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U.S. MONETARY POLICY REGIMES AND U.S.-JAPAN FINANCIAL RELATIONS

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ABSTRACT

This paper examines the pervasiveness of the effects of U.S. monetary policy regime shifts and unanticipated changes in money on international financial markets. Four potential regimes from October 1977 to May 1985 are examined in terms of the response of yen-denominated securities in the Tokyo market to U.S. money surprises. The rationality of the responses in domestic and foreign onshore financial markets is further examined by testing whether the responses of dollar-denominated securities, yen-dominated securities, the spot yen/dollar exchange rate, and the forward yen/dollar exchange rate violate covered interest parity. The use of yen-denominated assets and the yen/dollar exchange rate allows further tests of the effects of the liberalization of restrictions on capital mobility in Japan since the late 1970s on market efficiency.

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Financial markets experienced the effects of at least two major changes in Federal Reserve monetary policy in recent years. The first occurred in October 1979 when the Federal Reserve changed from a federal funds rate (or money market conditions) operating procedure to a nonborrowed reserves operating procedure for the stated purpose of improving monetary control. The second change is marked by the Federal Reserve's announced abandonment of the nonborrowed reserves procedure in October 1982, replacing it with the so-called "borrowed reserves" procedure. The Federal Reserve also indicated that targets for the narrowly-defined money stock (M1) would be de-emphasized.[1/] A third potential change in U.S. monetary-policy regimes coincides with the adoption of the contemporaneous reserve requirements (CRR) system in February 1984. Under the federal funds rate operating procedure, differences between CRR and lagged reserve requirements (LRR) are inconsequential as monetary policy is implemented using the demand for money in both systems. Under the nonborrowed reserves procedure, however, the differences in terms of interest-rate volatility and monetary control are potentially significant. Depending on the particular form of the borrowed reserves procedure in effect since October 1982, CRR and LRR also may have different implications for the behavior of interest rates and the monetary aggregates. Moreover, the February 1984 change may have coincided with a further shift in the Federal Reserve's emphasis on its monetary targets.

Empirical estimates of the response of U.S. interest rates to the Federal Reserve's weekly money announcements have demonstrated their usefulness in both identifying changes in policy regimes and determining

the implications for interest-rate volatility. Roley (1982, 1983) and Cornell (1983a) provide estimates indicating that the response of interest rates to money announcement surprises increased significantly following the change in policy in October 1979. Recent studies (e.g., Gavin and Karamouzis 1984 and Loeys 1985) focusing on the period following October 1979 find that the interest-rate response declined by October 1982 if not before.

Other studies examine the response of foreign exchange rates to money announcement surprises in an attempt to distinguish between the two main hypotheses associated with the U.S. interest-rate response (e.g., Cornell 1982, Frankel and Hardouvelis 1985, and Engel and Frankel 1984). Under the policy anticipations hypothesis (e.g., Urich and Wachtel 1981), real U.S. interest rates rise in response to positive money announcement surprises, leading to an appreciation of the dollar in foreign exchange markets. Alternatively, under the expected inflation hypothesis (e.g., Cornell 1983a), movements in nominal U.S. interest rates reflect changes in expected inflation, causing the dollar to depreciate. Most of the evidence from the response of a variety of exchange rates to U.S. money announcement surprises supports the policy anticipations hypothesis.[2/] In addition, different monetary policy regimes are found to significantly affect the response of at least some foreign exchange rates to money announcement surprises (e.g., Hardouvelis 1984 and Hakkio and Pearce 1985).

The purpose of this paper is to examine the pervasiveness of the effects of U.S. monetary policy regime shifts and unanticipated changes in money on international financial markets. Husted and Kitchen (1985) and Hardouvelis (1984) provide mixed evidence on the response of yields

on assets denominated in foreign currencies to money announcement surprises, but then only during the nonborrowed reserves regime. The response of yen-denominated securities in the Tokyo market is examined here across the four potential regimes from October 1977 to May 1985. The rationality of the responses in domestic and foreign financial markets and foreign exchange markets is further examined by testing whether the responses of dollar-denominated securities, yen-denominated securities, the spot yen/dollar exchange rate, and the forward yen/dollar exchange rate violate covered interest parity. The use of onshore yen-denominated assets and the yen/dollar exchange rate allows further tests of the effects of the liberalization of restrictions on capital mobility in Japan since the late 1970s on market efficiency.

In the first section, the responses of U.S. interest rates to the Federal Reserve's weekly M1 announcements are used to identify changes in U.S. monetary policy regimes. The volatility of interest rates and foreign exchange rates over different periods also is discussed. The behavior of the spot yen/dollar exchange rate and a short-term interest rate in Japan are similarly examined in the second section in terms of the effects of money announcement surprises across U.S. monetary policy regimes. The effects of the implementation of Japan's Foreign Exchange and Foreign Trade Control Law in December 1980 also are investigated. The third section considers the rationality of the responses of interest rates and foreign exchange rates in the context of covered interest parity. Further tests examine the information content of money announcement surprises in predicting future spot yen/dollar exchange rates. The main conclusions are summarized in the final section.

I. Identifying Changes in U.S. Monetary Policy Regimes

On the basis of Federal Reserve policy statements, U.S. monetary policy can potentially be characterized by as many as four different regimes during the past decade. First, since at least the mid 1970s to October 1979, monetary policy was conducted using the federal funds rate procedure. Second, from October 1979 to October 1982, the nonborrowed reserves procedure was implemented. Third, from October 1982 to February 1984, the borrowed reserves procedure was used under lagged reserve requirements. Finally, since February 1984 the borrowed reserves procedure has been in effect under contemporaneous reserve requirements.

The effects of the October 1979 change in monetary policy regimes are well documented with respect to both the sharp rise in U.S. interest rate volatility and the significant increase in the response of interest rates to money announcement surprises (e.g., Roley 1982, 1983, and Cornell 1983a). Roley and Walsh (1985) also find that this change in regimes affected important domestic financial relationships such as the demand for money.[3/] There is no reason to expect a priori that the effects of monetary policy regime shifts remain isolated in domestic financial markets.

To consider initially the potential changes in Federal Reserve policy regimes, the volatility of the federal funds rate and the 3-month Treasury bill yield over four different periods is presented in the first two rows of Table 1. For both interest rates, the reported values correspond to mean absolute weekly changes measured on days immediately following the Federal Reserve's weekly money announcement.[4/] The dramatic rise in the volatility of both of these interest rates from the

pre-October 1979 to the October 1979 - October 1982 periods is apparent in the table. The mean absolute change of the federal funds rate, for example, increased from 14 to 81 basis points. Following October 1982, the volatility dropped, but the volatility of the federal funds rate failed to achieve pre-October 1979 levels. In contrast, the volatility of the 3-month Treasury bill yield in the two post-October 1982 sub-periods is about the same as that in the pre-October 1979 period. As a whole, these summary statistics suggest that U.S. monetary policy changed fundamentally following October 1982. Moreover, on the basis of the behavior of the federal funds rate, the post-October 1982 regimes are not the same as that in effect prior to October 1979. In terms of the switch in reserve requirement systems to CRR in February 1984, the results are inconclusive concerning the significance of this change.

Response of U.S. Interest Rates to Money Announcement Surprises

To evaluate further the significance of potential changes in Federal Reserve policy since 1977, the responses of the federal funds rate and the 3-month Treasury bill yield to weekly money announcement surprises are estimated. The federal funds rate is examined due to the close link between Federal Reserve policy actions and the federal funds market. The 3-month Treasury bill yield is used in a subsequent section when the rationality of the response to money announcement surprises across international financial markets is considered.

Specification and Data. The usual efficient markets model is used to estimate the response of interest rates to weekly money announcements. This model may be represented as

$$\Delta R_t = b_0 + b_1 \cdot UM_t + b_2 \cdot EM_t + e_t \qquad (1)$$

where ΔR_t = change in the interest rate over a time interval including the money stock announcement in week t

$UM_t = \ln M_t - \ln M_t^e$

$EM_t = \ln M_t^e - \ln M_{t-1}$

M_t = announced level of the money stock in week t

M_t^e = markets rational expectation of the announced level of the money stock in week t

e_t = random error term uncorrelated with any information available to the public prior to the money announcement in week t

b_0, b_1, b_2 = estimated coefficients.

Under the null hypothesis of market efficiency, both the coefficient on the expected announced percentage change in money (b_2) and the constant should equal zero.

The data used in estimating both interest rate and later foreign exchange rate responses to money announcement surprises span the periods indicated on the top of Table 1. The dates correspond to money announcement days. The first observation is for the money announcement on October 6, 1977, and the final observation occurs on May 30, 1985.[5/]

The money stock data consist of announced weekly levels of the narrowly defined money stock, in billions of dollars, as reported in the Federal Reserve's H.6 release.[6/] Data for the expected announced level of the money stock are based on the survey data compiled by Money Market Services, Inc. The survey data represent the market's expected announced change in the money stock. To construct expected levels, market participants are assumed to expect no revision in the previous week's announced level.

The survey data are further adjusted to alleviate two potential problems. First, in the pre-October 1979 period, Grossman (1981) estimates a significant additive bias for the survey data. Second, at times the survey data were collected several days before the weekly money announcement. To form an unbiased and informationally efficient measure of expected money, fitted values are taken from estimated equations of the form

$$\ln M_t - \ln M_{t-1} = c_0 + c_1 \cdot (\ln M_t^e - \ln M_{t-1}) + c_2 \cdot \Delta RTB_t' + v_t \qquad (2)$$

where $\Delta RTB_t'$ = change in the 3-month Treasury bill yield from the first daily observation following the previous money announcement (M_{t-1}) to the daily observation just before the current week's money announcement (M_t)

v_t = random error term

c_0, c_1, c_2 = estimated coefficients.

The estimation results of equation (2) indicated serveral biases, including a statistically significant intercept in the pre-October 1979 period and an estimate of c_1 significantly greater than unity in the post-February 1984 period. In addition, the change in the Treasury bill yield prior to the money announcement provided statistically significant information in the October 1979 - October 1982 period. While the revised measure does not significantly change the estimated responses of interest rates as well as exchange rates to money announcement surprises, it reduces the statistical significance of expected money in several of the estimated equations.[7/]

The yield data are taken from the H.15 release, published by the Federal Reserve. The change in the 3-month Treasury bill yield is

measured from 3:30 P.M. on the day of a money announcement to 3:30 P.M. on the following business day. The change in the federal funds rate is defined similarly, except that it is a daily-averaged figure. Nevertheless, it predominately reflects federal funds trading prior to 3:30 P.M. Thus, any effect of money announcements -- which are made at 4:10 P.M. -- should be reflected in the measured yields.

Empirical Results. Estimation results of the efficient markets model (1) for the federal funds rate and the 3-month Treasury bill yield over four sub-periods are presented in Table 2.[8/] The estimated response of the federal funds rate to money announcement surprises suggests the possibility of several different monetary policy regimes. In the pre-October 1979 period, the response is not statistically significant, as expected under the federal funds rate operating procedure. In the October 1979 - October 1982 period, the results indicate that the federal funds rate increased 39 basis points in response to a positive 1 percent money announcement surprise. Following Roley and Walsh (1985), this estimated response is consistent with the nonborrowed reserves operating procedure. The estimated response is once again insignificant in the two post-October 1982 subperiods.

Estimation results for the response of the 3-month Treasury bill yield to money announcement surprises are similar, with the exception that the estimated response is statistically significant at the 5 percent level in three of the four periods. Moreover, the estimated response of 18.8 basis points to a 1 percent money announcement surprise in the October 1982 - February 1984 period is over twice that of the pre-October 1979 period. Also in contrast to the estimation results for the federal funds rate, the coefficient on expected money is statistically significant at the 5 percent

level in the October 1979 - October 1982 period. This result appears to be due to the measurement of the change in the 3-month Treasury bill yield over a 24-hour period and in many cases over a weekend rather than the 1½-hour period used by Roley (1983).[9] While this result, along with the presence of statistically significant constant terms in some regressions, is inconsistent with the efficient markets hypothesis, it has no affect on the estimated responses to money announcement surprises. In particular, the revised measure used for expected money is constructed to be orthogonal to the money announcement surprise.

Changes in the interest-rate responses across different monetary policy regimes are formally tested on the right-hand side of Table 2.[10] Both the federal funds rate and the 3-month Treasury bill yield give similar qualitative results. In particular, across all four potential regimes (S1, S2, S3, and S4), the hypothesis that the responses to money announcement surprises are the same can be rejected at the 5 percent significance level. Moreover, the pre-October 1979 and October 1979 - October 1982 periods have significantly different responses. The hypothesis of identical responses in the October 1979 - October 1982 and October 1982 - February 1984 periods also can be rejected at low significance levels. The estimated responses in the last two sub-periods, however, do not differ significantly for the Federal funds rate, but they do differ significantly for the Treasury bill yield. Thus, different monetary policy regimes are evident in the pre-October 1979, October 1979 - October 1982, and post-October 1982 periods. The empirical results for the Treasury bill yield also indicate the possibility of a different monetary policy regime beginning in February 1984.

II. Behavior of the Exchange Rate and the Gensaki Rate Acorss Regimes

Hardouvelis (1984) and Hakkio and Pearce (1985) examine the response of exchange rates to money announcement surprises across different U.S. monetary policy regimes. As a whole, the evidence suggests that the change in regimes in October 1979 significantly affected a number of exchange rate responses. In particular, the dollar experienced larger appreciation in foreign exchange markets in response to a positive money surprise beginning in October 1979.

Others investigate the response of Euro-currency rates to money announcement surprises (e.g., Hardouvelis 1984, and Husted and Kitchen 1985), but these studies are confined to the October 1979 - October 1982 period. As a consequence, the effects of different U.S. monetary policy regimes have not been considered. Moreover, the effects of changes in U.S. monetary policy regimes on foreign onshore security markets have not been examined.

The international effects of U.S. monetary policy regime shifts are examined below for the yen/dollar exchange rate and the 3-month Gensaki rate, a repurchase agreement rate in Japan. In addition to the possible effects eminating from changes in U.S. policy regimes, Japanese markets have been subjected to varying degrees of deregulation over time. In particular, capital controls were relaxed in Japan in May 1979 to allow nonresidents to purchase Gensaki assets. Further capital controls were lifted in December 1980 under the Foreign Exchange and Foreign Trade Control Law. This law removed several important barriers to capital flows in Japan (e.g., Ito 1983, 1984, and Eken 1984). Additional measures were taken to liberalize international capital flows throughout 1983 and in April 1984, when the "real demand" principle applied to forward exchange transactions by Japanese residences was abolished along with other changes designed to integrate Japanese financial

markets further (e.g., Eken 1984). The effects of the 1980 law are examined explicitly below.

Selected summary statistics for the logarithm of the yen/dollar exchange rate and the Gensaki rate are presented in the third and fifth rows of Table 1, respectively. While the volatility of the yen/dollar exchange rate does not exhibit the dramatic swings registered by U.S. interest rates, the pattern is analogous. The exchange rate's volatility increased in the October 1979 - October 1982 period, and then declined in the two post-October 1982 periods. Similarly, the volatility of the Gensaki rate increased in the October 1979 - October 1982 period, but it then declined more markedly than the yen/dollar rate following October 1982.[11/]

Response to Money Announcement Surprises

The estimated responses of the spot yen/dollar exchange rate and the Gensaki rate to U.S. money announcement surprises are reported in Table 3. The responses are estimated using the same efficient-markets model (1) as before. For the yen/dollar exchange rate, this empirical specification is consistent with the view that most movements in exchange rates are unanticipated, reflecting the impact of new information (e.g., Mussa 1979, Dornbusch 1980, and Frenkel 1981). The change in the yen/dollar exchange rate is measured from 12:00 Noon, eastern time, on the day of the money announcement to 12:00 Noon on the subsequent business day. The change in the Gensaki rate is measured from 3:30 P.M., Tokyo time, on the day of the money announcement to 3:30 P.M., Tokyo time, on the next business day.

The estimation results for the yen/dollar rate exhibit the usual positive relationship over the various sub-periods. In the October 1979 - October 1982 period, for example, a positive 1 percent money surprise

causes the dollar to appreciate 0.3 percent against the yen. The effect of money announcement surprises is, however, estimated to be statistically significant at the 5 percent level only during this period. The further separation of this period at December 1, 1980 -- corresponding to the enactment of the Foreign Exchange and Foreign Trade Control Law -- yields significant responses in both samples, but only at the 10 percent level. The coefficient on expected money is not statistically significant at the 10 percent level in any of the estimated equations.

None of the estimated responses of the Gensaki rate to money announcement surprises are statistically significant at the 5 percent level, although the negative response estimated for the October 1979 - October 1982 period is significant at the 10 percent level. This result is in sharp contrast to those reported by Hardouvelis (1984) and Husted and Kitchen (1985), who report estimate responses that are positive and statistically significant.[12/] In the pre-October 1979 period, the effect of aniticipated money also is estimated to be statistically significant.

To examine the effects of U.S. monetary policy regime shifts, as well as the effects of the December 1980 law in Japan, the equality of the responses across periods is tested on the right-hand side of Table 3. In contrast to the results for U.S. interest rates, the null hypothesis of equal responses cannot be rejected at low significance levels for the four monetary policy regimes as a whole, or for pairs of adjacent sub-periods.[13/] The null hypothesis of equal responses across the October 1979 - December 1980 and December 1980 - October 1982 periods (S2a, S2b) also cannot be rejected. As a whole, this evidence suggests that U.S. monetary policy regime shifts have not had major effects on the yen/dollar exchange

rate and the Gensaki rate. Instead, the main effects appear to be isolated in U.S. credit markets. However, results using the forward yen/dollar exchange rate presented in the next section alter this conclusion substantially.

III. Rationality and the Effects of Money Announcement Surprises

By considering the combined effects of money announcement surprises on dollar-denominated securities, yen-denominated securities, and exchange rates, the rationality of the reactions can be tested in terms of whether covered interest parity is violated. In perfect international financial markets, all profitable arbitrage opportunities will be exploited across markets. Such real-world factors as transactions costs, differential taxes, default risk, and political risk could, however, result in apparent arbitrage opportunities that are not profitable. Nevertheless, in the case of the tests reported below, any major discrepancies are likely to be due to either capital controls in Japan or market inefficiency (e.g., Ito 1983). With respect to this later possibility, evidence presented by Ito (1983, 1984) suggests that the set of assets examined here satisfies both covered and uncovered interest parity since at least December 1980.

Husted and Kitchen (1985) also examine whether covered interest parity is violated in response to the new information provided by U.S. money announcements over the October 1979 - October 1982 period. Using Euro-currency rates for the U.S., Canada, and Germany, they cannot reject the restrictions implied by covered interest parity. Again, an analysis of onshore securities in Japan and the U.S. offers an opportunity to provide further evidence on the consequences of restrictions

on capital mobility in Japan, or alternatively, market efficiency, by considering the effects of this one source of economic news.

Covered Interest Parity

As an initial step in considering whether covered interest parity is maintained in response to money announcement surprises, the response of the 3-month yen/dollar forward premium is estimated in Table 4.[14/] As before, the dependent variable represents the change in the forward premium over successive business days. The forward premium is defined as

$$FYD_t = 400 \cdot (YD_t^f - YD_t) \qquad (3)$$

where YD_t^f = logarithm of the 3-month forward yen/dollar exchange rate.

The empirical results for the response of the forward premium to money announcement surprises differ from those reported for the spot exchange rate primarily in that the hypothesis of equal responses across periods can be rejected at the 5 percent significance level in each case except for the third and fourth periods. The responses during the October 1979 - December 1980 and December 1980 - October 1982 subperiods are of particular interest. In the first of these sub-periods, the estimated response to a positive 1 percent money announcement surprise is 0.15 percentage points, while the response is three times this amount in the latter sub-period. Also during the December 1980 - October 1982 period, the significantly positive response indicates that the forward yen/dollar exchange rate actually reacts more than the spot rate, implying further expected dollar appreciation in response to a positive money announcement surprise.[15/] In the other periods, the estimated response is not significantly different from zero.

The change in the forward premium is combined with the changes in the Gensaki rate and the 3-month Treasury bill yield in Table 5 to test whether the responses violate covered interest parity. In standard tests of covered interest parity, it is important to measure the forward and spot exchange rates and the interest rates as closely together as possible. This follows because such tests typically involve levels of the variables measured at a particular point in time.[16/] In contrast, when testing whether the responses of these variables to a specific piece of new-information are consistent with covered interest parity, the exact alignment of the data is not necessary.

To examine the consequences of data misalignment, consider the response of the 3-month Treasury bill yield to money announcement surprises

$$RTB_{t,4:10} - RTB_{t,3:30} = b_1 \cdot (\ln M_{t,4:10} - \ln M^e_{t,3:30}). \qquad (4)$$

Expected money, $\ln M^e_{t,3:30}$, is adjusted in (2) to reflect information available at 3:30 P.M. on the day of the announcement. If markets are efficient in the sense that only new information affects yields, and this information is reflected immediately by yields, then the yield response should be measured from 3:30 P.M. to 4:10 P.M., $RTB_{t,4:10} - RTB_{t,3:30}$. The data, however, are measured from 3:30 P.M. on the day of the announcement to 3:30 P.M. on the subsequent business day, $RTB_{t+1,3:30} - RTB_{t,\ 3:30}$. As a result, the empirical specification analogous to (1) becomes

$$RTB_{t+1,3:30} - RTB_{t,3:30} = b_1 \cdot (\ln M_{t,4:10} - \ln M^e_{t,3:30}) + (RTB_{t+1,3:30} - RTB_{t,4:10}). \qquad (5)$$

The term $(RTB_{t+1,3:30} - RTB_{t,4:10})$ is the error term in the regression, and it represents movements in the Treasury bill yield after it has already

adjusted to the money announcement surprise. Under efficient markets, this change in the Treasury bill yield is uncorrelated with information available at 4:10 P.M. on day t, such as the money announcement surprise. Thus, the estimated coefficient b_1 is a consistent estimate of the response from 3:30 P.M. to 4:10 P.M., but measurement of the change in the Treasury bill yield over a shorter interval would result in a more efficient estimate.

Changes in the forward premium and Gensaki rate are measured before expected money is formed at 3:30 P.M. on day t and after the 4:10 P.M. announcement on day t. The error term in (1) in these cases has two components. One component is analogous to that of the Treasury bill yield. That is, movements in these variables after 4:10 P.M. on the day of the announcement are included. As before, these movements are uncorrelated with the money announcement surprise under efficient markets. The other component represents movements prior to the 3:30 P.M. measurement of expected money. Because expected money already reflects this information, the money announcement surprise also is uncorrelated with these movements.[17/] As a consequence, the estimated responses are consistent estimates of the response from 3:30 P.M. to 4:10 P.M. on the day of the announcement. By combining the responses of the variables, their consistency with covered interest parity can be tested. The misalignment of the data does not bias the tests, but it does potentially reduce their power.

The null hypothesis of covered interest parity corresponds to $b_1 = 0$ in Table 5. The single-equation tests reported in the table are asymptotically equivalent to more elaborate tests across the individual response equations.[18/] The results on the top half of the table indicate that the combined responses of the forward premium, the Gensaki rate, and the 3-month

Treasury bill rate lead to rejection of the null hypothesis of covered interest parity at the 5 percent significance level in all periods prior to February 1984. The estimation results for the October 1979 - October 1982 period, for example, imply that covered interest parity is violated by 69 basis points in response to a 1 percent money announcement surprise. Moreover, the average absolute money announcement surprise is 0.4 percent over this period, implying that covered interest parity is on average violated by about 28 basis points. In the latter part of this sub-period (December 1980 - October 1982), the analogous magnitude is 33 basis points.

In contrast to these results, covered interest parity cannot be rejected at the 10 percent significance level for the period beginning in February 1984. As mentioned previously, it is noteworthy that further restrictions on forward exchange transactions were lifted in Japan in April 1984. An alternative explanation is that the markets' responses prior to early 1984 are not rational. Unfortunately, the joint hypotheses of the effects of restrictions on capital mobility and of market efficiency cannot be isolated in this empirical framework.

Another possible explanation of these results is that although covered interest parity is violated, transactions costs make potential arbitrage unprofitable.[19/] Moreover, the estimated effects may predominately reflect the effects of small money announcement surprises, in which case the profitable opportunities may be even more limited. To examine this possibility, money announcement surprises are separated into large and small categories. The critical value in forming these groups is taken as an absolute value of 0.5 percent.[20/] If large divergences from covered interest parity are arbitraged away, then the coefficient b_1' reported on the bottom half of Table 5 should not take values significantly different from zero.

As indicated in the table, however, the hypothesis that covered interest parity is maintained for large surprises can be rejected at the 5 percent level for the October 1979 - October 1982 and the October 1982 - January 1984 periods. This hypothesis can be rejected at the 10 percent level even for the post-February 1984 period. While both the magnitude and statistical significance of the deviations from covered interest parity declined since early 1984, the results suggest that covered interest parity was not maintained in response to money announcement surprises in earlier periods.

Future Spot Exchange Rates

The results in Table 5 indicate that the Gensaki - U.S. Treasury bill interest rate differential and the forward permium responded differently to money announcement surprises at times, thereby violating covered interest parity. As a consequence, one or both of these responses may be irrational in the sense that they do not accurately reflect the information content of money surprises in forecasting future dollar appreciation or depreciation against the yen. This characteristic is even more likely since the responses of the interest-rate differential and the forward premium are estimated to have opposite signs.

In Table 6, the estimated responses to money announcement surprises are used to update the implied forward premium forecast of yen/dollar exchange rate movements. In particular, forecast errors are calculated as

$$\varepsilon_t^i = 400 \cdot (YD_{t+13} - YD_t^a) - FYD_t^b - b_1^i \cdot UM_t \qquad (6)$$

where YD_{t+13} is the logarithm of the actual spot yen/dollar rate 3 months (13 weeks) in the future, the superscripts a and b denote quotes taken after and before money announcements, and the superscript i denotes either the response of the interest-rate differential (d) or the forward

premium (f). These forecasts are compared against the no change forecast ($b_1 = 0$), in which the forward premium before the money announcement is not updated.

The empirical results indicate that the response of the interest-rate differential improves the forecast of the future spot exchange rate in the October 1977 - October 1979 and post-February 1984 periods, while the forward premium response is superior in the remaining sub-periods. That is, one source of information does not dominate the other in terms of predictive ability across periods. Another interpretation is that the interest-rate differential responds in the rational direction during some periods in comparison to the forward premium response, and irrationally in others. Thus, not only do the earlier results suggest that covered interest parity does not hold in response to the new information provided by money announcements over several periods, but neither the response of the interest-rate differential nor the forward premium uniformly provide the correct information in predicting future movements in the exchange rate.

IV. Summary of Conclusions

Several conclusions emerge from this study of the international effects of money announcement surprises across U.S. monetary policy regimes. First, four distinct monetary policy regimes were identified since 1977 corresponding to stated changes in policy in October 1979, October 1982, and February 1984. Second, while the behavior of the spot yen/dollar exchange rate and an onshore interest rate in Japan was relatively insensitive to these changes in regimes, the yen/dollar forward premium exhibited significant changes. Third, until February 1984, covered

interest parity in terms of these assets was violated in response to the new information provided by U.S. money announcements. In the post-February 1984 period, the evidence more strongly supports covered interest parity. The further elimination of restrictions on forward exchange transactions in Japan in April 1984 appears to be a factor in this case. Finally, the responses of the yen/dollar forward premium and the Gensaki-Treasury bill interest-rate differential do not uniformly provide the correct information in terms of actual future spot exchange rate movements. This behavior may be a consequence of either international capital flow restrictions in Japan or market inefficiency.

Footnotes

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1. For a description of the borrowed reserves procedure along with a discussion of the events leading to the change in monetary policy in October 1982, see Wallich (1984).

2. Roley and Walsh (1985) also reconcile the positive relationship between long-term U.S. interest rates and money announcement surprises with the policy anticipations hypothesis, while Cornell (1983b) suggests that the magnitude of the response remains a puzzle.

3. The rise in the volatility of interest rates reduced the interest elasticity of the demand for money following Walsh (1984).

4. Other measures of volatility give similar results. In particular, both the standard deviations of weekly changes and weekly percentage changes also were calculated. Using the latter measure for both interest rates, hypotheses that the volatility in the first and second, second and third, and first and third subsamples is the same can be rejected at the 5 percent significance level in F-tests. See Roley (1986).

5. The usual starting point of September 29, 1977, is not used here. The available daily data on a short-term interest rate in the Tokyo market made it necessary to start one week later.

6. For further details concerning the money stock and interest rate data, see Roley and Walsh (1985).

7. For further details concerning the revised expected money measure, see Roley (1983). For a discussion of the relative merits of this measure, see Hein (1985) and Roley (1985).

8. These results for the first two subsamples differ from those reported by Roley and Walsh (1985) in that all weekly observations are used. Roley and Walsh delete observations whenever other major economic announcements occur during the measured change in interest rates. The results are, nevertheless, very similar.

9. Falk and Orazem (1985) report that with the unadjusted survey measure, the statistical significance of expected money is not sensitive to the interval used to measure the change in interest rates. Using the revised measure for expected money, however, this appears not to be the case.

10. To avoid potential problems associated with heteroscedasticity, the equations in each of the periods are weighted by the reciprocals of their estimated standard errors in the tests. The equations also are specified allowing different intercepts, and expected money is dropped.

11. The available daily data for the Gensaki rate begins in February 1980. Weekly data are available for the entire sample considered here. In the empirical work reported below, an alternative short-term deposit rate was used for the period prior to February 1980. Either using the weekly change in the Gensaki rate, or starting the second sub-period in February 1980, had no qualitative effects on the reported results.

12. This result appears to be robust. Omitting observations including Federal Reserve discount rate changes, applying a serial correlation correction procedure, and using a later initial date for this period to coincide with the beginning of the daily Gensaki rate series have virtually no affect on the statistical significance of the response coefficient.

13. Hakkio and Pearce (1985) reject this null hypothesis at the 5 percent level for the yen/dollar rate over the pre-October 1979 and October 1979 - October 1982 periods. Their methodology differs from that used here in two respects. First, the change in the exchange rate is measured over a shorter interval. Second, they use the unadjusted survey measure for expected money.

14. The response of the forward premium instead of the forward rate is estimated in part due to the availability of data for the former variable. It is nevertheless informative to consider the response of the forward premium since it represents the relative responses of the forward rate and the spot rate, and following Mussa (1979), one would expect the responses to be similar.

15. Husted and Kitchen (1985) also estimate statistically significant forward premium responses for other currencies during the October 1979 - October 1982 period.

16. Proper alignment also is important when daily changes in the relevant variables are compared as in Cornell and Shapiro (1985).

17. Movements in the variables prior to 3:30 P.M. on day t may be correlated with expected money in (1). Because expected money and the money announcement surprise are constructed to be orthogonal, however, this feature does not bias the estimated response.

18. Although they consider somewhat different tests, this result follows from Abel and Mishkin (1983).

19. Frenkel and Levich (1977) and Deardorff (1979) emphasize the role of transactions costs in tests of covered interest arbitrage. Otani and Tiwari (1981) and Ito (1983) consider transactions costs for the set of assets examined here. In general, the estimates reported in Table 5 are larger than the estimated transactions costs in these latter studies.

20. As a result of this procedure, about 25 percent of the money surprises are classified as large. In the October 1979 - October 1982 period, about 30 percent are large by this criterion.

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Table 1

VOLATILITY OF INTEREST RATES AND EXCHANGE RATES

Variable	Oct. 6, 1977-Oct. 4, 1979	Oct. 11, 1979-Oct. 1, 1982	Oct. 8, 1982-Jan. 27, 1984	Feb. 3, 1984-May 30, 1985
RFF	0.1376	0.8110	0.2522	0.3009
RTB	0.1582	0.5756	0.1624	0.1553
YD	2.3074	3.5111	2.6533	1.9414
FYD	0.4786	0.6698	0.1794	0.2151
RJ	0.1183	0.1516	0.0462	0.0183

Notes: Volatility is measured by mean absolute changes using one observation per week corresponding to the most recent daily observation following the Federal Reserve's weekly money announcement. Data for RFF and RTB are from the Board of Governors of the Federal Reserve System, H.15. Data for YD, FYD, and RJ are from the international data tape of the Board of Governors of the Federal Reserve System.

RFF = federal funds rate, daily average.

RTB = 3-month Treasury bill coupon-equivalent yield, 3:30 P.M., eastern time.

YD = logarithm of the spot yen/dollar exchange rate, 12:00 Noon, eastern time.

FYD = annualized 3-month forward premium defined as $400 \cdot (YD^f - YD)$, 2:00 P.M., eastern time, where YD also is a 2:00 P.M. rate.

YD^f = logarithm of the 3-month forward yen/dollar exchange rate, 2:00 P.M., eastern time.

RJ = 3-month Gensaki rate, 3:30 P.M., Tokyo time.

Table 2

RESPONSE OF U.S. INTEREST RATES TO MONEY ANNOUNCEMENT SURPRISES

$$\Delta RFF_t = b_0 + b_1 \cdot UM_t + b_2 \cdot EM_t + e_t$$

Estimation Period	Coefficient Estimates b_0	b_1	b_2	Summary Statistics $\bar{R}^2$	SE	DW	F-tests Across Regimes F(n,m)	Periods
Oct. 6, 1977- Oct. 4, 1979 (S1)	0.0053 (0.0093)	1.5903 (2.1257)	-1.9079 (2.2082)	-.01	.09	1.89	5.3474* (3,392)	S1,S2,S3,S4
Oct. 11, 1979- Oct. 1, 1982 (S2)	0.0708 (0.0540)	39.0666* (9.3500)	-7.3739 (13.4638)	.09	.64	2.49	15.3492* (1,257)	S1,S2
Oct. 8, 1982- Jan. 27, 1984 (S3)	0.0472** (0.0268)	6.5763 (6.5495)	1.0656 (6.2564)	-.01	.20	1.69	8.1642* (1,221)	S2,S3
Feb. 3, 1984- May 30, 1985 (S4)	-0.1068* (0.0303)	10.4846 (9.3464)	-11.7970** (6.2475)	.04	.24	1.51	0.1149 (1,135)	S3,S4

$$\Delta RTB_t = b_0 + b_1 \cdot UM_t + b_2 \cdot EM_t + e_t$$

Oct. 6, 1977- Oct. 4, 1979 (S1)	0.0256* (0.0103)	7.4061* (2.3475)	-3.0893 (2.4386)	.08	.10	1.68	9.3334* (3,392)	S1,S2,S3,S4
Oct. 11, 1979- Oct. 1, 1982 (S2)	0.0708* (0.0316)	33.8377* (5.4763)	-16.1662* (7.8858)	.21	.37	1.98	19.3222* (1,257)	S1,S2
Oct. 8, 1982- Jan. 27, 1984 (S3)	0.0057 (0.0135)	18.8441* (3.3125)	-2.1911 (3.1643)	.31	.10	1.94	5.4169* (1,221)	S2,S3
Feb. 3, 1984- May 30, 1985 (S4)	0.0068 (0.0123)	4.1358 (3.7898)	-2.3145 (2.5332)	.00	.10	1.79	8.5795* (1,135)	S3,S4

Note: For more complete definitions of RFF and RTB, see Table 1.

*Significant at the 5 percent level.

**Significant at the 10 percent level.

ΔRFF, ΔRTB = daily change in the federal funds rate and the 3-month Treasury bill yield, respectively.

UM = money announcement surprise defined as $\ln M - \ln M^e$, where M and M^e are the actual and expected announced levels of the money stock, in billion of dollars (Source: Board of Governors of the Federal Reserve System, H.6; and Money Market Services, Inc.).

EM = expected announced percentage change of the money stock defined as $\ln M^e - \ln M_{-1}$.

e_t = random error term.

$\bar{R}^2$ = multiple correlation coefficient corrected for degrees of freedom.

SE = standard error.

S1,S2,S3,S4 = sample periods 1, 2, 3, and 4.

F(n,m) = F-statistic with n and m degrees of freedom, respectively.

Table 3

RESPONSE OF THE EXCHANGE RATE AND THE GENSAKI RATE TO MONEY ANNOUNCEMENT SURPRISES

$$\Delta YD_t = b_0 + b_1 \cdot UM_t + b_2 \cdot EM_t + e_t$$

Estimation Period	Coefficient Estimates b_0	b_1	b_2	Summary Statistics $\bar{R}^2$	SE	DW	F-tests Across Regimes F(n,m)	Periods
Oct. 6, 1977- Oct. 4, 1979 (S1)	0.0006 (0.0006)	0.0478 (0.1345)	-0.0092 (0.1397)	-.02	.006	1.92	0.7433 (3,392)	S1,S2,S3,S4
Oct. 11, 1979- Oct. 1, 1982 (S2)	0.0008 (0.0007)	0.3127* (0.1254)	-0.2027 (0.1806)	.03	.009	1.91	2.0836 (1,257)	S1,S2
Oct. 11, 1979- Nov. 24, 1980 (S2a)	-0.0017 (0.0012)	0.3441** (0.1764)	0.3391 (0.3499)	.04	.008	2.11	--	--
Dec. 1, 1980- Oct. 1, 1982 (S2b)	0.0019* (0.0009)	0.2864** (0.1726)	-0.3421 (0.2108)	.03	.009	1.87	0.0541 (1,152)	S2a,S2b
Oct. 8, 1982- Jan. 27, 1984 (S3)	-0.0006 (0.0009)	0.2464 (0.2229)	0.1715 (0.2129)	-.00	.007	1.50	0.0676 (1,221)	S2,S3
Feb. 3, 1984- May 30, 1985 (S4)	0.0004 (0.0007)	0.1261 (0.2247)	-0.0036 (0.1502)	-.03	.006	2.02	0.1460 (1,135)	S3,S4

$$\Delta RJ_t = b_0 + b_1 \cdot UM_t + b_2 \cdot EM_t + e_t$$

Oct. 6, 1977- Oct. 4, 1979 (S1)	0.0211* (0.0059)	-0.4978 (1.3429)	-3.0607* (1.3950)	.03	.058	1.97	0.9487 (3,392)	S1,S2,S3,S4
Oct. 11, 1979- Oct. 1, 1982 (S2)	-0.0009 (0.0086)	-2.6636** (1.4838)	2.6043 (2.1367)	.02	.101	1.54	1.1500 (1,257)	S1,S2
Oct. 11, 1979- Nov. 24, 1980 (S2a)	0.0061 (0.0206)	-5.1350** (2.9917)	7.8315 (5.9352)	.04	.138	1.63	--	--
Dec. 1, 1980- Oct. 1, 1982 (S2b)	-0.0083 (0.0071)	-0.5412 (1.3451)	0.5672 (1.6435)	-.02	.068	1.56	1.9708 (1,152)	S2a,S2b
Oct. 8, 1982- Jan. 27, 1984 (S3)	-0.0042 (0.0039)	-0.3872 (0.9603)	1.2185 (0.9173)	-.00	.029	1.63	1.6495 (1,221)	S2,S3
Feb. 3, 1984- May 30, 1985 (S4)	0.0016 (0.0020)	0.0439 (0.6102)	0.5318 (0.4079)	-.00	.016	1.91	0.1420 (1,135)	S3,S4

Note: See the notes in Tables 1 and 2.

ΔYD, ΔRJ = daily change in the yen/dollar exchange rate and the Gensaki rate, respectively.

Table 4

RESPONSE OF THE FORWARD PREMIUM TO MONEY ANNOUNCEMENT SURPRISES

$$\Delta FYD_t = b_0 + b_1 \cdot UM_t + b_2 \cdot EM_t + e_t$$

Estimation Period	Coefficient Estimates			Summary Statistics			F-tests Across Regimes	
	b_0	b_1	b_2	$\bar{R}^2$	SE	DW	F(n,m)	Periods
Oct. 6, 1977- Oct. 4, 1979 (S1)	-0.0414 (0.0342)	8.5058 (7.7996)	9.2483 (8.1024)	.00	.33	2.37	4.9580* (3,392)	S1,S2,S3,S4
Oct. 11, 1979- Oct. 1, 1982 (S2)	-0.0405 (0.0385)	32.6206* (6.6666)	-18.4592** (9.5998)	.14	.46	1.85	5.4740* (1,257)	S1,S2
Oct. 11, 1979- Nov. 24, 1980 (S2a)	0.0595 (0.0722)	15.2965 (10.4903)	-26.6494 (20.8113)	.03	.49	1.80	--	--
Dec. 1, 1980- Oct. 1, 1982 (S2b)	-0.0940* (0.0440)	47.3379* (8.3622)	-17.8230** (10.2176)	.26	.42	2.02	5.5779* (1,152)	S2a,S2b
Oct. 8, 1982- Jan. 27, 1984 (S3)	0.0236 (0.0197)	3.6484 (4.8081)	-3.3221 (4.5930)	-.01	.15	1.62	12,3121* (1,221)	S2b,S3
Feb. 3, 1984- May 30, 1985 (S4)	0.0111 (0.0168)	3.0734 (5.1891)	-2.8999 (3.4686)	-.01	.13	1.49	0.0066 (1,135)	S3,S4

Notes: See the notes in Tables 1 and 2.

ΔFYD = daily change in the forward premium, yen/dollar.

Table 5

TESTS OF COVERED INTEREST PARITY IN RESPONSE TO MONEY ANNOUNCEMENT SURPRISES

$$\Delta FYD_t - \Delta RJ_t + \Delta RTB_t = b_0 + b_1 \cdot UM_t + b_2 \cdot EM_t + e_t$$

Estimation Period	Coefficient Estimates				Summary Statistics		
	b_0	b_1	b_1'	b_2	$\bar{R}^2$	SE	DW
Oct. 6, 1977-	-0.0369	16.4097*	--	9.2197	.03	.35	2.25
Oct. 4, 1979	(0.0361)	(8.2353)		(8.5550)			
Oct. 11, 1979-	0.0312	69.1219*	--	-37.2297*	.27	.65	1.88
Oct. 1, 1982	(0.0551)	(9.5374)		(13.7338)			
Oct. 11, 1979-	0.1271	53.4494*	--	-52.2022*	.24	.61	1.82
Nov. 24, 1980	(0.0908)	(13.1894)		(26.1661)			
Dec. 1, 1980-	-0.0156	82.4062*	--	-34.0687*	.30	.67	1.93
Oct. 1, 1982	(0.0704)	(13.3783)		(16.3465)			
Oct. 8, 1982-	0.0336	22.8797*	--	-6.7318	.11	.23	1.75
Jan. 27, 1984	(0.0307)	(7.5111)		(7.1750)			
Feb. 3, 1984-	0.0163	7.1653	--	-5.7461	.01	.19	1.54
May 30, 1985	(0.0233)	(7.1946)		(4.8091)			
	$\Delta FYD_t - \Delta RJ_t + \Delta RTB_t = b_0 + b_1 \cdot UM_t^S + b_1' \cdot UM_t^L + b_2 \cdot EM_t + e_t$						
Oct. 6, 1977-	-0.0368	34.2478*	9.8551	9.7668	,04	.35	2.24
Oct. 4, 1979	(0.0360)	(15.8453)	(9.5992)	(8.5346)			
Oct. 11, 1979-	0.0310	73.4414*	68.0071*	-36.8716*	.27	.65	1.88
Oct. 1, 1982	(0.0553)	(21.2379)	(10.7459)	(13.8659)			
Oct. 11, 1979-	0.1314	31.4885	58.0877*	-54.0819*	.24	.61	1.89
Nov. 24, 1980	(0.0913)	(31.8158)	(14.5816)	(26.3822)			
Dec. 1, 1980-	-0.0146	98.8541*	77.4580*	-32.6289*	.29	.67	1.94
Oct. 1, 1982	(0.0707)	(28.1286)	(15.3415)	(16.5374)			
Oct. 8, 1982-	0.0360	31.7270*	18.4109*	-6.3945	.10	.23	1.77
Jan. 27, 1984	(0.0309)	(13.0840)	(9.2683)	(7.2038)			
Feb. 3, 1984-	0.0111	-6.0070	15.5541**	-6.3891	.02	.18	1.47
May 30. 1985	(0.0234)	(11.6035)	(9.2137)	(4.7919)			

Notes: See the notes in Tables 1 and 2.

UM^L = UM, if UM > |.005|, (0.5 percent)
= 0, otherwise

UM^S = UM, if UM < |.005|
= 0, otherwise

Table 6

INFORMATION CONTENT OF MONEY ANNOUNCEMENT SURPRISES IN PREDICTING FUTURE EXCHANGE RATE MOVEMENTS

	Forecast Using Estimated Response of:+ (Difference in RMSE from Baseline Forecast)	
	Forward Premium	Interest-Rate Differential
Oct. 6, 1977-Oct. 4, 1979	.0070	-.0064
Oct. 11, 1979-Oct. 1, 1982	-.0221	.0060
Oct. 11, 1979-Nov. 24, 1980	-.0084	.0221
Dec. 1, 1980-Oct. 1, 1982	-.0369	.0290
Oct. 8, 1982-Jan. 27, 1984	-.0009	.0039
Feb. 3, 1984-May 30, 1985	.0002	-.0003

Notes: See the notes in Tables 1 and 2.

+ Forward premium response equals the fitted value of $\Delta FYD_t = b_1^f \cdot UM_t + e_t$.

Interest-rate differential response equals the fitted value of $\Delta RJ_t - \Delta RTB_t = b_1^d \cdot UM_t + e_t$.

The baseline forecast uses the forward premium before the weekly money announcement. Forecast errors are computed as

$$\varepsilon_t = 400 \cdot (YD_{t+13} - YD_t^a) - FYD_t^b.$$

Forecast errors using the forward premium and interest-rate differential responses are calculated as

$$\varepsilon_t^f = 400 \cdot (YD_{t+13} - YD_t^a) - FYD_t^b - b_1^f \cdot UM_t$$

$$\varepsilon_t^d = 400 \cdot (YD_{t+13} - YD_t^a) - FYD_t^b - b_1^d \cdot UM_t.$$

Numbers reported in the table correspond to $RMSE(\varepsilon^f) - RMSE(\varepsilon)$ and $RMSE(\varepsilon^d) - RMSE(\varepsilon)$.

YD_{t+13} = logarithm of the spot yen/dollar exchange rate 13 weeks (3 months) in the future.

YD_t^a = logarithm of the spot yen/dollar exchange rate after the money announcement.

FYD_t^b = forward premium before the money announcement.

RMSE = root-mean-square error.