Kuan-Min Wang (Taiwan), Thanh-Binh Nguyen Thi (Taiwan), Shu-Hui Wu (Taiwan)

Dynamic hetero-risk: the major determinant of loan rate pass-through mechanism in Taiwan

Abstract

This study investigates the existence of interest pass-through mechanism of Taiwan within the asymmetric threshold cointegration framework. The empirical results provide a robust evidence of the asymmetric cointegration relationship between money market rate and loan rate when the dynamic hetero-risk is regarded as an indicator variable. Therefore, it is possible to infer that the interest hetero-risk determines whether the asymmetric interest pass-through mechanism exists in Taiwan's monetary market.

Introduction

The pass-through process of interest plays an important role in monetary policy. The interest rate "pass-through" is defined as the transference of official rate to retail rates. Central bank adjusts official rates according to business cycle volatility, which is followed by correction of market rates among banks. Banks, then, transfer the change of market rates to retail rates. If this adjusted rate is transferred completely to retail rates, this is called a complete pass-through. However, banks are unable to immediately transfer this extra rate to retail rates because of their contract maturities, financial structure, or operating system. In general, one part of rate is borne by customers; the other part is passed through markup on fixed rates that might be different among banks. Hence, the pass-through of market rates to retail rates is not 1:1 proportion, in other words, it is a non-complete pass-through.

The pass-through process of market rates to retail rates differs among countries based on their economic policy and control power. There are many factors that influence this process, such as economy cycle, short-run disequilibrium caused by asymmetric information and risk of interest rate and so on. Therefore, retail rates are unable to completely reflect the changes of official rate. Accordingly, the asymmetric pass-through process appears.

"Asymmetric interest rate pass-through" is a common term used to describe, as stated in Sander and Kleimeier (2002, 2004), the influence of error variation on adjustment of banking retail rates. If the variation of error values does not affect the adjustment of retail rates and mean-reverting process is symmetry, the pass-through process is referred to as symmetry. However, we consider that the asymmetric pass-through process is influenced by the dynamic hetero-risk rather than long-run error variation. Horváth et al. (2004) first discover the asymmetric adjustment of interest risk effect on interest

pass-through which, in our opinion, also exists in Taiwan. To verify this inference, we further expand the idea of Horváth et al. (2004) with belief that the risk variation causes the asymmetric adjustment.

It might be considered what the dynamic hetero-risk of interest is? For simplification, when the Central Bank changed its interest charge, banks would try to pass this charge partly through loan rate. For maximizing profits, banks might immediately increase loan rate along with additional charge, but might slowly reduce loan rate along with subtractive charge. In other words, the adjustment of loan rate might be asymmetric. Hence, loan rate heterogeneously responses to a change of interbank rate. Besides, the credit risk also causes the rigidity in loan rate in short run because banks adjust loan rate based on credit history that can help to make inferences about the risk of customers. The asymmetric reaction to interbank rate adjustment and unstable credit criterion get the loan rate full of uncertainty. Therefore, loan rate risk is no longer a homo-risk; it becomes a hetero-risk with time-varying.

The focus of this study is the interest pass-through from market rate to loan rate and its characteristics. The first research question is whether the relationship between market rate and loan rate is an asymmetric cointegration. We apply the long-run error variation as well as the hetero-risk to answer it. The second research question is whether the adjustment of deviating loan rate occurred in the short run is rigid. When the asymmetric cointegration and the rigidity of loan rate adjustment are shown to be sustained by empirical results, the asymmetric adjustment of pass-through mechanism should exist in Taiwan. Our empirical results reveal that the information of interest risk changes leads to the asymmetric cointegration between loan rate and market rate; it also causes the downward rigidity of loan rate in the short run.

The rest of the paper is organized as follows. Section 1 explains the methodology. Section 2 presents the empirical results, and conclusion is in the last section.

1. Methodology

We employ threshold autoregressive (TAR) and momentum threshold autoregressive (MTAR) model introduced by Enders and Siklos (2001) for testing the long-run relationship between market rate and loan rate. We investigate the pass-through degree by estimating the model of long-run relationship between loan rate and market rate:

$$li_t = \beta_0 + \beta_1 mi_t + e_t, \qquad (1)$$

where mi represents the market rate, and li represents the loan rate. β_0 denotes the markup on a fixed loan rate. β_1 is the pass-through degree of interest rate, e_t is error term. In order to test for the cointegration between variables, we test for unit-root of e_t.

$$\Delta e_t = \rho e_{t-1} + \varepsilon_t. \qquad (2)$$

ε_t is considered as a white noise process. When $-2 < \rho < 0$, the long-run relationship of symmetric stationarity exists presented in Engle and Granger (1987). The symmetric assumption should lead to a wrong model if long-run relationship is asymmetric stationarity. To overcome this problem, the necessary assumption is that the long-run equilibrium error is the signal source of asymmetric adjustment. Then, the TAR and MTAR models are developed and presented in Enders and Siklos (2001) to analyze the equilibrium adjustment of asymmetric stationarity. TAR model is described as follows:

$$\Delta e_t = I_t \rho_1 e_{t-1} + (1 - I_t)\rho_2 e_{t-1} + \varepsilon_t. \qquad (3)$$

I_t of equation (3) is an indicator variable, it means:

$$I_t = \begin{cases} 1 & if \quad e_{t-1} \geq \tau \\ 0 & if \quad e_{t-1} < \tau \end{cases}. \qquad (4)$$

MTAR is described as follows:

$$\Delta e_t = M_t \rho_1 e_{t-1} + (1 - M_t)\rho_2 e_{t-1} + \varepsilon_t. \qquad (5)$$

The indicator variable M_t is selected as stated in equation (6):

$$M_t = \begin{cases} 1 & if \quad \Delta e_{t-1} \geq \tau \\ 0 & if \quad \Delta e_{t-1} < \tau \end{cases}. \qquad (6)$$

Because the interest payment is yearly, the standard deviation of rolling average of 12 month loan rate is calculated as $\sigma_t = [\sum_{t=s+1}^{s+12} (y_t - \overline{y})/11]^{0.5}$, $s = 0, ..., N - 12$, where N presents observations. In order to measure the dynamic interest risk with indicator variable σ_t, equations (4) and (6) are modified as:

$$I_t = \begin{cases} 1 & if \quad \sigma_{t-1} \geq \tau \\ 0 & if \quad \sigma_{t-1} < \tau \end{cases}, \qquad (7)$$

$$M_t = \begin{cases} 1 & if \quad \Delta\sigma_{t-1} \geq \tau \\ 0 & if \quad \Delta\sigma_{t-1} < \tau \end{cases}. \qquad (8)$$

For simplification, model using e_{t-1} as indicator variable is named model 1, model using σ_{t-1} as indicator variable is named model 2.

In models 1 and 2, if equations (3) and (5) are autocorrelation, TAR and MTAR can be corrected as:

$$\Delta e_t = I_t \rho_1 e_{t-1} + (1 - I_t)\rho_2 e_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta e_{t-j} + \varepsilon_t, \qquad (9)$$

$$\Delta e_t = M_t \rho_1 e_{t-1} + (1 - M_t)\rho_2 e_{t-1} + \\ + \sum_{j=1}^{p} \gamma_j \Delta e_{t-j} + \varepsilon_t. \qquad (10)$$

The sufficient condition for $\{e_t\}$ being stationary is the satisfaction with $-2 < (\rho_1, \rho_2) < 0$. We follow the test for the asymmetric threshold cointegration with Φ-statistic. The Φ-statistic tests for the null hypothesis $\rho_1 = \rho_2 = 0$ with F-distribution. If the null hypothesis is rejected, then there exists cointegration. Thus, F- test could be further utilized to investigate if the null hypothesis ($\rho_1 = \rho_2$) is true. If the null hypothesis of symmetric adjustment is accepted, the long-run relationship between variables is symmetric and we back to results of Engle-Granger cointegration test. If the null hypothesis $\rho_1 = \rho_2$ is rejected, the existence of a long-run asymmetric cointegration is verified. In addition, we employ the method of Chan (1993) to estimate the threshold value τ. When using the Φ statistic for test, the related critical values are referred to the simulation results of Wane et al. (2004).

Moreover, when the asymmetric threshold cointegration exists, MTAR, suggested by Enders (2004), should be used for setting up the error correction model in order to analyze the adjustment of short-run deviation. The asymmetric error correction model is described as follows:

$$\Delta li_t = \mu + \eta_1 M_t \widehat{e}_{t-1} + \eta_2 (1 - M_t)\widehat{e}_{t-1} + \\ + \sum_{j=1}^{k} a_{1j} \Delta li_{t-j} + \sum_{j=1}^{k} a_{2j} \Delta mi_{t-j} + \xi_t, \qquad (11)$$

where μ is the intercept, η_1 and η_2 represent the adjusting speed of positive and negative error correction term respectively. $\widehat{e}_{t-1} = li_{t-1} - \widehat{\beta}_0 - \widehat{\beta}_1 mi_{t-1}$. a_{ij} (i=1,2; j=1,...,k) is the coefficient of variable i with j lag.

Particularly, the variation margin of loan rate can be observed upward or downward through the error correction $M_t \hat{e}_{t-1}$ and $(1 - M_t) \hat{e}_{t-1}$. Thus, $|\eta_1| > |\eta_2|$ denotes the adjustment with upward rigidity and $|\eta_1| \leq \eta_2|$ denotes the adjustment with downward rigidity.

2. Data and empirical results

This study uses monthly data ranging from February 1986 to July 2005. The interbank overnight call-loan rate (mi_t) represents the market rate, and loan rate (li_t) is the loan rate mean of 36 major banks in Taiwan. The data are provided by Taiwan Economic Journal Data Bank (TEJ).

First, we used the Augmented Dickey Fuller (ADF) unit root test to check for stationarity in rate series. Table 1 reports the ADF test results of the level and first differential. Under 1% significant level, the level terms of both interbank rate and loan rate are unable to reject the null hypothesis of non-stationarity. However, the differential terms significantly reject this null hypothesis.

Table 1. ADF unit root test

Variable		Level		First-order differential
li_t		-2.336 [1]		-9.960*** [0]
mi_t		-0.791 [8]		-8.711*** [7]

Note: The regression of ADF is $\Delta y_t = a_0 + \gamma y_{t-1} + \sum_{i=2}^{p} \phi_i \Delta y_{t-i+1} + \varepsilon_t$. The maximum lag is 14 periods. The values in [.] are the most fitting lags determined by the least AIC value. *** denotes the 1% significance level and the 1% critical value is -3.463 (see MacKinnon, 1996).

The estimated values of β_0, β_1 and results of En-gle-Granger cointegration test are provided in Table 2. The estimated coefficient on the market rate vari-

able in the equation (1) is 0.259 and it is statistically significant at 1% level, showing the non-complete pass-through of market rate to loan rate. The estimated coefficient of β_0 is significantly greater than zero, indicating that the markup on loan rate is commonly applied to offset the additional charge. Besides, the results of Engle-Granger cointegration test indicate the inexistence of symmetric long-run relationship; it means that the market rate is unable to be used for forecasting the tendency of loan rate under the symmetric information.

Table 2. Engle-Granger cointegration test

Long-run equation		β_0		β_1		H_0 : no cointegration
$li_t = \beta_0 + \beta_1 mi_t$		7.043*** (63.50)		0.259*** (13.17)		-2.144 [8]

Note: In Engle-Granger cointegration test, the regression of ADF is $\Delta y_t = \gamma y_{t-1} + \sum_{i=2}^{p} \phi_i \Delta y_{t-i+1} + \varepsilon_t$. The maximum lag is 14. The value in [.] is the most fitting lag determined by the least AIC value. The values in (.) are t-statistics. *** denotes the 1% significance level and the critical value is -3.98 (see MacKinnon, 1996).

Table 3 shows the results of TAR and MTAR tests on model using e_{t-1} as an indicator variable (referred to as model 1) and on model using σ_{t-1} as an indicator variable (referred to as model 2). Under 5% significance level, it is discovered that model using $e_{t-1} (\Delta e_{t-1})$ as an indicator variable shows the inexistence of cointegration relationship, whereas model using σ_{t-1} ($\Delta \sigma_{t-1}$) as an indicator variable provides a robust evidence of asymmetric cointegration relationship. This result indicates that the factor determining the existence of pass-through mechanism from market rate to loan rate in Taiwan is the dynamic hetero-risk.

Table 3. TAR and MTAR cointegration test

Model	Indicator variable	Lags	ρ_1	ρ_2	$H_0 : \rho_1 = \rho_2 = 0$ Φ -statistic	τ	$H_0 : \rho_1 = \rho_2$ F-statistic	p-value
TAR	e_{t-1}	7	-0.058	-0.057	3.066	-0.061	0.000	0.983
MTAR	Δe_{t-1}	7	-0.049	-0.061	3.130	-0.111	0.056	0.812
TAR	σ_{t-1}	6	-0.161	-0.040	7.255**	0.141	5.747	0.017**
MTAR	$\Delta \sigma_{t-1}$	5	-0.168	-0.037	6.479**	0.116	5.823	0.016**

Note: The maximum lag is 14. The most fitting lag determined by the least AIC value, which ensures that the residual of model is a white noise. ** denotes the 5% significance level. The critical values of Φ test are consulted, Table 2 of Wane et al. (2004).

We, then, apply the error correction model to check for the rigid property of loan rate. In order to avoid sample deficiency caused by estimated coefficients, the insignificant coefficients are omitted before re-estimation. The estimation of error correction model is illustrated with equation (12):

$$\Delta li_t = -0.046 + 0.012 M_{it}\hat{e}_{it-1} - 0.051(1-M_{it})\hat{e}_{it-1} + 0.364\Delta li_{t-1} + 0.022\Delta mi_{t-1},$$
$$\quad (0.117) \quad (0.817) \quad\quad (0.048) \quad\quad\quad (0.000) \quad\quad\quad (0.058)$$

(12)

$$Q_{LB}(24) = 3.950 \,(1.000) \quad ARCH(24) = 0.096 \,(1.000)$$

$$M_t = \begin{cases} 1 & if \quad \Delta\sigma_{t-1} \geq 0.116 \\ 0 & if \quad \Delta\sigma_{t-1} < 0.116 \end{cases}$$

The values in brackets are p-values, $Q_{LB}(24)$ and *ARCH* (24) are statistics of Ljung-Box autocorrelation test and ARCH-LM hetero-variance test with 24-period lag, respectively. Under the significance level of 1%, the residuals of the model do not have auto-correlation and heteroskedasticity variance, which shows that the model meets the stability requirement and that the adequate model is fitted. Comparing η_1 and η_2, $|\hat{\eta}_1|$=0.012 <$|\hat{\eta}_2|$=0.051, we find that the downward adjusting speed is smaller than the upward one, indicating a downward rigidity.

Under the significance level of 5%, $\hat{\eta}_2$=-0.051 is significantly different from 0, showing that the loss caused by credit risk is smaller than that caused by risk that is estimated by banks ($\Delta\sigma_{t-1} < \hat{c}$) in previous period. Then, banks should adjust loan rate based on credit risk of customers. Moreover, if the demand for fund increases, banks would adopt a high loan rate tactic that leads to the downward rigidity adjustment. The above results provide the evidence of relation between the loan rate adjustment and the interest risk variation. In order to maximize profit along with risk, banks apply the policy of markup on a fixed rate and do not completely transfer the charge caused by an additional market rate to loan rate. This phenomenon displays the imperfect competition in Taiwan's monetary market.

Conclusion

Under the dynamic hetero-risk regime, we discover the asymmetric loan rate pass-through in Taiwan. Using the asymmetric error correction model to explore the adjustment of loan rate deviation from equilibrium, we also find the downward rigidity in loan rate. We, therefore, infer that the factor determining the existence of asymmetric pass-through process is the dynamic hetero-risk. These results show the inexistence of perfect competition in this market, and the characteristics of monopoly or oligopoly of Taiwan's banking industry.

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