# CHAPTER 4

# EMPIRICAL RESULTS

## 4.1 Introduction

This chapter reports the findings on the response of commercial bank lending to the money market interest rate changes in Malaysia. The two-step principle suggested by Cover (1992), and Dell'Ariccia and Garibaldi (1998) discussed in Chapter 3 forms the basis of analysis. The finding of the two-step procedure is divided into two sections. The first part relates to the estimation of the money market rate processes and the residuals obtained from the model for these processes are used for constructing the positive and negative interest rate shocks. This is discussed in Section 4.2. The effect of the interest rate shocks on aggregate commercial bank lending is discussed in Section 4.3.

As mentioned in Chapter 3, unit root tests for all the variables are performed. Cointegration tests are used to detect presence of long-run relationships. The vector error correction model is used for modelling the money market interest rate processes and also the relationship between commercial bank lending and interest rate shocks.

## 4.2. Money Market Interest Rate Shocks

### 4.2.1. Unit Root Tests

The first step is to determine if unit roots are present in the logarithms of the seven-day money market interest rate (LMM7), one-month money market interest rate (LMM1), three-month money market interest rate (LMM3), gross domestic product (LGDP) and consumer price index (LCPI). This is for estimating the stationarity of theses series.

These series are referred to as the level of the data. If the unit root test fails to reject the test in levels but rejects the test in first differences, the series is not stationary in their levels and it needs to be differenced to achieve stationarity. It means that the series contains one unit root and is integrated of order one, I(1). The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are used to test for presence of unit roots in LMM1, LMM3, LMM7, LGDP and LCPI.

This ADF test and PP test depend crucially on the correct choice of deterministic components such as constant and trend terms, and sufficient lagged terms of the dependent variable are to be included to ensure that the error terms behave like white noise. A constant is included in the test regression in testing for presence of unit roots in the LMM7, LMM1, LMM3 because the series have non-zero mean level. The t-statistic has a nonstandard distribution if the underlying process contains a unit root with a zero constant. A constant and linear trend are included in the test regression in testing for presence of unit roots in LGDP and LCPI, because the series have non-zero mean level and a trend. The t-statistic has a nonstandard distribution if the underlying process contains a unit root with a zero linear trend. The test is run with 1 to 8 lagged dependent variable in the right hand side of the test regression.

The ADF unit root test for level of the variables is presented in Table 4.1. The use of the Schwarz criterion for selecting the optimal lag length suggests lag 2 for LMM1; lag 1 for LMM3 and LMM7; lag 4 for LGDP and lag 2 for LCPI. The ADF test statistics are not significant for all the level of the data (LMM1, LMM3, LMM7, LGDP and LCPI). This shows that these variables have at least a unit root. It means the series are not stationary at their level.

Presence of unit root are tested for the first differences of the series. The results are also presented in Table 4.1. The Schwarz criterion suggests an optimal lag length of 1 for LMM1, LMM3, LMM7 and LCPI but lag 3 for LGDP. The ADF test statistics are significant, this rejecting the null hypothesis of unit root for four of the variables (LMM1, LMM3, LMM7, and LCPI) at first differences. This means that the series are stationary after taking first differences. The null hypothesis cannot be rejected for LGDP, suggesting this series is not first difference stationary.

## TABLE 4.1 AUGMENTED DICKEY-FULLER (ADF) UNIT ROOT TESTS

| Number of lagged dependent variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| **LMM7** | | | | | | | | |
| LEVEL | **-1.482** | -1.915 | -2.282 | -2.955 ** | -2.187 | -2.033 | -2.566 | -2.060 |
| SCHWARZ CRITERION | **-1.031** | -0.962 | -0.890 | -0.858 | -0.732 | -0.616 | -0.585 | -0.432 |
| IST DIF | **-3.120** ** | -2.705 * | -2.414 | -3.063 ** | -2.908 * | -1.738 | -2.148 | -1.376 |
| SCHWARZ CRITERION | **-0.956** | -0.839 | -0.707 | -0.679 | -0.575 | -0.455 | -0.369 | -0.229 |
| **LMM1** | | | | | | | | |
| LEVEL | -1.269 | **-2.119** | -2.248 | -2.511 | -1.930 | -2.028 | -2.198 | -2.156 |
| SCHWARZ CRITERION | -1.115 | **-1.120** | -1.030 | -0.954 | -0.821 | -0.761 | -0.648 | -0.511 |
| IST DIF | **-2.942** ** | -2.731 * | -2.627 * | -2.978 ** | 2.617 * | -1.749 | -1.603 | -1.417 |
| SCHWARZ CRITERION | **-1.093** | -0.983 | -0.866 | -0.800 | -0.721 | -0.575 | -0.433 | -0.274 |
| **LMM3** | | | | | | | | |
| LEVEL | **-1.416** | -1.144 | -2.314 | -2.697 * | -2.185 | -2.131 | -2.085 | -1.982 |
| SCHWARZ CRITERION | **-0.863** | -0.760 | -0.794 | -0.752 | -0.615 | -0.515 | -0.381 | -0.234 |
| IST DIF | **-4.252** *** | -2.730 * | -2.541 | -2.827 * | -2.783 * | -2.226 | -2.039 | -1.356 |
| SCHWARZ CRITERION | **-0.817** | -0.739 | -0.639 | -0.562 | -0.461 | -0.325 | -0.182 | -0.043 |
| **LGDP** | | | | | | | | |
| LEVEL | -2.885 | -1.508 | -0.684 | **-2.344** | -1.978 | -0.976 | -0.818 | -1.654 |
| SCHWARZ CRITERION | -2.730 | -2.840 | -2.983 | **-3.634** | -3.497 | -3.401 | -3.444 | -3.528 |
| IST DIF | -8.417 *** | -7.235 *** | **-2.148** | -2.362 | -2.984 | -3.318 | -1.891 | -2.562 |
| SCHWARZ CRITERION | -2.869 | -3.064 | **-3.564** | -3.465 | -3.467 | -3.521 | -3.517 | -3.534 |
| **LCPI** | | | | | | | | |
| LEVEL | -2.124 | **-2.033** | -1.726 | -2.439 | -1.737 | -2.118 | -2.787 | -2.499 |
| SCHWARZ CRITERION | -7.286 | **-7.430** | -7.302 | -7.304 | -7.190 | -7.190 | -7.138 | -7.082 |
| IST DIF | **-6.073** *** | -4.313 *** | -2.483 | -2.885 | -2.647 | -2.481 | -2.927 | -2.661 |
| SCHWARZ CRITERION | **-7.409** | -7.308 | -7.220 | -7.187 | -7.080 | -6.962 | -6.938 | -6.835 |

NOTE
Figures in bold are for the model with optimal lag length chosen using the Schwarz criterion.
*** Significant at 1% Level
** Significant at 5% Level
* Significant at 10% Lvel
Level : At the level of the series
1st Dif : At the first difference of the series

**TABLE 4.2** **PHILLIPS-PERRON (PP) UNIT ROOT TESTS**

| TRUNCATION LAG | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **LMM7** | | | | | | | | | | | | | | | | |
| LEVEL | -0.677 | | -0.938 | | -1.093 | | -1.192 | | -1.218 | | -1.200 | | -1.179 | | -1.145 | |
| IST DIF | -3.915 | *** | -3.948 | *** | -3.963 | *** | -3.998 | *** | -3.966 | *** | -3.905 | *** | -3.875 | *** | -3.834 | *** |
| **LMM1** | | | | | | | | | | | | | | | | |
| LEVEL | -0.531 | | -0.827 | | -0.990 | | -1.075 | | -1.090 | | -1.072 | | -1.043 | | -1.010 | |
| IST DIF | -4.023 | *** | -4.102 | *** | -4.140 | *** | -4.160 | *** | -4.123 | *** | -4.081 | *** | -4.043 | *** | -4.011 | *** |
| **LMM3** | | | | | | | | | | | | | | | | |
| LEVEL | -0.986 | | -1.089 | | -2.222 | | -1.315 | | -1.330 | | -1.310 | | -1.287 | | -1.257 | |
| IST DIF | -4.503 | *** | -4.688 | *** | -4.719 | *** | -4.739 | *** | -4.714 | *** | -4.681 | *** | -4.660 | *** | -4.641 | *** |
| **LLOAN** | | | | | | | | | | | | | | | | |
| LEVEL | -0.811 | | -1.020 | | -1.206 | | -1.346 | | -1.457 | | -1.541 | | -1.595 | | -1.624 | |
| IST DIF | -4.236 | *** | -4.299 | *** | -4.434 | *** | -4.545 | *** | -4.643 | *** | -4.728 | *** | -4.784 | *** | -4.809 | *** |
| **LGDP** | | | | | | | | | | | | | | | | |
| LEVEL | -3.070 | | -2.876 | | -2.864 | | -3.064 | | -3.155 | | -3.140 | | -3.144 | | -3.224 | * |
| IST DIF | -7.231 | *** | -7.874 | *** | -8.730 | *** | -8.102 | *** | -8.066 | *** | -8.722 | *** | -9.417 | *** | -8.998 | *** |
| **LCPI** | | | | | | | | | | | | | | | | |
| LEVEL | -1.866 | | -1.707 | | -1.564 | | -1.600 | | -1.565 | | -1.445 | | -1.313 | | -1.179 | |
| IST DIF | -5.676 | *** | -5.639 | *** | -5.667 | *** | -5.662 | *** | -5.674 | *** | -5.724 | *** | -5.791 | *** | -5.852 | *** |

NOTE
*** Significant at 1% Level
** Significant at 5% Level
* Significant at 10% Lvel
Level : At the level of the series
1st Dif : At the first difference of the series

The ADF test is not robust to a mild class of heteroscedastic and autocorrelated disturbance terms. The PP unit root test is more robust as the procedure uses a non-parametric correction to the t-statistic of the AR(1) coefficient to account for the serial correlation and heteroscedastic errors.

The PP unit root test for the level and first difference of the variables LMM7, LMM1, LMM3, LGDP and LCPI are presented in Table 4.2. The results show that the test does not reject the null hypothesis of a unit root for the level of the series. This means the series are non-stationary at level. However the PP test for first difference of the series rejects the null hypothesis of a unit root at one percent level. This suggests that all five series are I(1).

### 4.2.2 Cointegration

The unit root tests shows that the variables LMM7, LMM1, LMM3, LGDP and LCPI are non-stationary at the level but stationary after taking first difference. It is tested if LMM7, LGDP and LCPI are cointegrated. The cointegration test is also performed using LMM1 and LMM3. To take into account the possibility of a structural break, dummy variable is added in the test regression. This is to take care of the changes in the financial market in Malaysia after the implementation of the capital control since the fourth quarter of year 1998. The results for the cointegration test are presented in Table 4.3.

**Table 4.3 Testing for Cointegration between Interest Rate, CPI and GDP**

Seven-day Money Market Interest Rate (LMM7)

| Eigenvalue | Likelihood Ratio | 5 Percent Critical Value | 1 Percent Critical Value | Hypothesized No. of CE(s) |
|---|---|---|---|---|
| 0.566149 | 48.55781 | 29.68 | 35.65 | None ** |
| 0.274845 | 15.15563 | 15.41 | 20.04 | At most 1 |
| 0.055897 | 2.300815 | 3.76 | 6.65 | At most 2 |

One-month Money Market Interest Rate (LMM1)

| Eigenvalue | Likelihood Ratio | 5 Percent Critical Value | 1 Percent Critical Value | Hypothesized No. of CE(s) |
|---|---|---|---|---|
| 0.565365 | 50.13231 | 29.68 | 35.65 | None ** |
| 0.306697 | 16.80238 | 15.41 | 20.04 | At most 1 * |
| 0.052352 | 2.150880 | 3.76 | 6.65 | At most 2 |

Three-month Money market Interest Rate (LMM3)

| Eigenvalue | Likelihood Ratio | 5 Percent Critical Value | 1 Percent Critical Value | Hypothesized No. of CE(s) |
|---|---|---|---|---|
| 0.563962 | 47.20008 | 29.68 | 35.65 | None ** |
| 0.243858 | 13.99900 | 15.41 | 20.04 | At most 1 |
| 0.068025 | 2.817979 | 3.76 | 6.65 | At most 2 |

Notes : *(**) denotes rejection of the hypothesis at 5%(1%) significance level
CE refers to cointegration equation
The number of lag used in the tests is 1
Test assumption : Linear deterministic trend in the data
Intercept (no trend) in CE
Exogenous series : Dummy variable (1 for fourth quarter of 1998 to second quarter of 2000; 0 otherwise )

As shown in Table 4.3 one cointegration equation is found for LMM7, LCPI and LGDP. Two cointegration equations are found for LMM1, LCPI and LGDP. One cointegration equation is found for LMM3, LCPI and LGDP. This shows that a long-run equilibrium relationship exists among the variables, that is, the money market interest rates move in random with CPI and GDP in long run. The normalized cointegrating equations are presented in Tables 4.4.

**Table 4.4 Normalized Cointegrating Equation**

| | | Dependent Variable | | | |
|---|---|---|---|---|---|
| | | LMM7 * | LMM1 (First CE) | LCPI (Second CE) ** | LMM3 * |
| Dependent Variables | LCPI | 82.394 (65.355) | | | 74.161 (64.229) |
| | LGDP | -38.384 (30.505) | 0.396 (0.383) | 0.473 (0.018) | -34.518 (29.903) |
| | Constant | 26.353 | -2.322 | -0.374746 | 23.623 |

Notes: The figures in parentheses are standard errors.
* One Cointegrating equation.
** Two Cointegrating equations.

### 4.2.3 Error Correction Model

The Error Correction model (ECM) is employed to estimate the relationship between the interest rate, CPI and GDP. The ECM accounts for the long and short run relationships among the variables. Any deviation from the long-run equilibrium is corrected gradually through a series of partial short-run adjustments. This is incorporated in the model by including the error correction term (ECT) that is obtained from the cointegrating equation.

As there are two cointegration equations for LMM1, LCPI and LGDP, two ECTs are used in the model. For other cases where one cointegration equation is found, only one ECT is used.

The ECTs in the equations for LMM7, LMM1 and LMM3 are shown as follow:-

LMM7 : $Z_t = -26.35310 + LMM7_t + 38.38410\, LGDP_t - 82.3944010 LCPI_t$

LMM1 : $Z_{1t} = 2.321697 + LMM1_t - 0.395834 LGDP_t$

$Z_{2t} = 0.374746 + LCPI_t - 0.473161 LGDP_t$

LMM3: $Z_t = -23.62339 + LMM3_t + 34.51768 LGDP_t - 74.16050\, LCPI_t$

Table 4.5 reports the ECM for the three interest rates. ECMs with 1 to 8 lags of interest rate, LGDP and LCPI were estimated. The models that are reported in Table 4.5 have an optimal lag length as determined by the Schwarz criterion. All the ECTs are significant. The first ECT for the model of LMM1 is significant at the 1 percent level and the ECT for LMM3 and LMM7 and the second ECT for LMM1 are significant at the 10 percent level. The dummy variable is only significant in the case of LMM1.The short run responses to GDP and CPI seen not significant. Long term adjustments may be a result of market forces or government intervention through monetary policy. In the long run, all the three interest rate series adjusted positively to increase in GDP but negatively to an increase in CPI with a one quarter lag. This shows that interest rate has been used as a counter business cyclical tool for long term targeting. The negative relationship with CPI seems an outcome of market reaction to such policy. This could be a result of the expectation formation. Inflationary pressure pushes interest rate up in the short run. A market with rational agents would expect this trend to be reversed in the long run.

**Table 4.5: The Vector Error Correction Model**

| Dependent Variable | $LMM7_t$ | $LMM1_t$ | $LMM3_t$ |
|---|---|---|---|
| Constant | 0.0074<br>(0.05565) | 0.0096<br>(0.04625) | 0.0452<br>(0.05962) |
| $Z_{t-1}$ | 0.0213 *<br>(0.01292) | -0.1793 ***<br>(0.06639) | 0.0280 *<br>(0.01520) |
| $Z_{2t-1}$ | | -1.4538 *<br>(0.87414) | |
| $\Delta LMM1_{t-1}$ | | 0.1124<br>(0.15687) | |
| $\Delta LMM3_{t-1}$ | | | 0.1007<br>(0.17221) |
| $\Delta LMM7_{t-1}$ | 0.1866<br>(0.17224) | | |
| $\Delta LGDP_{t-1}$ | - 0.2544<br>(0.46126) | - 0.3750<br>(0.38121) | -0.6526<br>(0.48452) |
| $\Delta LCPI_{t-1}$ | -1.8983<br>(4.56343) | 0.9378<br>(3.86859) | -5.9224<br>(4.91857) |
| $DUM_t$ | - 0.0261<br>(0.09823) | - 0.1745 *<br>(0.9130) | 0.0085<br>(0.10451) |

Notes: Figures in parentheses are standard errors.
Quarterly data: 1990:1 to 2000:2
*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

The seven-day money market interest rate is adjusts by 2.1 percent every quarter for any money market interest rate deviation from the long run equilibrium relationship. The one-month money market interest rate adjusts by 18 but the three-month money market interest rate adjusts by 2.8 percent every quarter. Of the three series, the one-month money market interest rate (LMM1) has the highest adjustment for a given change in GDP in the long run. Adjustments in the seven-day money market interest rate (LMM7) and three-month money market interest rate (LMM3) are comparatively lower. The magnitude for all the three cases, however is very low, indicating the rigidity in the money market.

The residuals from the three models are used for constructing positive and negative interest rate shocks in the seven-day, one-month and three-month money market respectively.

The positive money market interest rate shock ($TIGHT_t$) is defined as below:

$$TIGHT_t = \max(\varepsilon_t, 0)$$

The negative money market interest rate shock ($EASY_t$) is defined as below:

$$EASY_t = \min(\varepsilon_t, 0)$$

## 4.3 Effects of the Interest Rate Shocks on Aggregate Bank Lending

### 4.3.1 Unit Root Test

The unit root test is performed on the logarithm of total commercial bank lending (LLOAN), logarithm of total deposit in commercial bank (LDEP), positive shocks to the money market interest rate (TIGHT) and negative shocks to the money market interest rate (EASY). This to examine for series stationarity. As before, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are used. We include a constant in the test regression for TIGHT_MM7, TIGHT_MM1, TIGHT_MM3, EASY_MM7, EASY_MM1, and EASY_MM3 because these series have non-zero mean level. We include a constant and linear trend in the test regression for LLOAN and LDEP because the series have non-zero mean level and a trend.

The ADF test is run with 1 to 8 lags of dependent variable. The Schwarz criterion is used to select the optimal lag length. The results are presented in Table 4.6. The optimal lag length is one for LLOAN, TIGHT_MM7, EASY_MM7, TIGHT_MM1, EASY_MM1, TIGHT_MM3 and EASY_MM3 and four for LDEP. The ADF test statistics are not significant for the level of LLOAN and LDEP but significant for the first difference. This shows that LLOAN and LDEP have one unit root and are not stationary in their level. On the other hand, the null hypothesis is rejected for TIGHT_MM7, EASY_MM7, TIGHT_MM1, EASY_MM1, TIGHT_MM3 and EASY_MM3, indicating these are stationary variables in level.

The results for the PP test are presented in Table 4.7. The results show that the PP test significantly reject the null hypothesis at one percent level for TIGHT_MM7, EASY_MM7, TIGHT_MM1, EASY_MM1, TIGHT_MM3, EASY_MM3.

The results also show that the null hypothesis of a unit root is not rejected for LLOAN and LDEP at their level. This means the series are non-stationary in level. However the test for first difference of the series significantly rejects the null hypothesis of a unit root at one percent level. This means that the LLOAN and LDEP are stationary in first difference.

**TABLE 4.6** **AUGMENTED DICKEY-FULLER (ADF) UNIT ROOT TESTS**

| Number of lagged dependent variable | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **LLOAN** | | | | | | | | | | | | | | | | |
| LEVEL | **-1.154** | | -1.692 | | -2.520 | | -2.866 | | -4.000 | * | -3.843 | ** | -3.958 | ** | -4.641 | *** |
| SCHWARZ CRITERION | **-4.035** | | -4.014 | | -4.074 | | -4.000 | | -3.947 | | -3.937 | | -3.875 | | -3.937 | |
| IST DIF | **-2.642** | | -1.764 | | -1.537 | | -1.546 | | -1.570 | | -1.729 | | -1.947 | | -2.014 | |
| SCHWARZ CRITERION | **-4.027** | | -3.988 | | -3.856 | | -3.724 | | -3.588 | | -3.476 | | -3.360 | | -3.339 | |
| 2ND DIF | **-7.571** | *** | -5.054 | *** | -3.499 | * | -2.882 | | -2.320 | | -1.993 | | -1.957 | | -1.957 | |
| SCHWARZ CRITERION | **-3.994** | | -3.880 | | -3.744 | | -3.602 | | -3.467 | | -3.313 | | -3.271 | | -3.139 | |
| **LDEP** | | | | | | | | | | | | | | | | |
| LEVEL | -1.064 | | -0.897 | | -1.158 | | -0.505 | | **-0.534** | | -0.650 | | -1.099 | | -0.542 | |
| SCHWARZ CRITERION | -3.947 | | -3.838 | | -3.819 | | -3.767 | | **-4.098** | | -3.968 | | -3.874 | | -3.798 | |
| IST DIF | -4.570 | *** | -3.596 | ** | -3.532 | * | **-4.584** | *** | -3.595 | ** | -2.442 | | -2.967 | | -2.656 | |
| SCHWARZ CRITERION | -3.909 | | -3.874 | | -3.857 | | **-4.188** | | -4.053 | | -3.929 | | -3.891 | | -3.799 | |
| **TIGHT_MM7** | | | | | | | | | | | | | | | | |
| LEVEL | **-3.949** | *** | -2.656 | * | -1.530 | | -2.099 | | -2.327 | | -1.925 | | -1.367 | | -0.720 | |
| SCHWARZ CRITERION | **-2.663** | | -2.549 | | -2.441 | | -2.445 | | -2.357 | | -2.210 | | -2.071 | | -1.989 | |
| **EASY_MM7** | | | | | | | | | | | | | | | | |
| LEVEL | **-3.700** | *** | -3.175 | ** | -2.780 | * | -2.619 | * | -2.984 | * | -1.809 | | -2.181 | | -1.726 | |
| SCHWARZ CRITERION | **-1.911** | | -1.793 | | -1.672 | | -1.551 | | -1.481 | | -1.392 | | -1.305 | | -1.159 | |
| **TIGHT_MM1** | | | | | | | | | | | | | | | | |
| LEVEL | **-4.496** | *** | -3.267 | ** | -1.643 | | -1.742 | | -1.598 | | -2.282 | | -2.459 | | -1.910 | |
| SCHWARZ CRITERION | **-2.975** | | -2.859 | | -2.957 | | -2.972 | | -2.829 | | -2.832 | | -2.719 | | -2.557 | |
| **EASY_MM1** | | | | | | | | | | | | | | | | |
| LEVEL | **-3.543** | ** | -3.028 | ** | -3.176 | ** | -2.892 | * | -2.753 | * | -2.492 | | -2.489 | | -2.131 | |
| SCHWARZ CRITERION | **-2.332** | | -2.225 | | -2.138 | | -2.022 | | -1.890 | | -1.748 | | -1.619 | | -1.468 | |
| **TIGHT_MM3** | | | | | | | | | | | | | | | | |
| LEVEL | **-4.606** | *** | -3.656 | *** | -1.946 | | -2.720 | * | -2.074 | | -2.033 | | -1.875 | | -1.527 | |
| SCHWARZ CRITERION | **-2.541** | | -2.418 | | -2.357 | | -2.443 | | -2.318 | | -2.203 | | -2.055 | | -1.900 | |
| **EASY_MM3** | | | | | | | | | | | | | | | | |
| LEVEL | **-4.701** | *** | -3.132 | ** | -2.889 | * | -2.834 | * | -3.268 | ** | -2.230 | | -2.530 | | -1.650 | |
| SCHWARZ CRITERION | **-1.793** | | -1.721 | | -1.601 | | -1.497 | | -1.444 | | -1.304 | | -1.213 | | -1.096 | |

NOTE

Figures in bold are for the model with optimal lag length chosen using the Schwarz criterion.

*** Significant at 1% Level

** Significant at 5% Level

* Significant at 10% Lvel

Level : At the level of the series

**TABLE 4.7** **PHILLIPS-PERRON (PP) UNIT ROOT TESTS**

| TRUNCATION LAG | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| **LLOAN** | | | | | | | | |
| LEVEL | -0.811 | -1.020 | -1.206 | -1.346 | -1.457 | -1.541 | -1.595 | -1.624 |
| IST DIF | -4.236 *** | -4.299 *** | -4.434 *** | -4.545 *** | -4.643 *** | -4.728 *** | -4.784 *** | -4.809 *** |
| **LDEP** | | | | | | | | |
| LEVEL | -1.212 | -1.271 | -1.371 | -1.360 | -1.347 | -1.378 | -1.405 | -1.422 |
| IST DIF | -5.818 *** | -5.840 *** | -5.829 *** | -5.888 *** | -6.007 *** | -6.032 *** | -6.096 *** | -6.139 *** |
| **TIGHT_MM7** | | | | | | | | |
| LEVEL | -5.907 *** | -5.908 *** | -5.912 *** | -5.921 *** | -5.913 *** | -5.901 *** | -5.896 *** | -5.895 *** |
| **EASY_MM7** | | | | | | | | |
| LEVEL | -6.097 *** | -6.108 *** | -6.111 *** | -6.109 *** | -6.103 *** | -6.095 *** | -6.095 *** | -6.101 *** |
| **TIGHT_MM1** | | | | | | | | |
| LEVEL | -7.207 *** | -7.189 *** | -7.153 *** | -7.100 *** | -7.080 *** | -7.075 *** | -7.074 | -7.074 |
| **EASY_MM1** | | | | | | | | |
| LEVEL | -5.336 *** | -5.367 *** | -5.379 *** | -5.353 *** | -5.326 *** | -5.298 *** | -5.280 *** | -5.277 *** |
| **TIGHT_MM3** | | | | | | | | |
| LEVEL | -6.079 *** | -6.082 *** | -6.094 *** | -6.095 *** | -6.103 *** | -6.114 *** | -6.135 *** | -6.162 *** |
| **EASY_MM3** | | | | | | | | |
| LEVEL | -6.398 *** | -6.404 *** | -6.399 *** | -6.402 *** | -6.414 *** | -6.442 *** | -6.474 *** | -6.521 *** |

NOTE

*** Significant at 1% Level

** Significant at 5% Level

* Significant at 10% Lvel

Level : At the level of the series

1st Dif : At the first difference of the series

### 4.3.2 Cointegration

This section examines the cointegration on between LLOAN and LDEP. In the cointegration test TIGHT and EASY are added as exogenous variables in the test, in order to control for the interest rate shocks while examing the relationship between LLOAN and LDEP. The results for cointegration test are presented in Table 4.8

The cointegration Test found one cointegration equation between LLOAN and LDEP. This means, that long-run equilibrium relationship exists between these variables. The normalized cointegration for the above respective series are presented in Tables 4.9. The results show approximately a one-to-one relationship between deposit and market lending.

**Table 4.8 Testing for Cointergration between LLOAN and LDEP**

Exogenous series :Seven-day Money Market Interest Rate Shock (EASY_MM7 & TIGHT_MM7)

| Eigenvalue | Likelihood Ratio | 5 Percent Critical Value | 1 Percent Critical Value | Hypothesized No. of CE(s) |
|---|---|---|---|---|
| 0.648346 | 33.53855 | 15.41 | 20.04 | None ** |
| 0.036113 | 1.140217 | 3.76 | 6.65 | At most 1 |

Exogenous series :One-month Money Market Interest Rate Shock (EASY_MM1 & TIGHT_MM1)

| Eigenvalue | Likelihood Ratio | 5 Percent Critical Value | 1 Percent Critical Value | Hypothesized No. of CE(s) |
|---|---|---|---|---|
| 0.572636 | 26.36070 | 15.41 | 20.04 | None ** |
| 0.000225 | 0.006976 | 3.76 | 6.65 | At most 1 |

Exogenous series :Three-month Money Market Interest Rate Shock (EASY_MM3 & TIGHT_MM3)

| Eigenvalue | Likelihood Ratio | 5 Percent Critical Value | 1 Percent Critical Value | Hypothesized No. of CE(s) |
|---|---|---|---|---|
| 0.638256 | 31.52144 | 15.41 | 20.04 | None ** |
| 2.15E-06 | 6.66E-05 | 3.76 | 6.65 | At most 1 |

Notes : *(**) denotes rejection of the hypothesis at 5%(1%) significance level
CE refers to cointegration equation
The number of lag used in the tests are: 2 lags of money market interest rate shocks
10 lags of LLOAN and LDEP
Test assumption: Linear deterministic trend in the data
Intercept (no trend) in CE

**Table 4.9 The Normalized Cointegrating Equations**

| | | Dependent Variable | | |
|---|---|---|---|---|
| | | LLOAN* | LLOAN** | LLOAN*** |
| Dependent Variable | LDEP | 1.007<br>(0.015) | 0.937<br>(0.032) | 0.903<br>(0.051) |
| | Constant | 0.034 | 0.880 | 1.279 |

Notes: The figures in parentheses are standard errors.
* Exogenous series :Seven-day Money Market Interest Rate Shock (EASY_MM7 & TIGHT_MM7)
** Exogenous series :One-Month Money Market Interest Rate Shock (EASY_MM1 & TIGHT_MM1)
*** Exogenous series :Three-month Money Market Interest Rate Shock (EASY_MM3 & TIGHT_MM3)

### 4.3.3 Error Correction Model

The ECM is used to examine how commercial bank lending respond to changes in deposits and interest rate shocks. The results are reported in Table 4.10.

For the ECM, models with 1 to 10 lags of ΔLLOAN and ΔLLDEP were considered in combination with a maximum of 5 lags of the exogenous variables (EASY and TIGHT). The reported models are those with the optimal lag length determined by the Schwarz criterion.

**Table 4.10: The Error Correction Model**

| | ΔLLOAN $_t$ | | |
|---|---|---|---|
| Constant | -2.213*** (0.373) | -3.893*** (1.045) | -2.346*** (0.751) |
| $Z_{t-1}$ | -1.844*** [a] (0.304) | -1.348*** [b] (0.343) | -1.208*** [c] (0.337) |
| $\Delta LLOAN_{t-1}$ | 0.783*** (0.183) | 0.783*** (0.140) | 0.716*** (0.178) |
| $\Delta LLOAN_{t-2}$ | 0.441* (0.235) | 0.966*** (0.239) | 0.561** (0.210) |
| $\Delta LLOAN_{t-3}$ | 0.398* (0.232) | 1.307*** (0.278) | 1.514*** (0.275) |
| $\Delta LLOAN_{t-4}$ | 0.426** (0.185) | 0.984*** (0.236) | 0.833*** (0.220) |
| $\Delta LLOAN_{t-5}$ | 0.840*** (0.192) | 1.003*** (0.325) | 0.126 (0.326) |
| $\Delta LLOAN_{t-6}$ | 1.216*** (0.259) | 0.901*** (0.290) | 1.273*** (0.260) |
| $\Delta LLOAN_{t-7}$ | 1.731*** (0.308) | 1.101*** (0.298) | 1.044** (0.450) |
| $\Delta LLOAN_{t-8}$ | 1.686*** (0.371) | 1.030*** (0.347) | 0.506 (0.451) |
| $\Delta LLOAN_{t-9}$ | 0.960** (0.350) | 0.668** (0.271) | 0.680** (0.283) |
| $\Delta LLOAN_{t-10}$ | 0.538 (0.331) | 0.560** (0.223) | 0.860*** (0.257) |
| $\Delta LDEP_{t-1}$ | 0.426 (0.268) | 1.412*** (0.467) | 0.453 (0.382) |
| $\Delta LDEP_{t-2}$ | 0.010 (0.286) | 0.488 (0.450) | -0.403 (0.365) |
| $\Delta LDEP_{t-3}$ | 0.084 (0.180) | 0.866*** (0.232) | 0.462** (0.216) |
| $\Delta LDEP_{t-4}$ | 0.080 (0.189) | 1.007** (0.373) | -0.174 (0.285) |
| $\Delta LDEP_{t-5}$ | -0.459** (0.186) | 0.873** (0.363) | 0.309 (0.218) |
| $\Delta LDEP_{t-6}$ | -0.124 (0.221) | 0.570* (0.318) | -0.159 (0.245) |
| $\Delta LDEP_{t-7}$ | -0.398* (0.199) | 0.380* (0.224) | -0.0185 (0.171) |
| $\Delta LDEP_{t-8}$ | 0.368** (0.161) | 0.870*** (0.254) | 0.266 (0.225) |
| $\Delta LDEP_{t-9}$ | -0.021 (0.145) | 0.716** (0.293) | 0.379* (0.221) |
| $\Delta LDEP_{t-10}$ | 0.302** (0.137) | 0.433* (0.239) | -0.052 (0.243) |
| $EASY\_MM7_{t-1}$ | 0.186** (0.077) | | |
| $EASY\_MM7_{t-2}$ | 0.079 (0.068) | | |

**Table 4.10: The Error Correction Model ( cont'd)**

| | | | |
|---|---|---|---|
| EASY_MM1$_{t-1}$ | | -0.209*** (0.072) | |
| EASY_MM1$_{t-2}$ | | -0.127 (0.075) | |
| EASY_MM3$_{t-1}$ | | | -0.230** (0.084) |
| EASY_MM3$_{t-2}$ | | | 0.009 (0.066) |
| TIGHT_MM7`$_{t-1}$ | 0.092 (0.110) | | |
| TIGHT_MM7$_{t-2}$ | 0.273** (0.127) | | |
| TIGHT_MM1$_{t-1}$ | | 0.568*** (0.091) | |
| TIGHT_MM1$_{t-2}$ | | 0.093 (0.240) | |
| TIGHT_MM3$_{t-1}$ | | | 0.575*** (0.129) |
| TIGHT_MM3$_{t-2}$ | | | -0.494** (0.202) |
| TREND | 0.069*** (0.011) | 0.119*** (0.031) | 0.074*** 0.022) |

Notes: Figures in parentheses are standard errors.

Number of lags selected in the above models are determined using Schwarz criterion.

*** Significant at the 1% level

** Significant at the 5% level

* Significant at the 10% level

[a] $Z_t = -10.364 + LLOAN_t - 0.150\ LDEP_t$
(0.068)

[b] $Z_t = -24.800 + LLOAN_t + 1.048\ LDEP_t$
(0.201)

[c] $Z_t = -17.826 + LLOAN_t + 0.470\ LDEP_t$
(0.196)

The results of our estimation indicate for every one percent deviation of the aggregate commercial bank lending from the long run equilibrium, an adjustment of between 1.2 to 1.8 percent in lending is found in the next quarter. This implies that when aggregate commercial bank lending deviates from the long run equilibrium, it needs less than one quarter to adjust to the long run equilibrium position.

The high speed of adjustment may be due to the government interventions in the aggregate commercial bank lending. For instant, the time needed to recover the non-performing loans (NPL) has been speed up through Asset Management Company (AMC), namely, Pengurusan Danaharta Nasional Berhad (Danaharta). Beside that, commercial banks can also sell existing loans to National Mortgage Corporation known as Cagamas Berhad. Furthermore, the aggregate commercial lending can be influenced by Bank Negara Malaysia through the funds under its monitoring.

The results show that trend the coefficient is positive and significant at one percent level. This suggests that the aggregate commercial bank lending has upward trend with a quarterly growth between 7 to 12 percent. Besides that, the results also indicate that both the negative and positive money market interest rate shocks have significantly influenced the commercial bank lending.

The commercial lending react more quickly to negative seven-day money market interest rate shocks (EASY_MM7) than positive interest rate shocks (TIGHT_MM7). We find a significant coefficient for $EASY\_MM7_{t-1}$ at 5 percent level but not for $TIGHT\_MM7_{t-1}$. This means that the commercial bank lending reacts more quickly to the negative interest rate shocks of one quarter ago but not to the positive interest rate shocks of one quarter ago. Furthermore, the null hypothesis of a zero coefficent is rejected for $EASY\_MM1_{t-1}$,$EASY\_MM3_{t-1}$ $TIGHT\_MM1_{t-1}$ and $TIGHT\_MM3_{t-1}$. It means that the commercial bank lending reacts quickly to both the positive and negative one-month and three-month interest rate shocks of one quarter ago.

The negative one-month and three-month money market interest rate shocks ($EASY\_MM1_{t-1}$ and $EASY\_MM3_{t-1}$) have a negative effect on the aggregate commercial bank lending instead of increasing the aggregate commercial bank lending . The positive one-month and three-month money market interest rate shocks ($TIGHT\_MM1_{t-1}$ and $TIGHT\_MM3_{t-1}$) have a positive effect to the aggregate commercial bank lending instead of decreasing the aggregate commercial bank lending. The results suggest that the commercial banks are prudent in their lending in easy money market conditions and willingness to increase lending in tight market condition is high. These results are different from the findings of Dell'Ariccia and Garibaldi (1998) who studied the response of aggregate bank lending to changes in the money market rate for the case of US and Mexico. They showed that the interest rate increases (TIGHT) have negative effects on the aggregate bank lending.

The only exception to the result is the negative seven-day money market interest rate shocks ($EASY\_MM7_{t-1}$) that has a positive effect on the aggregate commercial bank lending. In this case, easy short- term money market conditions have increased bank lending.

Further analysis is conducted using the Wald restriction test for asymmetry in the responses of market lending to positive and negative shocks. The results of the test are shown in Table 4.11.

**Table 4.11 The Wald Test for Symmetry between Positive and Negative Interest Shocks in the Money Market**

Seven-day Money Market Interest Rate Shock (EASY_MM7 & TIGHT_MM7)

| | |
|---|---|
| Marginal Test $H_0 : \lvert\varphi_i\rvert = \lvert\tau_i\rvert$ | 0.306 (0.580) |
| Overall Test $H_0 : \lvert\varphi_i\rvert = \lvert\tau_i\rvert \ \forall_i$ | 1.898 (0.387) |

One-month Money Market Interest Rate Shock (EASY_MM1 & TIGHT_MM1)

| | |
|---|---|
| Marginal Test $H_0 : \lvert\varphi_i\rvert = \lvert\tau_i\rvert$ | 11.860 (0.001) |
| Overall Test $H_0 : \lvert\varphi_i\rvert = \lvert\tau_i\rvert \ \forall_i$ | 18.496 (0.000) |

Three-month Money Market Interest Rate Shock (EASY_MM3 &TIGHT_MM3)

| | |
|---|---|
| Marginal Test $H_0 : \lvert\varphi_i\rvert = \lvert\tau_i\rvert$ | 12.798 (0.000) |
| Overall Test $H_0 : \lvert\varphi_i\rvert = \lvert\tau_i\rvert \ \forall_i$ | 25.373 (0.000) |

Notes: The test statistic are reported and p-values are given in parentheses.
The coefficients $\varphi_i$ and $\tau_i$ refer to those used in equations (3.10) to (3.12).

The Wald test shows that we are unable to reject the null hypothesis of a symmetric marginal impact of $EASY\_MM7_{t-1}$ and $TIGHT\_MM7_{t-1}$ on the aggregate commercial lending. We are also unable to reject the null symmetry of all coefficients for the seven-day money market interest rate shocks. The Wald test indicates that the response of aggregate commercial bank lending to positive and negative seven-day money market interest rate shocks (EASY_MM7 & TIGHT_MM7) is symmetric.

However, for the one-month and three-month money market interest rate shocks, the null hypothesis of symmetric marginal impact of the first quarter lag and the null hypothesis of symmetric of all coefficients are rejected. From the results, the Wald test indicates that the response of total commercial bank lending to negative and positive one-month money market interest rate shocks are asymmetric. This is also true for the three-month money market interest rate shocks. Generally, the results in Table 4.10 show that the magnitudes of $TIGHT\_MM1_{t-i}$ and $TIGHT\_MM3_{t-i}$ are larger than those for $EASY\_MM1_{t-i}$ and $EASY\_MM3_{t-i}$ respectively. Note also that the three-month money market interest rate plays an important role in determining the Base Lending Rate (BLR) of commercial banks especially during period the November 1995 to September 1998. So, this indirectly has very strong influence on the commercial bank lending.

In Malaysia, the one-month and three-month money market interest rate have higher influences on the financial market. This may be because the commercial bank Base Lending Rate (BLR) was computed based on a weighted average of the three-month inter-bank rate from November 1995 to September 1998.

However, the Bank Negara Malaysia has introduced the intervention rate as a substitute to the inter-bank rate for the computation of BLR. But the one-month and three-month money market interest rate still play an important role in determining the aggregate commercial bank lending. The money market is an avenue for channelling of short term funds among the financial institutions. Furthermore, the average monthly volume of transactions in inter-bank deposits has increased from RM17.8 billion in 1989 to RM101.2 billion in 1999. Also, the average monthly volume of money market papers transacted has increased from RM2.6 billion in 1989 to RM18.0 billion in 1999. This shows the reliance of the financial institutions on the money market to meet their funding requirements and portfolio adjustments. So, the money market is expected to continue playing an important role in determining the aggregate commercial bank lending.

In addition, we estimate a restricted regression of the response of commercial bank lending to money market interest rate shocks. The interest rate shocks are defined as follows:

$$Shock\_MM7_{t-i} = EASY\_MM7_{t-i} + TIGHT\_\_MM7_{t-i}$$

$$Shock\_MM1_{t-i} = EASY\_MM1_{t-i} + TIGHT\_\_MM1_{t-i}$$

$$Shock\_MM3_{t-i} = EASY\_MM3_{t-i} + TIGHT\_\_MM3_{t-i}$$

The results are shown in Table 4.12

**Table 4.12 Impact of Combined Interest Rate Shocks on Commercial Bank Lending.**

| | $\Delta LLOAN_t$ | | |
|---|---|---|---|
| Constant | -1.871*** (0.305) | -2.044*** (0.497) | -1.575* (0.786) |
| $Z_{t-1}$ | -1.837*** (0.290) | -1.848*** (0.423) | -0.746** (0.300) |
| $\Delta LLOAN_{t-1}$ | 0.802*** (0.169) | 1.136*** (0.259) | 0.311 (0.234) |
| $\Delta LLOAN_{t-2}$ | 0.514** (0.217) | 0.629* (0.304) | 0.688** (0.292) |
| $\Delta LLOAN_{t-3}$ | 0.516*** (0.167) | 0.643*** (0.231) | 0.861*** (0.283) |
| $\Delta LLOAN_{t-4}$ | 0.421** (0.162) | 0.606*** (0.201) | 1.136*** (0.269) |
| $\Delta LLOAN_{t-5}$ | 0.665*** (0.167) | 0.591** (0.221) | 0.665** (0.297) |
| $\Delta LLOAN_{t-6}$ | 1.167*** (0.241) | 0.944** (0.287) | 0.596* (0.301) |
| $\Delta LLOAN_{t-7}$ | 1.561*** (0.263 | 1.414*** (0.371) | 0.491 (0.393) |
| $\Delta LLOAN_{t-8}$ | 1.724*** (0.357) | 1.624*** (0.492) | 0.405 (0.389) |
| $\Delta LLOAN_{t-9}$ | 0.987*** (0.328) | 1.012** (0.450) | 0.218 (0.362) |
| $\Delta LLOAN_{t-10}$ | 0.817*** (0.274) | 0.827** (0.373) | 0.600* (0.323) |
| $\Delta LDEP_{t-1}$ | 0.129 (0.234) | -0.207 (0.251) | 0.0965 (0.396) |
| $\Delta LDEP_{t-2}$ | -0.342* (0.200) | -0.231 (0.270) | -0.423 (0.394) |
| $\Delta LDEP_{t-3}$ | -0.033 (0.176) | 0.042 (0.232) | -0.133 (0.327) |
| $\Delta LDEP_{t-4}$ | -0.079 (0.161) | 0.067 (0.214) | -0.168 (0.319) |
| $\Delta LDEP_{t-5}$ | -0.620*** (0.176) | -0.501** (0.230) | -0.584* (0.307) |
| $\Delta LDEP_{t-6}$ | -0.393** (0.190) | -0.373 (0.250) | 0.131 (0.229) |
| $\Delta LDEP_{t-7}$ | -0.580*** (0.188) | -0.421* (0.238) | -0.206 (0.251) |
| $\Delta LDEP_{t-8}$ | 0.272* (0.149) | 0.188 (0.180) | 0.327 (0.253) |
| $\Delta LDEP_{t-9}$ | -0.158 (0.126) | -0.004 (0.216) | -0.185 (0.264) |
| $\Delta LDEP_{t-10}$ | 0.185 (0.116) | -0.054 (0.157) | 0.123 (0.190) |

**Table 4.12 Impact of Combined Interest Rate Shocks on Commercial Bank Lending. (cont'd)**

| | | | |
|---|---|---|---|
| SHOCK_MM7$_{t-1}$ | 0.141*** (0.036) | | |
| SHOCK_MM7$_{t-2}$ | 0.128** (0.049) | | |
| SHOCK_MM1$_{t-1}$ | | 0.185** (0.071) | |
| SHOCK_MM1$_{t-2}$ | | 0.062 (0.084) | |
| SHOCK_MM3$_{t-1}$ | | | -0.054 (0.061) |
| SHOCK_MM3$_{t-2}$ | | | -0.158** (0.068) |
| SHOCK_MM3$_{t-3}$ | | | -0.213*** (0.062) |
| SHOCK_MM3$_{t-4}$ | | | -0.109* (0.055) |
| TREND | 0.059*** (0.009) | 0.065*** (0.015) | 0.052** (0.024) |

Notes: Figures in parentheses are standard errors.
Number of lags selected in the models are determined by Schwarz criterion.
*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

The results indicate that most of the coefficients for the lagged LDEP are not significant compared to the results in Table 4.10 where almost all the coefficients are significant. Also, the results show that the seven-day and one-month money market interest rate shocks have a positive effect on the aggregate commercial bank lending, but the three-month money market interest rate shocks have negative effect. This set of findings highlight that an analysis based on combined interest rate shocks can lead to misleading results. It is unlikely that LDEP is insignificant in explaining LLOAN. Therefore, this shows that the earlier analysis with positive and negative interest rate shocks separated is more relevant.