation methods for these macroprudential policies, several economies managed systemic risks through re-fashioning their unconventional monetary policies. Reserve requirement ratios are examples of such policies that were used by a number of countries (for example in Brazil, India, Peru or Poland) as a liquidity and credit risk policy tool. However, in designing a framework to foster financial stability, care must be taken as macroprudential policies may impose restrictions that would unnecessarily hamper innovation or reduce the efficiency of the financial system. Therefore, in keeping in line with the financial stability mandate of the Central Bank of Trinidad and Tobago, the paper explores how reserve requirement ratios may be used to enhance its macroprudential framework. This was accomplished by using a Vector Autoregressive Model and Event Analysis to trace the impact of reserve requirement hikes on key macro-financial indicators. Simulations showed that the primary reserve requirement ratio would be an effective tool for curbing unsustainable credit growth but, secondary reserve requirements ability to treat credit risks appears limited. A thorough understanding of the domestic financial sector, including its structure, characteristics and behaviors would be invaluable in alleviating potential policy frictions.

JEL Classification Numbers: C58, E44, E58

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1.0 Introduction

One of the key messages from the 2007/08 global financial crisis (GFC) has been that with the complexity and many interlinkages of financial systems – as well the tendency for risks to mutate over time – more holistic measures are needed to mitigate systemic risk, minimise contagion effects and strengthen the resilience of the financial system. Consequently, many Central Banks have responded through extensive financial policy reforms. A central part of which has been the introduction and calibration of macroprudential instruments (prudential tools).

Macroprudential tools are designed to buttress the stability of financial systems by addressing the main sources and dimensions of systemic risk (Eichengreen, et al. 2011). While there is a suite of policies available, the reserve requirement ratio (RRR) has emerged as a common prudential instrument for economies that grapple with liquidity management challenges from capital inflows (Brei and Moreno 2018). More specifically, if countries raise their policy rate to control inflation when confronted with economic overheating (high inflation and domestic credit growth) they risk attracting capital inflows which might further stimulate credit growth and push up asset prices, with adverse implications for financial stability (Montoro and Moreno 2011). Raising reserve requirements (RRs) is less likely to attract capital inflows as higher RRs may keep deposit rates stable or even lower them (which is most relevant for foreign investors). In addition to this, RRRs seek to address the financial imbalances related to liquidity pressures by making intermediaries hold a portion of the deposits that they mobilise from the public in non-interest bearing accounts at the monetary authority, this instrument can also constrict aggregate demand by reducing the amount of resources available for lending. Consequently, RRs can be employed in a countercyclical manner to help limit boom-to-bust cycles in financial markets.

Despite the aforementioned benefits of RRRs, it should be noted that there is no one-size-fits-all approach and which tools to use; how to calibrate them and when to deploy them depends on country-specific circumstances as well as how the policymaker views the build-up of vulnerabilities. Additionally, there are costs to using any macroprudential policy tool. For instance, banks may pass the costs of RRs onto their customers by raising interest rates. While this may not appear significant at a systemic level, higher lending rates may deter smaller borrowers which could undermine financial inclusion and stymie investment. At the same time, these actions may push some borrowers to less regulated and unsupervised areas within the financial system which may lead to a build-up of pockets of vulnerabilities. As the foregoing developments can have detrimental effects on the real economy, a thorough understanding of the domestic financial sector, including its structure, characteristics and behaviours would be invaluable in alleviating potential policy frictions from recommended macroprudential instruments. With this in mind, the paper attempts to evaluate: (i) how the RRR has been used as a policy instrument in Trinidad and Tobago; (ii) the effectiveness of the RRR as a countercyclical measure for tightening domestic credit conditions and; (iii) the potential costs and benefits of the RRR as a macroprudential policy instrument for Trinidad and Tobago.

To address these research questions, the remainder of the paper is organised as follows. Section 2 reviews the literature guiding how the efficacy of the RRR as a macroprudential instrument will be conducted. Section 3 presents a historical overview on the RRR in Trinidad and Tobago. Section 4 discusses the data and methodology utilised while Section 5 presents and discusses the results of the model. The paper concludes in Section 6 with some implications for policy.

2.0 Literature Review

Although macroprudential tools are specially equipped for treating systemic risks (Eichengreen, et al. 2011), some tools concentrate solely on addressing the cross-sectional dimension of systemic risk[1] while others are intended to respond to the time dimension[2] (Claessens 2014). There has been growing interest however in instruments that can be used to address both dimensions of systemic risk and still support monetary policy functions (Montoro and Moreno 2011, Claessens 2014, Cordella, et al. 2014). One such tool has been the RRR. It directly reduces the supply of money – which can dampen excessive asset prices or credit growth during upswings in the business cycle (that is, the time dimension of systemic risk). They can also provide emergency liquidity to financial intermediaries in case of a systemic shock – reducing the possibility that financial losses will spread to multiple corners of the financial system (that is, the cross-sectional dimension of systemic risk). Also, in some cases[3] the RRR has been used alongside Central Banks' policy rate or to help improve their monetary policy transmission mechanism. Yet still, despite the many purported benefits of the RRR, in the macroprudential arena no single instrument is a 'silver bullet' (Nicolò, Favara and Ratnovski 2012).

RRs are often criticised by banks for being counterproductive. This was best proven by Fatima and Samreen (2015) where ordinary least squares regressions showed that the RRR had a significant negative impact on Pakistani banks' return on equity and return on assets ratios between 2005 and 2014. Also, by mapping the monetary transmission of a hike in the RRR in a new-Keynesian model for Colombia, Prada (2008) found that to preserve their profitability banks may pass on the costs of higher RRs to borrowers by raising interest rates but, higher lending costs can push borrowers to less regulated and unsupervised areas within the financial system which can fuel systemic risks. With this in mind, to reduce the likelihood of a 'RR tax' on borrowers, several jurisdictions (Table 1) have modified their RR regimes (Lim, Columba, et al. 2011). Lebanon, for instance, occasionally lowered RRs for banks that supported lending to certain sectors the Banque du Liban deemed necessary for providing countercyclical economic stimulus. In 2008, to reduce the 'tax burden' of RRs within their banking system, China adopted a two-tier RR system where-in the RRR for the largest commercial banks were 200 basis points higher than that applied to the smaller commercial banks. Bulgaria has a similar approach as the RRR is higher for banks that experience more rapid loan growth than others. Finally, in some other countries, remunerated RRs are used to partially reduce their 'tax effect'; however, this arrangement has been criticised for distorting or weakening the financial stability objectives of the RRR (Gray 2011) so countries like Peru only remunerate excess reserves.

Most tailored RRRs were designed by taking into consideration country-specific characteristics as well as key microprudential indicators; such as provisioning, loan to value ratios and capital adequacy positions (Guonan, Yan and Liu 2011). However, the timing and calibration of RRRs were dependent on the country's position in the financial cycle as it is common practice to release the limits on RR as the cycle is in a decline but increase the limit in response to excessive credit expansion (Lim, Columba, et al. 2011). Nevertheless, in deciding their optimal RRR strategies, the efficacy of the macroprudential instrument was first evaluated. This was done to trace the link between policy outcomes and objectives, its effects on expectations and the possible scope for regulatory arbitrage (Gadanecz and Jayaram 2015). More specifically, for Tovar et al. (2012), the impulse response functions (IRFs) from a Vector Autoregression (VAR) model showed that a hike in RRRs led to an immediate but modest and short-lived effect on credit growth in several Latin American countries (Brazil, Chile, Colombia, Mexico and Peru) while event analysis proved that RRRs worked best when used alongside other policy measures. Mimir et al. (2012) arrived at a similar conclusion for RRRs in Turkey but, for their study, it was

[1] The cross-sectional dimension of systemic risk deals with how risk is spread across the financial system at a point in time (Smaga 2014). It includes risks to financial stability arising from the instability of particular institutions, size and structure.
[2] The time dimension deals with how aggregate risk in the financial system evolves over the financial cycle (Smaga 2014). It includes risks which don't directly result from activities of a single institution, but from their collective behaviour.
[3] Please see Montoro and Moreno (2011).

a Dynamic Stochastic General Equilibrium (DSGE) model that proved that time-varying RRs reduces the intertemporal distortions created by excessive credit growth.

The literature showed that much of the recent thinking on banks' RRRs focused precisely on their role as a non-capital based, countercyclical macroprudential instrument, aimed at smoothing financial cycles and mitigating the spread of contagion risks from credit or liquidity shocks. Nevertheless, some downsides have been noted in practice. As a result, some jurisdictions have developed differentiated and complex arrangements to re-purpose traditional RRRs into a dynamic instrument aimed at monetary and financial stability. In light of the following, while the literature on RRR regimes is particularly diverse, the paper follows Tovar et al. (2012) to provide a thorough evaluation of the efficacy of this macroprudential instrument for Trinidad and Tobago. Additionally, steps were taken to propose a potential optimal domestic RRR regime.

Table 1
Selected Country Examples of Reserve Requirements Being Used as a Macroprudential Tool

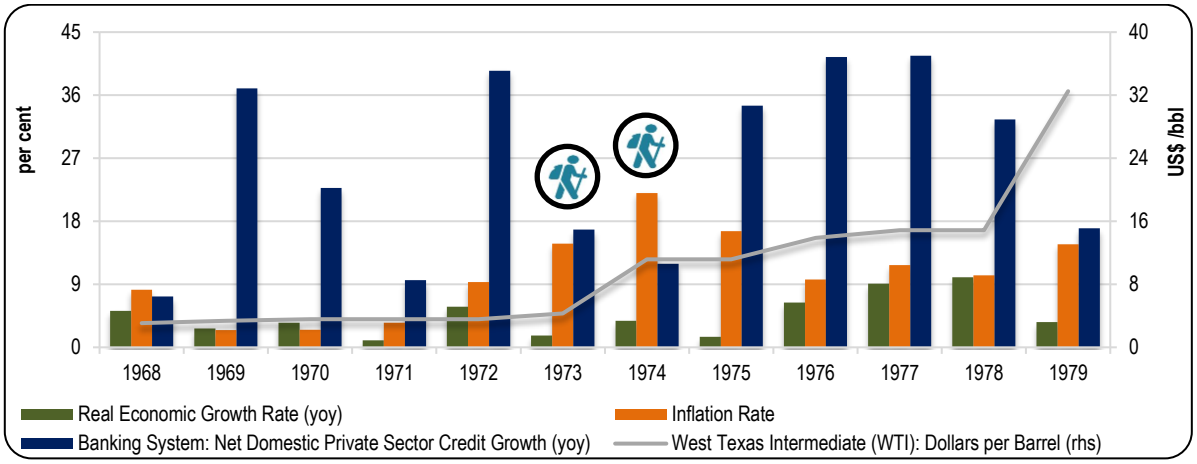
Country	Application of Reserve Requirements
Bulgaria	The Bulgarian National Bank used RRs to help curb rapid credit growth in there economy between 2001 and 2008.
China	China lowered the RRRs for banks' offshore Renminbi deposits and foreign exchange derivatives to zero (in September 2017) to aid there capital flow management.
Indonesia	To improve liquidity in their banking sector (in July 2017), the Bank of Indonesia lowered the RRR by 150 basis points (to 5 per cent) – this was done over a two-week period.
Lebanon	To raise lending in certain sectors of the economy the Banque Du Liban exempted some lenders (in 2017) from having to meet RRs (for instance investment banks were exempted from obligatory RRs on commitments denominated in Lebanese Lira).

Sources: IMF (2017a, 2017b, 2018a, 2018b).

3.0 Stylized Facts

In the early 1960s the economy shifted from a low rate of growth to an economic boom – following the quadrupling of oil prices in 1974. To curb resulting inflationary pressures and the rise in credit growth the Central Bank of Trinidad and Tobago (CBTT) enacted a system of RRs in 1973 (Figure 1) (CBTT 2004).

Figure 1
Selected Macro-financial Indicators (1968 – 1979)



Source: CBTT and Federal Reserve Bank of St. Louis.
Note: rhs stands for right hand side and yoy stands for year-on-year. Also, designates a **hike** in the primary RRR.

When the price of oil fell from US$ 37 per barrel (in 1980), to about US$ 25 per barrel (in 1984), the domestic economy faltered. Trinidad and Tobago experienced; stagnant growth, declining incomes, rising unemployment and fiscal and balance of payments deficits. By the mid-1980s the disequilibrium in the real economy, following concurrent decreases in oil prices, spread to the financial sector – which witnessed the collapse of four non-financial institutions in 1986. In light of the lacklustre performance of the local economy the CBTT sought to maintain confidence in the financial system by easing RRs (Figure 2) and focusing on protecting depositors. But, given the rapidly deteriorating fiscal and external current account positions and the steady depletion of foreign exchange reserves, the country was forced to embark on a programme of structural adjustment as part of an International Monetary Fund (IMF) facility in 1988. This move initiated a holistic programme of economic and financial reforms for Trinidad and Tobago whereby monetary policy was conducted by restricting domestic demand (Figure 3), sterilising the effects of capital inflows[4] and restoring external balances (CBTT 2009).

[4] In Trinidad and Tobago, the structural reforms undertaken in the latter part of the 1980s and the early 1990s improved its status in the global financial market, which encouraged a surge in capital inflows in the first half of the 1990s (Harripaul 1997).

Figure 2
Selected Macro-financial Indicators (1980 – 1989)

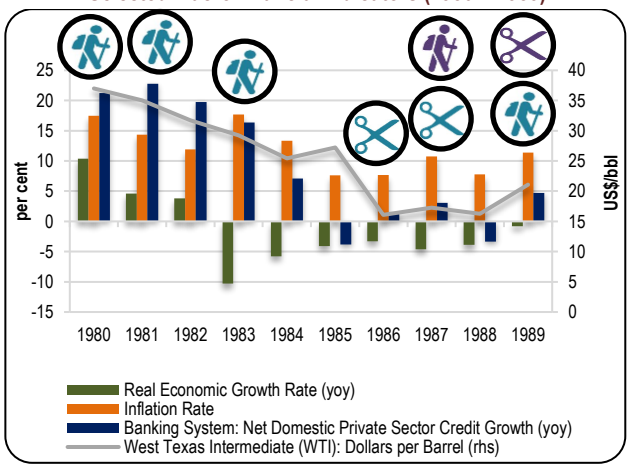
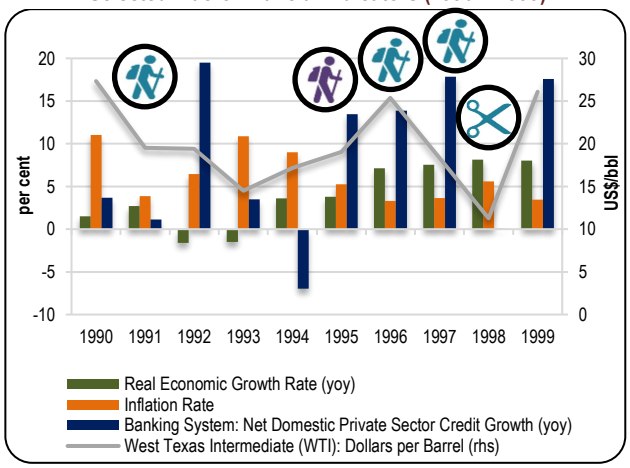


Figure 3
Selected Macro-financial Indicators (1990 – 1999)



Source: CBTT and Federal Reserve Bank of St. Louis.

Note: designates a **hike** in the primary RRR and designates a **cut** in the primary RRR while refers to a **hike** in the secondary RRR and refers to a **cut** in the secondary RRR.

In mid-2002, as part of its plan to de-emphasise direct monetary instruments (Figure 4) and reduce intermediation costs, the CBTT implemented an indirect monetary policy framework based on the use of the Repurchase ('Repo') rate – the rate that the CBTT charges commercial banks for borrowing funds on an overnight basis (CBTT 2009). However, following the negative spill-over effects from the GFC, secondary (Figure 4) and primary (Figure 5) RRs were revisited to help mop up excess liquidity and curb escalating inflation. As the economic recovery effort gathered pace, in keeping with the CBTT's movement towards more market-based measures, the secondary RRR was removed in the latter half of 2018 (CBTT 2018).

Figure 4
Selected Macro-financial Indicators (2000 – 2009)

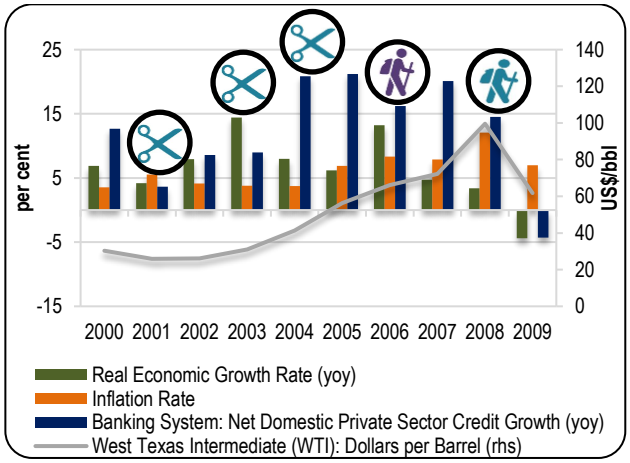
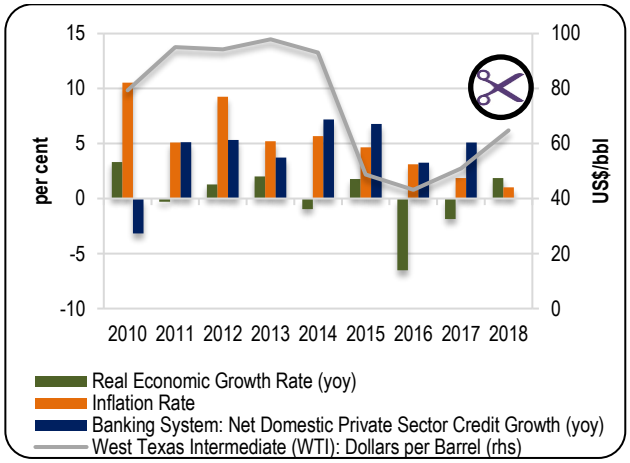


Figure 5
Selected Macro-financial Indicators (2010 – 2018)



Source: CBTT, Federal Reserve Bank of St. Louis.

Note: designates a **hike** in the primary RRR and designates a **cut** in the primary RRR while refers to a **hike** in the secondary RRR and refers to a **cut** in the secondary RRR.

4.0 Data and Methodology

For macroprudential instruments to be effectively applied, they must have an immediate binding effect. With this in mind, while Trinidad and Tobago employs three direct monetary instruments (the primary RRR, the secondary RRR and the special liquidity facility[5]); the empirical analysis focused on evaluating the primary and secondary RRR's effectiveness at constricting credit growth. Following Tovar et al. (2012), this was completed through VAR and event analysis.

4.1 Data

Considering the literature, quarterly data for the following indicators (Table 2) was used to evaluate the efficacy of RRs as a risk-reducing prudential instrument for Trinidad and Tobago. This focused on; (i) the specific features of the domestic macro-financial environment, and (ii) monetary instruments from June 1995 to December 2018[6].

Table 2 Dataset

Category	Variable	Definition	Reasons for Inclusion
The Macro-Financial Environment	**Banking System: Money Supply (MSUP)**	The total amount of money in circulation or in existence in a country.	Money supply growth can result in a rise in loans as well as inflation; at the same time policy response enacted to reduce inflation may reduce loan demand.
	Commercial Banks: Credit to the Private Sector (PCREDIT)	The financial resources or debt securities provided to the private sector with a claim for repayment.	To evaluate if RRs can be used to contain credit growth.
	Commercial Banks: Interest Rate Spread (IRS)	The difference between the commercial banks' weighted average loan rate and weighted average deposit rate.	The channel through which changes in RRs should constrict aggregate demand.
	Inflation rate (INFL)	Refers to the general increase in prices.	Inflation can undermine financial activity by inducing uncertainty.
Monetary Instruments	**Commercial Banks: Primary Reserve Requirement Ratio (PRES)**	In accordance with the Central Bank Act (1964), all licensed financial institutions are required to maintain a fraction of their prescribed liabilities in a non-interest earning account at the CBTT.	The principal instruments used by the CBTT to influence commercial banks' RRs.
	Commercial Banks: Secondary Reserve Requirement Ratio (SRES)	In accordance with the Central Bank Act (1964), commercial banks may be required to maintain a certain per cent of their prescribed liabilities in an interest-earning account at the CBTT.	

Source: Authors, CBTT, IMF (2008), Gray (2011) Carlson (2012), Tovar, Garcia-Escribano and Martin (2012), Brown, Haas and Sokolov (2013), Cordella, et al. (2014), ECB (2015), FDIC (2015), Português and Licha (2015) and CFGS (2017).
Note: In the econometric models, all variables (but the RRRs and PCREDIT) are expressed in logs[7].

[5] This facility invites commercial banks to deposit a proportion of their prescribed liabilities (total demand, savings and time deposits, short-term credit instruments with a maturity up to and including one year and all fund raising instruments maturing within or beyond one year of the reporting date) in an interest bearing account at the CBTT. Given that this option is based on moral suasion (when appeals to morality are used to influence or change behavior), its usefulness as a macroprudential instrument may be limited.
[6] The time period for the analyses was dependent on data availability.
[7] Log transformations drastically straightened out the data and generally improve model results (Joseph , et al. 2010).

4.2 Methodology

4.2.1 *VAR model*

Following Tovar, et al. (2012), the dynamic feedback mechanisms between RRs and the macro-financial system were estimated using a standard reduced form VAR (Equation 1). This framework provides a systematic way to capture information from the inter-relationships observed across individual time series. More importantly VARs allow for IRFs – systems that trace the effects of a one-time shock (a one unit increase) in an independent variable on the future values of the dependent variable. The choice of variables was guided by traditional relationships between RRs, money supply and price stability. That is, by requiring commercial banks to hold a portion of the deposits they mobilise from the public in non-interest bearing accounts at the Central Bank, RRs constrict aggregate demand (and therefore inflation) by reducing the amount of resources available for lending (Português and Licha 2015). RRs can also affect credit demand, as banks may pass on this 'reserves tax' to borrowers by raising interest rates.

Equation 1: VAR model

$$\boldsymbol{Z y_t = W + \Gamma(L) y_{t-1} + \varepsilon_t}$$

Where:

- y_t is the vector of n endogenous variables (that is, $PRES, SRES, PCREDIT, MSUP, IRS$ and $INFL$).
- Z is a $n \times n$ matrix of contemporaneous coefficients of y_t.
- W denotes the $n \times 1$ vector of constant.
- $\Gamma(L)$ is the $n \times n$ matrix of lag operator polynomials of the endogenous variables.
- ε_t is the $n \times 1$ vector of white noise processes (that is, $\varepsilon_t \backsim N(0, \Omega)$).

Although Tovar, et al. (2012) and Português and Licha (2015) adopted the Choleski decomposition to evaluate the response of the macro-financial system to an increase in RRRs, this paper makes use of accumulated generalised IRFs[8] to; (i) treat the spikiness in traditional impulse response functions (which follows when the endogenous variables are not stationary at level[9]) and (ii) avoid the criticism of 'manipulating' IRF results as, unlike with Choleski IRFs, generalised IRFs are insensitive to variable ordering.

4.2.2 *Event Analysis*

Event analysis was used to trace how a change in RRs influenced commercial banks' private sector credit (year-on-year growth). The event analysis was conducted over a five year period. This allowed for evaluating the response of commercial banks' private sector credit (year-on-year growth) before, during and after an increase in RRs.

[8] Generalised IRFs includes all observed patterns of correlation amongst variables without imposing restrictions which generates unique responses following a shock to a variable (Pesaran 1997).
[9] See Appendix A1.

5.0 Results and Discussion

This paper incorporates stationary variables into the models. Stationary variables evade the problem of spurious regression and enable hypothesis testing to be performed using the standard t and f distributions. All indicators were differenced to the level that was recommended by at least two of the three (that is the Augmented-Dickey Fuller, Phillips-Perron and Kwiatkowski–Phillips–Schmidt–Shin) unit root tests. A number of robustness checks were also performed to ensure that the models were statistically sound (Appendix A2).

Econometric results (Figure 6) show that a one-time hike (specifically a 100 basis point increase) in the primary RRR, over a two-year period, squeezes money out from the financial system. As there is less money chasing goods and services inflation slows; however, to counteract the increase in RRs banks widen the interest rate margin making borrowing less attractive. Credit growth contracts but, as in Tovar et al. (2012) the slowdown is modest and appears to dissipate over time (credit growth shows signs of improvement into the fifth quarter of the forecast horizon). On this basis, from a practical policy perspective, results showed that the primary RRR can help address the pro-cyclicality of the domestic credit cycle. The same cannot be said about the secondary RRR (Figure 9) where the IRFs indicated that a rise (a 100 basis point increase) in these RRs will increase credit growth. At first glance this may seem alarming but this development is consistent with observations made by Gray (2011), that is, "*remuneration of reserves reduces or eliminates a distortionary tax and reduces incentives on the financial system to avoid reservable liabilities, but will also weaken or eliminate the impact of RR.*"

Figure 6
Impact of an Increase in the Primary Reserve Requirement Ratio on Macro-Financial Activity

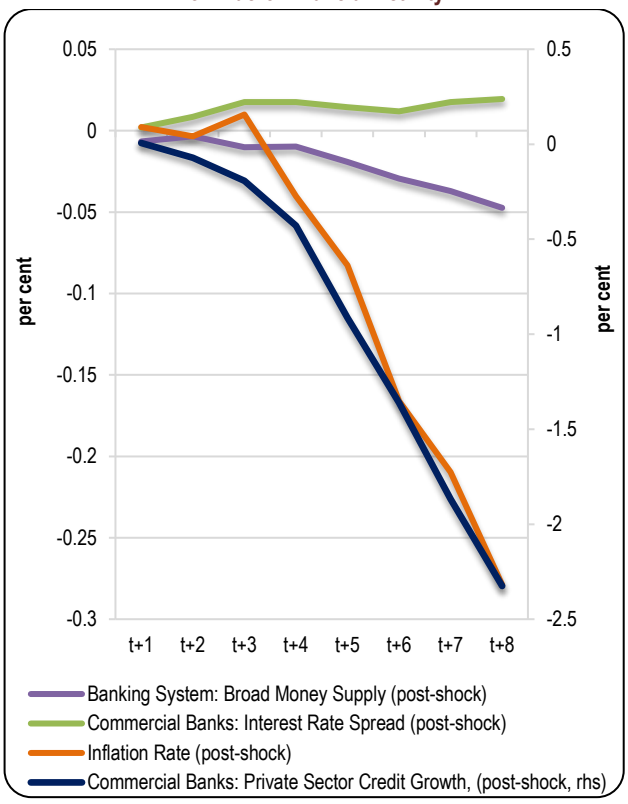
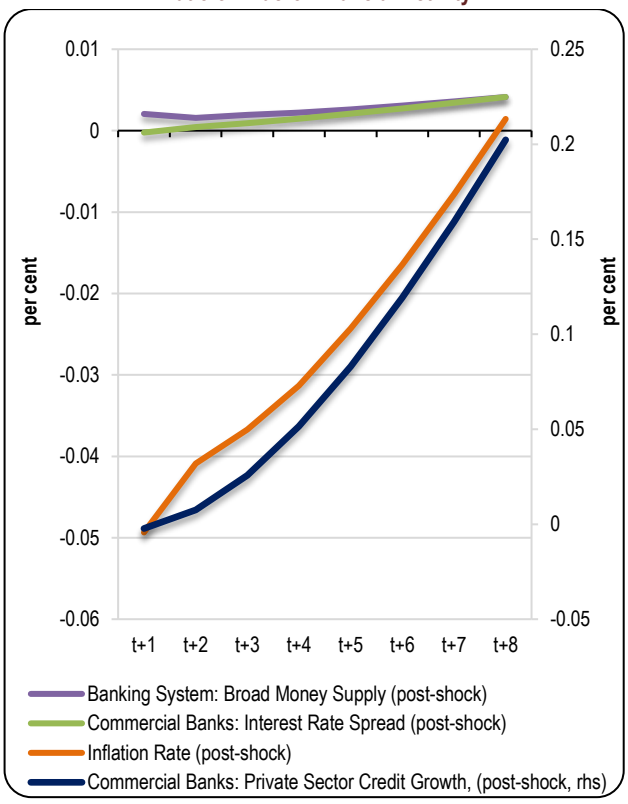


Figure 7
Impact of an Increase in the Secondary Reserve Requirement Ratio on Macro-Financial Activity



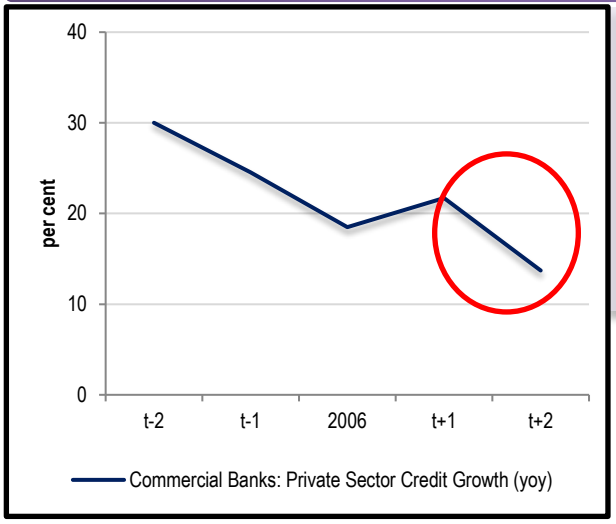
Source: Authors.

Finally, from Table 3 credit growth appears to be high in the periods preceding the increase in RRs, however following the hike, private credit growth dissipates. Notably, the primary RRR is shown to immediately dampen

credit growth when compared to the secondary RRR. The delayed response of the secondary RRR is in line with its distortionary impact on private sector credit growth that was observed in the IRF analysis.

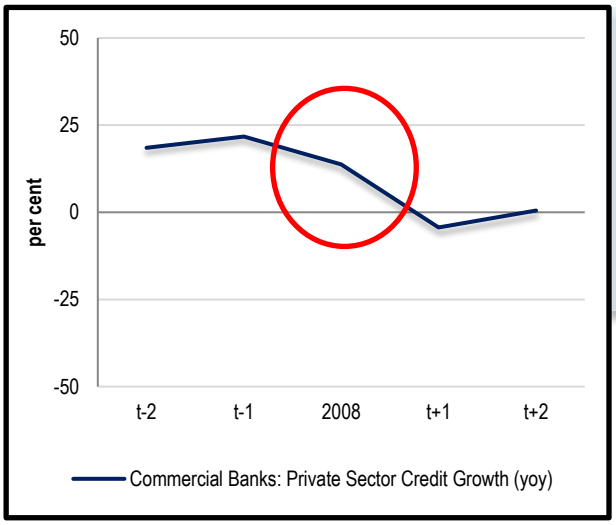
Table 3
Event Analysis - Results

Hike in Secondary Reserve Requirements in 2006



In 2006, to help address excess liquidity concerns, commercial banks were required to hold a secondary RR of 2 per cent of their prescribed liabilities.

Hike in Primary Reserve Requirements in 2008



The primary RRs applicable to commercial banks was raised in steady increments from 11 per cent (in December 2007) to 17 per cent (in December 2008) to increase liquidity absorption, curb inflation and credit demand.

Source: Authors.
Note: The **red** circle highlights the period of decline in private sector credit growth following a hike in the RRR.

6.0 Policy and Recommendations and Conclusion

In exploring the efficacy of RRs as a risk-reducing prudential instrument for the domestic economy, this paper sought to examine its ability to contain credit growth. IRFs revealed that an increase in the primary RRR will subdue aggregate demand and unsustainable credit growth. However, secondary RRs' ability to counter excessive credit growth appears limited. A development consistent with observations in Gray (2011) – that is, remunerated reserves weaken or eliminate the impact of the RRR. With this in mind, primary RRs could form part of the Trinidad and Tobago toolkit for curbing excessive credit growth.

Notably, country experiences indicate that RRs are not meant to be a 'one-size-fits-all' instrument for systemic risks (Cordella, et al. 2014). This tool should therefore, be used alongside other indicators and expert judgement to reduce the risk of over-looking other channels through which financial instability may impair macroeconomic stability. Moreover, international best practices advise that changes in the RRR be guided by some 'optimal level of required reserves' (Tovar, et al. 2012). This strategy centres on making rating decisions based on the optimal response of credit growth to the underlying macro-financial conditions. With this intention, studies like Walsh (2011) and Glocker and Towbin (2012) opted for DSGEs, to determine the equilibrium level of required reserves given the optimal choices of economic agents. However, this intention requires more granular and micro data reflective of all sectors in the economy such as consumption and firm level data. Domestically, this type of data is sparse which may require the use of proxies or exclusions, reducing the reliability of DSGE modelling. Therefore, to improve the authenticity of results and widen the knowledge gained, future research is called for as rating decisions without knowledge of the 'optimal level of required reserves' could weaken the impact of RRRs.

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Appendix

A1: Unit root test

This paper incorporates stationary variables in all models. Stationarity evades the problem of spurious regression and enable hypothesis testing to be performed using the standard *t* and *F* distributions. Variables were differenced to the level that was recommended by at least two of the three traditional unit root tests.

Table 4
Unit Root Test Results

Variables	Augmented Dickey Fuller Unit test		Phillips Perron test		Kwiatkowski-Phillips-Schmidt-Shin test	
	Test statistic	Level	Test statistic	Level	Test statistic	Level
Banking System: Money Supply (MSUP)	-11.0	I(1)	-11.1	I(1)	0.2	I(2)
Commercial Banks: Credit to the Private Sector (PCREDIT)	-7.1	I(1)	-7.8	I(1)	0.3	I(0)
Commercial Banks: Interest Rate Spread (IRS)	-8.6	I(1)	-8.6	I(1)	0.3	I(0)
Commercial Banks: Primary Reserve Requirement Ratio (PRES) *	-9.3	I(1)	-9.3	I(1)	0.2	I(1)
Commercial Banks: Secondary Reserve Requirement Ratio (SRES) *	-		-8.7	I(1)	0.3	I(1)
Inflation rate (INFL)		I(1)	-3.5	I(0)	0.3	I(0)

Source: Authors and Eviews.

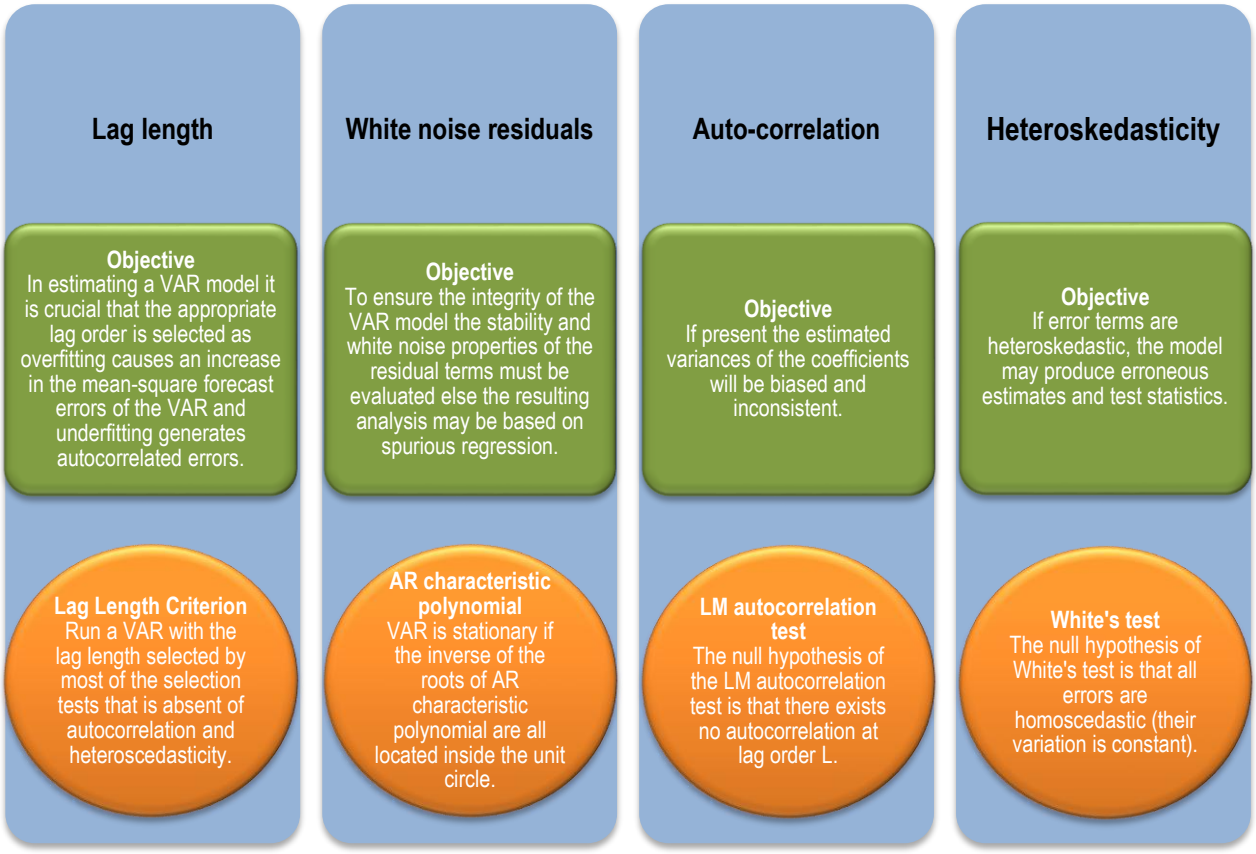
Notes: All 'Test Statistics' were rejected at the 5 per cent level of significance.

* Despite the presence of non-stationarity no adjustments were made to the primary and secondary RRR as the observations in these variables assume the same value for several periods at a time. In other words, first differencing these variables will produce a significant number of null (0) observations.

A2: VAR Model specification tests

Two separate VARs were used in this paper to ensure that study looked at the primary and secondary RRR's individual impact on credit growth.

Figure 8
VAR Statistical Adequacy Checks



Source: Authors' summary and (Lütkepohl 2007).
Notes: Green rectangles discuss the objective of the specification test; Orange ovals describe the test statistic or index for the specification test.

Table 5
VAR Lag Length Selection Tests of the PRES VAR

Lag	LR test statistic	Final prediction error	Akaike information critetion	Schwarz information criterion	Hannan-Quinn information criterion
0	-13.4	NA	0.0	0.5	0.7
1	150.7	300.8	**0.0**	**-3.4**	**-2.4**
2	166.6	26.9	0.0	-3.1	-1.4
3	185.9	30.0	0.0	-2.9	-0.4
4	214.8	41.0	0.0	-3.1	0.3
5	250.3	**45.4**	0.0	-3.3	0.8

Source: Authors and Eviews.
Note: Bold cells refer to the lag length chosen by the lag length selection criterion. Also, in estimating a VAR model it is crucial that the appropriate lag order is selected. Given that the literature suggests different criteria for estimating the maximum lag lengths a common way to overcome this problem, is to run a VAR with the lag length (selected by most of the selections tests) that is absent of autocorrelation and heteroscedasticity (Lutkepohl, 2005). As a result, while Table 7 indicates that a lag length of 1 was appropriate the paper used a lag length of 5 for the PRES VAR as the PRES VAR with a lag length of 1 produced spurious results.

Table 6

VAR Lag Length Selection Tests of the SRES VAR

Lag	LR test statistic	Final prediction error	Akaike information critetion	Schwarz information criterion	Hannan-Quinn information criterion
0	23.1	NA	0.0	-0.5	-0.4
1	186.7	**298.4**	**0.0**	**-4.6**	**-3.6**
2	207.3	34.4	0.0	-4.5	-2.7

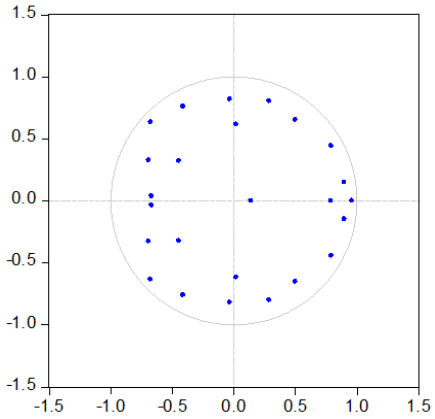
Source: Authors and Eviews.

Note: Bold cells refer to the lag length chosen by the lag length selection criterion. Also, while Table 8 indicates that a lag length of 1 was appropriate the paper used a lag length of 2 for the SRES VAR as the SRES VAR with a lag length of 1 produced spurious results.

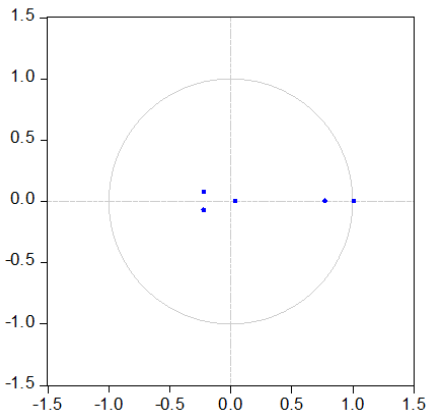
Figure 11

VAR White Noise Residuals

Inverse Roots of AR Characteristic Polynomial Roots Graph for the PRES VAR



Inverse Roots of AR Characteristic Polynomial Roots Graph for the SRES VAR



Source: Authors.

Table 7

Auto-correlation VAR results

	Lag	LM-Stat	Prob
PRES VAR	**1**	21.4	0.7
	2	24.3	0.5
	3	39.5	0.0
	4	19.7	0.8
	5	13.5	1.0
	6	25.2	0.5
	7	37.5	0.1
	8	19.6	0.8
	9	19.9	0.8
	10	31.4	0.2
	11	16.9	0.9
	12	22.7	0.6
SRES VAR	**1**	14.1	1.0
	2	32.1	0.2
	3	32.8	0.1
	4	31.7	0.2
	5	22.5	0.6
	6	14.7	0.9

	7	41.4	0.0
	8	24.8	0.5
	9	30.0	0.2
	10	30.3	0.2
	11	36.3	0.1
	12	22.7	0.6

Source: Authors and Eviews.

Note: Bold cells refer to no autocorrelation for the associated probability of greater than 5 per cent.

Table 8

Heteroskedasticity VAR results

Model	Chi-sq	P-value	Decision
PRES VAR	784.5	0.18	Do not reject H^0
SRES VAR	193.0	0.01	Do not reject H^0

Source: Authors and Eviews.