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ASYMMETRIES IN RESPONSES OF COMMERCIAL BANKS TO MONETARY POLICY: THE CASE OF THAILAND

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Abstract: *The empirical results of this study reveal the following six characteristics of the Thailand banking sector over the period 1985-2015. First, the commercial bank lending rates and the Central Bank discount rates are linearly cointegrated. Second, the lending-Central Bank discount rate spread was stable and adjusted to its long-run threshold asymmetrically. Third, lending institutions respond faster to contractionary than expansionary countercyclical monetary policy actions. Fourth, the Thailand Central Bank authority successfully utilizes monetary policy as evidenced by the short-run dynamic and long run Granger-causalities from the discount rate to the lending rate. Fifth, results suggest that it takes almost two years for the lending rate to adjust to changes in monetary policy. Sixth, Thailand monetary policy makers should intervene to bring the economy to its long-term trend more frequently and in small adjustments to minimize the conditional variance of the rates spread which, in turn, minimizes the magnitudes of the lending rate cycles*.

Keywords: *Asymmetry; countercyclical monetary policy; lending rate; Central Bank discount rate; lending-Central Bank discount rate spread; linear cointegration, Thailand*.

I. INTRODUCTION

Cyclical fluctuations in economic activities have contributed to periodic increases in unemployment and inflation as well as external sector disequilibria (Gbosi, 2001). Internally, unstable investment and consumption patterns, improper public policy implementation and changes in expectations for policy outcomes are some of the factors responsible for economic instability. External factors that are known to cause negative economic stability include war, social upheaval, population growth, migration and technological transfer acceleration.

Keynes in his General Theory (1936) wrote that the task of restoring these macroeconomic variables back to their long-term trends cannot be left to supply and demand. Countercyclical monetary and fiscal policies are instruments governments use to manage their economies.

Since the late 1930s Keynesian fiscal policy has played a critical role in managing market economies. Beginning in the 1960s changes in international economic conditions resulted in persistently large government budget deficits worldwide. Mishkin (1995) argued that concerns about persistent budget shortfalls and rising deficits reduced the use of fiscal policy. Consequently, the stabilization of output and inflation has been left largely to monetary policy.

Bernanke and Gertler (1995) pointed out that monetary policy, at least in the short run, can affect the real economy. Recent empirical research (Romer and Romer, 1990; Bernanke and Blinder, 1992; Christiano, Eichenbaum, and Evans, 1994) confirmed earlier findings by Friedman and Schwartz (1963) that monetary policy actions affect real output for two years or more. However, Mishkin (1995) pointed out that this instrument can have unintended consequences and, in order to conduct monetary policy successfully, monetary authorities must have accurate feedback as to the timing and effect of their policy actions. This in turn requires policymakers to understand how monetary policy impacts the economy. This mechanism is often termed the monetary transmission mechanism or the "black box".

Bernanke and Gertler (1995) argued that changes in monetary policy are eventually followed by changes in real output. However, their writing is largely silent about what happens in the interim. To address this void, the Fall 1995 issue of the *Journal of Economic Perspectives* arranged a symposium on the monetary transmission mechanism. Very important papers were presented at this symposium by prominent economists such as Frederic S. Mishkin, John B. Taylor, Ben S. Bernanke and Mark Gertler, Allan H. Meltzer, Maurice Obstfeld and Kenneth Rogoff. In summarizing the symposium papers, Mishkin (1995) wrote that these authors identified the following important channels through which monetary policy actions are transmitted to real economic activities: the interest rates, exchange rates, credit and other asset price effects.

Commercial banks are an integral part and perform a very important role in the monetary policy transmission mechanism. These intermediaries derive their interest income from the spread between the lending rate and the cost of funds which is very much affected by monetary policy. Economic theory articulates that large spreads indicate inefficiencies or lack of competition. In turn this means that commercial banks will not be able to contribute to economic growth and social progress. Furthermore, the commercial banks' behavior in setting their lending and deposit rates significantly influences the effectiveness of monetary policy. Two of the most important pieces of empirical information policy makers need to conduct effective countercyclical policy are (1) how the target variable responds to policy actions and (2) time lags. To this end, this paper empirically investigates how Thailand's commercial banks respond to changes in the Central Bank discount rates and, therefore, the spread between the commercial banks' lending rate and the Central Bank discount rate. This study first determines whether the spread between the commercial banks' lending rate and the Central Bank discount rate experienced a structural break over the period between 1985 and 2015. Second, this study investigates how Thailand's commercial banks respond to countercyclical monetary policy actions as reflected in symmetric/asymmetric adjustments to the long-term threshold of the spread. Finally, this study posits that such asymmetries reveal predatory/collusive behavior by Thailand's commercial banks.

The remainder of this paper is organized as follows: The next section briefly reviews the literature. Next is a characterization of the Thailand banking sector. Following that is a description of the methodological issues and analytical framework used. The article ends with a discussion of the test results and concluding remarks.

II. A BRIEF REVIEW OF LITERATURE

The rationale for hypothesizing asymmetric responses to national countercyclical monetary policy can be attributed to the documented asymmetric rate-setting behavior of the commercial banks via rates of return on financial market instruments. Arak et al. (1983), Goldberg (1984), Forbes and Mayne (1989), Levine and Loeb (1989), Mester and Saunders (1995), Dueker (2000), and Tkacz (2001) have all reported past asymmetries in the U.S. lending rate. Thompson (2006) found asymmetries in the U.S. prime lending and deposit rates. Cook and Hahn (1989), Moazzami (1999), and Sarno and Thornton (2003) found asymmetries in U.S. Treasury securities. Nguyen and Islam (2010) found asymmetries in the Thailand lending and deposit rates and attributed it to oligopolistic nature of the Thailand banking industry. Frost and Bowden (1999) and Scholnick (1999) reported asymmetries in mortgage rates in New Zealand and Canada. Heffernan (1997) and Hofmann and Mizen (2004) indicated asymmetric behavior of retail rates in the United Kingdom. Hannan and Berger (1991), Neumark and

Sharpe (1992), and Diebold and Sharpe (1990) examined various deposit rates for the same behavior. Scholnick (1999) reported asymmetries in mortgage rates in Canada.

There are three main hypotheses for 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 but faster to adjust them downward, while exhibiting the opposite behavior with respect to lending rates (Neumark & Sharpe, 1992; Hannan & Berger, 1991). The consumer characteristic hypothesis asserts that the greater the ratio of unsophisticated to sophisticated consumers, plus 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).

The consumer reaction hypothesis predicts that asymmetric lending rates adjustment may actually benefit consumers. According to 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 are reluctant to raise lending rates even if market rates rise. The banks' opportunity cost of not raising lending rates when their marginal cost of fund increases are offset by the benefit of fewer higher-risk borrowers.

III. STYLIZED FACTS OF THE THAI ECONOMY

A Thailand Study (1987) articulated that Thai monetary policy was traditionally passive. Control over the credit extension rate was reported to be the primary support for growth, maintaining price stability and monitoring the balance of payments. Interest rates were allowed to adjust to the rate of credit expansion, and were strongly affected by international rates because of Thailand's open economy. Domestic prices were reported largely determined by world price movements because of the open economy and minimal domestic price controls.

The July 2010 edition of Asia Focus reported that Thailand regulators began to consider systemic reform after recognizing that weaknesses inherent in the financial system had intensified during the 1997-98 Asian Financial Crisis. This was said to spawn a banking crisis in addition to the currency crisis. In 2004, Thailand implemented the Financial Sector Master Plan (FSMP), a very important long-term reform program aimed at creating a more efficient, transparent and internationally competitive financial sector serving a larger proportion of the Thai population. With the first phase of the FSMP completed in 2009, Thailand announced that a second phase of financial sector reforms would begin in 2010.

The Bank of Thailand, the central bank of Thailand, (2015) reported that for the past ten years the banking sector remained the main channel of financial intermediation by competing for most deposits and loan business, especially in the private sector. Specifically, specialized financial institutions (SFIs) played a greater role in financial intermediation in Thailand. Within the Thai banking sector, SFIs have gained more importance in credit extension, initially as a main part of the government's countercyclical policies during the global financial crisis (GFC). SFIs also supported the government's spending and stimulus measures in subsequent periods.

At the end of 2013, total credits extended by all deposit-taking corporations (excluding the central bank) accounted for 47 % of Thailand's total financing sources. The four largest domestic commercial banks have maintained their dominance as financial intermediaries for households and firms and have, therefore, maintained their strong influence on the pass-through of monetary policy to the economy. Unlike during the 1997 Asian economic crisis, the GFC did not directly bring significant changes to the Thai financial landscape. This was largely due to Thailand's sound economic fundamentals and its banking system. The largest four domestic commercial banks, Bangkok Bank, Kasikorn Bank, Siam Commercial Bank and Krungthai Bank, made up 61 % of commercial banks' total assets at the end of 2013. Over the past decade, the Thai banking sector has maintained its preeminence in intermediating financial resources to the real economy. Government policies have played a part in influencing the degree of competition within the sector. In addition, changes in economic and financial conditions at home and abroad have altered banks' balance sheets and business operations.

Foreign banks are defined as commercial banks with foreign control of 50 % or more of the bank's total ownership. They are categorized as either branches or subsidiaries. Foreign banks remain of limited importance in the Thai economy, accounting for just 14 % of the Thailand banking sector's total assets. In contrast to SFIs and domestic banks, foreign banks participate only minimally in retail lending and deposits, a major sector of the Thai banking business. With only a small number of branches to facilitate retail lending, foreign banks tend to focus on areas where they have a comparative advantage, such as in wholesale funding, investment banking, and trading services and in credit extension to affiliated foreign firms. Competition from foreign banks remains on a small-scale despite Thailand's attempt to promote foreign competition by introducing reforms in the second phase of the Financial Sector Development Plan (2010–14)

Additionally, as pointed out by Alp and Elekdag (2012), Thailand had to endure three major shocks during the years of 2009 through 2011: (1) the after effects of the global financial crisis, (2) the spillovers from the 2011 Japanese earthquake and (3) the most destructive floods in at least 50 years in 2011.

Before the global financial crisis, Thailand had been in an investment slump since 2006. Nonetheless, export performance had average growth of over 10 % during 2006–07. This enabled Thailand's real GDP to grow strongly during this period. However, exports plunged in the last quarter of 2008 in tandem with the collapse in global trade. At the same time, the broad-scale pull back from foreign investors was associated with a marked rise in market volatility and a sharp decline in the stock market.

The earthquake which devastated Japan in March 2011 particularly affected Thailand because Japan is a key source of sophisticated intermediate and capital goods (accounting for over 90 % of some components). Because of the specialization and concentration of upstream manufacturers, supply chains were particularly disrupted, causing an abrupt production slowdown. Moreover, from August, 2011 to November, 2011 severe flooding, killed over 800 Thai people and displaced millions of residents.

To address its economics vulnerabilities, in May 2000 (IMF Country Report no. 16/176) Thailand formerly adopted an inflation targeting framework. As articulated by Alp and Elekdag (2012), the main objective of policy was to ensure price stability. However, the Bank of Thailand also carefully considers economic growth and stability. To counter the negative impacts precipitated by the three major economic shocks described above, the Thai government implemented an infrastructure investment plan, and the Bank of Thailand cut interest rates significantly.

IMF Country Report no. 15/144 (2015) argued that while Thailand's recent monetary stance was accommodative, further easing of monetary policy was recommended if economic recovery is weaker than anticipated. The Bank of Thailand, in an attempt to support the economy during a period of heightened political unrest, cut the interest rate by twenty-five basis points in November 2013 and again in March 2014, maintaining the rate at 2 %. Furthermore, the Thai baht has depreciated by more than 8 % during 2015 (CIA World Factbook March 14, 2016.)

IV. METHODOLOGICAL ISSUES AND ANALYTICAL FRAMEWORK

4.1. Structural Break

It is expected that long time-series data will experience structural breaks. To search endogenously for the possibility of any structural break in the commercial bank lending rate-Central Bank discount rate spread, our study utilized Perron's (1997) endogenous unit root test function with the intercept, slope, and the trend dummy to test the hypothesis that the spread has a unit root.

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

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 υ_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).

4.2. Nonlinear Cointegration

Breitung (2001) suggests in many cases a nonlinear relationship between economic and financial time series. This implies that LR_t and DR_t may be nonlinearly cointegrated. To discern this possibility, we used Breitung's nonparametric procedure. This 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 $LR_1,\dots,LR_T$] and $R_T(DR_t)$ accordingly. Breitung's two-sided rank test statistic, testing for the null hypothesis of no nonlinear cointegration, denoted by Ξ_T^*, is calculated as follows:

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

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), $\sigma_{\Delta r}^2$ 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).

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 the null hypothesis of nonlinearity) is to regress the Thai lending rate, LR_t, on a constant, the deposit rate, DR_t, the ranked series of the central bank discount rate, $R_T(DR_t)$, and the disturbance ζ_t.

$$LR_t = \delta_0 + \delta_1 DR_t + R_t^*(DR_i) + \zeta_t \qquad (3)$$

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 least squares regression of ζ_t, under the null hypothesis, on a constant, 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), 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.

4.3. Threshold Autoregressive (TAR) model

If the results of Breitung's nonparametric tests are positive, we follow Thompson (2006) to regress the spread, SP_t, on a constant, a linear trend and an intercept dummy (with values of zero prior to the structural break point and values of one at the structural break point and thereafter) to formally examine the Thai commercial bank lending rates, the Central Bank discount rates and their spread.

$$SP_t = \varphi_0 + \varphi_1 Trend_t - \varphi_2 Dummy_t + \varepsilon_t \qquad (4)$$

where SP_t is the Thai intermediation premium, φ_0, φ_1, and φ_2 are coefficients to be estimated. The saved residuals from the above estimated model, denoted by $\hat{\varepsilon}_t$, are then used to estimate the following TAR model:

$$\Delta\hat{\varepsilon}_t = I_t \rho_1 \hat{\varepsilon}_{t-1} + (1 - I_t)\rho_2 \hat{\varepsilon}_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta\hat{\varepsilon}_{t-p} + \hat{u}_t \qquad (5)$$

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:

$$I_t = \begin{cases} 1 & if\ \hat{\varepsilon}_{t-1} \geq \tau \\ 0 & if\ \hat{\varepsilon}_{t-1} < \tau \end{cases} \qquad (6)$$

The threshold autoregressive (TAR) model allows the degree of autoregressive decay to depend on the state of the commercial bank lending rate-Central Bank discount rate spread, i.e. the "deepness" of cycles. The estimated TAR model empirically reveals if the commercial bank lending rate-Central Bank discount rate spread tends to revert to the long-run position faster when the spread is above or below the threshold. Therefore, the TAR model indicates whether troughs or peaks persist more when shocks or countercyclical monetary policy actions push the commercial bank lending rate-Central Bank discount rate spread out of its long-run equilibrium path. In this model's specification, the null hypothesis that the commercial bank lending rate-Central Bank discount rate spread contains a unit root can be expressed as $\rho_1 = \rho_2 = 0$, while the hypothesis that the spread is stationary with symmetric adjustments can be stated as $\rho_1 = \rho_2$.

4.4. Asymmetric Error-Correction Model

If the results of the tests on the above TAR model are positive, this study uses the following Threshold Autoregressive Vector Error-Correction (TAR-VEC) model, specified by equations (6), (7) and (8), to further investigate the asymmetric dynamic behavior of the Thai lending rate (LR_t) and the Central Bank discount rate (DR_t). The estimation results of this model can be used to study the nature of the Granger causality between the Thai lending rates and the Central Bank discount rates. The statistical nature of the Granger causality will help empirically evaluate whether and how the lending rates and the Central Bank discount rate respond to changes in the lending-Central Bank discount rate spread.

$$\Delta LR_t = \alpha_0 + \rho_1 I_t \hat{\varepsilon}_{t-1} + \rho_2 (1 - I_t)\hat{\varepsilon}_{t-1} + \sum\nolimits_{i=1}^{n} \alpha_i \Delta LR_{t-i} + \sum\nolimits_{i=1}^{q} \gamma_i \Delta DR_{t-i} + u_{1t} \quad (7)$$

$$\Delta DR_t = \tilde{\alpha}_0 + \tilde{\rho}_1 I_t \hat{\varepsilon}_{t-1} + \tilde{\rho}_2 (1 - I_t)\hat{\varepsilon}_{t-1} + \sum\nolimits_{i=1}^{n} \tilde{\alpha}_i \Delta LR_{t-i} + \sum\nolimits_{i=1}^{q} \tilde{\gamma}_i \Delta DR_{t-i} + u_{2t} \quad (8)$$

where $u_{i,t} \sim i.i.d.(0, \sigma^2)$, $i = 1, 2$ and I_t is set in accordance with equation (6). Additionally, as pointed out by Thompson (2006, pp. 327-328), the above specified TAR-VEC model differs from the convention error-correction models by allowing asymmetric adjustments toward the long-run equilibrium. In addition, 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 effects (dynamics) between changes in lending rate and Central Bank discount rate. This in turn reveals the nature of the Granger causality.

4.5. GARCH(s, r)-M Model

Our investigation specifies and estimates the following GARCH (s, r)-in-Mean (GARCH-M) model to answer the important question as to whether the variance in the spread between Thai lending-Central Bank discount rates in one month affects the premia and the variances in the future months. This information is very important for countercyclical monetary policy makers with regard to whether they should intervene to bring the economy to its long-term trend less frequently and by larger adjustments or more frequently with smaller adjustments given these two alternative policy actions result in different spread variance. It is of some interest to note that GARCH-M models have been very popular and effective for modeling the volatility dynamics in many asset markets.

$$SP_t = c + \varpi SP_{t-1} + \lambda Ln(\omega_t^2) + \nu_t \quad (9)$$

$$\omega_t^2 = \alpha + \sum_{l=1}^{r} \beta_l \nu_{t-l}^2 + \sum_{m=1}^{s} \eta_m \omega_{t-m}^2 \quad (10)$$

where SP_t is the spread, *Ln* is the natural logarithm, SP_{t-1} is the value of the premium in the previous month, and ω_t^2 is its variance at time *t*; ν_t is a disturbance; c is a constant; λ , α , β_l , ϖ , and η_m are the parameters to be estimated of the model. The retentions of these estimated coefficients are determined by the calculated z-statistics at the 5 percent level of significance. The *r* and *s* indices are the highest subscripts *l* and *m* of retained β_l and η_m .

V. DATA, EMPIRICAL RESULTS AND DISCUSSIONS

5.1. Data and Descriptive Statistics

This study uses the monthly Thai commercial bank lending rates and Central Bank discount rates over the period 1985:01-2015:11. The commercial bank lending rate, the Central Bank discount rate and their spread are denoted by LR_t, DR_t and SP_t, respectively. Figure 1 displays the commercial bank lending rate and the Central Bank discount rate over the sample period.

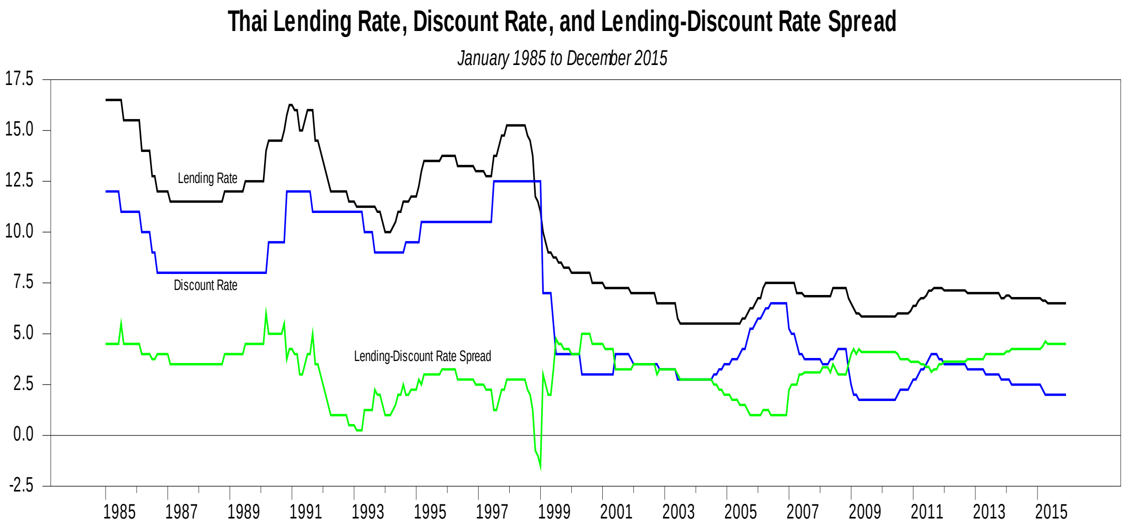

Figure 1: Thai Lending Rates, Discount Rates, and Lending-Discount Rate Spread January 1985 to November 2015

Sources: International Monetary Fund and calculations by the author.

5.2. Results of Perron's Test for Structural Break

The estimation results of Perron's endogenous unit root tests are summarized in Exhibit 1. The post-break intercept dummy variable, *DU*, is negative and is significant at the 1 % level. The post-break slope dummy variable, *DT*, and the time trend are positive but both insignificant. The results of these tests suggest that the spread between the Thai commercial bank lending rate and the Central Bank discount rate followed a stationary process with a break date of August 1991. Even through the Perron's test is only significant at the 10 % level, Chow's test also confirmed the structural break date. This structural break in the spread may be attributable to the impact of the Thai 17th coup d'état on March 2, 1991.

Exhibit 1. Perron's Endogenous Unit Root Test, Thai Monthly Data 1985:01 to 2015:11

$$SP_t = 0.43548 - 0.34330DU + 0.00007t + 0.00004DT + 1.47269D(T_b) + 0.88415SP_{t-1} + \upsilon_t$$

(3.17836*) (-2.55336*) (0.34687) (0.17278) (1.47269*) (37.63025*)

No. of augmented lags: $k = 5$ Break Date: August 1991 $t(\alpha = 1) = -4.93075$***

Notes: *Critical values for t-statistics in parentheses: Critical values based n = 100 sample for the break-date (Perron, 1997). "*" and "***" indicate significance at 1 percent and 10 percent levels.*

5.3. Breitung's Test Statistics

Empirical calculations indicate that Breitung's nonparametric rank test and score test are 1.00×10^{-25}, which rejects the null hypothesis of no cointegration, and 32.3133, which rejects the null hypothesis of nonlinearity, respectively. These test results reveal that the Thai lending rates and Central Bank discount rates are statistically significantly linearly cointegrated.

5.4. Results of the Cointegration Test with Asymmetric Adjustment

The estimation results of equation (5) are reported in Exhibit 2.

Exhibit 2. Estimation Results, Equation (4), Thai Monthly Data, 1985:01 - 2015:11

$$SP_t = 3.80944 + 0.00725 Trend_t - 2.49891 Dummy_t + \varepsilon_t$$
$$(35.34991^*) \quad (11.28168^*) \quad (-14.87419^*)$$

ln L = -501.4651 $\quad$ R^2 = 0.3759 $\quad$ DW statistic[(a)] = 0.2181 $\quad$ $F_{(2,369)}$ =111.1125*

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.*

Given the estimation results of equation (4), the estimation results of the TAR model are summarized in Exhibit 3. An analysis of the overall estimation results indicate 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 = 14.4532 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 Thai lending-Central Bank discount rate spread is stationary.

Exhibit 3. Unit Root and Tests of Asymmetry, Thai Monthly Data, 1985:01 - 2015:11

ρ_1	ρ_2	τ	$H_0 : \rho_1 = \rho_2 = 0$	$H_0 : \rho_1 = \rho_2$	aic	sic
-0.11417*	-0.37429*	-0.79366	Φ_μ = 14.45320*	F = 8.21275*	-1.7254	-1.6726
$Q_{LB\ (12)}$ = 3.4900[0.10156]			*ln L = -200.8018*	*$F_{(4,365)}$=9.17825**	D.W. = 1.9936	

Notes: *The null hypothesis of a unit root, $H_0 : \rho_1 = \rho_2 = 0$, uses the critical values from Enders and Siklos (2001, p. 170, Table 1 for four lagged changes and n = 100). "*", "**" and "***" indicate 1 percent, 5 percent and 10 percent levels 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. $Q_{LB\ (12)}$ 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 the 1 percent level. In fact, the point estimates suggest that the commercial bank lending rate-Central Bank discount rate spread tends to decay at the rate of $|\rho_1| = 0.11417$ for $\hat{\varepsilon}_{t-1}$ above the threshold, $\tau = -0.79366$, and at the rate of $|\rho_2| = 0.37429$ for $\hat{\varepsilon}_{t-1}$ below the threshold. Additionally, the empirical results also reveal that, based on the partial *F = 8.21275,* the null hypothesis of symmetry, $\rho_1 = \rho_2$, should be rejected at the 1 percent significance level indicating that adjustments around the threshold value of the commercial bank lending rate-Central Bank discount rate spread are asymmetric.

More specifically, given the finding of $|\rho_2| > |\rho_1|$, the adjustment of the commercial bank lending rate-Central Bank discount rate spread toward the long-run equilibrium tends to persist more when the premium is widening than when it is narrowing. These findings reveal that Thai lending institutions adjust their lending rates differently in response to rising versus declining Central Bank discount rates. These findings can also be interpreted to show that these institutions react differently to expansionary monetary policy versus contractionary policy. The $|\rho_2| > |\rho_1|$ results support those reported by Thompson (2006) for the U.S. and support the hypothesis that banks adjust their lending rates differently to rising versus declining market rates.

Therefore, the finding of $|\rho_2| > |\rho_1|$ seems to suggest predatory pricing behavior of the Thai lending institutions which is consistent with their highly concentrated operating environment and the behavior of their counter parts in most advanced economies as well as the bank concentration hypothesis and the consumer characteristic hypothesis.

5.5. Results of the Asymmetric Error-Correction Model

The estimation results of the asymmetric error correction model are reported in Exhibit 4. In the summary of the estimation results, the partial F_{ij} represents the calculated partial *F-statistics* with the p-value in square brackets testing the null hypothesis that all coefficients *ij* are equal to zero. "*" indicates the 1 percent significant level of 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* with the p-value in square brackets tests the overall fitness of the model. The retained 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*.

Exhibit 4. Asymmetric Error Correction Model, Thai Monthly Data, 1985:01 - 2015:11

	Independent Variables			
Eq. (7)	*Overall* $F_{(14,334)} = 8.6559[0.0000]$; *lnL= 24.2307* $Q_{(12)}$ *=10.1180[0.6056];* $\bar{R}^2$ *= 0.27*			
ΔLR_t	$\alpha_1 = \alpha_3 = \alpha_8 = \alpha_{13} = \alpha_{14} = \alpha_{19} = \alpha_{20} = \alpha_{22} = 0$	$\gamma_5 = \gamma_6 = \gamma_{18} = \gamma_{19} = 0$	ρ_1	ρ_2
	Partial F_{11} *= 12.7657[0.000]*	*Partial* F_{12} *= 4.6373[0. 0012]*	-0.0414*	-0.0022
	Independent Variables			
Eq. (8)	*Overall* $F_{(10,339)} = 10.3749[0.0000]$; *lnL= -142.4295* $Q_{(12)}$ *=9.3530[0.6725];* $\bar{R}^2$ *= 0.23*			
ΔDR_t	$\tilde{\alpha}_1 = \tilde{\alpha}_2 = \tilde{\alpha}_3 = \tilde{\alpha}_8 = \tilde{\alpha}_{14} = 0$	$\tilde{\gamma}_4 = \tilde{\gamma}_{15} = \tilde{\gamma}_{21} = 0$	$\tilde{\rho}_1$	$\tilde{\rho}_2$
	Partial F_{21} *=11.9807[0.0000]*	*Partial* F_{22} *= 3.9145[0.0090]*	0.0578**	0.1198*

Notes: *Partial F-statistics for lagged values of changes in the lending rate and Central Bank discount rate, respectively, are reported under the specified null hypotheses.* $Q_{(12)}$ *is the Ljung-Box Q-statistic to test for serial correlation up to 12 lags. "*" and "**" indicate 1 percent and 10 percent levels of significance, respectively.*

An analysis of the overall empirical results indicates that equations (7) and (8) are devoid of serial correlation and have good predictive power, as evidenced by the Ljung-Box statistics and the overall *F-statistics*, respectively. As to the short-run dynamic adjustment, the calculated partial *F-statistics* in equations (7) and (8) indicate bidirectional Granger-causality between the Thai lending and Central Bank discount rates. These results imply that the Thai lending rate and Central Bank discount rate adjustments affected each other's movements.

In addition, the asymmetric error correction model allows the investigation of the long-run adjustments of the lending rate when the short-run dynamic Granger-causality was introduced to the model. Inconsistent with the empirical results of the TAR model, the finding that $|\rho_1| > |\rho_2|$ in equation (7), indicates that the lending rate adjusted to the long-run equilibrium more slowly when a countercyclical monetary policy action or a shock widened than when it narrowed the lending-Central Bank discount rate spread. However, only ρ_1 is significant at 10 % level while ρ_2 is insignificant at any conventional level. Economically, this result seems to suggest that the Thai lending institutions responded to the expansionary monetary policy but not the contractionary monetary policy in the long run. With regard to the long-run behavior of the Thai Central Bank, as evidenced by the behavior of the discount rate, the estimation results for equation (8) show that $|\tilde{\rho}_2| > |\tilde{\rho}_1|$. Additionally, $\tilde{\rho}_1$ and $\tilde{\rho}_2$ are statistically significant at the 10% and 1% levels, respectively. These findings, coupled with the dynamic Granger-causality, indicate that the Central Bank successfully uses countercyclical monetary policy; however, the economic impacts are asymmetric.

Furthermore, the empirical results for equation (7) reveal that the longest time lags for α_i and γ_i are 22 and 19 months respectively, while those for $\tilde{\alpha}_i$ and $\tilde{\gamma}_i$ are 14 and 21 months, respectively. These findings suggest that the Thai monetary authority considered the lending institutions' lending rate fourteen months back when formulating its countercyclical monetary policy, while the lending institutions took up to nineteen months to respond to monetary policy. These empirical findings suggested that the Thai countercyclical monetary policy affected the real output of its economy which is consistent with those reported for the US by Bernanke and Gertler (1995), Romer and Romer (1990), Bernanke and Blinder (1992), Christiano, Eichenbaum, and Evans (1994).

5.6. GARCH (s, r)-M Model

As previously mentioned, the retentions of the estimated coefficients of equations (9) and (10) are determined by the calculated z-statistics at the 5 % significance level. The values of *l* and *m*, in turn, suggest GARCH (2, 2) is the best model for this investigation**.** The estimation results of the GARCH (2, 2)-M model are reported in Exhibit 5.

Exhibit 5. GARCH (2, 2)-M Model Results, Thai Monthly Data, 1985:01 - 2015:11

$$SP_t = 0.284604 + 0.908180 SP_{t-1} - 0.018747 Ln(\omega_t^2) + v_t$$

(11.42467*) (89.49364*) (-2.945378*)

$$\omega_t^2 = -0.000058 + 0.568321 v_{t-1}^2 - 0.5544511 v_{t-2}^2 + 1.230884 \omega_{t-1}^2 - 0.246303 \omega_{t-2}^2$$

(-2.061813**) (7.620405*) (-7.646185*) (19.29262*) (-3.970954*)

Notes: *Akaike info criterion=-0.32987; Schwarz criterion =-0.20445; Hannan-Quinn Criterion=-0.27920; Log likelihood = 43.46166; Durbin-Watson Statistic = 1.857645.*
"", and "**" indicate the 1 percent and 5 percent levels of significance, respectively.*

The results of the GARCH (r, s)-M model suggests the presence of the GARCH (2, 2) effect on the Thai lending-Central Bank discount rates spread and its variance. The empirical results indicate that the one month spread variance affect the variances in the subsequent months.

VI. SUMMARY AND CONCLUSION

This study used the threshold autoregressive (TAR) model by Enders and Siklos (2001) to investigate the behavior of the Thai lending and Central Bank discount rates and their spread. First and foremost, the TAR model's estimation results indicated that adjustments to the lending-Central Bank discount rate spread toward the long-run equilibrium are asymmetric and tend to respond faster to contractionary than to expansionary countercyclical monetary policy. This finding suggests that the Thai lending institutions exhibit predatory pricing behavior which is consistent with the behavior of their counterparts in most advanced economies. These findings support both the bank concentration and the consumer characteristic hypotheses.

Furthermore, the estimation results of the Asymmetric Error-Correction Model suggest a bidirectional Granger-causality between the Thai lending and Central Bank discount rates. These results imply that the Thai lending rate and the Central Bank discount rate adjustments affected each other's movements. This finding suggests that Thai lending institutions do respond to countercyclical monetary policy actions and that the Central Bank authority successfully applies monetary policy in the short run.

As to the countercyclical monetary policy time lags in the banking sector, the estimation results suggest that the Thai monetary authority considers the commercial banks' lending rate fourteen months back in formulating its countercyclical monetary policy while lending institutions take up to nineteen months to respond to the monetary policy. These findings are consistent with results reported for the US economy.

Finally, the GARCH (2,2)-M model results suggest that Thai monetary policymakers should intervene to bring the economy to its long-term trend more frequently by using small adjustments to minimize the conditional variance of the lending-Central Bank discount rate spread to minimize the length of the lending rate cycle.

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