Business and Economics Journal

Nguyen et al., Bus Eco J 2015, 6:2
http://dx.doi.org/10.4172/2151-6219.1000144

Research Article Open Access

Asymmetric Adjustment in the Singaporean Consumer Loans-Interbank Overnight Rate Spread and Conditional Heterokedasticity

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Abstract

Asymmetries in the Singaporean consumer loans lending-interbank overnight rate spread were documented. Empirical results revealed that the spread adjusts to the threshold more slowly when the interbank overnight rates decrease relative to the consumer loans rates than when the interbank overnight rates move in the opposite direction. Additionally, the empirical findings indicate that Singaporean commercial banks exhibit predatory rate setting behaviour in consumer loans market. The results also show bidirectional Granger causality between the Singaporean consumer loans rate and the interbank overnight rate, indicating that the consumer loans rate and the interbank overnight rate affect each other's movements. These results suggest that monetary authority can use its countercyclical monetary policy instruments to achieve its macroeconomics objectives. However, the estimation results of the GARCH (3, 3)-in-Mean model suggest that they should intervene more frequently and by small policy measures to minimize the conditional variance of the spread to minimize the magnitude of the cycle of the consumer loans rate.

Keywords: Asymmetry; Consumer loans rate; Interbank overnight rate; Singapore; Predatory pricing behaviour; Granger causality; Countercyclical monetary policy

JEL classification codes: C22; E44; G21.

Introduction

Financial intermediation is a critical facilitator of investment and economic growth [1-3]. Commercial banks play a crucial role in determining the spread or the basis between the lending rate charged to borrowers and the cost of funds. Their cost of funds is affected, by interbank overnight borrowing, deposit and other borrowed money cost, and by the central bank's countercyclical monetary policy measures.

Moreover, economic theory has well established the strong causality between consumer loans rates and the consumption which is the largest component of the GDP of every economy. In addition, the interbank over-night cash rate is the policy instrument and consumption is the target of countercyclical monetary policy; therefore, the behaviour of this spread reveals the effectiveness of a central bank's monetary policies. Some of the spread is risk related to the instrument; that is, the intermediation premium over and above the "cost of funds" level. This "risk" portion provides useful insights into banks' behaviour. Accordingly, this paper explores the behaviour of Singaporean banks in particular—with an emphasis on the factors that affect the spread between Singaporean consumer loans rates and the interbank overnight rates, and the dynamic relationships amongst these factors.

Additionally, the Singaporean banking sector has become more and more internationalized and the international economic landscape, over the last two decades or so, has been dotted with international political and social turmoil. These developments precipitate the central bank to utilize its policy instrument more often since now it has to counter international contagions in addition to domestic business matters. This phenomenon, in turn, exacerbates the variance of the spread and cause the variance to be different from some sub-periods to others over the sample period. Therefore, another important question is whether the fluctuations in the variance of the spread from one month affect the spreads, their variances and ultimately the consumer loans rates in the subsequent 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 large policy measures or more frequently and by small policy measures because these two alternative policy actions result in a different variance of the spread. An increase in variance is indicative of increased risk associated with the debt instrument, which, in turn, exacerbates the consumer loans rate in the banking sector. This investigation specifies and estimates a simple GARCH(s, r)-in-Mean (GARCH-M) model to discern this possibility.

In theory, banks operating in a free market economy could be expected to consider all sources of risk in determining and setting the basis that separates the rate paid to lenders from the rate charged to borrowers. If banks set a spread either too high or too low, market forces would force an adjustment back to some equilibrium spread. Three main hypotheses explain this rate-setting behaviour: the bank concentration hypothesis, the consumer characteristic hypothesis, and the consumer reaction hypothesis. The bank concentration hypothesis theorizes that oligopolistic banks are fast to raise consumer loans rates when the interbank overnight rate rises as a result of tightening monetary policy action, but slow to reduce lending rates when market in response to declining interbank overnight rate [4,5]. The consumer characteristic hypothesis posits that banks can adjust rates to widen the spread and increase their profitability to the extent that consumers are unsophisticated and/or are saddled with higher costs of searching and switching [6-8].

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Received February 02, 2015; **Accepted** March 16, 2015; **Published** March 23, 2015

Citation: Nguyen CV, Ali MM, Penkar S (2015) Asymmetric Adjustment in the Singaporean Consumer Loans-Interbank Overnight Rate Spread and Conditional Heterokedasticity. Bus Eco J 6: 144. doi:10.4172/2151-6219.1000144

The consumer reaction hypothesis proposes that asymmetric adjustments in lending rates may actually benefit consumers, because the presence of asymmetric information can foster an adverse selection problem in lending markets such that higher interest rates will tend to attract riskier borrowers [9]. Therefore, even if the market rates rise, banks would be reluctant to raise lending rates, because the expected cost to the banks of not raising the lending rates (when their marginal cost of funds increases) is offset by the risk reduction benefits of not encouraging the higher-risk borrowers.

As is discussed in the next section, in the last two decades or so, which were dotted with considerable international, political, and social turmoil, the Singaporean banking sector has gone through drastic deregulations and liberalizations. Therefore, it is now of special interest to assess the Singaporean commercial banks' rate setting behavior after almost two decades of liberalization and reforms of the banking sector. It is also of interest to compare the Singaporean banks' rate setting behavior to those of their counterparts in advanced market economies to gauge the effectiveness of the aforementioned liberalization and reforms. To this end, this paper explores whether asymmetries exist in the Singaporean consumer loans-interbank overnight rate spread and, if such asymmetries are present, how consumer loans and interbank overnight rates respond to these asymmetries. Furthermore, this paper explores whether responses to such asymmetries are independent or are dynamically interrelated. Also, this analysis seeks to determine whether the Singaporean lending institutions exhibit competitive or predatory pricing behaviours, and to what extent. Finally, this study investigates whether the variance of the spread between the consumer loans-interbank overnight rates from the one month affects the variances and spreads in the subsequent 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 large policy measures or more frequently and by small policy measures because these two alternative policy actions result in different variance of the spread.

The remainder of this study is organized as follows: The upcoming section summarizes the literature on asymmetric rate adjustments by international lending institutions and the Singaporean banking sector; the section after describes the data and the descriptive statistics used in the analysis; the next section describes the methodology used in the investigation; and the last section provides a summary of the study's takeaways and offers concluding remarks and policy implications.

Asymmetric Rate Adjustments and the Singaporean Banking Sector

Asymmetric rate adjustments

The rationale for hypothesizing asymmetric responses to the national countercyclical monetary policy can be attributed to the documented asymmetric rate-setting behavior of the commercial banks in the context of rates of return on financial market instruments. Economically, the theoretical rationale for hypothesizing the asymmetric adjustment process of the basis between the banks' consumer loans rates and interbank overnight rates may be attributable to the seemingly opposite effect of the lending market and the countercyclical monetary policy over different phases of business cycles. More specifically, during the expansionary phases of business cycles, the countercyclical monetary policy would lower the interbank overnight rates while the information from that state of the economy would precipitate the lending institutions to resist adjusting their spread between the consumer loans rate and interbank overnight rates downward because their perceived risk profiles of loan applicants increase. Consequently, the spread would increase or widen. By the same logic, it may be argued that the spread between the consumer loans rates and the interbank overnight rates would decrease or narrow during the contractionary phases of the business cycles while the interbank overnight rate is increasing.

As to reports in the literature on emerging and advanced economies, Dueker and Tkacz have reported asymmetries in the U.S. consumer loans rate in the past [10,11]. Thompson found asymmetries in the U.S. consumer loans-deposit rate spread [12]. Sarno and Thornton found asymmetries in U.S. Treasury securities in their studies [13]. Frost and Bowden and Scholnick reported asymmetries in mortgage rates in New Zealand and Canada [14,15]. Hofmann and Mizen indicated asymmetric behavior of retail rates in the United Kingdom [16]. Hannan and Berger and Neumark and Sharpe examined various deposit rates for the same behavior [4,5]. Several studies have found asymmetric cointegration between bank lending and deposit rates. For instance, Nguyen et al. documented similar asymmetries in Mexican lending and deposit rates [17]. Nguyen and Islam reported asymmetries in the Thai bank lending and deposit rates [18]. Nguyen and Henney found asymmetries in the US housing mortgage market [19]. Chang and Su reported nonlinear cointegration between the lending and the deposit rate in ten Eastern European countries [20]. Also, Haug and Basher found nonlinear cointegration in the purchasing power parity relationships for Canada, Japan, Switzerland, the U.K., Belgium, France, Germany, Italy and Netherlands [21].

The Singaporean Banking Sector

An articulated by Huat et al. after Singapore became independent from the Federation of Malaysia in 1965, the new government started to develop Singapore into, an industrial center as well as other trading activities [22]. Historically, prior to 1970, the various monetary functions of the current central bank were performed by several government departments and agencies. As Singapore progressed, the demands of an increasingly complex banking and monetary environment necessitated streamlining the functions to facilitate the development of a more dynamic and coherent policy on monetary matters. Consequently in 1970, Parliament passed the Monetary Authority of Singapore Act which led to the formation of Monetary Authority of Singapore, known as Monetary Authority of Singapore (MAS), on January 1, 1971. The passing of the MAS Act gave MAS the authority to regulate the financial services sector in Singapore.

As in many other economies, the MAS have also acted as a banker to and financial agent of the Government. It has also been entrusted to formulate and implement policies to promote monetary stability, and credit and exchange policies conducive to the growth of the economy. In April 1977, the Government decided to bring the regulation of the insurance industry under the wing of the MAS. The regulatory functions under the Securities Industry Act (1973) were also transferred to MAS in September 1984. The MAS also administers the various statutes pertaining to money, banking, insurance, securities and the financial sector in general. Following its merger with the Board of Commissioners of Currency on October 1, 2002, the MAS has also assumed the function of currency issuance.

The MAS has always taken a proactive approach to develop the banking industry. It is careful in balancing the need to develop the local banks as while providing the necessary incentives to attract foreign banks to operate in Singapore. In 1999, the MAS introduced a five-year program to liberalize foreign access to Singapore's domestic banking

market. It worked with banks to set guidelines for best practices and give banks more room for innovation.

As the banking industry is further liberalized, local banks over the years have merged to fortify against foreign competition. As to the desired structure of the banking industry, during an interview with Business Week in 1999, Deputy Prime Minister Lee articulated that "the domestic market is big enough for two major banks." Subsequently, a statement released by the MAS (May 17) reiterated the stance that the smallness of the domestic market and the growing economies of scale in banking make it unlikely that Singapore can sustain more than two local banks with that critical size, although there may be other smaller players occupying niche markets. The MAS lowered the Capital Adequacy Requirements for local banks in May 2004 (MAS Press Release on May 28). The revision in the Capital Adequacy Requirements would allow the local banks to be more competitive as they would have to hold less regulatory capital in reserves and deploy the freed capital more meaningfully.

The MAS is also moving towards a disclosure based regime, which is a shift from the supervision approach. In the new regime, banks will take the onus of monitoring their risk management practices, which is in line with the proposed new Basel Capital Accord to be implemented in 2007. This move from a one-size-fits-all approach will allow the banks to pursue their banking activities with fewer restrictions while maintaining the appropriate measures to control their credit, market, operational, business and systemic risks.

Further liberalization measures have been introduced in June 2004 by the MAS to drive the banking industry forward. In liberalization of the banking sector, the government created a new category under the foreign banks category, called the Qualifying Full Bank. These Qualifying Full Banks are now permitted to establish 25 service locations up from the previous 15. This expansion in the network allows Qualifying Full Banks to widen their presence in the domestic market. Qualifying Full Banks can negotiate with the local banks on a consumer basis to let their credit card holders obtain cash advances through the local banks' automated teller machine networks.

The Data and Descriptive Statistics

This study used the Singaporean banks' monthly consumer loans rates and the interbank overnight rates from 1987:07 to 2013:12, when the data is available. These time series are reported by the Monetary Authority of Singapore. The monthly Singaporean consumer loans rates, interbank overnight rates, and their spread are denoted by CR_t, OR_t, and SP_t, respectively. Figure 1 describes the movements of CR_t, OR_t, and SP_t over the sample period (Figure 1).

The mean prime consumer rate during this period is 6.05 percent and ranges from 2.87 to 8.27, with a standard deviation of 1.10. The mean interbank overnight rate over the same period is 1.93 percent and ranges from 0.00 to 8.50, with a standard deviation of 1.81. The mean spread during this period is 4.12 percent, and ranges from -1.57 to 8.14, with a standard deviation of 1.61. Figure 1 suggests that the Singaporean consumer loans-interbank overnight rate spread experiences a structural change over the sample period.

Methodological Issues and Analytical Framework

Structural break

This study specifies and estimates endogenous unit root test function with the intercept, slope, and the trend dummy to test the hypothesis that the Singaporean consumer loans-interbank overnight rate spread has a unit root [23].

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

Where, $DU = 1(t > T_b)$ is a post-break constant dummy variable; t is a 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 $\beta = 1$ [23].

Nonlinear cointegration

Breitung articulated that there is often a nonlinear relationship between economic and financial time series, implying that PR_t and OR_t may be nonlinearly cointegrated [24]. To discern this possibility, this investigation utilizes Breitung's nonparametric procedure to test for their 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. To calculate the rank test for cointegration, this study first defines a ranked series as $R_T(CR_t)$ [of CR_t among $R_1,...,R_T$] and $R_T(OR_t)$. Breitung's two-sided rank test statistic, testing for cointegration, denoted by Ξ_T^*, is then calculated as

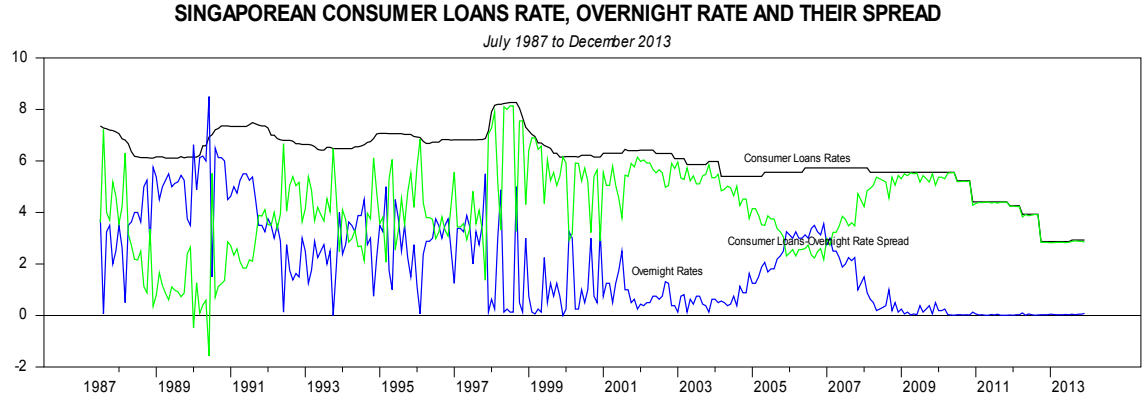

Figure 1: Singaporean Consumer Loans Rate, Interbank Overnight Rate, and their Spread since 1987.

follows:

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

where T is the sample size, r_i^R is the least squares residual from a regression of $R_T(R_t)$ on $R_T(OR_t)$. According to Haug and Basher [21], $\sigma_{\Delta r}^2$ is the variance of Δr_i^R, which is included to adjust for the potential correlation between the two time series CR_t and OR_t. The critical values for this rank test are found in Table 1 of Breitung.

Given a 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 Singaporean consumer loans rate, CR_t, on a constant, the interbank overnight rate, OR_t, the ranked series of the interbank overnight rate, $R_T(OR_t)$, and the disturbance ζ_t.

$$CR_t = \delta_0 + \delta_1 OR_t + \delta_2 R_t^*(OR_i) + \zeta_t \quad (3)$$

Where, $\delta_0 + \delta_1 DR_t$ is the linear part.

Under the null hypothesis, $R_t^*(OR_i) = 0$, implying that CR_t and OR_t are linearly cointegrated. Under the alternate hypothesis, $R_t^*(OR_i) \neq 0$, implying that CR_t and OR_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 interbank overnight rate, $R_T(OR_t)$, and a disturbance term. T is the sample size. As explained by Breitung [24], 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.

Threshold Autoregressive (TAR) Model

If the results of Breitung's nonparametric tests are positive, this study follows Thompson [12] 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 date and values of one for the structural break date and thereafter) to formally examine the Singaporean CR_t, OR_t, and SP_t. The estimation results are reported in the appendix 1. The saved residuals from the above estimated model, denoted by $\hat{\varepsilon}_t$, are then used to estimate the following TAR model:

$$\Delta\hat{\varepsilon}_t = I_t\rho_1\hat{\varepsilon}_{t-1} + (1-I_t)\rho_2\hat{\varepsilon}_{t-1} + \sum_{i=1}^{p}\alpha_i\Delta\hat{\varepsilon}_{t-p} + \hat{u}_t \quad (4)$$

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) [25], the Heaviside indicator function for the threshold autoregressive (TAR) model specification is given as:

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

The threshold value, τ, is endogenously determined using Chan's [26] procedure, which obtains τ by minimizing the sum of squared residuals after sorting the estimated residuals in ascending order, and eliminating the largest and smallest 15 percent of values. The elimination of the largest and the smallest values assures that the $\hat{\varepsilon}_t$ series crosses through the threshold in the sample period.

The (TAR) model allows the degree of autoregressive decay to depend on the state of the spread between the lending rates and the central bank's policy related rate, i.e. the "deepness" of cycles. The estimated TAR model reveals whether the basis reverts back 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 countercyclical monetary policy actions or economic shocks push the basis out of its long-run equilibrium path. The null hypothesis (that the basis contains a unit root) is expressed as $\rho_1 = \rho_2 = 0$, while the hypothesis that the spread is stationary with symmetric adjustments is expressed as $\rho_1 = \rho_2$.

The Asymmetric Error-Correction Model

If the results of the above asymmetric co-integration tests are positive, a Threshold Autoregressive Vector Error-Correction (TAR-VEC) model is specified and estimated to continue an investigation into any asymmetric short-run dynamic behaviours that occur between consumer loans rates and the interbank overnight rates. Results of this model can be used to study the Granger causality between consumer loans rates and the interbank overnight rates. The Granger causality will help to evaluate empirically (through statistics) how the Singaporean consumer loans rates and the interbank overnight rates respond to the widening and the narrowing of their spread due to external economic shocks or countercyclical policy measures. Again, conventional error-correction models do not suffice for this purpose, because they do not allow the asymmetric adjustments toward the long-run equilibrium that the TAR-VEC model does.

$$\Delta CR_t = \alpha_0 + \rho_1 I_t\hat{\varepsilon}_{t-1} + \rho_2(1-I_t)\hat{\varepsilon}_{t-1} + A_{11}(L)\Delta CR_{t-i} + A_{12}(L)\Delta OR_{t-i} + u_{1t} \quad (6)$$

$$\Delta OR_t = \tilde{\alpha}_0 + \tilde{\rho}_1 I_t\hat{\varepsilon}_{t-1} + \tilde{\rho}_2(1-I_t)\hat{\varepsilon}_{t-1} + A_{21}(L)\Delta CR_{t-i} + A_{22}(L)\Delta OR_{t-i} + u_{2t} \quad (7)$$

Where, $u_{1,2t} \sim i.i.d(0,\sigma^2)$ and the Heaviside indicator function is set in accordance with (5). This assumes that the Singaporean lending rates may respond differently depending on whether the spread is widening or narrowing as a result of expansionary monetary policy, contractionary monetary policy, or external shocks.

GARCH(s, r)-M Model

As previously mentioned, this investigation specifies and estimates the following GARCH(s, r)-in-Mean (GARCH-M) model to discern the important question that is whether the fluctuations in the spread and hence its variance from one month affect the spreads 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 path less frequently and by large policy measures or more frequently and by small policy measures because these two alternative policy actions result in different variances of the spread. It is of some interest to note that GARCH-M models have been very popular and effective for

$SP_t = 0.2368 + 1.6335DU + 0.0068t - 0.0107DT - 2.6501D(T_b) + 0.7836SP_{t-1} + \upsilon_t$ (1.132) (3.7980*) (2.4739*) (-3.2792*) (-2.7591*) (15.0181*)		
Number of augmented lags: $k = 4$	Break Date: October 1997	$t(\alpha = 1) = -4.1485$

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

Table 1: Perron's Endogenous Unit Root Test Using Singaporean Data, 1987: 07-2013:12.

modeling the volatility dynamics in many asset markets.

$$SP_t = c + \lambda\omega_t^2 + \varepsilon_t \quad (8)$$

$$\omega_t^2 = \alpha + \sum_{l=1}^{r} \beta_l \varepsilon_{t-l}^2 + \sum_{m=1}^{s} \eta_m \omega_{t-m}^2 \quad (9)$$

Where, SP_t is the spread, and ω_t^2 is its variance at time *t*; ε_t is a disturbance; c is a constant; λ , α , β_l, and β_l are the parameters to be estimated. 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.

Empirical Results

Structural break

Table 1 summarizes the results of Perron's endogenous unit root tests.

The post-break intercept dummy variable, *DU* is positive and significant at the 1 percent level. Both the post-break slope dummy variable, *DT*, and the break dummy, $D(T_b)$ are negative, and both are significant at any conventional level. The time trend, *t*, is positive and is significant at the 1 percent level. These results suggest a stationary trend process, with a break date of October 1997, for the Singaporean spread between the consumer loans rates and the overnight bank rates. This break date suggests a definite connection to the impacts of the 1997 Asian financial crisis of international dimension.

Results of breitung's nonparametric tests

Breitung's nonparametric rank tests calculates to be 0.00036423, a result that fails to reject the null hypothesis of cointegration, while the score test calculates to be 137.5402152, which rejects the null hypothesis of linear cointegration. These results show that, at all conventional levels of significance, the Singaporean consumer loans rates and the overnight bank rates are nonlinearly cointegrated.

Results of the cointegration test with asymmetric adjustment

Also, analysing the overall estimation results of the TAR model (Table 2) indicates that the estimation results are without serial correlation and have good predicting power, as shown by the Ljung-Box statistics and the overall *F*-statistics, respectively. The model confirms that the Singaporean lending- the interbank overnight rate spread is stationary, as statistic Φ_μ=10.8925 indicates that the null hypothesis of no cointegration, $\rho_1 = \rho_2 = 0$, should be rejected at the 1 percent significant level.

The results also show that both ρ_1 and ρ_2 are statistically significant at the 1 percent level. In fact, the estimation results reveal that the spread tends to decay at the rate of $|\rho_1| = 0.1409$ for $\hat{\varepsilon}_{t-1}$ above the threshold, τ = -1.3653 , and at the rate of $|\rho_2| = 0.8587$ for $\hat{\varepsilon}_{t-1}$ below the threshold. On the strength of the partial *F=11.9620,* the null hypothesis of symmetry, $\rho_1 = \rho_2$, should be rejected at the 1 percent significance level, indicating statistically asymmetric adjustments around the threshold value of the spread between the Singaporean consumer loans and the interbank overnight rates.

Specifically, the adjustment of the spread toward the long-run equilibrium tends to persist more when the spread is widening than when it is shrinking, given the finding of $|\rho_1| < |\rho_2|$. This suggests that Singaporean commercial banks react differently to rising interbank overnight rates than they do to declining interbank overnight rates. These findings may also show that these institutions react differently to expansionary monetary policy than to contractionary monetary policy, since the interbank overnight rate is itself the target of countercyclical monetary policy of the central bank. The empirical results indicate the predatory pricing behaviour of the Singaporean lending institutions. These results are consistent with those reported in advanced and emerging economies. Furthermore, these empirical findings support the aforementioned bank concentration hypothesis and the consumer characteristic hypothesis.

Results of the asymmetric error-correction model

The estimation results of the TAR-VEC model, specified by Equations (5), (6), and (7), using the Singaporean consumer loans rates and the interbank overnight rates are summarized in Table 3. Therein, $A_{ij}(L)$ is the first-order polynomial in the lag operator *L*. F_{ij} is the calculated *F*-statistic (with the p-value in brackets), which tests the null hypothesis that all coefficients of A_{ij} are equal to zero. $Q_{(4)}$ is the Ljung-Box statistic (with its significance in brackets), which tests whether the first four of the residual autocorrelations are both equal to zero. *ln L* is the log likelihood.

The empirical results suggest that the estimated equations (6) and (7) are without serial correlation and have good predicting power, as shown by the Ljung-Box statistics and the overall *F-statistic*, respectively. The estimation results of equation (6) of the TAR-VEC model indicate that ρ_1 is insignificant at conventional level while ρ_2 is significant at any conventional level. This finding shows that the Singaporean consumer loans rates respond to the spread only when it narrows, but not when it widens in the long run when the short-run dynamic is introduced to the model. These empirical findings suggest that Singaporean lending institutions respond only to the contractionary monetary policy, but not to the expansionary policy actions in the long run. Regarding the long-term adjustment of the interbank overnight rates, the estimation results of Equation (7) show that $\widetilde{\rho}_1$ is statistically insignificant at any level, while $\widetilde{\rho}_2$ is significant the 10 percent level (Table 3).

In addition to estimating the long-run equilibrium relationship and asymmetric adjustment, the estimated TAR-VEC model also allows for determinations of the Granger causality between the Singaporean

ρ_1	ρ_2	τ	$H_0 : \rho_1 = \rho_2 = 0$	$H_0 : \rho_1 = \rho_2$	aic	sic
-0.1409*	-0.8587*	-1.3653	Φ_μ=10.8925*	F=11.9620*	-0.0187	-0.0527
$Q_{LB\ (4)}$=8.3330[0.0801]			ln L=-438.0195	$F_{(5,309)}$=34.0402*	D.W.=2.0286	

Notes: The null hypothesis of a unit root, $H_0 : \rho_1 = \rho_2 = 0$, uses the critical values from Enders and Siklos (2001). "*" indicates 1 percent 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's (1993) method. $Q_{LB\ (4)}$ denotes the Ljung-Box Q-statistic with four lags.

Table 2: Unit Root and Tests of Asymmetry, Singaporean Data, 1987:07- 2013:12.

$$\Delta CR_t = -0.0119 - 0.0116 I_t \hat{\varepsilon}_{t-1} - 0.0217(1-I_t)\hat{\varepsilon}_{t-1} + A_{11}(L)\Delta CR_{t-i} + A_{12}(L)\Delta OR_{t-i} + u_{1t}$$

(-1.4928) (-1.5594) (-2.8496*) F_{11}= 7.3257[0.0008] F_{12}=4.8295[0.0086]

$Q_{(4)}$ = 0.3260[0.9881] *ln L* = 231.1479 $F_{(6,299)}$-*statistic* =5.9393*

$$\Delta OR_t = -0.0439 + 0.0620_t \hat{\varepsilon}_{t-1} + 0.1191(1-I_t)\hat{\varepsilon}_{t-1} + A_{21}(L)\Delta CR_{t-i} + A_{22}(L)\Delta OR_{t-i} + u_{2t}$$

(-0.7010) (0.9809) (1.9090**) F_{21}=4.9043[0.0080] F_{22}=30.4235[0.0000]

$Q_{(4)}$ =0.3870 [0.9835] *ln L* = -394.1714 $F_{(8,293)}$-*statistic* =27.5286*

Note: "*" and "***"indicate 1 percent and 10 percent levels of significance.

Table 3: Singaporean Consumer loans and Interbank Overnight Rates, Data, 1987:07- 2013:12.

$$SP_t = 5.226235 - 0..139888\omega_t^2 + \varepsilon_t$$

(240.4430*) (-5.088944*)

$$\omega_t^2 = 0.089951 + 0.404989\varepsilon_{t-1}^2 + 0.5396892\varepsilon_{t-2}^2 + 0.338992\varepsilon_{t-3}^2$$

(2.261845**) (3.826279*) (3.513315) (4.427333*)

$$-0.919570\omega_{t-1}^2 + 0.113703\omega_{t-2}^2 + 0.574480\omega_{t-3}^2$$

(-10.96169*) (1.191068) (11.61947*)

Notes: Akaike info criterion=3.230618; Schwarz criterion=3.337092; Hannan-Quinn Criterion =3.273144; Log likelihood=-504.6683; Durbin-Watson Statistic=0.552986. "*" and "**" indicate the 1 percent and 5 percent levels of significance.

Table 4: GARCH (3, 3)-M Model Results, Singaporean Data, 1987:07-2103:12.

consumer loans rates and interbank overnight rates. Equation (6) reveals in the partial *F*-statistic that the consumer loans rate responds to the lagged changes in the interbank overnight rate, and to its own lagged changes. Similarly, the estimation results show that the interbank overnight rate responds to lagged changes of the consumer loans rates and its own lagged changes. These findings suggest a bidirectional Granger-causality between the Singaporean consumer loans rate and the interbank overnight rate and reveal that the Singaporean consumer loans rate and the interbank overnight rate affect the movements of each other's rates in the short run in the sample period.

GARCH(s, r)-M model

As aforementioned, the retentions of the estimated coefficients of equations (7) and (8) 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 which are *l*=3 and *m*=3, respectively. The values of *l* and *m*, in turn, suggest GARCH (3, 3) be the best model for this investigation**.** The estimation results of the GARCH (3, 3)-M model are reported in Exhibit 4.

An analysis of the estimation results of the GARCH(r, s)-M model suggests the presence of the GARCH (3, 3) effect on the Singaporean consumer loans-interbank overnight rate spread and its variance. Financially, the empirical results indicate that the fluctuations in the Singaporean spread between the consumer loans rate and the interbank overnight rate, and hence its variance from the one month affects the spread and the variances in the subsequent months (Table 4).

Concluding Remark and Policy Implications

This study investigates the behaviour of the Singaporean consumer loans rate, the interbank overnight rate and their spread over the sample period, by estimating the threshold autoregressive (TAR) model developed by Enders and Siklos.

First, the study tested the hypothesis that the Singaporean spread has a unit root by specifying and estimating Perron's endogenous unit root test function with the intercept, slope, and trend. This test suggested that the spread followed a stationary trend process with a structural break in October 1997. This break date suggests a definite connection to the impacts of the 1997 Asian financial crisis of international dimension.

Second, the study tested whether the Singaporean consumer loans rates and the interbank overnight rates are linearly and/or nonlinearly cointegrated. Breitung's nonparametric rank tests reveal nonlinear cointegration at all conventional levels of significance.

Third, the estimation results of the TAR model reveal that Singaporean commercial banks react differently to rising versus declining interbank overnight rates. These findings suggest that these institutions react differently to expansionary monetary policy than to contractionary. Furthermore, these results on asymmetric responses reveal the predatory pricing behaviour of the Singaporean lending institutions. These results are consistent with those reported in advanced and emerging economies. Furthermore, these empirical findings support the aforementioned bank concentration hypothesis and the consumer characteristic hypothesis.

Finally, the study tested for Granger causality between the consumer loans rate and the interbank overnight rate in the short run by the empirical estimation of the TAR-VEC model. The testing results revealed bidirectional Granger causality, and indicate that the consumer loans rate and the interbank overnight rate affect each other's movement in the short run. The finding also reveals asymmetric responses of financial markets to contractionary and expansionary monetary policy actions, and suggests the ability of the Singaporean monetary authority to use its countercyclical monetary policy instruments to alter the banks' lending rate. However, the GARCH(3,3)-M model results suggest that monetary policymakers should intervene to bring the economy to its long-term trend more frequently and by small policy

measures to minimize the conditional variance of the intermediation premium and to minimize the magnitude of the cycle of the consumer loans rate.

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Citation: Nguyen CV, Ali MM, Penkar S (2015) Asymmetric Adjustment in the Singaporean Consumer Loans-Interbank Overnight Rate Spread and Conditional Heterokedasticity. Bus Eco J 6: 144. doi:10.4172/2151-6219.1000144