An Empirical Analysis of Asymmetric Responses of Sri Lankan Commercial Banks to Monetary Policy

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Abstract

This study investigates how Sri Lankan commercial banks respond to countercyclical monetary policy over the post economic liberation 1990:06-2011:11period when the latest data available. First, the Perron's endogenous unit root test function with the intercept, slope, and trend were specified and estimated to test the hypothesis that the Sri Lankan commercial bank lending-Central Bank discount rate spread has a unit root. The results of this test suggest that the Sri Lankan lending-discount rate spread followed a stationary trend process with a break date beginning in July 2006. Secondly, the threshold autoregressive (TAR) and the momentum threshold autoregressive (M-TAR) models are estimated. The Akaike information Criterion (AIC) and the Schwarz information criterion (SIC) indicate that the M-TAR model fits the sample data better than the TAR model. Therefore, the M-TAR model's specification is utilized for further investigation in this study. The empirical findings suggest the asymmetrical response of Sri Lankan commercial banks to countercyclical monetary policy and monetary authority successfully utilizes monetary policy to achieve its objectives. Additionally, the results can interpreted as indications that the Sri Lankan commercial banks exhibit predatory pricing behavior, which is consistent with their monopolistic/oligopolistic operating environment. The estimation results of the Asymmetric Error Correction Model reveal bi-directional Granger causality between the Sri Lankan commercial banks' lending rate and the Central Bank's discount rate. Finally, the estimation results also describe the length of the impact lag of the Sri Lankan countercyclical monetary policy.

Introduction

Commercial banks are an integral part of the monetary policy transmission mechanism. These intermediaries would derive their interest income from the spread between the lending rate charged to borrowers and the cost of funds. Their cost of funds is in turn affected by the monetary policy. Economic theory has articulated that if the spread is high, it would reflect inefficiency and/or lack of competition, indicating that these institutions would not be able to fulfill their expected role in promoting economic growth and social progress. Furthermore, the commercial banks' behavior in setting their lending and deposit rates significantly influences the effectiveness of the monetary authority in its monetary policymaking. [3]

Several studies have found asymmetric cointegration between bank lending and deposit rates. For instance, Nguyen et al. (2008) documented similar asymmetries in Mexican lending and deposit rates. Nguyen and Islam (2010) reported asymmetries in the Thai bank lending and deposit rates. Nguyen et al. (2010) found asymmetries in the Bangladeshi lending deposit rates. Chang and Su (2010) reported nonlinear cointegration between the lending and the deposit rate in ten Eastern European countries. Lately, Haug and Basher (2011) found

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[3] Sellon (2002) provides a nice overview of the impact of the changing U.S. financial system on the interest rate channel for monetary policy transmission.

nonlinear cointegration in the purchasing power parity relationships for Canada, Japan, Switzerland, the U.K., Belgium, France, Germany, Italy and Netherlands.

Moreover, there are three main theoretical explanations for the commercial bank interest rate asymmetries: the bank concentration hypothesis, the consumer characteristic hypothesis, and the consumer reaction hypothesis. The bank concentration hypothesis posits that banks in more concentrated markets are slower to adjust deposit rates upward and faster to adjust them downward, while exhibiting the opposite behavior regarding the lending rates (Neumark and Sharpe, 1992; Hannan and Berger, 1991). The consumer characteristic hypothesis asserts that the greater the proportion of unsophisticated consumers relative to sophisticated consumers in the market, together with the potential search-and-switching costs, the greater the banks' ability to adjust interest rates to their advantage (Calem and Mester, 1995; Hutchison, 1995; Rosen, 2002).

However, the asymmetric adjustment in lending rates may actually benefit consumers. As articulated by Stiglitz and Weiss (1981), the presence of asymmetric information may create an adverse selection problem in lending markets such that higher interest rates will tend to attract riskier borrowers. Therefore, banks would be reluctant to raise lending rates, even if the market rates rise. The expected cost to the banks of not raising the lending rates, when their marginal cost of fund increases, will be offset by the benefits of not encouraging the higher-risk consumers to borrow. [4]

As to the relative effectiveness of fiscal and monetary policies, since the late 1930s, Keynesian fiscal policy has played a critical role in macroeconomic management in market economies. Beginning in the 1960s, changes in international economic conditions resulted in persistently large government budget deficits in economies around the world. As articulated by Mishkin (1995, p. 3), partly because of concern over persistent budget shortfalls including large public debts and partly because of doubt about the political system's ability to utilize the fiscal policy instruments in a timely and effective manner to achieve the desirable stabilization outcome, the fiscal policy has thus lost its luster. Consequently, the stabilization of output and inflation has been left largely to monetary policy.

Sri Lanka's Banking Sector

As pointed out by Perera, et al. (2012) based on total banking sector assets to GDP ratio, shares of government and private borrowings, Sri Lankan banking industry plays a significant economic role in Sri Lanka and is highly concentrated and dominated by the two large domestic banks. The three largest banks account for 64 percent of the total banking sector assets in Sri Lanka. The Sri Lankan domestic banks dominate the industry because most foreign banks have centered their operations in the major cities and operate limited branch networks and held approximately 7 percent of Sri Lanka's banking sector assets.

With regard to supervision, Sri Lanka's financial sector is regulated by multiple agencies with bank regulation under the direct control of the Central Bank of Sri Lanka. A two-tier interest rate structure existed: the market rate and a subsidized rate used to channel credit to priority sectors. Foreign direct investments were restricted and discouraged. These excessive controls resulted in distorted market mechanism and led to a stagnated financial system.

Even though Sri Lanka's financial sector reforms started with the introduction of liberalized economic policies in 1977, the Banking Act No. 30 of 1988 was the impetus for transforming the Sri Lankan banking sector. The Central Bank of Sri Lanka (CBSL) was

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[4] Scholnick (1999) provides the survey on these three types of explanations for commercial banks' interest rate asymmetries in the literature.

given wider powers in terms of the Control of Finance Companies Act No. 78 of 1988 to regulate finance companies and establish a new department for non-bank financial institution supervision. However, the nation's banking industry was truly liberated by a series of new Acts in 1990 which broadened the institutional infrastructure of the financial system. That allowed the establishment of merchant banks in 1990. Additionally, to strengthen the debt recovery process of commercial banks, specific legislation was introduced: Debt Recovery (Special Provision) Act No. 2 of 1990, Mortgage (Amendment) Act No. 3 of1990 and Recovery of Loans by Banks (Special Provisions) Act No. 4 of 1990.

Perera, et al. (2012) also reported that new capital adequacy standards based on Basel guidelines were introduced for all Sri Lankan commercial banks in 1993. As a result, the then capital-strapped two state-owned banks were recapitalized to restore their financial viability. The state-owned National Development Bank's capital was also enhanced through a public share issue. Since 1995, commercial banks were allowed to obtain foreign loans without CBSL's approval. The government also placed savings banks and development banks under CBSL's supervision to streamline the regulatory function.

Additionally, Perera, et al. (2012) posited that to improve the financial viability of the two state-owned commercial banks, an agreement was signed in 1998 between the government and the Bank of Ceylon and People's Bank. The objectives were to improve these banks' profitability, efficiency and financial soundness by commercializing and consolidating operations, increasing productivity, reducing costs, rationalizing staff levels and branch network, increasing loan recoveries and improving risk management. Since then, the government has continuously monitored the quarterly financial performance of these banks.

Also according to Perera, et al. (2012), prudential norms hitherto applicable to the domestic banking operations of commercial banks were extended to their off-shore banking units in 2002. Furthermore, to streamline the deregulatory process further, a separate Financial Sector Reform Committee (FSRC) (consisting of members from the government, the CBSL and banking and other financial institutions) was formed in 2003. This committee is striving to remove undue political influence in banking transactions and strengthen the legal, accounting, regulatory frameworks to create a market-oriented financial system.

Across the spectrum of changes that took place in the country in the last twenty years, there is some debate as to whether the Sri Lankan banking industry can be characterized as highly oligopolistic and more recently as highly competitive. In light of the above mentioned banking structure changes since the 1990s, Sri Lanka is of particular interest for empirical research on how commercial banks respond to countercyclical monetary policy. This paper empirically investigates how the Sri Lankan commercial banks respond to countercyclical monetary policy actions as reflected in changes in the Central Bank's discount rates and hence the spread between the commercial banks' lending and the Central Bank discount rates. To this end, the study first endogenously determines whether the commercial banks' lending and Central Banks' discount rate spread experienced a structural break over the period 1990:06-2011:11. Second, the question of how commercial banks respond to countercyclical monetary policy actions as reflected in symmetric/asymmetric adjustments to the long-term threshold of the spread is investigated. Finally, if the asymmetries exist, do such asymmetries reveal collusive or competitive behavior by the Sri Lankan commercial banks?

The Data and Descriptive Statistics

One of the great, if not the greatest, challenges in empirical studies of developing and emerging economies is the availability of data. This study uses monthly data on the State Bank of Sri-Lanka discount rate to capture the Central Bank countercyclical monetary policy measures and the commercial banks' lending rates since the banking has been truly liberated:

1990:06 to 2011:11 where latest data is available. The data is collected from the International Financial Statistics, published by the International Monetary Fund (IMF). The monthly lending rates and the Central Bank discount rates are denoted by LR_t and DR_t, respectively. The difference between the lending rate and the discount rate is defined as the landing and discount rate spread, or the spread, and is denoted by SP_t.
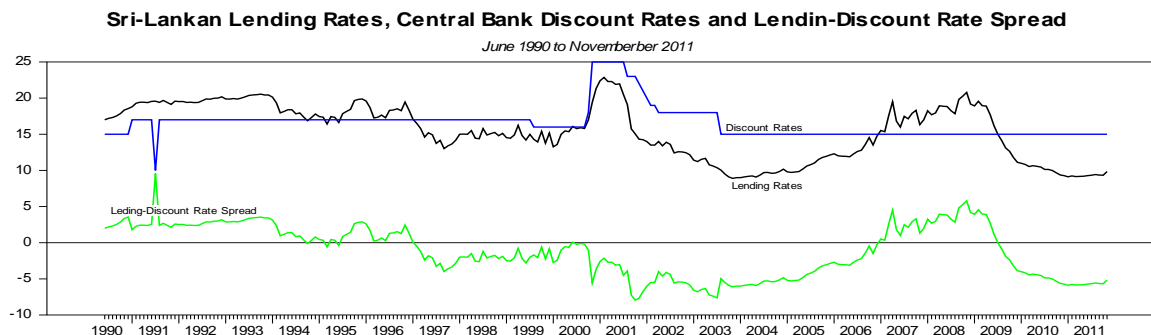

Figure 1

Figure 1 displays the behavior of the respective lending and Central Bank discount rates over the sample period. As figure 1 suggests, the Sri Lankan lending oscillated around a downward trend from the beginning of the sample to the late 1999, then fluctuated around a fairly steep upward trend until the middle of 2001, and then oscillated around a steep downward trend until the early 2005. The Sri Lankan lending rate then gradually climbed to another peak peak in the early 2009 and then slowly descended until the end of the sample period. The Central Bank discount rate made a steep jump in the late 1990 and then was held constant until the middle of 1991. It then dropped and recovered sharply in the middle 0f 1991. The Central Bank discount rate was again held constant the middle of 1991 the late 2000. It increased sharply reaching the peak the early 2001and then declined sharply until the end of 2001. It remained constant until the middle of 2003, took a sharp drop and ten maintained at about 15 percent for the remainder of the sample period.

The mean lending rate during the sample period was 15.36 percent, and ranged from 8.90 percent to 22.86 percent with the standard error being 3.78 percent. The mean Central Bank discount rate over the same period was 16.57 percent, and ranged from 10.00 percent to 25.00 percent with the standard error being 2.16 percent. The mean lending-discount rate spread during the sample period was -1.17 percent, and ranged from -7.94 percent to 9.58 percent with the standard error being 3.51 percent. Moreover, as suggested by Figure 1, it is likely that the Sri Lankan lending-discount rate spread experienced a structural shift over the sample period.

Methodology:
Stationarity and Structural Shift

As mentioned, the Sri Lankan banking sector have gone through many changes; therefore, it is possible that the lending-Central Bank discount rate relationship might experience structural breaks, as reflected in the shift in their spread, over the sample period. To discern this possibility, this study followed Perron's (1997) procedure to specify and estimate the following endogenous unit root test function with the intercept, slope, and the trend dummies to test the hypothesis that the Sri Lankan lending rate and deposit rate have experienced structural shifts over the sample period. The equation's specification and the estimation results are reported in Table 1 in Appendix I

The empirical results of these tests suggest that the Sri Lankan lending-Central Bank discount rate spread followed a stationary trend process with a break date of July 2006. However, the test statistics failed to support this suggested structural shift at any conventional levels of significance. To reevaluate the strong suggestion of the data in Figure 1, the Chow test was performed and the result statistically confirmed the structural shift at all conventional significant levels.

Tests for Nonlinearity

As to the nonlinearity, Breitung (2001, p. 331) articulated that economic theory suggests in many cases a nonlinear relationship between economic and financial time series. This implies that we have to test for the nonlinear cointegration. The analysis of the behaviors of and the cointegration between the Sri Lankan lending and deposit rates as well as their spread should be done next if the results of these tests are statistically significant. In this study, we use Breitung's nonparametric procedure to test for nonlinear cointegration.

Breitung's nonparametric testing procedure consists of the cointegration test, known as the rank test for cointegration, and the nonlinearity test, referred to as the score statistic for a rank test of neglected nonlinear cointegration. Following Breitung (2001), this study defines a ranked series as $R_T(LR_t)$ [of LR_t among $LR_1,...,LR_T$] and $R_T(DR_t)$ accordingly. Breitung's two-sided rank test statistic, testing for cointegration, denoted by Ξ_T^*, is calculated as follows:

$$\Xi_T^* = T^{-3} \sum_{i=1}^{T} (r_i^R)^2 / (\sigma_{\Delta r}^2) \tag{1}$$

where T is the sample size, r_i^R is the least squares residual from a regression of $R_T(LR_t)$ on $R_T(DR_t)$. As pointed out by Haug and Basher (2011, p. 187), $\sigma_{\Delta r}^2$ is the variance of Δr_i^R, which is included to adjust for the potential correlation between the two time series LR_t and DR_t. The critical values for this rank test are given in Table 1 in Breitung (2001, p. 334).

Given the positive result of the rank test, the first step in calculating Breitung's score statistic for a rank test of neglected nonlinear cointegration (testing for nonlinearity) is to regress the Sri Lankan lending rate, LR_t, on a constant, the deposit rate, DR_t, the ranked series of the deposit rate, $R_T(DR_t)$, and the disturbance ζ_t.

$$LR_t = \delta_0 + \delta_1 DR_t + R_t^*(DR_i) + \zeta_t \tag{2}$$

where $\delta_0 + \delta_1 DR_t$ is the linear part. Under the null hypothesis, $R_t^*(DR_i) = 0$ implying that LR_t and DR_t are linearly cointegrated. Under the alternate hypothesis, $R_t^*(DR_i) \neq 0$ implying that LR_t and DR_t are nonlinearly cointegrated. The score test statistic is given by $T.R^2$; where R^2 is the coefficient of determination of the regression from regressing ζ_t on a constant, the deposit rate, DR_t, the ranked series of the deposit rate, $R_T(DR_t)$, and a disturbance term. T is again the sample size. As articulated by Breitung (2001, p. 337), under the null hypothesis of linear cointegration, the score statistic for a rank test of neglected nonlinear cointegration is asymptotically Chi-Square distributed with one degree of freedom.

Specifications of TAR and MTAR Models

If the results of Breitung's nonparametric tests are positive, this study follows Thompson's (2006) modeling approach by regressing the Sri-Lankan lending-Central Bank discount rate

spread on a constant, linear trend, and an intercept dummy (with values of zero prior to July 2006 and values of one for July 2006 and thereafter), and the saved the residuals, denoted by $\hat{\varepsilon}_t$, are used to estimate the following threshold autoregressive (TAR) and the momentum threshold autoregressive (M-TAR) models. The estimation results are summarized in Table 2 in Appendix II.

$$\Delta\hat{\varepsilon}_t = I_t\rho_1\hat{\varepsilon}_{t-1} + (1-I_t)\rho_2\hat{\varepsilon}_{t-1} + \sum_{i=1}^{p}\alpha_i\Delta\hat{\varepsilon}_{t-p} + \hat{u}_t \qquad (3)$$

where $\hat{u}_t \sim i.i.d.(0,\sigma^2)$, and the lagged values of $\Delta\hat{\varepsilon}_t$ are meant to yield uncorrelated residuals. As defined by Enders and Granger (1998), the Heaviside indicator function for the TAR specification is given as:

$$I_t = \begin{cases} 1 & \text{if } \hat{\varepsilon}_{t-1} \geq \tau \\ 0 & \text{if } \hat{\varepsilon}_{t-1} < \tau \end{cases} \qquad (4)$$

while indicator function for the M-TAR specification is stated as:

$$I_t = \begin{cases} 1 & \text{if } \Delta\hat{\varepsilon}_{t-1} \geq \tau \\ 0 & \text{if } \Delta\hat{\varepsilon}_{t-1} < \tau \end{cases} \qquad (5)$$

The threshold value, τ, is endogenously determined using the Chan (1993) procedure, which obtains τ by minimizing the sum of squared residuals after sorting the estimated residuals in ascending order, and eliminating 15 percent of the largest and smallest values. The elimination of the largest and the smallest values is to assure that the $\hat{\varepsilon}_t$ series crosses through the threshold in the sample period. Throughout this study, the included lags are selected by the statistical significances of their estimated coefficients as determined by the *t-statistics*. The model selection for further empirical investigation is based on their fitness to the data as measured by the Akaike's information criterion (Aic) and the Schwarz information criteria (Sic) from the empirical estimations.

The threshold autoregressive model (TAR) allows the degree of autoregressive decay to depend on the state of the lending-deposit rate spread. For instance, if the autoregressive decay is fast when the spread is above trend and slow when the spread is below trend, troughs will be more persistent than peaks. Likewise, if the autoregressive decay is slow when the spread is above trend and fast when the spread is below trend, peaks will be more persistent than troughs. The momentum threshold autoregressive model (MTAR) allows the lending-deposit rate spread to display differing amounts of autoregressive decay depending on whether the spread is increasing or decreasing. The MTAR model is also valuable when the adjustment is believed to exhibit more momentum in one direction than the other. For both the TAR and MTAR models, the null hypothesis is that the lending-deposit rate spread contains a unit root, while the alternative hypothesis is stationarity with asymmetric adjustment.

Empirical Results
Breitung Tests Results
Empirical calculations indicate that Breitung's nonparametric rank tests and score test are $3.7510e^{-14}$, which fails to reject the null hypothesis of cointegration and 73.5331 which rejects the linear null hypothesis, respectively. These statistics reveal that the Sri Lankan lending and Central Bank discount rates are nonlinearly cointegrated at all conventional levels of significance.

Results of the Co-integration Test with Asymmetric Adjustment
The empirical results of the estimations of the TAR model specified by equations (3) and (4), and the M-TAR model described by equations (3) and (5), are reported in Table 3. As shown by Petrucelli and Woolford (1984), the necessary and sufficient condition for the Sri Lankan lending-Central Bank discount rate spread to be stationary is: $\rho_1 < 0$, $\rho_2 < 0$ and $(1 + \rho_1)(1 + \rho_2) < 1$. Therefore, analysis of the estimations of both TAR and M-TAR models reveals that the Sri Lankan lending-discount rate spread is stationary over the sample period.

In regard to the TAR model, specified by equations (3) and (4), an analysis of the overall estimation results indicates that the estimation results are devoid of serial correlation and have good predicting power as evidenced by the Ljung-Box statistics and the overall F-statistics, respectively. The calculated statistic Φ_μ = 10.1205 indicates that the null hypothesis of no co-integration, $\rho_1 = \rho_2 = 0$, should be rejected at the 1 percent significant level, confirming that the Sri Lankan lending-discount rate spread is stationary.

Table 3: Unit Root and Tests of Asymmetry, Sri-Lankan Monthly Data, 1990:06 to 2011:11

Model	ρ_1	ρ_2	τ	$H_0 : \rho_1 = \rho_2 = 0$	$H_0 : \rho_1 = \rho_2$	aic	sic
TAR	-0.5699*	-0.0830**	1.8377	Φ_μ = 10.1205*	$F_{(1,285)}$= 11.5338*	0.1129	_0.1821_
	$Q_{(12)}$ = 10.201 [0.5987]			ln L = -372.6935	$F_{(4,251)}$= 9.6386*		
M-TAR	-0.0054	-0.3095*	-0.6144	Φ_μ = 22.1326*	$F_{(1,251)}$= 13.3422*	-0.3716	_-0.3024_
	$Q_{(12)}$ = 5.331 [0.9460]			ln L = -310.6805	$F_{(4,251)}$=54.7602*		

Notes: *The null hypothesis of a unit root, $H_0 : \rho_1 = \rho_2 = 0$, uses the critical values from Enders (2001, p. 259, Table 2, for four lagged changes and n = 100)." *" indicates 1% level of significance. The null hypothesis of symmetry, $H_0 : \rho_1 = \rho_2$, uses the standard F distribution. τ is the threshold value determined via the Chan (1993) method. $Q_{(12)}$ denotes the Ljung-Box Q-statistic with 12 lags.*

The estimation results further reveal that both ρ_1 and ρ_2 are statistically significant at 1 percent and 5 percent levels, respectively. In fact, the point estimates suggest that the Sri Lankan lending-discount rate spread tends to decay at the rate of $|\rho_1| = 0.5699$ for $\hat\varepsilon_{t-1}$ above the threshold, $\tau = 1.8377$, and at the rate of $|\rho_2| = 0.0830$ for $\hat\varepsilon_{t-1}$ below the threshold. The empirical results also reveal that, based on the partial *F = 11.5338,* the null hypothesis of symmetry, $\rho_1 = \rho_2$, can be rejected at any conventional significant level, indicating statistically that adjustments around the threshold value of the spread are asymmetric.

As to the M-TAR model, specified by equations (3) and (5), overall, the estimation results are also absent of serial correlation and have good predicting power as evidenced by the Ljung-Box statistics and the overall *F-statistics*, respectively. The calculated statistic Φ_μ =22.1326 indicates that the null hypothesis of no co-integration, $\rho_1 = \rho_2 = 0$, should be rejected at the 1 percent significance level.

In regard to the question of asymmetry, the empirical results reveal that, based on the partial *F = 13.3422,* the null hypothesis of symmetry, $\rho_1 = \rho_2$, should also be rejected at the 1 percent significant level, indicating statistically that adjustments around the threshold value of Sri

Lankan lending-discount rate spread are asymmetric. The estimation results reveal that while ρ_1 is insignificant at any conventional level, ρ_2 is statistically insignificant at 1 percent level. The point estimates suggest that the Sri Lankan lending-discount rate spread tends to decay at the rate of $|\rho_1| = 0.0054$ for $\Delta\hat{\varepsilon}_{t-1}$ above the threshold, $\tau = -0.6144$, and at the rate of $|\rho_2| = 0.3095$ for $\Delta\hat{\varepsilon}_{t-1}$ below the threshold.

Additionally, given the finding of $|\rho_2| > |\rho_1|$ in the *M-TAR* specification, the adjustment of the Sri Lankan lending-discount rate spread toward the long-run equilibrium tends to be fast when the spread is narrowing than when the Sri Lankan lending-discount rate spread is widening. These findings support the hypothesis that the Sri Lankan commercial banks adjust their lending rates differently to rising versus declining the Central Bank's discount rates. These findings can also be interpreted to show that these institutions react differently to expansionary monetary policy than to contractionary. More importantly, this finding supports the articulations by the market concentration and the consumer characteristics hypotheses. This finding of asymmetric adjustment in the Sri Lankan lending-discount rate spread suggests that the Sri Lankan commercial banks exhibit predatory pricing behavior. Finally, the Aic and the Sic indicate that the M-TAR model fits the sample data better than the TAR model. Therefore, the M-TAR model's specification will be utilized for further investigation in this study.

Results of the Asymmetric Error-Correction Model

The positive results of the above asymmetric co-integration tests as well as the Aic's and the Sic's that resulted from estimating the above TAR and M-TAR models necessitate the use of a Momentum Threshold Autoregressive Vector Error-Correction (M-TAR VEC) model to further investigate the asymmetric dynamic behavior between the Sri Lankan lending rates and the Central Bank's discount rates. The estimation results of this model can be used to study the nature of the Granger causality between the commercial banks' lending rates and the Central Bank's discount rates. The empirical determined nature of the Granger causality will help to empirically evaluate whether and how the lending rates and the Central Bank's discount rates respond to changes in their spread. The Granger causality from the discount rates to the lending rates indicates that the Sri Lankan commercial banks respond to monetary policy. The Granger causality from the lending rates to the Central Bank's discount rates reveals that the Sri Lankan Central Bank reacts to financial market conditions. Additionally as aforementioned, the following M-TAR VEC model differs from the conventional error-correction models by allowing asymmetric adjustments toward the long-run equilibrium. Also as pointed out by Thompson (2006, p. 24), the error correction models replace the single asymmetric error correction term with two asymmetric error correction terms as follow:

$$\Delta LR_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i \Delta LR_{t-i} + \sum_{i=1}^{q} \gamma_i \Delta DR_{t-i} + I_t \rho_1 \hat{\varepsilon}_{t-1} + (1 - I_t)\rho_2 \hat{\varepsilon}_{t-1} + u_{1t} \qquad (6)$$

$$\Delta DR_t = \tilde{\alpha}_0 + \sum_{i=1}^{n} \tilde{\alpha}_i \Delta LR_{t-i} + \sum_{i=1}^{q} \tilde{\gamma}_i \Delta DR_{t-i} + I_t \tilde{\rho}_1 \hat{\varepsilon}_{t-1} + (1 - I_t)\tilde{\rho}_2 \hat{\varepsilon}_{t-1} + u_{2t} \qquad (7)$$

where $u_{i,t} \sim i.i.d.(0, \sigma^2)$, $i = 1, 2$ and the Heaviside indicator function, I, is set in accord with (5). This model specification recognizes the fact that the mutual responses between the countercyclical monetary policy action of the Sri Lankan Central Bank and the lending institutions may be different, depending on whether the policy action causes the discount rate to rise or to decline.

As pointed out by Thompson (2006, pp. 327-328), the above specified M-TAR-VEC model differs from the convention error-correction models by allowing asymmetric adjustments toward the long-run equilibrium. Also, the asymmetric error correctional model replaces the

single symmetric error correction term with two error correction terms. Thus, in addition to estimating the long-run equilibrium relationship and asymmetric adjustment, the model also allows for tests of the short-run dynamic between the changes in the Central Bank discount rates and the lending rates. This in turn reveals the nature of their Granger causality.

In reporting the estimation results, the partial F_{ij} represents the calculated partial *F-statistics* testing the null hypothesis that all coefficients *ij* are equal to zero. "*" indicates the 1 percent significant level of both the *F-statistics* and the *t-statistics*. $Q_{LB\ (12)}$ is the Ljung-Box statistics and its significance is in square brackets, testing for the first twelve of the residual autocorrelations to be jointly equal to zero. *lnL* is the log likelihood. The overall *F-statistic* tests the overall fitness of the model. The retentions of estimated coefficients α_i, γ_i, $\tilde{\alpha}_i$, and $\tilde{\gamma}_i$ are based on the 5 percent level of significance of the calculated *t-statistics*.

Table 4: Asymmetric Error Correction Model, Sri Lankan Data, 1990:06- 2011:11

	Independent Variables			
Eq. (6)	*Overall* $F_{(8,235)}$ = 7.8817*; *lnL* = -243.9081 $Q_{(12)}$=7.852[0.7966]; $\overline{R}^2$ = 0.1847			
ΔLR_t	$\alpha_3 = \alpha_6 = \alpha_{13} = 0$	$\gamma_1 = \gamma_9 = \gamma_{10} = 0$	ρ_1	ρ_2
	Partial F_{11}-stat.=10.0686*	*Partial F_{12}-stat.*= 6.8871*	-0.0265	-0.1576*
	Independent Variables			
Eq. (7)	*Overall* $F_{(8,231)}$ = 16.6998*; *lnL* = -169.9938 $Q_{(12)}$ =15.687[0.2060]; $\overline{R}^2$ = 0.1672			
ΔDR_t	$\tilde{\alpha}_{10} = \tilde{\alpha}_{11} = \tilde{\alpha}_{12} = \tilde{\alpha}_{14} = \tilde{\alpha}_{17} = 0$	$\tilde{\gamma}_1 = 0$	$\tilde{\rho}_1$	$\tilde{\rho}_2$
	Partial F_{21}-stat.= 5.9661*	*Partial F_{22}-stat.* = 18.2600*	0.0504*	0.0961*

Notes: *Partial F-statistics for lagged values of the lending rates and the Central Bank discount rates respectively, are reported under the specified null hypotheses. $Q_{(12)}$ is the Ljung-Box Q-statistics to test for serial correlation up to 12 lags. Overall F-statistics are for the respective overall equations. "*" indicates 1 percent and 5 percent significance levels respectively.*

Table 4 reports the results of asymmetric error correction model. A general diagnostic analysis of the overall empirical results indicates that the estimated equations (6) and (7) are devoid of serial correlation and have good predicting power as evidenced by the Ljung-Box statistics and the overall *F-statistics*, respectively. As to the short-run dynamic adjustment, the calculated *partial statistics,* partial F_{12} *and* F_{21}, in equations (6) and (7) indicate bidirectional Granger causality between the countercyclical monetary policy action of the Sri Lankan Central Bank as reflected in changes in the discount rates and the lending rates charged by lending institutions. These results imply that the countercyclical monetary policy action of the Sri Lankan Central Bank and the lending rates affects each other. This Granger bidirectional causality indicates that the Sri Lankan Central Bank uses its countercyclical monetary policy to manage the short-run macroeconomic conditions and lending institutions respond to the countercyclical monetary policy actions in the short run.

In addition to revealing the short-run dynamic Granger causality, the asymmetric error correction model also reveals the long-run behavior of the countercyclical monetary policy action of the Sri Lankan Central Bank. The results from estimating equation (6) reveal that $|\rho_2| > |\rho_1|$, and ρ_2 is significant at 1 percent level; while ρ_1 is statistically insignificant at

any conventional level. These findings suggest that that the Sri Lankan lending institutions only respond to contractionay countercyclical monetary policy in the long run. Also, the estimation results for equation (7) show that $|\tilde{\rho}_2| > |\tilde{\rho}_1|$ and both of them are significant at any conventional levels. These findings suggest that the Sri Lankan Central Bank has been successfully in influencing the commercial lending rates with its countercyclical monetary policy in the long run; i.e., the Sri Lankan monetary policy matters in the long run.

Discussion of Empirical Findings

As to the behavior of the Sri Lankan lending-Central Bank discount rate spread, the estimation results of the M-TAR model suggest that the spread converges to its long-run threshold faster when it is below the threshold. With regard to the empirical results from the estimations of equations (6) and (7), these findings seem to suggest that the Sri Lankan Central Bank has been able to affect the lending rate in the long run.

As to the empirical results pertaining to the short-run dynamic causality, the calculated partial *F-statistics* from equations (6) and (7) reveal the bidirectional Granger causality from Sri Lankan countercyclical monetary policy actions to the lending rates in the country. The obvious and trivial interpretation of this bidirectional causality is that the Sri Lankan Central Bank uses its monetary policy instruments to manage the macro-economy. Perhaps, the more conventional interpretation is that money and hence countercyclical monetary policy matters in the Sri Lankan economy in the short run.

Another contribution of this study to the literature as well as to the ability of the Sri Lankan Central Bank to formulate and implement the countercyclical monetary policy is the empirically determination of the time lags of the bidirectional Granger causality between the Sri Lankan countercyclical monetary policy as reflected in changes in the Central Bank discount rates and the lending rates in the short run.

As aforementioned, based on a 5 percent significance level, estimated coefficients $\alpha_i's$ and $\gamma_j's$ of equation (6) and the estimated coefficients $\tilde{\alpha}_i's$ and $\tilde{\gamma}_j's$ of equation (7) are retained. Economically, the inclusions of coefficients α_{13} and γ_{10} of equation (6) indicate that that the countercyclical monetary policy actions in the last ten months and the change in the lending rate thirteen months ago help predict the lending rate in the current month. Likewise, the inclusions of the coefficients $\tilde{\alpha}_{17}$ and $\tilde{\gamma}_1$ of equation (7) suggest that the Sri Lankan monetary authority looked at the changes in the lending rates back to seventeen months ago and the changes in its discount rate in the last month to formulate its counter cyclical monetary policy in the current period.

From the countercyclical monetary policy time lag perspective, the retentions of the estimated coefficients α_{13} and γ_{10} of equation (6) indicate that countercyclical monetary policy actions, reflected in changes in the Central Bank discount rate, back to ten months and the change in the lending rate back to thirteen months ago affect the current change in the lending rate. This finding implies that after implemented, it will take ten months for the Sri Lankan countercyclical monetary policy to fully affect the market lending rates. The inclusions of the coefficients $\tilde{\alpha}_{17}$ and $\tilde{\gamma}_1$ of equation (7) means that when formulating the current countercyclical monetary policy the Sri Lankan Central Bank is influenced by its actions taken in the last month and the change in the commercial bank lending rate back to seventeen months ago.

The commercial banking sector is expected to provide efficient intermediation to mobilize savings and channel those into productive investments and thus promote industrialization, economic development and social progress. These intermediaries would make profit from the

spread between the lending rate charged to borrowers and deposit rate paid to savers. In this transmission mechanism, commercial banks' behavior in setting their lending rates significantly influences the effectiveness of the monetary authority in its monetary policymaking. Economic theory has long proved that to maximize social welfare resources, financial or otherwise, must be allocated in such a manner to assure both allocative and productive efficiencies. Monopolistic/oligopolistic market structure and its attendant characteristics prevent optimal allocation of national resources, which leads to losses in social welfare. Thus, the aforementioned manifestation of the high market concentration and dominance by commercial bank in the industry in the economy prevents the banking system from fulfilling its expected role in the economic development process.

Clearly, the root causes of the Sri Lankan banking sector problem are the lack of market economy disciplines. *Excessive government intervention and political connections, possibly* management corruption, inefficiency and ineffectiveness are part of a vicious circle that inhibits economic development, industrialization, and social progresses in poor and developing countries in general and in Sri Lanka in particular. It is well known that these problems exist in the economies without true checks and balances in the political system. These problems cannot be corrected without the infrastructure of a political framework with a true check and balance system that can foster an effective market economy.

Conclusion

First, following Perron's (1997) procedure, an endogenous unit root test function with the intercept, slope, and trend were specified and estimated to test the hypothesis that the Sri Lankan commercial bank lending-Central Bank discount rate spread has a unit root. The results of this test suggest that the Sri Lankan lending-discount rate spread followed a stationary trend process with a break date beginning in July 2006. However, the test statistics failed to support this suggested structural shift at conventional levels of significance. To further investigate the possible structural break, the Chow test was performed and the result statistically confirmed the structural shift at all conventional significant levels. Additionally, that Breitung's nonparametric rank test and score test indicate that the Sri Lankan lending and Central Bank discount rates are nonlinearly cointegrated

Secondly, this study estimated the threshold autoregressive (TAR) and the momentum threshold autoregressive (M-TAR) models, developed by Enders and Siklos (2001), to investigate how Sri Lankan commercial banks responded to countercyclical monetary policy. The empirical findings indicate that the adjustments of Sri Lankan lending-discount rate toward the long-run equilibrium are asymmetric. Additionally, the estimated aic and sic indicate that the M-TAR model fits the sample data better than the TAR model; therefore, the M-TAR model's specification will be utilized for further investigation in this study. Also, based on the estimation results of the M-TAR model, the Sri Lankan lending-Central Bank discount rate spread tend to adjust to its long-run threshold faster when the spread is narrowing than when the spread is widening. These findings can also be interpreted to demonstrate that these institutions exhibit predatory pricing behavior, which is consistent with the observed monopolistic/oligopolistic structure of their market.

Finally, the empirical estimation of the M-TAR-VEC model reveals a bi-directional Granger-causality from the Central Bank discount rate to the commercial bank lending rate in the short-run. The finding of bi-directional Granger causality is important since it reveals that Sri Lankan commercial banks respond to countercyclical monetary policy and that the monetary authority successfully utilizes the policy to influence the financial market conditions. The

estimation results also describe the length of the impact lag of the Sri Lankan monetary countercyclical monetary policy.

References

- Breitung, J. (2001). Rank Tests for Nonlinear Cointegration, Journal *of Business and Economic Statistics, 19*, 331-340.
- Calem, P. S., and Mester, L. J. (1995). "Consumer Behavior and the Stickiness of Credit-Card Interest Rate," *American Economic Review, 85*(5), 1327-1336.
- Chan, K. S. (1993). Consistency and Limiting Distribution of the Least Squares Estimator of a Threshold Autoregressive Model, *Annals of Statistics, 21*(2), 520-533.
- Chang, H. L., and Su, C. W. (2010). The Lending-Deposit Rate Relationship in Eastern European Countries: Evidence from the Rank Test for Nonlinear Cointegration, *Czech Journal of Economics and Finance, 60*(6), 534-544.
- Enders, W. (2001). Improved Critical Values for the Enders-Granger Unit Root Test," *Applied Economic Letters, 8*(4), 257-261.

- Enders, W., and Granger, C. W. J. (1998). "Unit Root Tests and Asymmetric Adjustment with an Example Using the Term Structure of Interest Rates, *Journal of Business and Economic Statistics*, *16*(3), 304-311.
- Enders, W., and Siklos, P. L. (2001). Cointegration and Threshold Adjustment," *Journal of Business & Economic Statistics,* 19(2), 304-311.
- Hannan, T. H., and Berger, A. N. (1991). The Rigidity of Prices: Evidence from the Banking Industry, *American Economic Review, 81*(4), 938-945.
- Haug, A. A., and Basher, S. E. (2011).   Linear or nonlinear Cointegration in the Purchasing Power Parity Relationship? *Applied Economics, 43*, 185-196.
- Hutchison, D. E. (1995). Retail Bank Deposit Pricing: An Intertemporal Asset Pricing Approach, *Journal of Money, Credit, and Banking, 27*, 217-231.
- Mishkin, F. S. (1995). Symposium on the Monetary Transmission Mechanism*, Journal of Economic Perspectives,* 9(4), 3-10.
- Neumark, D., and Sharpe, S. (1992). Market Structure and the Nature of Price Rigidity: Evidence from the Market for Consumer Deposits, *Quarterly Journal of Economics*, *107*(2), 657-680.
- Nguyen, C. V., Islam, A. M., and Ali, M.M. (2010). Bangladeshi Lending-Deposit Rate Spread: An Econometric Analysis, *Global Economy and Finance Journal,* Vol. 3(2), 238-246.
- Nguyen, C.V., and Islam, A. M. (2010). Asymmetries in the Thai lending-deposit rate Spread: an econometric analysis, *Applied Economics Letters,* 17(13), 1229-1236.
- Nguyen, C. V., Pointer, L., and Smith, C., 920080 The Asymmetric Behavior of the Mexican Banking
  Interest Rate Margin, *Journal of Business and Economics Perspectives,* Vol. 34(2), Fall/Winter,57-67.
- Perera, S., Skully, M., and Nguyen, M. (2012). Market concentration and pricing behaviour of Sri Lankan banks, South Asian Journal of Global Business Research, Vol. 1(1), 63 – 78
- Perron, P. (1997). "Further Evidence on Breaking Trend Functions in Macroeconomic Variables, *Journal of Econometrics, 80*, 355-385.
- Petrucelli, J., and Woolford, S. (1984). A Threshold AR(1) Model, *Journal of Applied Probability*, 21, (1984), 473-481.

- Rosen, R. J. (2002). What Goes Up Must Come Down? Asymmetries and Persistence in Bank Deposit Rates, *Journal of Financial Services Research, 21*(3), 173-193.
- Scholnick, B. (1999). Interest Rate Asymmetries in Long-Term Loan and Deposit Markets, *Journal of Financial Services Research, 16,* 5-26.
- Sellon, G. H. (2002). The Changing U.S. Financial System: Some Implications for the Monetary Transmission Mechanism, *Federal Reserve Bank of Kansas City Economic Review, First Quarter,* 5-35.
- Stiglitz, J. E., and Weiss, A. (1981). "Credit Rationing in Markets with Imperfect Information," *American Economic Review, 71*(3), 393-410.
- Thompson, M. A. (2006). Asymmetric Adjustment in the Prime Lending-Deposit Rate Spread, *Review of Financial Economics, 15*(4), 323-329.

Appendix I

To search endogenously for the possibility of any structural break in the Sri Lankan lending-Central Bank discount rate spread, the following Perron's (1997) endogenous unit root test function with the intercept, slope, and the trend dummy is estimated to test the hypothesis that the Sri Lankan lending-discount rate spread has a unit root.

$$SP_t = \mu + \theta DU + \alpha t + \gamma DT + \delta D(T_b) + \beta SP_{t-1} + \sum_{i=1}^{k} \psi_i \Delta SP_{t-i} + \upsilon_t$$

where $DU = 1(t > T_b)$ is a post-break constant dummy variable; t is a linear time trend; $DT = 1(t > T_b)$ is a post-break slope dummy variable; $D(T_b) = 1(t = T_b + 1)$ is the break dummy variable; and ε_t are white-noise error terms. The null hypothesis of a unit root is stated as $\beta = 1$. The break date, T_b, is selected based on the minimum t-statistic for testing $\beta = 1$ (see Perron, 1997, pp. 358-359).

Table 1: Perron's Endogenous Unit Root Test, Sri Lankan Data, 1990:06 to 2011:11

$$SP_t = 0.4164 + 6.3828 DU - 0.0062t - 0.0243DT - 0.9050D(T_b) + 0.08737 SP_{t-1} + \upsilon_t$$

$$(2.2186^*) \quad (3.5700^*) \quad (-2.9726^*) \quad (-3.2693^*) \quad (-0.9050) \quad (11.5889^*)$$

No. of augmented lags: $k = 5$ Break Date: July 2006 $t(\alpha = 1) = -3.9910$

Notes: *Critical values for t-statistics in parentheses: Critical values based n = 100 sample for the break-date (Perron, 1997). "*" indicates significance at 1 percent level.*

Appendix II

Table 2: Spread on a constant, Dummy, and a Trent Data, Sri Lankan Data:1990:06 to 2011:11

$$SP_t = 4.1008 + 7.7696 Dummy_t - 0.0556 Trend_t + \hat{\varepsilon}_t$$

$$(13.2583^*) \quad (16.4514^*) \quad (-20.2972^*)$$

$ln\ L = -564.9585$ $R^2 = 0.6168$ DW statistic[a] $= 0.2638$ $F_{(2,255)} = 207.8137^*$

Notes: *"*" indicates significance at 1 percent level.*

(a) *As articulated by Enders and Siklos (2001, p. 166), in this type of model specification, ε_t may be contemporaneously correlated.*