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The Steady State Relationship and the Spread between Treasury Bill and Commercial Lending Rates

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Cesar C. Rufino, Ph. D.
De La Salle University-Manila, Philippines

Table of Contents

List of Tables

List of Figures

Abstract

This study demonstrates the existence of a long run steady state relationship between the Philippine commercial lending and Treasury bill rates. The spread between these rates was determined to constitute the cointegrating vector.

The Steady State Relationship and the Spread between Treasury Bill and Commercial Lending Rates

Two of the most important interest rate measures used frequently in representing the time value of money in economic and financial analyses are treasury bills and commercial lending rates. Treasury bills are short-term instruments issued by the government under varying tenors to partly finance its operations, while interest-bearing commercial papers are usually short-term unsecured promissory notes issued by large corporations to credit worthy issuers. These measures are by themselves vital indicators of the financial soundness of the economy, but an even more useful measure is their differential value. Such spread has traditionally been considered as one of the exceptional leading indicators of the country's economic performance.

The strong predictive performance of the T-bills-commercial paper spread over the years prompted leading economists to advocate its use in planning and policy making. Friedman and Kuttner (1992, 1993) demonstrated its predictive power throughout the 80s and even suggested its use in place of monetary aggregates as a leading predictor of economic activity. Bernanke (1990), in a follow-up study on the work of Stock and Watson (1989), showed that even after controlling for the growth in money supply, this indicator is still highly significant statistically. They stated that among interest rates it is the best single leading predictor of the economy's performance.

Traditionally, the T-bills-commercial paper spread has been regarded as the normal market risk premium. Ordinarily, this spread is relatively stable over time. However, during times of uncertainty, the rate differential becomes unusually large and volatile to reflect the growing concern of market participants over safety against defaults. Also during inflationary periods, when both T-bill rates and commercial paper yields are highly unpredictable, their spreads are also very erratic prompting risk averse investors to stay away from the market.

The study seeks to determine whether there exist empirical bases on the general belief that there is a long-run equilibrium relationship between the Treasury bill rates and commercial lending rates in the Philippine setting. Furthermore, this study also attempts to establish the cointegtrating equation between the two rates, as well as the error correction mechanism that govern this relationship when short-run disequilibrium are smoothened out to bring the rates back to their long run path.

The paper is organized as follows: after the introduction, a discussion on the time series properties of the two series is undertaken, focusing on the assessment of the departure of the time series from stationarity. The next section is an econometric analysis of the cointegration of the T-bill rates and the commercial paper rates to establish their long run linkage. Included in this section is the examination of the stability of the T-bills-commercial paper rates spread, as well as the short-run dynamics of the spread. The final section deals with the discussion of the insights and other predictive information uncovered in the study.

Framework and Methodology

Data

Monthly historical data from the Bangko Sentral ng Pilipinas database on both the benchmark 91-day Treasury bill rates and average commercial lending rates (all maturities) are used in the study. Period covered is from October 1981 to December 2003, involving 266 monthly observations – substantial enough to undertake long-run analysis. Figure 1 shows the line graph of the two series as they move together over time.

Also shown in Figure 1 is the differential value of the two time series, which is aptly, called the spread. A visual inspection of the behavior of the line graphs reveal that both rates follow each other closely, as if one shadows the other across the whole time horizon. The movement of the series seems to be sideways without any recognizable long-term trend except for some brief periods in the mid to late 80s. Commercial lending rate (clr) appears to be on top of the Treasury bill rate (tbr) most of the time. During most of the 80s, both rates exhibit wide variability, with the plateaus reached during the late 1984 and the troughs attained in the early 1987. It was also during this time span when the spread between the two rates widely fluctuated, in sharp contrast with the rest of the sample period when the rates differential was generally stable at a shade above zero.

The figure shows that the series do not exhibit mean reversion, with the spread displaying a basically well-behaved pattern. Such observed tendencies are graphical indications that the level series are non-stationary, while their spread is stationary. Additional pictorial evidence that clr and tbr are difference stationary (ds) stochastic processes can be gleaned from the plot of their first differenced series, shown in Figure 2.

Figure 2 intensifies the suspicion that clr and tbr are $\mathrm{I}(1)$. The figure reveals that the line graphs of Δclr and Δtbr (the first differenced series) fluctuate around a zero mean and appear to be stationary. These findings are in accordance with the conjecture made by Engle and Granger (1987) that interest rates are generally non-stationary time series variables. Visual inspection however is not always very reliable since different people may see different patterns when looking at the same graphic material. In this study, we employ three different unit root tests to empirically check the graphical analysis of the line graph of the series.

Unit Root Tests of the Rates and Their Spread

The idea behind the stationarity property of time series variables used in regression studies is central to the understanding of the long run relationship among these variables. Modern time series econometrics prescribes the implementation of various unit root diagnostics to empirically verify the stationarity of the observed time series. The presence of unit roots in a time series implies its departure from stationarity.

The number of unit roots detected in a series is equivalent to the number of times the variable is to be differenced from its lagged values to attain stationarity. For instance, a time series, say Y_t that contains a single unit root is basically non-stationary in its level or original form. However when the series is first differenced (that is, when $\Delta\mathrm{Y}_t = \mathrm{Y}_t - \mathrm{Y}_{t-1}$ is generated), the resulting series becomes stationary. If this is the case, it is said that Y_t is $\mathrm{I}(1)$ and $\Delta\mathrm{Y}_t$ is $\mathrm{I}(0)$. The number of unit roots also determines the order of integration of the series.

In this study, the time series variables to be examined for the presence of unit roots are commercial lending rates $clrt$, benchmark Treasury bill rates $tbrt$ and their spread $spread = clrt - tbrt$. Three powerful unit root testing procedures will be used – the Augmented Dickey Fuller (ADF), the Phillips-Perron (PP) and the KPSS tests. The use of these unit roots tests is deemed necessary to truly explore the dynamics of the series moving forward in time. Consensus results of the tests would indeed give confidence on the order of integration of the series, which is important in establishing their long run steady state relationship.

Analysis of Data

Results of Tests

The Augmented Dickey-Fuller (ADF) test.

The ADF test has been the workhorse model for unit root testing ever since Dickey and Fuller introduced the technique in 1979. Despite being an old procedure, it remains to be one of the most reliable and powerful tests when used appropriately. The most critical aspect of applying this test is the choice of the number of lags to be used in order to remove high order autocorrelations in the series being tested. With the advent of the latest versions of the Eviews (versions 4.1 and 5.0) software, the optimal lag length can be readily identified instead of going through a lengthy trial and error process. Table 1 shows the results of applying the ADF test to the three series of interest using the three different assumptions on the exogenous components included in the test regression.

Results of the ADF tests reveal that in all exogenous regressors assumptions, commercial lending rate series is deemed to be $\mathrm{I}(1)$. This can be inferred from the highly significant ADF τ-statistic of the first differenced series $\Delta clrt$ and the insignificance of the level series $clrt$ in all assumptions. The benchmark Treasury bill series $(tbrt)$ however, appears to be stationary (p=0.0206) at level when ADF test regression is augmented by trend and intercept. In the other exogenous factors assumptions, $(tbrt)$ can be considered $\mathrm{I}(1)$.

The main revelation presented by Table 1 is the perceived absence of unit roots in the spread of commercial and T-bill rates. The statistical evidence is the extremely significant ADF τ-statistic of series $spreadt$. This means that the proxy for the default risk in the Philippine financial market is inherently stationary.

The Phillips-Perron (PP) test.

To look for additional information in establishing the order of integration of the time series being studied, the PP unit root test is likewise applied. This unit root diagnostics is a worthy alternative to the ADF test since it is robust to a wide variety of serial correlations and time dependent heteroscedasticity (Newey & West, 1987).

Like the ADF procedure, the PP test is implemented in three ways: by choosing whether to include a constant, a constant and a linear time trend, or neither, in the test regression. The asymptotic distribution of the PP modified t-ratio is the same as that of the ADF statistic. Eviews reports MacKinnon lower tail critical and *p*-values for this test. Shown in Table 2 are the outcomes of implementing PP test.

It appears from Table 2 that PP test is more emphatic and conclusive in passing judgment on the order of integration of the series. Using all exogenous regressors assumptions, and optimal band-width (determined via the Newey-West criterion), the test led us to conclude that both commercial lending and benchmark treasury bill rates are I(1). It also confirmed the ADF result that the spread between the two rates is I(0).

The Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test.

Unlike the ADF and the PP unit root tests, the KPSS test has as its null hypothesis the stationarity of the series tested. Hence, statistically significant KPSS Statistic indicates presence of unit root. The KPSS statistic is based on the residuals from the Ordinary Least Squares regression of the series on the exogenous regressors, which are either a constant, or a constant and a time trend variable. So, to specify the KPSS test, one must specify the set of exogenous regressors and a method for estimating the residual spectrum at frequency zero.

It is interesting to observe the glaring differences in the KPSS test results under the two assumptions on the exogenous regressors entering the test regression. When only the intercept is allowed to be included as regressor, KPSS duplicates the results of both ADF and PP tests that commercial lending and treasury bill rates are I(1) and their spread is I(0). These findings underscore the empirical validity of our visual analysis of Figure 1 that a recognizable long-term trend in both interest rate series seems to be missing. Visual inspection of the line graph of the rates prompted one to believe that they fluctuate around a more or less constant intercept.

The Long Run Behavior of the Rates

This section makes use of the procedure introduced by Johansen and Juselius [1992] in examining the long-run co-movement of the series. Let the series *clrt* and *tbrt* be the jointly endogenous I(1) variables forming the vector y_t in the unrestricted Vector Autoregression (VAR):

$$y_t = \mathrm{A}_1 y_{t-1} + \mathrm{A}_2 y_{t-2} + \ldots + \mathrm{A}_k y_{t-k} + \delta + \varepsilon_t$$

where the A ’s are 2x2 matrices of parameters, δ is a drift parameter, $\varepsilon_t \sim$ iid normal ($0, \Omega$) and k the maximum lag length that can remove all traces of autocorrelation in the VAR equations residuals.

Using the Granger Representation Theorem, the above VAR equation can be reformulated into a Vector Error Correction Model with the form:

$$\Delta y_t = \Gamma_1 \Delta y_{t-1} + \ldots + \Gamma_{k-1} \Delta y_{t-k+1} + \Pi y_{t-1} + \delta + \varepsilon_t$$

where Π is a 2x2 matrix of the form $\Pi = \alpha\beta r$ with α and β being (2xr) matrices of full rank. β is known to carry the r cointegrating vectors ($r \leq 2$) and α the corresponding adjustment coefficients in each of the r vectors. Both α and β play crucial roles in establishing the equilibrium relationship of the elements of y_t.

The initial challenge in determining these two important matrices is to identify the optimal lag length k that will be used in the unrestricted VAR. In choosing the most appropriate k, we use five information criteria as basis. These are: the Sequential Modified Likelihood Ratio (LR) Criterion, the Final Prediction Error (FPE) Criterion, the Schwarz Information Criterion (SIC), the Akaike Information Criterion (AIC), and the Hannan-Quinn (HQ) Information Criterion. Table 4 below summarizes the computed values of these criteria using trial Vector Autoregressions (VARs) of up to 8 lags. It can be seen in the table that all selection criteria specify the lag length of $k = 2$ as the most appropriate one.

Now that the optimal number of lags to be incorporated in the unrestricted VAR to be implemented, the stage is now clear to examine the long run behavior of the system. Using the vector $\mathrm{Y}_t = [clr_t tbr_t]'$ and the lag length $k = 2$, Table 5 presents the diagnostics on the residuals of the two equations in the unrestricted VAR.

Table 5 shows the marked deviation from both normality and ARCH effects hypothesis of the two equations in the unrestricted VAR. Only autocorrelation of the residual series registered no problem as shown by the insignificant Breusch-Godfrey Serial Correlation LM test. Non-normality of the residuals as captured by the Jarque-Bera statistics is mainly due to excess kurtosis brought about by the presence of outstanding outliers in the two series during the 80s. The presence of ARCH effect is somewhat expected because of some clustering of volatilities during the 80s and the 90s.

Despite the presence of the above problems on the residual series of the VAR equations, the Johansen cointegration test can still be carried out. Using the same unrestricted VAR model, both the Maximum Eigenvalue and the Trace Statistics criteria of the test support the $r = 1$ cointegrating vector, which nonetheless requires identification. Below is the summary table of the Johansen unrestricted cointegration tests.

According to the results in Table 6, both test statistics used in the Johansen unrestricted cointegrated rank test support the presence of $r = 1$ cointegrating equation which requires identification. Normalizing the cointegrating vector with respect to *clrt* to identify the cointegrating relationship yields the following long-run equation as shown in Table 7.

The cointegrating equation established by the Johansen maximum likelihood procedure may be considered as the long-run equilibrium relationship that exists between commercial lending rate and the benchmark 91-days Treasury bill rate in the local financial market. The algebraic signs and magnitudes of the estimated long-run slope and intercept are intuitively appealing. The signs of the adjustment coefficients are also within our theoretical expectations.

Testing the restriction that the slope of CE is unity.

When one looks at the cointegrating equation (CE) between clr and tbr, one may notice the closeness of the slope of the CE to 1. When it can be empirically established that this is so, we will be able to determine the long-run market risk premium, which is synonymous to the equilibrium spread of the two rates. In order to verify the significance of such a restriction, a Vector Error Correction Model with cointegrating restriction needs to be estimated, then imposing the restrictions $\beta_1 = 1$ and $\beta_2 = -1$ in the cointegrating space. Table 8 provides the results of the Likelihood Ratio (LR) test of the validity of the imposed restriction in the VEC Model.

With a p-value of $p = 0.14615$ on the Likelihood Ratio (LR) statistic, the restrictions imposed on the VEC model are deemed valid empirically. This means that the equilibrium differential of commercial lending rate and treasury bill rate is not significantly different from 2.25 percentage points. The positive long run differential also supports the liquidity premium hypothesis. Short run adjustments of the model to transitory shocks can also be inferred from the estimated adjustment coefficients in the error correction terms.

The Short Run Dynamics

To analyze the short-run dynamics associated with the estimated long-run cointegrating equation, the graph of the Vector Error Correction model with cointegrating restrictions is plotted in Figure 3. The error correction term is scaled so that the deviations from the long-run equilibrium will have an average of zero over the period October 1981 to December 2003. Deviations from the zero horizontal line are indications that actual contemporaneous spread is veering away from the equilibrium interest rate differential.

When the graph falls above (below) the zero line, the level of actual spread is above (below) the equilibrium level. Such short-run departure from steady state is corrected through short-run adjustments, the speed of which is determined by the error correction parameters of the model.

Visual inspection of Figure 3 implies that during the period 1984 to 1985, political uncertainties created substantial negative shocks to the equilibrium relationship of the two rates. During most of this period, enormous negative departures from the equilibrium spread were noted. It took considerable time before negative spreads returned to normal equilibrium, and this happened during the initial years of the Ramos presidency.

Negative shocks once again appeared when the power crisis gripped the country, which persisted until early 1994. Spreads above the equilibrium were noted immediately after Ramos solved the power crisis signaling an era of growth, but as soon as Estrada assumed the presidency, a downward spiral appeared culminating in his ouster (note the very prominent spike before his departure). During the incumbency of President Arroyo, newfound confidence emerged in the financial market, as evidenced by normal spreads above the steady-state rate noted in practically the whole of the short three years era. Who knows what will happen next.

The VEC form of the cointegrating relationship of the rates dramatically captures the capability of the spread as a useful indicator of the economy's growth or decline.

Conclusion

The outcome of the study validates the general belief that commercial lending and Treasury bill rates form a highly stable and efficient steady state relationship. The study also uncovered the equilibrating role of the spread between these two rates and that such rate differential actually defines the cointegrating vector. The study also confirms the validity the liquidity premium hypothesis in the Philippines financial market.

An analysis of the outcome of the Vector Error Correction Model's dynamic adjustment process reveals the dramatic way the model is able to track positive and negative political shocks that happened in the country's modern political history. Such finding provides compelling evidence of the efficiency of the T-bill-commercial lending rates spread as a predictor of market sentiment, thus, a useful indicator of the country's economic performance.

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Table 1

Results of ADF Unit Root Test

	Exogenous Regressors Assumption					
Series to Be Tested	**Intercept**		**Trend and Intercept**		**None**	
	τ-value (*p*-value)	**Optimal lag length**	**τ-value (*p*-value)**	**Optimal lag length**	**τ-value (*p*-value)**	**Optimal lag length**
clr$_t$	-2.1146 (0.2392)	2	-3.3630 (0.0587)	3	-0.8709 (0.3379)	2
tbr$_t$	-2.8608 (0.0514)	1	-3.7527 (0.0206)	1	-1.2986 (0.1791)	1
spread$_t$	-4.5210 (0.0002)	9	4.5706 (0.0014)	9	-2.9379 (0.0005)	11
Δclr$_t$	-10.293 (0.0000)	1	-10.291 (0.0000)	1	-10.310 (0.0000)	1
Δtbr$_t$	-11.999 (0.0000)	0	-11.989 (0.0000)	0	-12.021 (0.0000)	0

Table 2

Results of PP Unit Root Test

Series to Be Tested	**Exogenous Regressors Assumption**					
	Intercept		**Trend and Intercept**		**None**	
	τ-value (*p*-value)	**Optimal Band Width**	**τ-value (*p*-value)**	**Optimal Band Width**	**τ-value (*p*-value)**	**Optimal Band Width**
clr_t	-2.0410 (0.2692)	4	-3.1024 (0.1078)	4	-0.8529 (0.2362)	3
tbr_t	-2.3189 (0.1668)	1	-3.1441 (0.0984)	1	-1.1266 (0.1791)	1
$spread_t$	-7.0915 (0.0000)	2	7.0948 (0.0000)	2	-4.4079 (0.0000)	6
Δclr_t	-16.771 (0.0000)	3	-16.761 (0.0000)	3	-16.797 (0.0000)	3
Δtbr_t	-11.667 (0.0000)	7	-11.650 (0.0000)	7	-11.692 (0.0000)	7

Table 3

Results of KPSS Unit Root Test

Series to Be Tested	**Exogenous Regressors Assumption**			
	Intercept		**Trend and Intercept**	
	KPSS Statistic	**Optimal Band Width**	**KPSS Statistic**	**Optimal Band Width**
$\mathbf{clr_t}$	1.045870***	12	0.066649^{ns}	12
$\mathbf{tbr_t}$	0.890519***	12	0.083389^{ns}	11
$\mathbf{spread_t}$	0.152049^{ns}	10	0.135316*	9
$\mathbf{\Delta clr_t}$	0.064825^{ns}	3	0.039221^{ns}	3
$\mathbf{\Delta tbr_t}$	0.053318^{ns}	2	0.028374^{ns}	2

Table 4

Lag Length Selection Summary

Lag	LR	FPE	AIC	SC	HQ
0	NA	158.8362	10.74363	10.77057	10.75445
1	971.9886	4.064036	7.077929	7.158759	7.110402
2	**84.09908***	**3.034479***	**6.785785***	**6.920503***	**6.839907***
3	7.771432	3.034738	6.785855	6.974460	6.861625
4	7.716337	3.034974	6.785905	7.028398	6.883324
5	2.324664	3.099387	6.806864	7.103244	6.925931
6	3.386139	3.151748	6.823555	7.173822	6.964271
7	8.722210	3.137312	6.818881	7.223035	6.981245
8	0.382506	3.228490	6.847420	7.305461	7.031433

* Indicates lag order selected by the criterion

LR: sequential modified LR test statistic

FPE: Final prediction error AIC: Akaike information criterion

SC: Schwarz information criterion HQ: Hannan-Quinn information criterion

Table 5

Diagnostics Tests on the Residuals of VAR Equations

Diagnostics	**Clr Equation**	**Tbr Equation**
Autocorrelation	4.170986 [0.3834]	0.822730 [0.4404]
ARCH Effect	6.939627 [0.0089]	11.5015 [0.0008]
Normality	151.2905 [0.0000]	1694.253 [0.0000]

Table 6

Johansen Unrestricted Cointegrating Rank Tests

Null Hypothesis	**Estimated Eigenvalue**	**Trace Statistic [p-value]**	**Maximum Eigenvalue Statistic [p-value]**
Number of CE (r = 0)	0.110065	34.73061** [0.0003]	31.01746** [0.0001]
Number of CE (r ≤ 1)	0.013862	9.1645 [0.4565]	9.1645 [0.4565]

** Denotes rejection of the null hypothesis at 0.01 level using the MacKinnon-Haug-Michelis (1999) *p*-values (presented by Eviews 5.0 Beta Version).

Table 7

Long Run Equation after Normalizing the Cointegrating Vector

$$\mathbf{Clr_t = 3.447953 + 0.918562\ tbr_t}$$

$$\mathbf{(0.68522)\quad (0.04242)}$$

with adjustment coefficients: -0.10118 (0.04242) for Δclr_t and 0.261484 (0.0487) for Δtbr_t

Note: Standard errors in parenthesis.

Table 8

Results of the Likelihood Ratio Test

$$\mathbf{Clr_t = 2.25248 \quad + \quad tbr_t}$$

$$\mathbf{(0.33386) \quad (0.0000)}$$

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with adjustment coefficients: -0.067275 (0.03661) for Δclr_t and 0.236331 (0.0556) for Δtbr_t

LR Statistics to test Ho: $\beta_1 = 1$ and $\beta_2 = -1$

LR = 2.111982 [p = 0.14615]

Note: Standard errors in parenthesis.

Figure 1. Treasury bill rates and their spread.

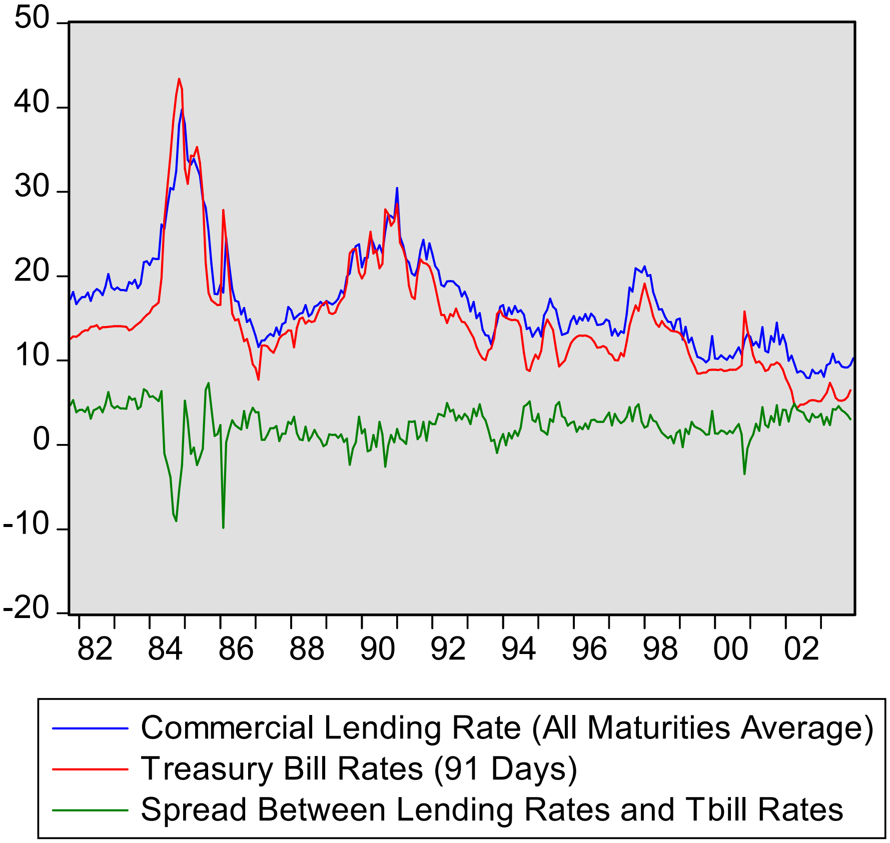

Figure 2. Plots of the first difference of the rates.

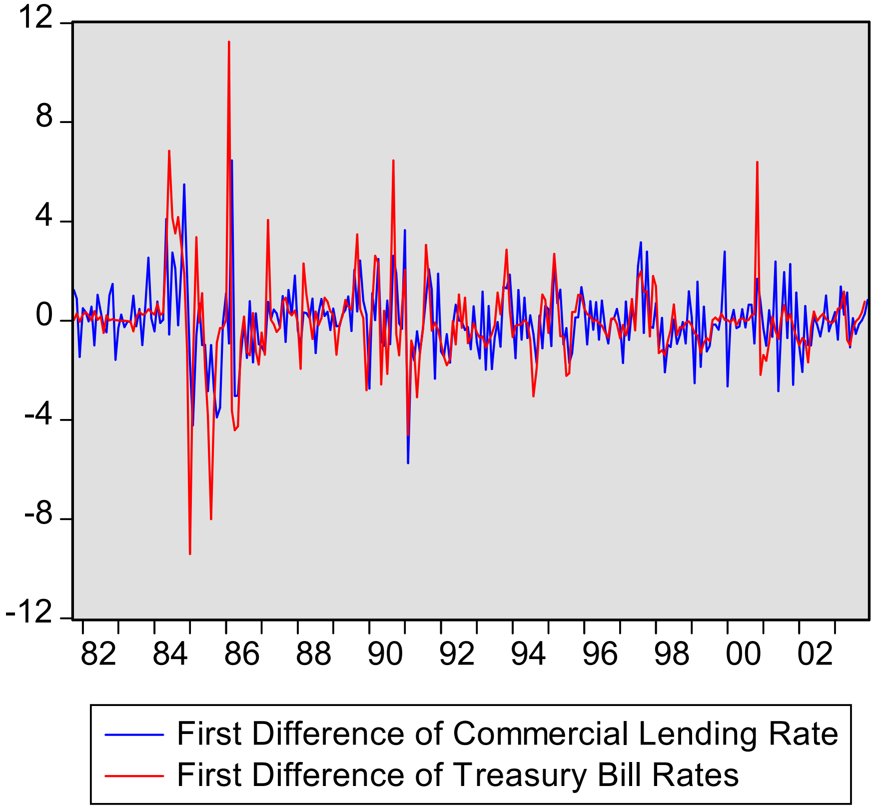

Figure 3. Short run adjustments to equilibrium.