Full Length Research Paper

The asymmetric adjustment between lending-deposit rates in G8 countries: Evidence from rank test

Hui-Lung, Chang[1], Long, Chen[2], Chi-Wei, Su[2,3]* Meng-Nan, Zhu[2] and Yu-Shao, Liu[2]

[1]Department of Money and Banking, National Cheng Chi University, Taiwan
[2]Department of Finance, Xiamen University, China.
[3]Department of International Business, Tamkang University, Taichung, Taiwan.

Using the non-parametric rank tests proposed by Breitung (2001), we set out in this study to determine whether any non-linear long-run equilibrium relationship exists between the lending and deposit rates of G8 countries. We go on to adopt the Threshold Error-Correction Model (TECM) to determine whether a similar relationship is discernible possibly non-linear functions of the lending and deposit rates. These findings clearly point that there are indeed such long-run non-linear cointegration relationships between the lending and deposit rates and successfully capture the dynamic adjustment in G8 countries.

Key words: Lending-deposit rates, rank test, asymmetric adjustment.

INTRODUCTION

The financial sector plays a crucial role in the operation of most economies, as it provides intermediation between borrowers and lenders of funds. Financial intermediaries are efficient institutions for channeling funds from savers to borrowers; they can affect investment decisions and economic growth. Banks can adjust the lending and deposit rate to influence the amount of the deposits and loan. Adjustment of interest rate will affect the spread set and relationship between the bank's profitability and operating. However, a Central Bank usually achieves its economic targets through its manipulation of the mone-tary markets, with the implementation of its monetary policy having direct effects on the country's interest rates. The transmission mechanism of monetary policy includes both credit and monetary transmission pipeline mecha-nisms, with the transmission of credit affecting the len-ding rate, and the monetary pipeline affecting the deposit rate (Arden et al., 2000). When the Central Bank adjusts the interest rate, they hope banks also adjust their lending

also adjust their lending and deposit rate at the same time that will increase the money supply of financial market.

Especially economic slump is started from the financial tsunami in 2008, central banks drive their policy rates to virtually zero. The commercial banks face the "floors" of managed rate that interest rate adjustment should be asymmetry. Most recently, empirical research into non-linear asset price dynamics has become a growth area over the recent past, and interest has focused on whether there is non-linear adjustment back to an equilibrium con-dition. Diebold and Sharpe (1990) and Hutchison (1995) refer to a common phenomenon amongst banks, which suggests that when policymakers announce that there is to be an adjustment to the interest rate, the banks may actually adjust their lending rates asymmetrically; that is, there may be a tendency for them to raise their lending rates much more rapidly when market interest rates are rising, as compared to the speed at which they are prepared to lower the lending rates with a decline in the market rate. This asymmetric relationship between lending rates and money market rates has been studied extensively. For example, Cover (1992), Rhee and Rich (1995), Karras (1996) have documented the asymmetry effects what downward-sticky lending rates could mini-mize the effect of expansionary monetary policy. Arden et

---

*Corresponding author. E-mail: cwsu@mail.tku.edu.tw. Tel: +886-422920677.

expansionary monetary policy. Arden et al. (2000) find the asymmetry in the effects of monetary policy in both the direction of the shock and the particular phase of the business cycle when relaxing the assumptions of linearity and symmetry. The behavior of the Prime does depend upon the direction of interest rates; it might indicate extra market forces such as oligopolistic behavior (Goldberg, 1984). According to Chatrath et al. (1997), evidence from the error correction model suggests that the US and Germany are the dominant countries in the bank lending and borrowing markets. The Prime and Certificate of Deposit rates for these countries are seen to cause (in the Granger sense) the rates of other countries. Tkacz (2001) find that the responsiveness of prime to changes in the Federal Funds rate is relatively symmetric, but that the speed of adjustment of prime is faster when there is a substantial deviation from the equilibrium relationship linking these rates. The results would confirm that lending markets are competitive in the US, and that monetary policy actions are readily transmitted to lending rates. Thompson (2006) utilizes asymmetric error correction models further indicate that only the prime lending rate adjusts to discrepancies in the spread and not the 1-month certificate of deposit rate. Thus, policymakers need to be aware that monetary policy may have differing effects due to these asymmetries in the banking industry.

In fact, banks may set their prime lending rates as some mark up relative to deposit rates. If this "mark up" becomes too high or low, the marketplaces will put pressure on the banking industry to adjust back to some "normal" or equilibrium spread. The equilibrium spread is supported by the Ewing et al. (1998) who find the spread between the prime lending and deposit rate are stationary. Specifically, stationary implies that the spread returns will recover to its long run equilibrium position following a shock. If banks have market power, they could gain above-normal profits by slowly adjusting their lending rates to falling deposit rates, even though that is unfair to common people. Although Dueker (2000) argues that banks are unlikely to lower their lending rates during cyclical downturns due to the higher risk of default. This risk adverse behavior of banks and their managers may result in lending rates adjusting asymmetrically to movements in market rates.

Although, Ho and Saunders (1981), McShane and Sharpe (1985), Allen (1988), all assume that variables are linear and symmetric of spread model. Laxton et al. (1993) proves that when economic variables are nonlinear and asymmetrical whereas using linear and symmetrical method to test that would have low power. However, it is difficult for the linear model to capture the character of dynamic adjustment behavior and have spurious regression if a non-linear adjustment relation-ship exists (Sarno and Chowdhury, 2003). Pippenger and Goering (1993), Balke and Fomby (1997) and Enders and Granger (1998) show that tests implicitly assume a linear adjustment mechanism for unit-roots and co-integration all have low power in the presence of presence of asymmetric adjustment.

It is, nevertheless, clear that the theory is not always capable of providing any precise specification of the functional form, such that non-parametric tools for use in estimation and inference are clearly desirable. The majority of the models adopted in the prior empirical studies addressing the issue of equilibrium have generally failed to take into account the non-linear properties of the adjustment process in the lending-deposit spread; however, as noted by Laxton et al. (1993), both bias and mistakes are increasingly likely when a linear and symmetrical methodology is adopted to test economic variables that are non-linear and asymmetric.

It is worth noting that in the non-linear evidence referred to in this studies, the tendency has been to adopt parametric residual-based tests in a cointegrational approach to the testing of the relationship between lending and deposit rates. The present study differs from these earlier examples by providing non-linear cointegrational evidence on G8 countries based on the non-parametric rank tests developed by Breitung (2001), which demonstrate power in both linear and non-linear frameworks, and which are also applicable to whatever the data generating process of the variables under examination. In contrast, parametric testing procedures assume that the data generating process is already known in advance; and thus, there is some danger of misspecification if the wrong parametric models are used to characterize the variables of interest.

The motivation for such non-linearlity can be found in policy-orientated explanations, whereby, central bank intervention only takes place when the economy deviates from equilibrium by a sufficient amount, and that the nature of such policy action may differ depending upon the sign of disequilibrium, with central banks paying more attention to rising interest rates than falling rates due to their different implication. Furthermore, market-orientated explanations could also provide a rationale for non-linear dynamics, whereby market agents, such as arbitrageurs, may only enter the market if the deviation from no-arbitrage equilibrium is sufficiently large to compensate for market frictions, such as transaction costs, the bid-ask spread, short-selling and borrowing constraints, and risk arising from the interaction with noise trader.

The aim of the present study is to examine whether the lending-deposit spreads of G8 countries have non-linear long-run relationships towards equilibrium using rank tests. The G8 countries are the world's most powerful industrial countries and the G8 Summit has consistently dealt with macroeconomic management, international trade with developing countries.

Thus, this present empirical study contributes significantly to this field of research. We go on to apply asymmetric error-correction models to describe the short-term dynamic adjustments to the lending-deposit spreads of these G8 countries, which may serve as a guideline for macro policy.

DATA AND METHODOLOGY

Co-integration and non-linearity rank test

As our preferred alternative to the linear residual-based cointegration tests, we employ the cointegration test based specifically on the Breitung (2001) time-series rank transformation. In specific terms, in order to test for non-linear cointegration between two time series, y_t and x_t, we consider the following slightly more general form:

$$\varepsilon_t = g(y_t) - f(x_t),$$

where $g(y_t) \sim I(1)$, $f(x_t) \sim I(1)$ and $\varepsilon_t \sim I(0)$.

Breitung (2001) has since demonstrated that residual-based linear cointegration tests are inconsistent for some classes of non-linear functions (Sargan and Bhargava, 1983; and Phillips and Oularis, 1990). In order to overcome this problem, Breitung proposed a co-integration test based on the rank transformation of the time series. Such rank transformation enables us to get away from the specific functional forms of the cointegrating relationship. One particular advantage of these rank tests is that there is no requirement to be explicit with regard to the exact functional form of the non-linear cointegrating relationship.
   Breitung (2001) considers $f(x_t)$ to be a non-linear function of x_t, as suggested in recent economic theory. Breitung (2001) defines the ranked series as:

$$R(w_t) = \text{Rank of } w_t \text{ among } (w_1, w_2, \ldots, w_T), \qquad (1)$$

where $w = \{y, x\}$.

The basic idea behind these rank tests is that if there is co-integration between the two series, y_t and x_t, the rank sequences tend to have similar evolutionary paths; otherwise the sequences of the ranks will tend to be divergent. The null hypothesis of no (non-linear) cointegration between y_t and x_t is rejected if these tests statistics are found to be smaller than their respective critical values.

Breitung (2001) developed the following test statistics, in which y_t and x_t are considered to be mutually series-correlated random walks:

$$\psi_T = \frac{\sum_{t=1}^{T} d_t^2}{T^3 \widehat{\sigma}_{\Delta d}^2} \qquad (2)$$

where $d_t = R(y_t) - R(x_t)$, for $R(w_t) = \text{Rank of } w_t \text{ among } (w_1, w_2, \ldots, w_T),$ where $w = \{y, x\}$. Meanwhile, $\widehat{\sigma}_{\Delta d}^2 = T^{-2} \sum_{t=1}^{T} (d_t - d_{t-1})^2$ are used to adjust for the potential correlation between the two series under examination.

The null hypothesis of no (non-linear) cointegration between y_t and x_t is rejected if these test statistics are found to be smaller than their respective critical values. The Monte Carlo experiments in Breitung demonstrated a property of superior power in the rank tests, not only in the non-linear case, but also in the linear case.
   Whenever the rank test for integration indicates a stable long-run relationship, it is of interest to determine whether the cointegrational relationship is linear or non-linear. Breitung (2001) further

suggested a score test statistic $T \cdot R^2$ computed from the following regression:

$$\widetilde{\varepsilon}_t = a_0 + a_1 x_t + a_2 R(x_t) + e_t \qquad (3)$$

where T is the sample size, R^2 is the coefficient of determination of Equation (3) and $\widetilde{\varepsilon}_t$ stands for the residual from regressing y_t on a constant and x_t.

Under the null hypothesis, the test statistic is distributed as χ^2 with one degree of freedom. The Monte Carlo simulations carried out by Breitung (2001) show that, for a wide range of non-linear models, the rank tests perform better than their parametric counterparts.

RESULTS AND DISCUSSION

The data used in this study comprises of monthly observations on the lending rate (LR) and the one-month certificate of the deposit rate (DR) between 1998 and 2009. There are two economic recession downturns occurred over this period in 2001 and 2008. The data are collected from the International Financial Statistics (IFS).

Cointegration and non-linear tests

The results of the tests estimated in this study are summarized in Table 1. As is clearly shown by the ψ^* statistic in Table 1, the null hypothesis is rejected for all G8 countries examined in this study, since the test statistics are smaller than the conventional critical values at the 1 and 5% level of significance. As such, according to the ψ^* statistic, we observed cointegrating relationships between the lending and deposit rates for all G8 countries. Based upon the cointegrational relationships previously identified, it is possible to go on to distinguish between non-linear and linear cointegration using the rank sum linearity test of Breitung (2001). Thus, the rank sum linearity test results to the $T \cdot R^2$ also clearly indicate that the cointegrating relationships can be said to be non-linear.

Threshold error-correction models

Following the positive finding of a non-linear equilibrium relationship, we use the asymmetric threshold error-correction model (TECM) to capture the short-run and long-run dynamic adjustment process with regard to the lending rate $(LR)_t$ and the deposit rate $(DR)_t$ of the G8 countries. We apply the 'Akaike Information Criterion' (AIC) to determine the appropriate lag lengths, with the estimated coefficients determining the speed of adjustment for positive and negative deviations from fundamental value. We specify and estimate the asymmetric error-correction model with regard to the lending and deposit rates, and the asymmetric TECM, for the case of Canada, as follows:

Table 1. Results of the cointegration and non-linearity rank tests.

Country	Rank Test[a]		Linearity Test[b]	
	ψ^*		$T \cdot R^2$	
Canada	0.0160	**	3.3193	*
France	0.0097	***	3.0582	**
Germany	0.0089	***	8.7561	***
Italy	0.0136	**	3.9873	**
Japan	0.0086	***	6.5605	**
Russia	0.0107	***	10.0490	***
UK	0.0178	**	3.3128	*
US	0.0134	**	9.9497	***
Critical Value (%)				
10	0.0232		2.71	
5	0.0188		3.84	
1	0.0130		6.63	

[a] The rank test is adjusted for autocorrelation. The null hypothesis of the rank test is that no cointegration exists between the lending rate and the deposit rate of the one-month certificate; the alternative hypothesis is that cointegration does exist between the two rates. The null hypothesis is rejected when the critical value exceeds the test statistic. [b] The null hypothesis of the linearity test is that a linear relationship exists with no cointegration between the lending rate and the deposit rate of the one-month certificate; the alternative hypothesis is that a linear relationship does not exist and cointegration does exist between the two rates. The null hypothesis is rejected when the computed t-R2 value exceeds the critical value. [c] *** indicates significance at the 0.01 level; ** indicates significance at the 0.05 level; and * indicates significance at the 0.1 level.

$$\Delta LR_t = \underset{(0.289)}{0.004} - \underset{(-0.052)}{0.035} Z_{t-1}^+ + \underset{(0.271)}{0.015} Z_{t-1}^- + \sum_{i=1}^{k_1} \delta_i \Delta LR_{t-i} + \sum_{i=1}^{k_2} \theta_i \Delta DR_{t-i} + \varepsilon_t \tag{4}$$

$$\Delta DR_t = \underset{(-0.966)}{-0.014} - \underset{(-2.899)***}{0.186} Z_{t-1}^+ - \underset{(-1.542)}{0.958} Z_{t-1}^- + \sum_{i=1}^{k_1} \delta_i \Delta LR_{t-i} + \sum_{i=1}^{k_2} \theta_i \Delta DR_{t-i} + \varepsilon_t \tag{5}$$

where LR_t and $\hat{DR}_t$ denote the lending and deposit rates. $Z_{t-1}^+ = h_t \hat{k}_{t-1}$, $Z_{t-1}^- = (1 - h_t) \hat{k}_{t-1}$ such that $h_t = 1$ if $k_{t-1} \geq \tau$, $h_t = 0$ if $k_{t-1} < \tau$ and ε_t is a white-noise disturbance. The estimation results for the TECM in Equation (4) indicate that there is a much larger lending rate when the lending-deposit spread is widening, for example, during an economic downturn when there is a fall in the market rate, as compared to the response to a narrowing spread; during an economic upturn when there is a rise in the market rate. This indicates that for Canada and Italy, the lending rate adjusts much more rapidly with a widening spread than when the spread is narrowing; in other words, the lending rates of these countries adjust more rapidly under a declining market rate than under an increasing market rate.

Furthermore, for France, Germany, Japan, Russia, UK and US, we find that the speed of adjustment in the lending rate is much more rapid under a narrowing spread than when the spread is widening. That is, the speed of adjustment in the lending rate for these countries is much more rapid when the market rate is rising, than when it is declining. However, we find that for the France, Germany, Russia, UK and US, the deposit rate adjusts more rapidly when the spread is widening than when it is narrowing. Furthermore, for Canada, Italy and Japan, the speed of adjustment is found to be much more rapid under a narrowing spread than when the spread is widening. All of the results of the TECM are presented in Table 2.

We find that for France, Russia, UK and US, the deposit rate adjusts more rapidly when the spread is widening than when it is narrowing. Furthermore, for Canada, Italy and Japan, the speed of adjustment is found to be much more rapid under a narrowing spread than when the spread is widening. In the entire empirical results where there is statistically significant asymmetric adjustment, the evidence suggests that there is rigidity in deposit rate when there is a change in the interest rate for upward adjustment. This confirms the evidence of rate

Table 2. The results of asymmetric threshold error correction model.

Country	Lending/ Deposit rate	Z_{t+1}		Z_{t-1}	
		Coeff.	t-statistic	Coeff.	t-statistic
Canada	$\Delta(LR)_t$	-0.035	-0.052	0.015	0.271
	$\Delta(DR)_t$	-0.186	-2.889***	-0.958	-1.452
France	$\Delta(LR)_t$	-0.021	-0.525	0.054	0.229
	$\Delta(DR)_t$	-0.832	-7.541***	-0.042	-1.580
Germany	$\Delta(LR)_t$	-0.031	-1.538	-0.065	-0.926
	$\Delta(DR)_t$	-0.065	-1.106	-0.025	-0.006***
Italy	$\Delta(LR)_t$	-0.256	-3.345***	-0.010	-0.333
	$\Delta(DR)_t$	0.021	-0.964	0.033	0.650
Japan	$\Delta(LR)_t$	0.016	1.617	-0.046	-4.056***
	$\Delta(DR)_t$	-0.044	-0.944	-0.087	-3.130***
Russia	$\Delta(LR)_t$	-0.152	-5.527***	-0.375	-5.655***
	$\Delta(DR)_t$	-0.373	-2.875***	-0.120	-2.159**
UK	$\Delta(LR)_t$	-0.019	-1.243	0.036	0.338
	$\Delta(DR)_t$	-0.882	-11.843***	-0.019	-0.561
US	$\Delta(LR)_t$	-0.036	-1.088	0.731	4.565***
	$\Delta(DR)_t$	-1.469	-8.085***	0.012	0.259

[a] LR denotes the lending rate; and DR denotes the deposit rate of the one-month certificate. [b] The ***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels, respectively.

spread to their long run equilibrium levels in developed market economies. These findings recognize that the banking systems across G8 countries differ enormously. For example, bank-based financing is much more prevalent in a country like Germany than it is. In the United States, where market financing tends to dominate.

It is argued that any persistent asymmetry in the short-term lending-deposit spread will result in inefficient monetary policy, ultimately leading to a failure to achieve policy targets. Thus, if the central banks of these countries wish to make their monetary policy more efficient, they must create the necessary symmetry in the lending-deposit spread; this is why the stable long-run relationship between the lending and deposit rates serves as an appropriate guideline for macro policy.

Conclusions

This study aims to empirically investigate the long-run equilibrium relationships that exist between the lending-deposit spreads of G8 countries using the non-linear rank tests developed by Breitung (2001). The adoption of this methodology provides much stronger evidence of long-run non-linear equilibrium relationships. Furthermore, the asymmetric TECM also indicates that the lending rate adjusts to discrepancies in the spread for virtually all of these G8 countries.

The evidence of asymmetric adjustment in the spread found in this study provides support for the hypothesis that banks are very quick to adjust their lending rates when the spread is widening (for example, during a period

of economic downturn when there is a fall in the market rate) and may also explain the diverse effects that monetary policy has on output. We find that for these G8 countries, the adjustment process of the lending and deposit rate is asymmetric. These findings offer new evidence in support of the existence of long-run relationships in the lending-deposit spread, with asymmetric adjustment, in the G8 countries examined in this study. The estimated model in this study can provide useful policy guidelines for the central banks of these G8 countries in their attempts to achieve much more spread stability, and a narrowing of the divergence between the lending and deposit rates. The policy implications of the empirical results are that to achieve the efficiency of the market economy.

REFERENCES

Allen L (1988). The Determinants of Banks Interest Margins: A Note. J. Financ. Quant. Anal., 23: 231-235.

Arden R, Cook S, Holly S, Turner P (2000). The Asymmetric Effects of Monetary Policy: Some Results from A Macroeconometric Model. The Manchester School, 68: 419–441.

Balke S, Fomby T (1997). Threshold Cointegration. Int. Econ. Rev., 38: 624-643.

Breitung J (2001). Rank tests for nonlinear cointegration. J. Bus. Econ. Stat., 19: 331-340.

Chatrath A, Ramachander S, Song F (1997). International Linkages in Bank Lending and Borrowing Markets: Evidence from Six Industrialized Countries. Appl. Financ. Econ., 7: 403–411.

Cover J (1992). Asymmetric Effects of Positive and Negative Money Supply Shocks. Q. J. Econ., 107: 1260–1282.

Diebold F, Sharpe S (1990). Post-Deregulation Bank Deposit Rate Pricing: The Multivariate Dynamics. Journal of Business and Economic Statistics, 8: 281–293.

Dueker M (2000). Are Prime Rate Changes Asymmetric? Federal Reserve Bank of St. Louis, 82: 33–40.

Enders W, Granger C W J (1998). Unit Root Tests and Asymmetric Adjustment with an Example Using the Term Structure of Interest Rates. J. Bus. Econ. Stat., 16: 304–311.

Ewing B, Payne J, Forbes S (1998). Co-movements of the Prime Rate, CD Rate, and the S&P Financial Stock Index. J. Financ. Res., 21: 469–482.

Goldberg M (1984). The Sensitivity of the Prime Rate to Money Market Conditions. J. Financ. Res., 7: 269–280.

Ho Y, Saunders A (1981). The Determinants of Bank Interest Margins: Theory and Empirical Evidence. Journal of Financial and Quantitative Analysis, 16: 581-600.

Hutchison D (1995). Retail Bank Deposit pricing: An Intertemporal Asset Pricing Approach. Journal of Money, Credit Bank., 27: 217–231.

Karras G (1996). Are the Output Effects of Monetary Policy Asymmetric? Evidence from a Sample of European Countries. Oxford Bull. Econ. Stat., 58: 267–278.

Laxton D, Rose D, Tetlow R (1993). Is the Canadian Phillips Curve Non-linear? Bank of Canada Working paper, 93-7.

McShane W, Sharpe IG (1985). A Time Series/Cross section Analysis of The Determinants of Australian Trading Bank Loan/Deposit Interest margins: 1962-1981. J. Bank. Finance, 9: 115-136.

Phillips PCB, Oularis S (1990). Asymptotic properties of residual based tests for cointegration. Econometrica, 58: 165-193.

Pippenger K, Goering E (1993). A Note on the Empirical Power of Unit Root Tests Under Threshold Processes. Oxford Bull. Econ. Stat,, 55: 473-481.

Rhee W, Rich R (1995). Inflation and the Asymmetric Effects of Money on Output Fluctuations. J. Macroecon., 17: 683–702.

Sargan JD, Bhargava A (1983). Maximum likelihood estimation of regression models with first order moving average errors when the root lies on the unit circle. Econometrica, 51: 799-820.

Sarno L, Chowdhury I (2003). The behaviour of the real exchange rate: evidence from an alternative price index. Econ. Notes, 32: 295-333.

Stock JH, Watson MW (1993). A simple estimator of cointegrating vectors in higher order integrated systems. Econometrica, 61: 783-820.

Thompson MA (2006). Asymmetric Adjustment in the Prime Lending-Deposit Rate Spread. Rev. Financ. Econ., 15: 323-329.

Tkacz G (2001). Endogenous Thresholds and Tests for Asymmetry in US Prime Rate Movements. Econ. Lett., 73: 207–211.