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ON THE RESPONSE OF INTEREST RATES TO UNEXPECTED WEEKLY MONEY: ARE POLICY CHANGES IMPORTANT?

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I. Introduction

Previous investigations into the response of financial markets to the weekly money announcement have focused on the effects stemming from changes in monetary policy operating procedures.[1/] The October 6, 1979 announcement of a shift from targeting on the federal funds rate to focusing more on total reserves has been extensively analyzed. Most theories suggest that this shift in policy emphasis should make interest rates more responsive to unexpected changes in money, a hypothesis that generally is not rejected.

Another institutional change that has attracted substantial attention is the October 1982 shift in monetary policy operating procedures away from direct control of reserves to one emphasizing the targeting of discount window borrowings. The new procedure heavily discounts the behavior of reserves and the money stock and places much more importance on the behavior of the federal funds rate relative to the discount rate.[2/] Thus, theory suggests that financial markets should respond less to money stock forecast errors, a hypothesis that also finds support in previous empirical studies.

While the October 1979 and October 1982 policy changes have received the most attention, other important events also are likely to have influenced the observed changes in the empirical relationship between interest rates and the money announcement. One such event is the requirement under the

Humphrey-Hawkins Act of 1978 that beginning in 1979 the Fed would announce annual money growth targets and abandon its use of drifting quarterly targets.[3/] Other changes overlooked in previous work are the special credit control program during the second quarter of 1980, the redefinition of the monetary aggregates in February 1980 which led to the publication of two narrow monetary measures (M1A and M1B), the nationwide introduction of NOW accounts that led to the transitory measure known as "shift adjusted" M1B, the introduction of money market deposit accounts (MMDA) in late 1982 and Super NOW accounts in early 1983 and the shift from lagged reserve accounting to contemporaneous reserve accounting in February 1984.[4/] As this list suggests, there are many important though neglected candidates that could explain changes in the empirical relationship between interest rates and money announcements during the period since 1979.

Our goal in this paper is to re-examine the temporal behavior of the weekly money announcement's effects on interest rates. Unlike most previous work, we use estimation procedures that allow the data to reveal points of change in the estimated relationship.[5/] Our evidence indicates that the empirical relationship between interest rates and the weekly money announcement changed at times other than October 1979 and October 1982. In fact, the evidence below rejects the importance of these two policy shifts in explaining the interest rate-money relationship.

The remainder of the paper is structured as follows. The estimated equation and data used are presented in section II.

Section III contains ordinary least squares estimates of the model for the full period and relevant subperiods to provide a basis of comparison. The results from a time varying parameter estimation procedure and Quandt test results also are presented. The paper closes with our conclusions.

II. The Model and Data

The relation between changes in interest rates and the weekly money announcement often has been analyzed by estimating the equation:

$$(1)\quad \Delta i_t = \beta_0 + \beta_1 UM_t + \varepsilon_t ,$$

where Δi is the change in the interest rate, and UM is the unexpected change in the money stock (M1). In the empirical work presented here, several interest rates are used as the dependent variable. While the three-month T-bill rate often is the only rate used to measure the effects of unanticipated money announcements on short-term rates, we also use changes in the federal funds rate. We also determine the effect of unanticipated money on other rates by testing its impact across the term structure. To do this, the rates on six-month, one-, two-, three-, five-, seven-, ten-, twenty- and thirty-year government securities are used. To insure that the results for longer-term maturities do not merely reflect responses by short-term rates, we use Shiller, Campbell and Schoenholtz's (1983) procedure to generate seven implicit forward rates. These are three- to six-month, six-month to one-year, one- to two-year, two- to three-year, three- to five-year, five- to

seven-year, seven- to ten-year, ten- to twenty-year and twenty- to thirty-year forward rates. In all cases, the change in the interest rate is measured from the close of the market on the day of the money announcement to the close on the following day.[6/]

The unexpected change in money is generated using the expected money series taken from the Money Market Services, Inc. weekly survey of market participants. The median forecast of this survey is our measure of expected money. The expected change is subtracted from the actual change to construct the unexpected change in M1.[7/]

A comment is in order on the specification of equation (1) concerning the omission of expected money. The efficient markets hypothesis posits that only unexpected changes in money should influence interest rates since anticipated effects already are incorporated into rates before the announcement. The evidence on this hypothesis is mixed. Roley (1983) argues, however, that the finding of a significant effect of expected money (EM) can be attributed to the survey being conducted on the Tuesday prior to the announcement. Thus, there is information available to forecasters just prior to the announcement that was unavailable at the survey time. Using a "corrected" survey response, Roley finds that expected money becomes insignificantly different from zero.[8/]

More recent evidence strongly indicates that the significance of expected money in an equation like (1) may well be an artifact of the sample data. The evidence presented in Belongia, Hafer and Sheehan (1987) and Deaves, Melino and

Pesando (1987) suggests that the significance of expected money is quite sensitive to the inclusion of a few data points. Both studies show that eliminating these outliers reduces the reliability of expected money's impact on interest rates.

Thus, on the weight of recent evidence we elect to use equation (1). We should note that expanding equation (1) to include expected money does not materially influence our results below. Since our main concern is to examine the temporal behavior of the estimated coefficient on UM across possible break points and not specifically to re-test the efficient markets hypothesis, equation (1) would seem suitable for our purpose.

III. Empirical Results

Ordinary Least Squares Estimation

We estimated equation (1) for the September 1977 through December 1985 sample period using the different interest rates discussed above. For purpose of comparison, we first estimated equation (1) using ordinary least squares using the popular subperiods of the pre-October 1979 era, October 1979 through September 1982 and the post-September 1982 sample. The specific breaks and estimation results are presented in table 1.

The regression results accord with previous evidence in that the estimated slope coefficients (βs) generally are larger during the 1979-82 sample than before or after. Moreover, during the 1979-82 period the coefficient on unexpected money is significant in 8 of 11 regressions, compared with 4 of 11 using the pre-October 1979 results. For

the 1979-82 period the estimated magnitude of the effect generally is larger the shorter the maturity of the interest rate. In contrast, the results for the pre-1979 period show a mix of effects across the maturity of rates (both in significance and magnitude), while the post-1982 evidence reveals an impact that is similar across the horizon of maturities.

One notable aspect of the OLS evidence is the consistent finding that unexpected changes in M1 do not influence the 7-10, 10-20 and 20-30 year forward rates. This result is consistent with other studies that have used long-term forward rates, such as Shiller, et. al. (1983), Hardouvelis (1984) and Judd (1984), but is contrary to those using actual long-term rates, such as Cornell (1983).[9/] Because actual long-term rates overlap shorter-term rates, the evidence based on the forward rates arguably provides clearer evidence on the long-term impacts of unexpected changes in weekly money. Based on the evidence in table 1 and in previous studies, unexpected money appears to have no effect on long-term forward rates. Consequently, in the following analysis, we only examine the time varying response of rates up to the 5-7 year forward rate.

Time Varying Parameter Estimation

We investigate the temporal evolution of unexpected money's effect on interest rates by using the time varying parameter model suggested by Garbade (1977). The procedure provides a useful approach to explore the changing response of market rates to announced or perceived changes in policy regime

over time. Moreover, since it does not impose a priori breaks in the estimated sample, this procedure gives us the flexibility to assess the market's response not only to announced policy changes but also to the heretofore ignored institutional changes that occurred during the period. Thus plotting the time varying coefficient for unexpected money across our sample will be of special interest.[10/]

To estimate the time varying parameter model, equation (1) is rewritten as:

$$(2) \quad \Delta i_t = \beta_{0,t} + \beta_{1,t} UM_t + \nu_t ,$$

where the path of $\beta_{1,t}$ is assumed to be a random walk process without drift. That is, $\beta_{1,t} = \beta_{1,t-1} + \rho_{i,t}$ and $\rho_{i,t}$ is distributed $N(0, \sigma^2 P)$. Constraining the conditioning P-matrix to zero reduces the estimation to ordinary least squares. To test for parameter stability, a maximum likelihood estimate (MLE) of equation (2) is calculated for the case in which P is constrained to zero and compared to an ML estimate without the constraint. Rejecting the restriction P = 0 implies rejecting the hypothesis of constant coefficients.

The relevant stability test results are reported in table 2. Comparing the constrained estimates (MLE(OLS)) to the unconstrained (MLE) estimates yields a χ statistic.[11/] The evidence reported in table 2 indicates that the hypothesis of a constant coefficient is rejected at very high levels for all forward rates except for the 3-5 year rate. Thus, like previous studies, the evidence in table 2 indicates that

interest rates generally have responded differently over time to unexpected money changes.

The time varying parameter estimation procedure also provides a visual portrayal of the parameter's evolution over time. Inspection of the plots of $\beta_{1,t}$ allows us to determine if changes in policy regime and changes in interest rate response coincide. More specifically, if marked movements in the estimated response of interest rates to unexpected money occur at points not associated with the popular October 1979 and October 1982 break points, then previous evidence used to support the regime-shift view should be re-evaluated.

The time varying behavior of unexpected money's coefficient is depicted in figures 1-7, with the ordering of the figures corresponding table 2. (The 3-5 year forward rate is excluded.) The plots for the federal funds rate and the three-month T-bill rate corroborate one aspect of previous research as well as the OLS results in table 1: Unexpected money has a greater average impact during the period 1979-82 than either before or after. Indeed, the finding of greater response during 1979-82 is consistent across rates.

The time series of the estimated UM coefficients found in figures 1-7 do <u>not</u> support the popular notion that October 1979 represents a unique shift in the impact of unexpected money. In every instance the coefficient on unexpected money begins to increase sharply in 1978. The estimated coefficient in the case of the federal funds rate, for example, is estimated to have increased from 0.031 in January 1979 to 0.068 just before the announced October 1979 policy shift. Similarly, the impact

of unexpected money on the three-month T-bill rate more than doubles between mid-1978 and September 1979. This pattern prevails whenever the slope parameter is time varying. Thus, the hypothesis that the change in the empirical relationship occurred at the October 1979 policy shift is dubious. Not only does the change occur earlier, but there also is no evidence of an abrupt change in the coefficient in October 1979.

The lack of a significant change in the behavior of the estimated UM coefficients in October 1982 also is evident in the figures. While the coefficient does drop at this point for the three-month T-bill and several of the forward interest rates, the decline in the response begins much earlier than the October 1982 change in operating procedures. For example, the plots reveal a decline in the response beginning in 1981 for the three-month T-bill rate, the three- to six-month and six-month to 1-year forward rates. The response slowly decays from early 1980 using the 1 to 2 and 2 to 3-year forward rates, and little change after an initial run up in early 1980 is evident using the 5 to 7-year forward rate.

The response of the important federal funds rate is more variable across the sample than that of other rates. It drops sharply following a peak in early 1980, rises again from mid-1981 through early 1982 and decays from that point through the end of the sample period. Although the timing differs somewhat from the other rates, the changing response of the federal funds rate to the change in operating procedures in October 1982 is not apparent in figure 1.

The visual evidence in figures 1-7 demonstrates that the shifts in monetary policy operating procedures do not coincide with changes in the effect of unexpected money on interest rates.[12/] What then explains the behavior depicted in the figures? The aforementioned changes that occurred during the sample period offer an explanation. For example, the initial increase in the estimated coefficients began in mid-1978 for all rates except the 1-2 year and 2-3 year forward rates. Beginning in 1979, the Fed abandoned its quarterly setting of monetary growth targets and instituted the annual growth targets required under the Humphrey-Hawkins Act of 1978. This change forced the Fed to set its targets from the fourth quarter to the fourth quarter to lessen the problem of base drift inherent in its previous approach. Even though the Fed had announced monetary growth targets prior to January 1979, the passage by Congress in 1978 of a new operating constraint clearly represents a change in the Fed's policy environment. The increasing response of interest rates to unexpected money changes following this procedural change suggests that the increasing importance placed on monetary developments by the financial market generally associated with the October 1979 announcement had been underway for some time.

Another common result is that money announcements have their peak effects in early 1980 for all rates except the three- to six-month forward rate where its peak occurs in 1981. The peak in early 1980 coincides with the imposition of the special credit control program by the Carter administration and carried out by the Fed from March 1980 until phased out in

July 1980.[13/] In addition, Congress enacted the Depository Institutions Deregulation and Monetary Control Act in March 1980. On February 7, 1980, the Fed also announced new definitions of the monetary aggregates, designating two narrow measures of money--M1A and M1B--even though policy continued to be discussed primarily in terms of M1B.[14/] The market's increased response to unexpected money changes in early 1980 could be due to any one of these changes or to some combination of effects.

Another important event that coincides with substantial changes in the estimated UM coefficient is the period in early 1981 that encompasses the nationwide introduction of NOW accounts.[15/] This effect is especially noticeable for the shorter-term rates. The behavior of the coefficient in the federal funds rate equation (figure 1) shows a slight change in the decline from April 1980 in January 1981. This decline in the coefficient continues until May 1981 when it begins to rise sharply. The often-studied T-bill response reveals a sharp increase from the beginning of 1981 through mid-1981 when the coefficient begins a descent that continues for the remainder of the sample. For both the three- to six-month forward rate and the six-month to 1-year forward rate, the episode of the NOW account introduction is associated with the beginning of the decline in the estimated coefficient on unexpected money.

In summary, the visual evidence presented in figures 1-7 provide little support for the hypothesis that October 1979 and October 1982 represent unique regime shifts. Based on the time varying parameter results, the points of change in the

empirical relationship are better aligned with other institutional changes such as the credit control period or the nationwide legalization of NOW accounts.

Quandt Test Results

The time-varying parameter results indicate that changes in the unanticipated money-interest rate relationship do not occur at times of announced policy regime shifts. Although the parameter plots are quite revealing on this point, they do suffer from one drawback: there is no statistical test associated with the evolution of the parameter estimates. That is, other than the MLE test of the null hypothesis of stability over the entire sample, there is no statistical test to determine the "most likely" point of change or whether the change at any point is significant. To bolster our claim that October 1979 and October 1982 are not unique regime shifts, we use Quandt's (1960) test to find the most likely shift point. Once the shift point is found, an F-test is used to determine its significance.

Two hypotheses are tested with the Quandt test: First, we test for parameter stability within the commonly used subperiods ending in September 1979, October 1979-September 1982 and post-September 1982. Because these periods form the basis of comparing effects of unanticipated money on interest rates in previous work, it is useful to determine if the relationship is stable within these periods. Rejection of the null hypothesis of stability would suggest that the October regime shifts are not unique.

Second, we test for the most likely break point using two periods, each including one of the October dates. That is, we employ the Quandt test to find the most likely break using one sample period running from September 1977 to September 1982 and another from October 1979 to March 1985.[16/] If the standard estimation procedure is correct, the first period should single out the October 6, 1979 date as the Quandt test's "most likely" break point, and the second period should pick out the October 1982 policy shift.

The Quandt test results are reported in table 3. For each interest rate, the first set of results test the hypothesis of stability within subperiods. The second set of results test the hypothesis that the October regime shifts are the most likely break points.

The results pertaining to the first hypothesis suggest that at reasonable levels of significance we can reject stability across both the September 1977-September 1979 and October 1982-December 1985 subperiods for every interest rate. This result shows that it is improper to compare estimates of the interest rate response to money announcements across different operating procedure regimes because the Quandt test results indicate that there is an unstable response within those subperiods. The most likely break point chosen for the October 1979-September 1982 sample generally is insignificant, however. The exceptions are the results using the 3-5 year forward rate, where the break point of April 6, 1981 is significant at the 10 percent level, and the 3-6 month forward rate where a break point of January 23, 1981 is significant at

the 5 percent level. In all other cases, we cannot reject stability only during October 1979 to September 1982.

We now turn to the issue of the likelihood of the break being in October 1979 and October 1982. First, the only break point considered in previous studies for the September 1977 through September 1982 period is October 6, 1979.[17/] The Quandt test results in table 3 report no evidence of a likely break near the October 6, 1979 policy change regardless of the interest rate used. The Quandt test results therefore do not support the contention that October 6, 1979 represents a unique shift in the unexpected money-interest rate relationship. Curiously, however, while no one break point is chosen for every rate, April 12, 1979 is selected as the most likely break for five out of eight interest rates.

Previous studies using periods like October 1979 to March 1985 a priori have broken the sample in October 1982. Nevertheless, in no case do the Quandt tests indicate any date in 1982 as the likely break point for our second sample. Again we find no evidence to support the October 1982 break point often used in previous work. The most common break of the five points detected for the different rates is October 21, 1983 which is chosen using the 6-12 month, 1-2 year, 2-3 year and 5-7 year rates.

The evidence from the Quandt tests corroborates the time varying parameter evidence in two ways: First, the relation between unexpected money and interest rates is unstable over time. This finding is consistent with virtually all previous research. Second, in no instance does the Quandt test validate

the use of either October policy change as a shift point in the estimated relationship. Like the time varying parameter evidence, the Quandt test results suggest examining other, more likely break points. While the uniqueness of the October policy announcements as break points is easily rejected by our evidence, an important and broader issue is raised: how important are announced policy shifts to the working of financial markets? The results presented here suggest that they have little influence. This conclusion should not be too surprising. The Federal Reserve has made many announcements since September 1977, a substantial fraction of which had no impact on financial markets. Apparently, financial market participants adopt a "wait-and-see" attitude toward those policy changes that do not have a clear impact on financial market variables.

IV. Conclusion

We have sought to provide an objective test of the importance of the commonly accepted October 1979 and 1982 policy announcements as break points in the empirical relationship between unexpected weekly money and interest rates. These likely candidates have been used based on an application of the Lucas critique. Because these dates are associated with monetary policy regime changes, they are plausible choices in assessing the potentially changing effects of unexpected money on interest rates. In fact, previous tests support the view that the estimated parameters from the subperiods delineated by the October breaks were from different populations.

The evidence we present suggests a different interpretation of previous results. The time varying parameter evidence indicates that major changes in the evolution of the estimated parameter on unexpected money do not occur in either October 1979 or October 1982. The evidence points to a major shift taking place in mid-1978 to early 1979 for most interest rates, coinciding with the passage and implementation of the Humphrey-Hawkins Act and the Fed's use of fourth-to-fourth quarter annual money targets. Other changes in the coefficient's time path also are found to better coincide with various institutional changes that transpired during the sample (e.g., credit controls, introduction of NOW accounts, redefinition of monetary aggregates) than with announcement of changes in monetary policy operating procedures.

To determine if our time varying parameter results are technique specific, we also employed the Quandt test. The Quandt test results corroborate our finding that October 1979 and October 1982 do not represent the most likely break points in the estimated equations. In no case were these dates, or even dates within a close proximity, selected by the test procedure.

The results presented here should serve as a reminder to researchers concerned with potential instability in their estimated relationships. Testing for specific breaks may yield findings of significant changes at the chosen break points. The standard Chow test, however, is not designed and cannot be used to rule out the possibility of other break points. Economists have singled out October 1979 and October 1982 as

likely break points in the money announcement-interest rate relationship. The null hypothesis of stability at these points is rejected. The null hypothesis of stability, however, can be rejected at other, equally plausible points. Thus, it is far from clear that the a priori chosen break points are, in fact, the "true" break points.

FOOTNOTES

1/ For references to the voluminous earlier work, see the survey papers by Cornell (1983) and Sheehan (1985).

2/ See Wallich (1984) and Gilbert (1985) for discussions of the 1982 policy shift.

3/ For a useful discussion of base drift and Fed policy targets, see Broaddus and Goodfriend (1984).

4/ Gavin and Karamouzis (1984) and Roley (1985) provide estimates of the differential announcement effects across the change in accounting procedures.

5/ Loeys (1985), Belongia, Hafer and Sheehan (1987) and Hein (1987) use procedures that specifically allow the estimated coefficients to vary over time. Loeys' procedure is based on a rolling 12-month sample. Belongia, et. al., use the time varying parameter estimation procedure. Hein's approach is to break the sample into N periods and test for stability across the subperiods. Clearly, the procedures used by Loeys and Hein require more a priori decisions than does the time varying parameter approach used in this paper.

6/ The measurement of the interest rate changes is dictated by data availability. While the preferable period over which to measure the interest rate response is just prior to the announcement to immediately following the report, for rates on maturities longer than three months we were forced to use the close-to-close change in rates. In this regard, we are subject to the criticisms raised by Falk and Orazem (1985) against Cornell (1983).

7/ Actual changes in M1 are calculated as first announced less first revised value. The data are from the Federal Reserve's H.6 statistical release. Because the definition of M1 changes across our sample, the following procedure is used. The "old" definition of M1 is employed until February 1980. From that point through November 1981 the definition is M1B not adjusted for NOW accounts. The current definition of M1 is used from November 1981 to the end of the sample. During each period our measure of M1 corresponds to the measure survey respondents were asked to forecast. Note, however, that our official measure was not the only measure announced by the Fed in some periods. There were, for example, the "shift-adjusted" M1B measure and the M1A measure.

8/ Roley "corrects" the informational content of the survey by estimating the regression:

$$M_t = \alpha_0 + \alpha_1 EM_t + \alpha_2 TBCH_t + \varepsilon_t ,$$

where M_t is the actual change in M1, EM the survey's expected change and TBCH is the change in the three-month T-bill rate from 3:30 on the day of the survey to 3:30 on the day of the money announcement. Roley's expected money series is the fitted series from the above equation, and unexpected money is the residual from the regression.

Hein (1985) contends that Roley's correction procedure merely corrects the survey measure's bias. Hein demonstrates that constraining the forecast to be unbiased and recalculating Roley's corrected measure, expected money continues to exert a significant effect on the interest rate

change. That is, Hein estimates the above equation and constrains the coefficient on EM to unity.

9/ We also estimated the equations using spot rates. Doing so yielded statistically significant coefficients for unexpected money for the 1979-82 and 1982-85 samples for all interest rates.

10/ The time varying parameter approach recently has been used to test the hypothesis that the change in policy procedures in October 1979 accounts for the rise and increased volatility in the short-term real rate of interest. In that study, October 6, 1979 was not found to be a likely break point. See Antoncic (1986).

11/ The test procedure is based on a concentrated log-likelihood function that produces a maximum likelihood (ML) estimator for P and a time series of the coefficient. The ML value $\hat{P}$ is compared to the OLS value using the statistic $-2(L(P_0) - L(P))$ where $L(P_0)$ is the likelihood function estimated at $\hat{P} = 0$ and $L(P)$ is the likelihood function evaluated at the ML value of $\hat{P}$. The resultant statistic is distributed as a χ^2 with one degree of freedom.

12/ Recent work [Roley (1985)] provides a theoretical model that suggests that the switch in February 1984 from lagged to contemporaneous reserve accounting provides another plausible break in the empirical relationship. The evidence in figures 1 and 2 show no dramatic departure from the coefficient path that would support this hypothesis. Note, however, that using February 1984 as a break point between October 1982 and

December 1985 likely will yield a significant result given the time path of the coefficients.

13/ The special credit control program effectively increased institutions' borrowing costs through the imposition of a discount rate surcharge on large banks that were frequent discount window borrowers and influenced the flow of credit between institutions. The impact of the controls on the behavior of money was dramatic: during April 1980, M1A and M1B declined at annual rates of 18.5 percent and 14.5 percent and showed essentially no change in May.

14/ The new monetary definitions were announced because recent financial innovations were blurring the distinction between transactions and savings deposits. FOMC policy deliberations consequently were set forth in terms of M1A, M1B and M2. Because the respondents to the Money Market Services survey were asked only their forecast for M1B changes, the heightened sensitivity to unexpected money changes may reflect increased uncertainty by market participants over which monetary measure was important in Fed policy discussions. Indeed, little has been written on this important institutional aspect, even though it clearly may affect the empirical weekly interest rate-money relationship.

15/ To our knowledge, no other study has examined the effects of this change on the relationship studied. As with the announcement of the new monetary aggregates in February 1980, the nationwide legalization of NOW accounts produced another monetary aggregate discussed in Fed policy deliberations--namely, "shift-adjusted" M1B. Again because

market participants did not know with certainty which measure dominated policy decisions, the apparent changing response of market rates to unexpected money (M1B) changes should not be surprising.

16/ The sample was truncated at March 21, 1985 rather than extended to the end of the data set based upon maximum number of observations allowed by the Quandt routine employed here.

17/ In all cases, the null hypothesis of stability at October 1979 (and October 1982) can be rejected, consistent with previous results.

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Table 1
Estimates (OLS) of Equation (1): $\Delta i_t = \beta_0 + \beta_1 UM_t + \varepsilon_t$
Alternative Sample Periods [1/]

Rate [2/]	Sept. 29, 1977 - Oct. 4, 1979			Oct. 11, 1979 - Sept. 29, 1982			Oct. 1, 1982 - Dec. 27, 1985		
	β_0 [3/]	β_1 [3/]	$\bar{R}^2$	β_0	β_1	$\bar{R}^2$	β_0	β_1	$\bar{R}^2$
Fed funds	.008 (.84)	.003 (.46)	.00	.034 (.64)	.086 (3.58)	.07	-.032 (1.47)	.010 (.83)	.00
3-month	.028 (2.93)	.017 (2.68)	.06	.045 (1.59)	.079 (6.18)	.20	.007 (.83)	.020 (4.40)	.10
3-6 month	.015 (2.27)	.011 (2.69)	.06	.044 (1.76)	.070 (6.13)	.19	.006 (.55)	.026 (4.57)	.11
6-12 month	.020 (3.05)	.015 (3.58)	.10	-.009 (.53)	.052 (6.41)	.21	-.012 (1.37)	.020 (4.09)	.09
1-2 years	.010 (1.59)	.002 (.43)	.00	.011 (.45)	.071 (6.45)	.21	.002 (.20)	.022 (3.77)	.07
2-3 years	.003 (.38)	.010 (2.05)	.03	.020 (.92)	.049 (5.03)	.19	-.003 (.28)	.016 (2.36)	.03
3-5 years	-.001 (.10)	.007 (1.70)	.02	.057 (3.35)	.022 (2.90)	.05	.004 (.38)	.022 (3.93)	.08
5-7 years	.004 (.53)	-.003 (.04)	.00	.027 (1.47)	.026 (3.18)	.06	.013 (1.08)	.018 (2.71)	.04
7-10 years	.005 (.59)	-.009 (1.71)	.02	.049 (2.60)	-.011 (1.23)	.00	-.030 (.99)	.023 (1.36)	.01
10-20 years	.003 (.53)	.001 (.25)	.00	.043 (2.04)	.009 (.94)	.00	.020 (.97)	-.003 (.24)	.00
20-30 years	-.100 (1.27)	-.041 (.83)	.00	-.060 (.72)	.054 (1.44)	.01	-.033 (1.64)	-.003 (.23)	.00

1/ The number of observations are 105, 153 and 169, respectively.

2/ The interest rates used are forward rates, except for the federal funds rate and the three-month Treasury bill rate. Forward rates are calculated using the Shiller, et. al. (1983) linearization procedure.

3/ Absolute value of t-statistics appear in parentheses.

Table 2
Time Varying Parameter Estimation Results
Sample Period: September 29, 1977 - December 27, 1985

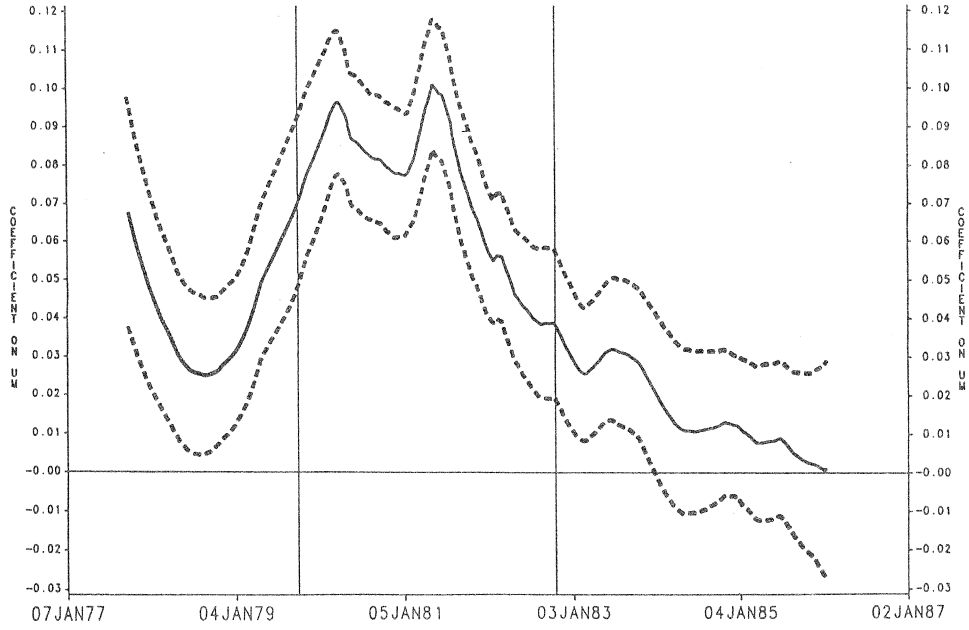
Rate	MLE(OLS)	MLE	χ^2(1d.f.)	σ_{MLE}	σ_{OLS}	ρ
Fed funds	348.906	352.846	7.88 *	.178	.189	.0006
3-month	599.319	608.003	17.37 *	.054	.057	.0006
3-6 month	661.692	667.924	12.46 *	.042	.044	.0003
6-12 month	785.395	792.277	13.76 *	.023	.025	.0005
1-2 years	593.996	607.079	26.17 *	.053	.060	.0014
2-3 years	649.700	654.719	10.04 *	.044	.046	.0006
3-5 years	740.262	---	---	---	---	0
5-7 years	653.133	663.726	21.19 *	.037	.046	.0080
7-10 years		---	---	---	---	0
10-20 years		---	---	---	---	0
20-30 years		---	---	---	---	0

* Indicates significance at the 1 percent level

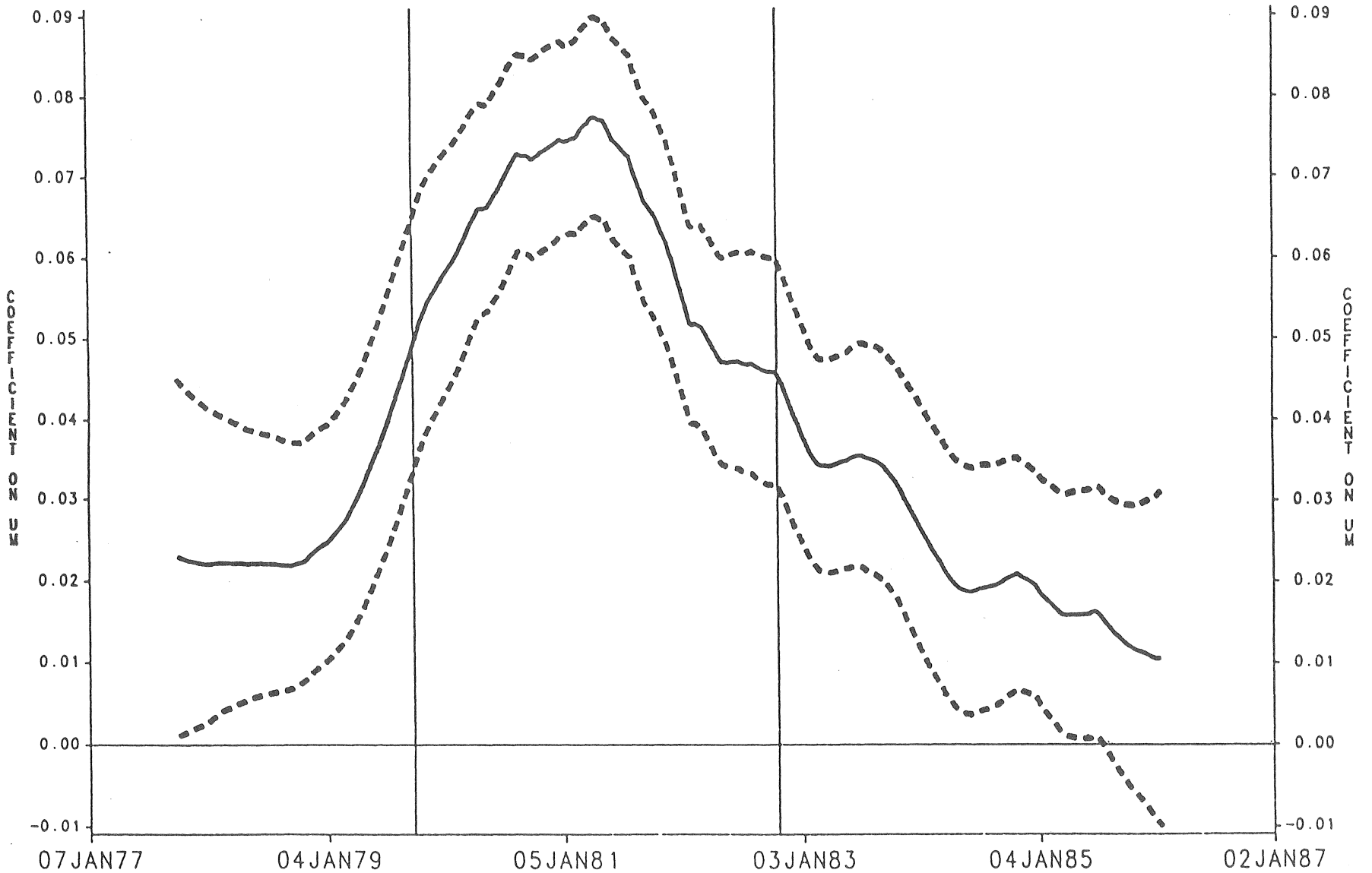
Table 3
Quandt Test Results

Rate	Test period	Date of max (L)	F(sig)
Federal funds	9/77 - 9/79	4/12/79	.0330
	10/79 - 9/82	5/9/80	.9193
	10/82 - 12/85	5/27/83	.0022
	9/77 - 9/82	5/9/80	.0111
	10/79 - 2/85	8/5/83	.0544
3-month T-bill	9/77 - 9/79	4/12/79	.0302
	10/79 - 9/82	10/9/81	.1557
	10/82 - 12/85	3/18/83	.0142
	9/77 - 9/82	4/12/79	.0521
	10/79 - 2/85	2/25/83	.0473
3-6 month	9/77 - 9/79	9/14/78	.0116
	10/79 - 9/82	1/23/81	.0391
	10/82 - 12/85	3/18/83	.0108
	9/77 - 9/82	1/16/81	.0057
	10/79 - 2/85	1/16/81	.0792
6-12 month	9/77 - 9/79	10/20/77	.0716
	10/79 - 9/82	7/31/81	.1444
	10/82 - 12/85	3/18/83	.0018
	9/77 - 9/82	4/12/79	.0024
	10/79 - 2/85	10/21/83	.0268
1-2 year	9/77 - 9/79	4/12/79	.0464
	10/79 - 9/82	10/9/81	.2326
	10/82 - 12/85	3/18/83	.0062
	9/77 - 9/82	4/12/79	.0205
	10/79 - 2/85	10/21/83	.0592
2-3 year	9/77 - 9/79	4/12/79	.0505
	10/79 - 9/82	5/9/80	.8559
	10/82 - 12/85	3/18/83	.0060
	9/77 - 9/82	4/12/79	.0091
	10/79 - 2/85	10/21/83	.0179
3-5 year	9/77 - 9/79	4/19/79	.0252
	10/79 - 9/82	4/6/81	.0747
	10/82 - 12/85	6/17/83	.0014
	9/77 - 9/82	11/6/81	.0084
	10/79 - 2/85	8/5/83	.1404
5-7 year	9/77 - 9/79	4/12/79	.0296
	10/79 - 9/82	6/6/80	.7634
	10/82 - 12/85	10/21/83	.0122
	9/77 - 9/82	4/12/79	.0022
	10/79 - 2/85	10/21/83	.0227

3 MONTH T-BILL



VERTICAL LINES REPRESENT OCT. 6, 1979 & OCT. 15, 1982.



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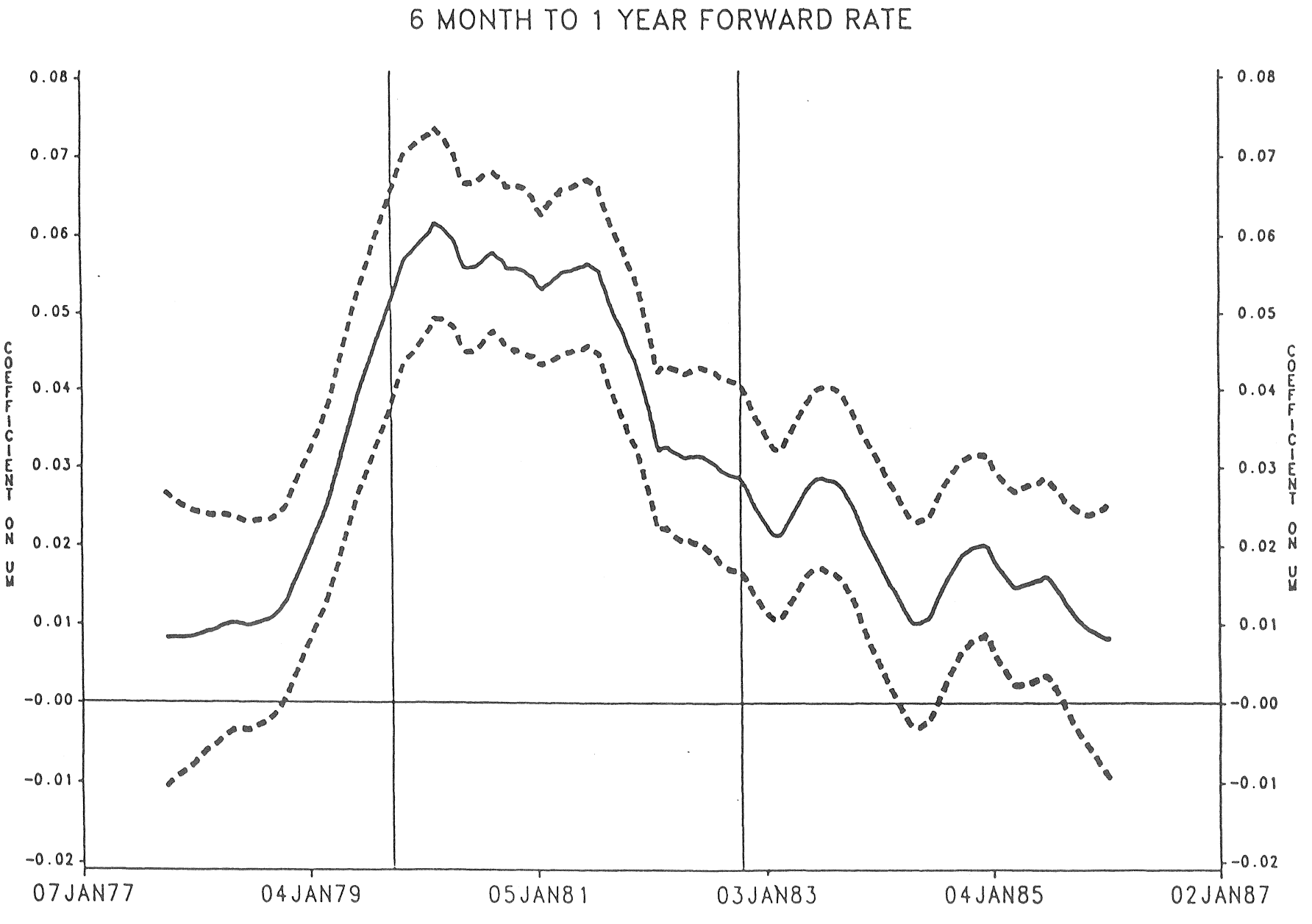

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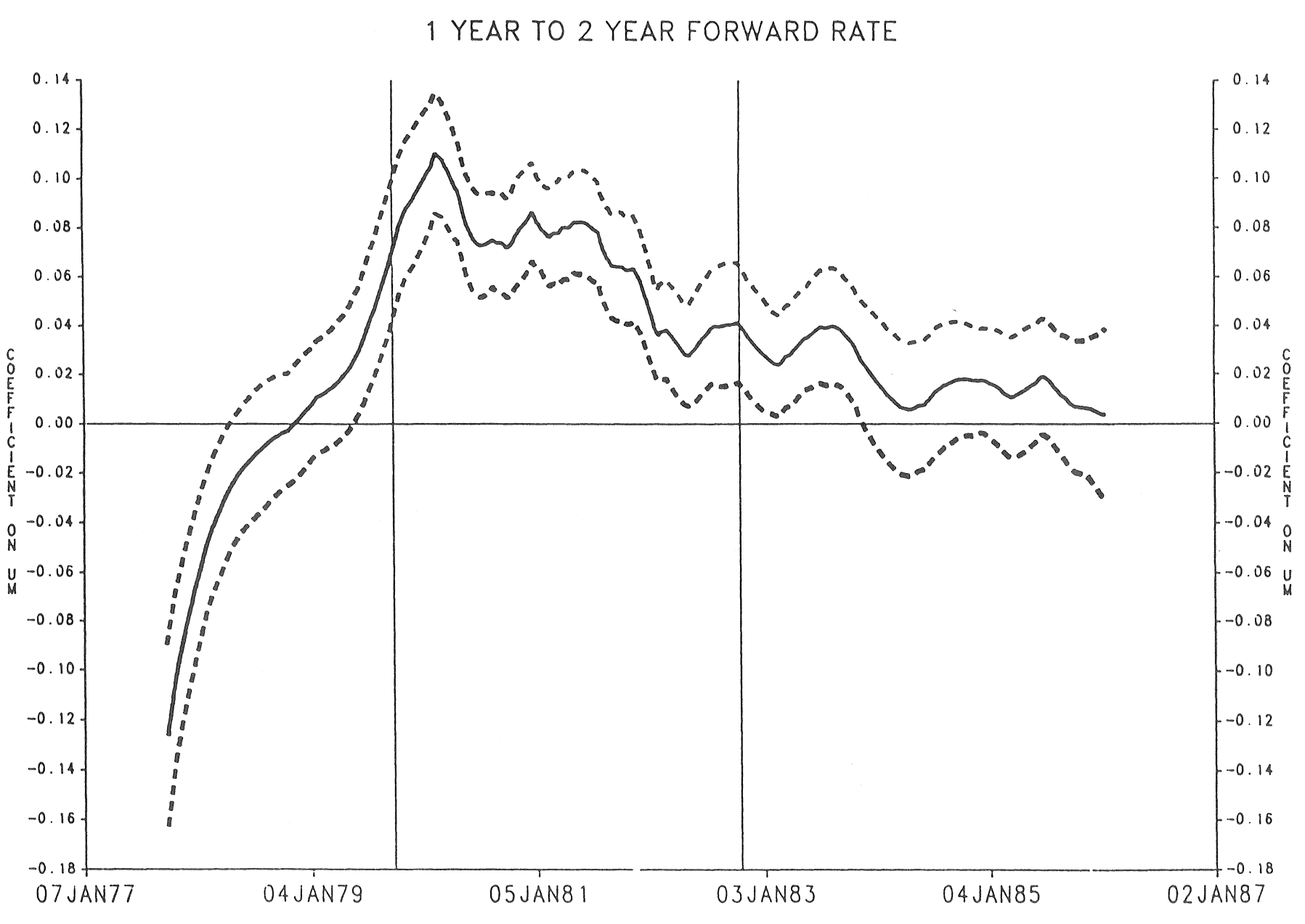

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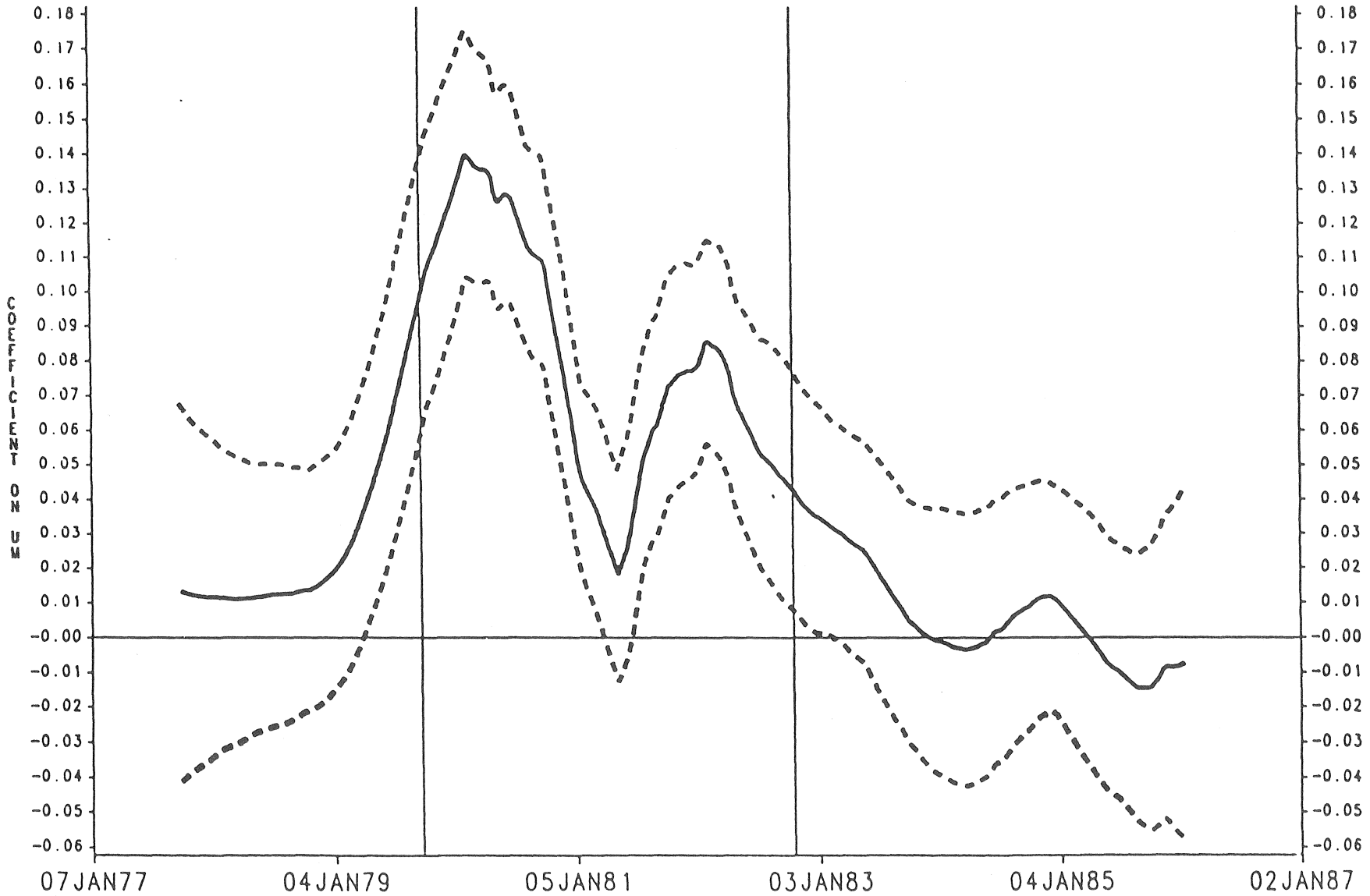
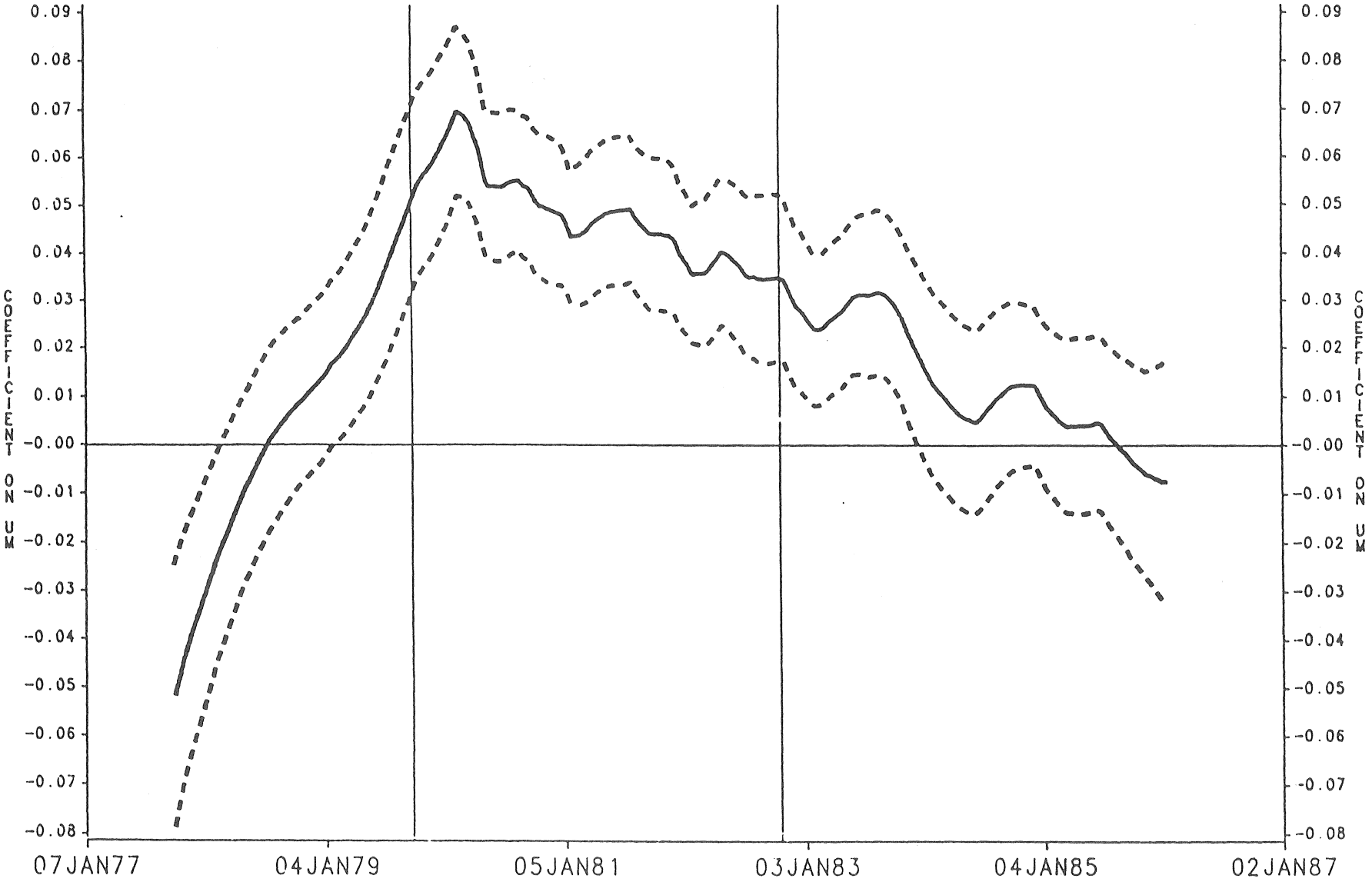
FEDERAL FUNDS RATE



VERTICAL LINES REPRESENT OCT. 6, 1979 & OCT. 15, 1982.

2 YEAR TO 3 YEAR FORWARD RATE



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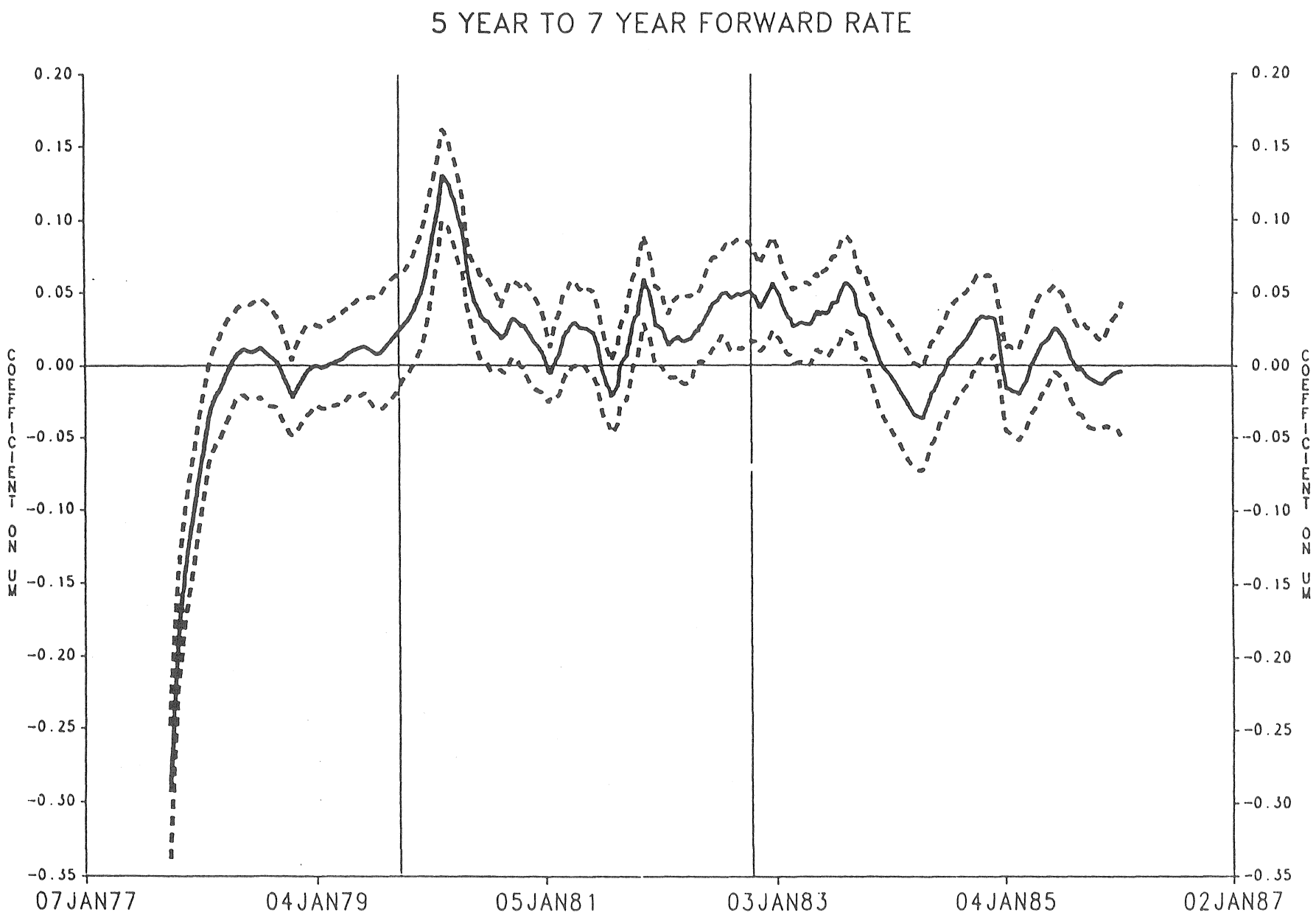

VERTICAL LINES REPRESENT OCT. 6, 1979 & OCT. 15, 1982.