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Yen/Dollar Exchange Rate Expectations in 1980-90's

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Yen/Dollar Exchange Rate Expectations in the 1980-90's

by

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Abstract

This paper examines survey expectations of the yen/dollar exchange rate. We fit simple mechanisms on the survey expectations and test their rationality. We present the puzzling fact that in the 1990's the short-horizon expectations have lost their destabilizing property observed in the late 1980's and instead become static unlike the actual movement of the spot exchange rate.

1. Introduction

Survey-based expectations of foreign exchange rates have become a popular research area since the late 1980's.[1] Interests are four-fold: (i) mechanisms of expectation formation, (ii) rationality of expectations, (iii) heterogeneity in expectations, and (iv) policy implications. The purpose of this paper is to examine the survey expectations of the yen/U.S. dollar exchange rate collected by the Japan Center for International Finance (JCIF) from these perspectives. Emphasis is on the recent behavioral changes of expectation formation.

To find the mechanism of expectation formation of foreign exchange rates, researchers have fitted various specifications on survey expectations, such as extrapolative, adaptive, and regressive expectations (e.g., Frankel and Froot [1987], Ito [1990], and Bank of Japan [1990]). There is consensus among researchers on behavioral properties of survey expectations (e.g., Takagi [1991]): Short-horizon expectations (e.g., no more than one month ahead in future) tend to divert from some "normal" levels;[2] however, long-horizon expectations (no less than three months

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[1] Takagi [1991] surveys the literature and gives brief description of various survey-forecasts on spot foreign exchange rates.

[2] "Normal" levels are subjective concepts and differ depending on market participants' mechanisms of expectation formation. We define them explicitly in a later section.

ahead in future) tend to revert to them. The literature calls these properties "expectations twist." We show that long-horizon expectations keep their reverting property, whereas short-horizon expectations have lost their diverting property recently.

In investigating relationships of survey expectations with actual spot rates, researchers have tested rationality of expectations. We can test the rationality by checking whether expectations mimic future spot rates (unbiasedness). The literature often reports irrationality of survey expectations: The expectations are so static as to underpredict the actual movements of spot rates systematically (e.g., Takagi [1991]). This paper shows, however, that rationality of survey expectations is time-varying: The expectations were rational in the late 1980's, but have lost their rationality, diverting from the actual spot rates in the 1990's.[3]

Researchers have found industrial heterogeneity in expectations. Two reasons are presented. One is "wishful expectations" (Ito [1990]), claiming that industries express their wishful expectations in the hope that their expectations lead the actual spot rates to their favorable directions. The other is "private information" (Wakita [1989]), claiming that industries have private information, which leads to heterogeneous expectations. Our purpose is not to test these hypotheses but to characterize the expectations by industrial heterogeneity. We show that the diverting property of short-horizon expectations is due to expectations of banks, brokers, securities companies, and trading companies.

Expectation formation has policy implications to the extent that market sentiment determines actual spot rates. Researchers have two views on determinants of foreign exchange rates: fundamentals and market sentiment.[4] There is growing literature that reports the failure of fundamentalist view (e.g., Meese [1990] and Rose [1994]). Market sentiment attracts many researchers on the other hand (e.g., Hopper [1997]). If market sentiment is a strong determinant, monetary authorities can stabilize foreign exchange markets by affecting market sentiment.

This paper is constructed as follows. Section 2 overviews the JCIF survey expectations. Section 3 fits various mechanisms on the survey expectations. Section 4 tests rationality of the expectations. Section 5 examines industrial expectations and finds their heterogeneity. Section 6 concludes our discussion with policy implications.

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[3] Market efficiency is another topic on relationships between the expected and actual foreign exchange rates. We can test the efficiency by checking whether expectations exploit all information available at prediction dates (orthogonality). The literature often reports inefficiency of spot exchange markets: In particular, long-horizon expectations fail to incorporate all available information like lagged exchange rates (e.g., Ito [1990]).

[4] When fundamentals affect market sentiment, they are not mutually exclusive. For instance, if market participants think that the other participants think that the yen depreciates against the U.S. dollar along with a decline in Japan's GDP, they sell their yen and the yen depreciates actually. In this case, market sentiment affects the foreign exchange market through the news on the fundamentals.

2. Overview of Survey Expectations

Here we overview the JCIF survey briefly. First, we describe the survey. Second, we summarize the events that happened in the sample period. Then we characterize the survey expectations. The expectations "twist" between short and long horizons. Market participants are not so naive as to predict depreciation in depreciation phases and appreciation in appreciation phases. The expectations underpredict the movement of the actual spot rate and the tendency has become stronger recently.

2.1. Brief Description of Survey

The survey covers the period from January 1986 to May 1998. It is conducted twice a month, once in the middle and once at the end of a month. The sample size is 298. The expectation horizons are one, three, and six months. The number of respondents is almost fixed at 44. The respondents are grouped into four industries as well as the total industries: banks and brokers (B & B), securities and trading companies (S & T), export-oriented companies (EOC), and life insurance and import-oriented companies (L & I). We use the time series of the sample means of the total industries and show how market participants form their expectations on average. See appendix 1 for full description of the survey.

2.2. Summary of Notable Events

Figure 1 shows the series of the spot rate from January 1986 to May 1998 (closing rates in the Tokyo foreign exchange market). We divide the sample at peaks and bottoms into four sub-samples:

Phase I: January 1986 to November 1988 (70 samples);
Phase II: December 1988 to April 1990 (34 samples);
Phase III: May 1990 to May 1995 (122 samples);
Phase IV: June 1995 to May 1998 (72 samples).

In phase I, the dollar depreciated quite fast in response to the Plaza Accord (September 1985). G6 reached the Louvre Accord (February 1987) for policy coordination in foreign exchange markets. The effects, however, lasted only several months. The Black Monday (October 1987) forced the dollar to depreciate. In phase II, the yen depreciated rapidly, as Japan's inflation rate rose sharply. In phase III, the dollar depreciated steadily along with the weak dollar policy by the United States

(February 1993). In phase IV, the dollar appreciated, following the policy change toward the strong dollar by the United States (April 1995), and continues to appreciate because of the Japanese recession after the burst of its asset bubble.

2.3. Characterizing Survey Expectations

Figure 2 shows the survey expectations of the total industries and table 1 compares the actual and expected spot rates in terms of average depreciation rates. First, note the “expectation twist.” On average, the yen has appreciated in the 1980’s and 90’s. In the full sample comparison, market participants have biased toward appreciation in a one-month horizon and toward static expectations in a six-month horizon.

Next, the expectations are not so naive as to predict depreciation in depreciation phases and appreciation in appreciation phases. In such naive expectations, the signs of the expected depreciation rates should coincide with those of the actual ones. Many counterexamples are observed, however, e.g., phase II of the one-month-ahead expectations. This happens even though our way of making sub-samples is favorable to the naive mechanism. The expectation formation is not that simple.

Finally, the expectations have a tendency of underprediction. The expected depreciation or appreciation rates become smaller over time, while the actual rates do not. Market participants continue to underpredict the actual depreciation and appreciation systematically for several years and have strengthened the tendency. In particular, the expectations are almost static recently. So rationality of the recent expectations is quite dubious.

3. Mechanisms of Expectation Formation

In this section, we fit five simple specifications on the survey expectations of the total industries. To observe evolution of expectation formation mechanisms over time, we fit the specifications not only on the full sample but also on the four sub-samples. We show that in the late 1980’s, the short-horizon expectations tend to divert from some “normal” levels; the long-horizon expectations tend to revert to them. In the 1990’s, however, the short-horizon expectations are losing their diverting property, whereas the long-horizon expectations keep their reverting property.

3.1. Models

Below we denote the actual spot exchange rate of the yen per dollar at time t by s_t and the k-period-ahead expectations by $s^e_{t,k}$. We fit the following simple specification on the survey expectations with various information substituted for x_t:

$$\Delta \ln s^e_{t,k} = a + b(\ln x_t - \ln s_t) + e_{t,k} ,$$

where $\Delta \ln s^e_{t,k} \equiv \ln s^e_{t,k} - \ln s_t$ and $e_{t,k}$ is a measurement error. Depending on b 's sign, we characterize the expectations into three types. When $b > 0$, market participants expect s_t to revert toward x_t (stabilizing expectations). When $b < 0$, they expect s_t to divert from x_t (destabilizing expectations). When $b = 0$, they expect s_t to stay at the present level ($a = 0$) or to move steadily ($a \neq 0$).

Extrapolative Expectations

We consider two types of extrapolative expectations. First, we define x_t as

(Extrapolative I) $x_t \equiv s_{t-k}$,

as modeled by Frankel and Froot [1987]. If $b < 0$, it is a bandwagon type. Under bandwagon expectations, when the yen depreciates from k-period ago, market participants expect further depreciation to follow k-period ahead in the future. The larger the b in absolute value, the larger the bandwagon effects.

If $b > 0$, the mechanism is a distributed lag type. In this case, if the yen depreciates, market participants expect appreciation to follow. The larger the b, the more strongly the expectations rebound.

Second, we define x_t as

(Extrapolative II) $x_t \equiv s_{t-2}$,

as modeled by Bank of Japan [1990].[5] Note that for the one-month-ahead expectations, extrapolative I is equivalent to extrapolative II.

[5] BOJ [1990] uses $x_t \equiv s_{t-2}$ instead of $x_t \equiv s_{t-1}$. This is a good choice to avoid the possible difference between the middle-of-month and end-of-month rates.

Adaptive Expectations

We can set up adaptive expectations by

(Adaptive) $x_t \equiv s^e_{t-k,k}$.

Market participants correct k-period-ahead expectations by partially adjusting k-period-ahead expectations formed k-period ago toward the current spot exchange rate: The smaller the b , the more adaptive the expectations.

Regressive Expectations

We consider two types of regressive expectations. The first is

(Regressive I) $x_t \equiv \Sigma_{i=1}^{12} s_{t-i} / 12$.

An interpretation is that market participants "learn" a nominal equilibrium exchange rate from past six-month realizations.

The second definition is

(Regressive II) $x_t \equiv (p_t / p_t^*) \Sigma_{i=1}^{12} (p_{t-i}^* s_{t-i} / p_{t-i}) / 12$,

where p_t^* is a consumer price index in the United States at time t ; p_t is that in Japan. An interpretation is that market participants first "learn" a real equilibrium exchange rate from past six-month realizations and then calculate the associated nominal exchange rate. In either definitions, the larger the b , the more regressive the expectations.[6]

3.2. Results

Table 2 shows the estimates of b under the five specifications for the three horizons. The first columns show the results of the full sample, followed by those of the four sub-samples. Student's *t*-values are in parentheses. We put "*" on significant b at one-tail 5 % level. In the estimation,

[6] Frankel and Froot [1987] use two alternatives for x_t . One alternative is a constant term. In this case, we found $\ln x_t - \ln s_t$ non-stationary but $\Delta \ln s^e_{t,k}$ stationary. To avoid a regression of a stationary process on a non-stationary one, we exclude this alternative. The other alternative is $x_t \equiv (p_t / p_t^*)(s_0 \cdot p_0^* / p_0)$. This setting is based on the purchasing power parity. We found $\ln x_t - \ln s_t$ non-stationary in this case. So we exclude it, too, for the same reason as above.

we assume an AR(1) process in disturbances.

First, note the clear difference of signs between the short- and long-horizon expectations: $b < 0$ for the one-month-ahead expectations; $b > 0$ for the six-month-ahead expectations and mostly for the three-month-ahead expectations. These results are consistent with the literature: short-horizon expectations tend to divert from "normal" levels; long-horizon expectations tend to revert toward them.

Second, focus on the significance of the coefficients. For the one-month-ahead expectations, the negative b is significant in the full sample. The significance, however, has decreased over time. For extrapolative and adaptive expectations, the negative b is insignificant during the recent three phases. For regressive expectations, the negative b is insignificant during the most recent phase. In other words, the short-horizon expectations are losing their diverting property. On the contrary, for the three- and six-month-ahead expectations, the positive b is significant during most phases. So the long-horizon expectations keep their reverting property.

Finally, the performance of regressive II (real equilibrium learning) is no better than that of regressive I (nominal equilibrium learning). This suggests that market participants form their expectations in a nominal term rather than in a real term. Comparing extrapolative I and II, the performance of the former is no better than the latter in terms of height of Student's *t*-values. So market participants use the recent realizations of the spot rate in forming expectations irrespective of forecast horizons.

4. Rationality of Expectations

In this section, we test rationality of the survey expectations. We conduct the test, using not only the full sample but also the sub-samples. By the full sample test, we cannot reject rationality of any mechanisms. By the sub-sample test, we cannot reject rationality of any mechanisms in the late 1980's, but can reject rationality of all the mechanisms in the 1990's. In general, the survey expectations are too static in comparison with the movements of the actual spot rate. We follow Hansen and Hodrick [1980] to deal with the "overlapping observation problem."

4.1. Testing Procedure

Here we test how well expectations mimic the movements of the actual spot rate. In the previous section, we estimate an expectation formation mechanism as

(1) $$s^e_{t,k} - s_t = a + b(x_t - s_t) + e_{t,k} ,$$

where $e_{t,k}$ is a measurement error. If market participants know the structure of the economy, the above formula must mimic the actual process of the spot rate:

(2) $$s_{t+k} - s_t = a^* + b^*(x_t - s_t) + h_{t+k} .$$

Subtracting (2) from (1) gives

$$s^e_{t,k} - s_{t+k} = g + d(x_t - s_t) + n_{t,k} ,$$

where $g = a - a^*$, $d = b - b^*$, and $v_{t,k} = e_{t,k} - h_{t+k}$. The null hypothesis is that $g = d = 0$. If g and d are close to zero, the expectations mimic the actual movements of the spot rates.[7] Since $v_{t,k}$ is serially correlated due to "overlapping observation problems", we use Hansen and Hodrick's [1980] c^2 test. See appendix 2 for details.

4.2. Results

Table 3 shows the estimates of d. We conduct c^2 test for $g = d = 0$ and put "*" on regressions found significant at 5% level. The mechanisms with * are irrational. We focus on the regressions found significant at one-tail 5% level in the previous section, since otherwise our test would be too favorable to rationality.[8] We put "-" for the formulae in which b is not significant in the previous section.

First, note that the survey expectations are rational in the late 1980's. By the full sample test, we cannot reject rationality of any mechanisms. Neither can we reject their rationality in phase I. So the survey expectations are not always irrational.

Second, the expectations have become irrational in the 1990's. Particularly, in phases III and IV, we can reject rationality of all the mechanisms with a few exceptions. A possible reason is that the process of the actual spot rate has evolved rapidly and the evolution is too fast for market participants to catch up with. If market participants are rational, the expectation mechanism should evolve so as to regain consistency with the movement of the actual spot rate in the future.

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[7] Though we design the above procedure primarily for testing rationality of the expectations, we can also interpret it as a test of the efficient market hypothesis, i.e., a test of predictability of data available at prediction dates. If we replace the k-period-ahead expectations with the k-period-ahead forward exchange rates, it is a typical test for the efficient forward exchange market (e.g., Hansen and Hodrick [1980]).

[8] Suppose that a formula does not explain the movements of the actual spot rate. The same formula is unlikely to explain the survey expectations. Then our test cannot reject rationality simply because the formula is irrelevant. So we pick up the significant regressions and focus on them.

Third, the irrational short-horizon expectations point to the opposite direction to the actual spot rate. When rejected, $d < 0$ in most cases, i.e., $b < b^*$. For instance, $d < 0$ for the one-month-ahead expectations of regressive I in phase II. The previous section shows that $b < 0$ significantly. Note that d is more negative than b. So $b < 0 < b^*$.

Finally, the irrational long-horizon expectations lack regressiveness. For instance, the six-month-ahead expectations of regressive I are irrational during phase IV. It is easy to deduce that $0 < b < b^*$. So, though the expectations point to the same direction as the actual spot rate, they regress to a "normal" level even slower than the actual spot rate.

5. Heterogeneity in Expectations

So far we have assumed a single mechanism for expectation formation. In this section, we allow for co-existence of heterogeneous mechanisms for expectation formation. To do so, we combine the simple mechanisms and estimate a hybrid model. Next, we attribute the heterogeneity to industrial difference. We first fit the simple mechanisms on the survey expectations industry by industry and then compare the industrial models with the hybrid model. We show that the most influential industries are banks and brokers for short-horizon expectations.

5.1. Hybrid Models

Here the expectations are the weighted average or a hybrid of various expectation formation mechanisms. As mentioned in section 3, extrapolative II is better than I and regressive I is than II. Hence, our hybrid model includes extrapolative II, adaptive, and regressive I expectations:

$$\Delta \ln s_{t,k}^e = a + b_1(\ln s_{t-2} - \ln s_t) + b_2(\ln s_{t-k,k}^e - \ln s_t) + b_3(\ln x_t - \ln s_t),$$

where x_t is as defined for regressive I in section 3. Table 4 shows the results of the estimation. For parsimony, we eliminate explanatory variables if insignificant at one-tail 5% level in terms of Student's *t*-values. Note that the one-month-ahead expectations include regressive I most frequently. Interestingly, in phase II, they include extrapolative or adaptive expectations as a reverting factor instead of a diverting one. Second, the three-month-ahead expectations include regressive I or extrapolative II frequently. Finally, the six-month-ahead expectations include extrapolative II frequently.

5.2. Industrial Heterogeneity

Here we attribute the heterogeneity to industrial difference. We fit the three mechanisms on the industrial survey expectations. The four industry categories are banks & brokers (B & B), securities & trading companies (S & T), export-oriented companies (EOC), and life insurance & import-oriented companies (L & I). As before, we assume an AR(1) process in disturbance terms.

Table 5 shows the results of the estimation. We put "*" on regressions significant at one-tail 5% level. First, note that there exists industrial heterogeneity in terms of significant regressions. We have two groups: B & B and S & T in one group and possibly, EOC and L & I in the other.

Second, the diverting property of the one-month-ahead expectations is attributable to B & B and S & T. This is clear from the coefficient of regressive I that is always negative significantly for B & B and S & T. Reverting factors from extrapolative or adaptive expectations are attributable to EOC, though not significant enough.

Third, the reverting properties of the three-month-ahead expectations are attributable to EOC. Extrapolative II and regressive I are significant for EOC in most phases. For the six-month-ahead expectations, their reverting property is attributable to any industries' expectations.

Table 6 shows the results of the industrial rationality test. There exists no large industrial difference in terms of rationality. That is, industrial expectations are rational or irrational all at once. Roughly speaking, all industries are rational in the late 1980's, but irrational in the late 1990's.

6. Concluding Remarks with Policy Implications

We have investigated the survey-based expectations collected by the JCIF in the late 1980's and the 1990's. Our findings are summarized as follows: The short-horizon expectations have a tendency to divert from some "normal" levels and the long-horizon expectations have a tendency to revert to them. On average, the expectations were rational in the late 1980's, but have lost their rationality in the 1990's. The diverting property of the short-horizon expectations is attributable to banks, brokers, securities, and trading companies. The most important and also quite a puzzling finding is that the short-horizon expectations have become static in comparison to the actual movement of the spot exchange rate in the 1990's.

The above findings have the following policy implications. In the late 1980's, the diverting property of the short-horizon expectations destabilized the spot exchange market, which gave a rationale to coordinated intervention by monetary authorities in foreign exchange markets.

We have shown that in the late 1980's, the short-horizon expectations had a diverting property, while the long-horizon expectations had a reverting property. From the market sentiment view of exchange rate determination, the spot rate is diverting if the short-horizon expectations dominate the long-horizon expectations. So the rapid depreciation of the U.S. dollar after the Plaza Accord was possibly reinforced by the destabilizing property of the short-horizon expectations. This, however, shows the possibility that monetary authorities can make use of market sentiment to stabilize foreign exchange markets. Especially, our analysis implies that the most effective intervention is to control the short-horizon expectations of banks, brokers, securities companies, and trading companies, though we are not sure about how monetary authorities can control market sentiment selectively.

In the 1990's, the short-horizon expectations are loosing their diverting property. So the expectations are not a destabilizing factor in the foreign exchange market. The actual spot rate has a strongly reverting property. The short-horizon expectations may gain a reverting property to be consistent with the actual spot rate. What should or should not monetary authorities do in this situation? Should they keep the current policy stance or switch to laissez-faire. One thing to note is that the current expectation formation mechanism depends on the current policy regime. A regime switch induces a change in expectation formation since market participants accommodate their expectation formation mechanism to a new regime. Therefore, to answer the above question, we need to analyze more explicitly how market participants incorporate their knowledge of a policy regime into their expectation formation mechanism.

Appendix 1. Survey Data Description

The Japan Center for International Finance (JCIF) has conducted a survey on forecasts of the yen/dollar exchange rates since May 29th, 1985. The forecast horizons are one, three, and six months. The frequency is twice a month at the end of a month (final Tuesday, previously final Wednesday) and in the middle of the month (Tuesday two weeks earlier than the final Tuesday, previously Wednesdays). So the survey intervals are two or three weeks. The survey skips the middle of August and the end of December with some exceptions. The respondents are fixed with some exceptions due to special events such as merger. Normally, the number of respondents is 44 in total (15 from banks and brokers, 10 from securities and trading companies, 9 from major export-oriented companies, and 10 from life insurance and major import-oriented companies).

The JCIF publishes the survey in two forms: (i) pooled data of the four industries and of all the industries and (ii) raw data of individual companies. The pooled data started on January 14th, 1986. It includes the following information: for each of one-, three-, and six-month-ahead expectations, a total and an industrial mean, maximum, minimum, and standard deviation as well as the histogram of all responses. The raw data started on May 29th, 1985. The JCIF does not make it public which respondent belongs to which industries. So we cannot reproduce the industrial data from the raw data. We use the time series of the total and industrial means of the pooled data in our analysis.

Appendix 2. Hansen and Hodrick Test for Overlapping Observation Data

In this appendix, we first explain the "overlapping observation problem" and then introduce Hansen and Hodrick's [1980] test to deal with the problem.

A.2.1. Overlapping Observations Problem

In testing rationality, we regress prediction errors, $s^e_{t,k} - s_{t+k}$, on some currently available data, $x_t - s_t$. Remember that the survey is conducted twice a month, while the expectation horizons are one, three, and six months. So the survey interval (two or three weeks) is shorter than the expectation horizons. In this case, the prediction errors are serially correlated. Suppose for instance that at time t market participants make expectations of a spot rate at $t+2$ (one-month-ahead expectations). The prediction error that realizes at $t+2$ depends on events that are unpredictable at t and happen at $t+1$ and $t+2$. Similarly, the prediction error that realizes at $t+3$ depends on events that are unpredictable at $t+1$ and happen at $t+2$ and $t+3$. Notice that the prediction errors that realize at $t+2$ and $t+3$ both depend on the event that happens at $t+2$. This causes the two prediction errors to be correlated with each other.

The following example clarifies our point. Let $e_{t,k} = 0$ and $h_{t+k} = \Sigma^k_{i=1} z_{t+i}$, where z_{t+i}'s are iid. Then the prediction error at $t+2$ is

$$s^e_{t,2} - s_{t+2} = g + d(x_t - s_t) + z_{t+1} + z_{t+2}.$$

Similarly, the prediction error at $t+3$ is

$$s^e_{t,3} - s_{t+3} = g + d(x_{t+1} - s_{t+1}) + z_{t+2} + z_{t+3}.$$

So z_{t+2} causes the two disturbances to be correlated serially.

A.2.2. Hansen and Hodrick's c^{2} test

We estimate the following equation of k-period-ahead forecasts from data with sample size T:

$$y_{t+k} = x_t b + e_{t+k},\ t = 1, \cdots, T,$$

where y_{t+k} is an excess return that realizes at time $t+k$; x_t is a l-dimensional vector whose elements are available information at t; e_{t+k} is a prediction error. b is a l dimensional vector. Denote Hansen and Hodrick's [1980] variance-covariance matrix by H. H enables various hypothesis testing on OLS estimators.

(Step 1) Estimate b by OLS. Keep its estimate as b and the residuals as e_{t+k}. Rename the residuals as $\{u_1, \cdots, u_T\}$.

(Step 2) Calculate c_j by

$$c_j = \Sigma_{t=j+1}^{T} u_t u_{t-j} / T.$$

(Step 3) Form matrix C whose lower triangular is given by

$$C = \begin{bmatrix} c_0 & & & & & & \\ c_1 & c_0 & & & & & \\ \vdots & \ddots & \ddots & & & & \\ c_{k-1} & & \ddots & \ddots & & & \\ 0 & \ddots & & \ddots & \ddots & & \\ \vdots & \ddots & \ddots & & \ddots & \ddots & \\ 0 & \cdots & 0 & c_{k-1} & \cdots & c_1 & c_0 \end{bmatrix}.$$

(Step 4) Let

$$X = \begin{bmatrix} x_1 \\ \vdots \\ x_T \end{bmatrix}$$

Then H is given by $H = T(X'X)^{-1} X'CX(X'X)^{-1}$.

(Step 5) Approximately, $T(b-b)'H^{-1}(b-b)$ follow the c^{2} distribution with l degrees of freedom.

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Figure 1. Actual Yen/Dollar Spot Exchange Rate

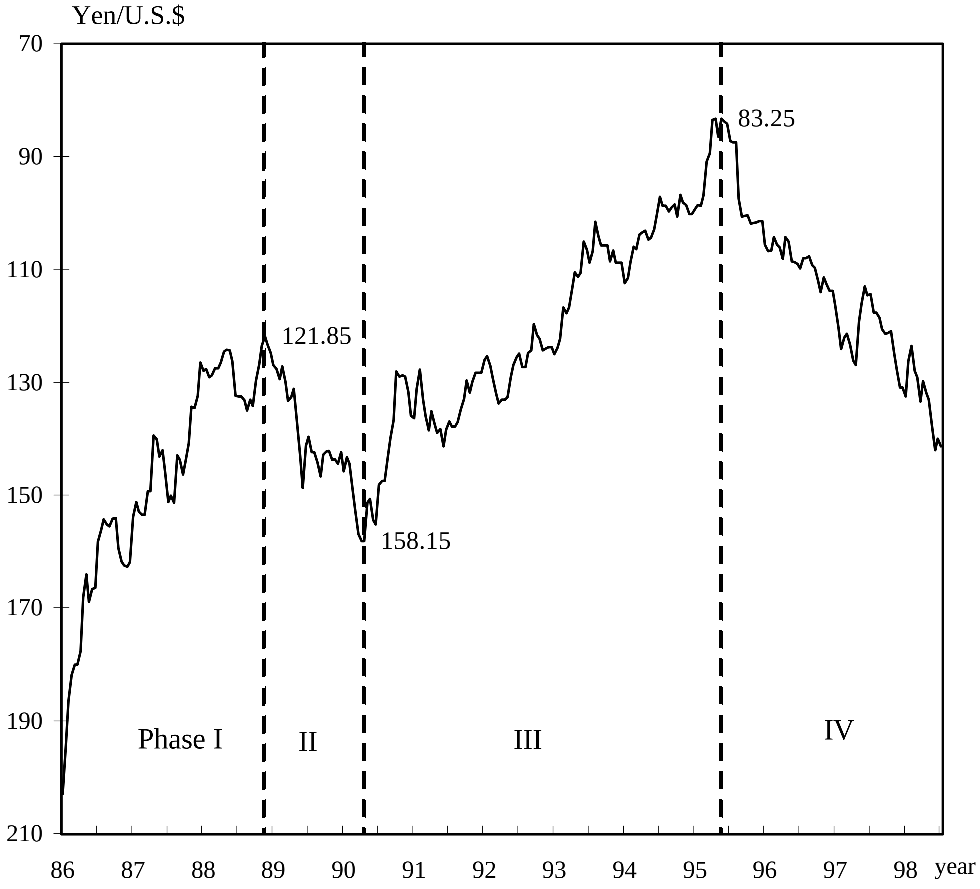
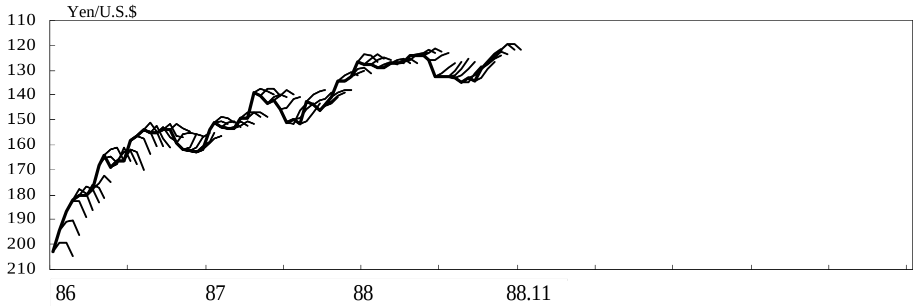
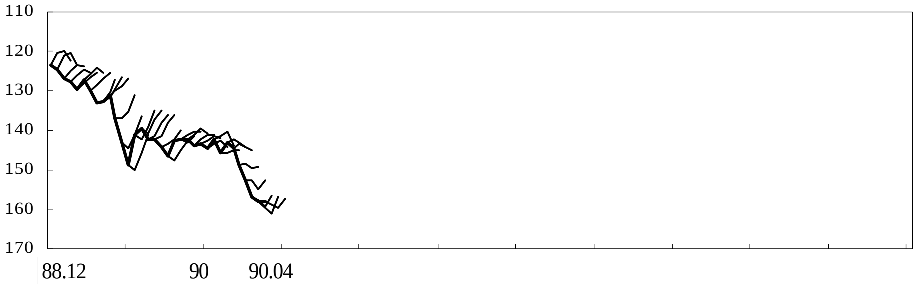


Figure 2. Expected Yen/Dollar Exchange Rates

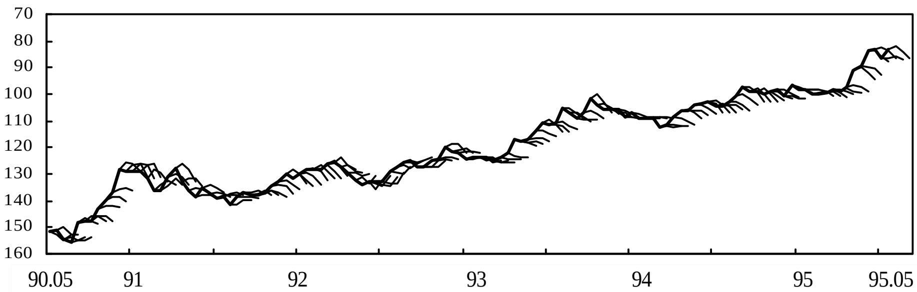
Phase I: Jan. 1986 to Nov. 1988



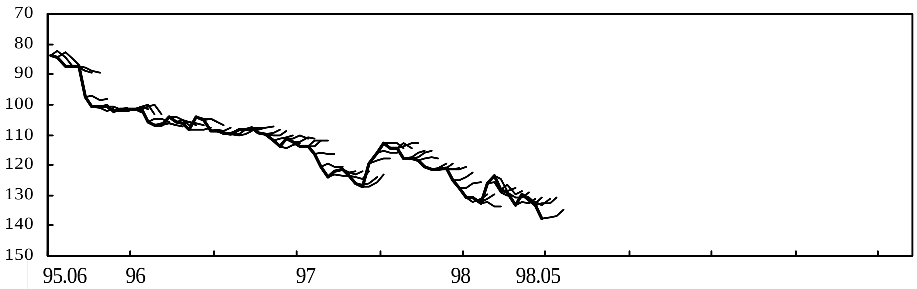
Phase II: Dec. 1988 to Apr. 1990



Phase III: May 1990 to May 1995



Phase IV: Jun. 1995 to May 1998



Note: Scales for time horizons are the same for 1, 3 and 6 month ahead expectations.

Table 1. Actual and Expected Depreciation Rates

(a) 1 month ahead

(%)[b]

Sample [a]	*Full*	*Phase I*	*II*	*III*	*IV*
Actual	-2.76	-16.12	13.86	-11.55	17.27
Expected	-6.60	-15.71	-5.55	-5.03	-0.89

a: Full sample: Jan. 1986 to May 1998; Phase I: Jan. 1986 to Nov. 1988;
Phase II: Dec. 1988 to Apr. 1990; Phase III: May 1990 to May 1995;
Phase IV: Jun. 1995 to May 1998.
b: per annum.

(b) 3 month ahead

(%)[b]

Sample [a]	*Full*	*Phase I*	*II*	*III*	*IV*
Actual	-2.51	-13.47	12.56	-10.69	15.62
Expected	-2.08	-8.29	-5.18	0.91	0.38

a, b: see above.

(c) 6 month ahead

(%)[b]

Sample [a]	*Full*	*Phase I*	*II*	*III*	*IV*
Actual	-2.42	-10.62	7.00	-8.34	13.09
Expected	-0.09	-2.72	-4.09	2.57	-0.15

a, b: see above.

Table 2. Estimates of *b*

(a) 1 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
extrapolative I or II	-0.028 *	-0.079 *	-0.041	-0.025	-0.009
	(-2.51)	(-3.81)	(-1.35)	(-1.58)	(-0.41)
adaptive	-0.023 *	-0.071 *	-0.038	-0.023	-0.003
	(-2.17)	(-3.38)	(-1.35)	(-1.50)	(-0.17)
regressive I	-0.059 *	-0.081 *	-0.180 *	-0.041 *	-0.029
	(-5.60)	(-6.13)	(-7.28)	(-2.33)	(-1.95)
II	-0.056 *	-0.077 *	-0.178 *	-0.043 *	-0.026
	(-5.26)	(-5.88)	(-6.38)	(-2.38)	(-1.82)

**: Significant at the 5 percent level (t-test: b = 0).*

(b) 3 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
extrapolative I	0.064 *	0.069 *	0.004	0.084 *	0.024
	(4.64)	(2.39)	(0.10)	(3.95)	(0.92)
II	0.097 *	0.090 *	0.036	0.116 *	0.094 *
	(7.13)	(2.88)	(0.94)	(5.71)	(3.26)
adaptive	0.066 *	0.064 *	0.010	0.087 *	0.025
	(4.51)	(2.07)	(0.25)	(3.80)	(0.93)
regressive I	0.125 *	0.114 *	-0.009	0.164 *	0.077 *
	(7.09)	(3.40)	(-0.16)	(6.31)	(2.24)
II	0.118 *	0.105 *	-0.010	0.157 *	0.073 *
	(6.69)	(3.14)	(-0.20)	(5.97)	(2.14)

**: see above.*

(c) 6 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
extrapolative I	0.168 *	0.170 *	0.141 *	0.198 *	0.125 *
	(9.90)	(4.57)	(3.01)	(7.53)	(4.27)
II	0.226 *	0.204 *	0.166 *	0.269 *	0.207 *
	(13.55)	(4.80)	(3.56)	(10.50)	(6.60)
adaptive	0.221 *	0.238 *	0.199 *	0.270 *	0.150 *
	(12.07)	(6.39)	(3.66)	(9.56)	(4.73)
regressive I	0.340 *	0.360 *	0.280 *	0.401 *	0.268 *
	(17.13)	(8.77)	(4.78)	(13.22)	(7.01)
II	0.329 *	0.343 *	0.277 *	0.387 *	0.264 *
	(16.40)	(8.16)	(4.94)	(12.46)	(6.82)

**: see above.*

Table 3. Estimates of *d*

(a) 1 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
extrapolative I or II	-0.013	-0.081	-	-	-
adaptive	0.019	-0.035	-	-	-
regressive I	-0.035	-0.116	-0.506 *	-0.103	-
II	-0.033	-0.105	-0.535 *	-0.124	-

**: Significant at the 5 percent level (c^2 test: g = d = 0).*

-: b is not significant at the 5 percent level.

(b) 3 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
extrapolative I	0.023	-0.186	-	-0.235*	-
II	0.159	-0.219	-	0.004*	-0.187*
adaptive	0.055	-0.219	-	-0.171*	-
regressive I	-0.036	-0.261	-	-0.454*	-0.631*
II	-0.038	-0.243	-	-0.498 *	-0.578 *

**, -: see above.*

(c) 6 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
extrapolative I	0.011	0.001	-0.630	-0.668 *	-0.416 *
II	0.030	-0.521	-0.985	-0.507 *	-0.342 *
adaptive	0.081	0.102	-0.670	-0.721 *	-0.471 *
regressive I	-0.040	-0.272	-1.329*	-1.032 *	-0.655 *
II	-0.044	-0.274	-1.482*	-1.057 *	-0.619 *

**: see above.*

Table 4. Estimates of b_i

(a) 1 month ahead

	Full	*Phase I*	*II(1)*	*II(2)*	*III*	*IV*
extrapolative	-0.156	**	0.085	-	-	-
	(-2.50)		(2.91)			
adaptive	0.163	**	-	0.068	-	-
	(2.86)			(2.85)		
regressive	-0.060	**	-0.224	-0.210	**	-
	(-4.60)		(-9.15)	(-9.53)		

-: Not significant at the 5 percent level.

***: Significant only individually. See Table 2.*

(b) 3 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
extrapolative	0.061	**	-	0.062	**
	(3.06)			(2.15)	
adaptive	-	**	-	-	-
regressive	0.064	**	-	0.099	**
	(2.47)			(2.61)	

*- , **: see above.*

(c) 6 month ahead

	Full	*Phase I*	*II*	*III*	*IV(1)*	*IV(2)*
extrapolative	0.080	**	0.109	0.111	0.166	0.112
	(3.61)		(2.16)	(3.41)	(4.87)	(2.63)
adaptive	-	**	0.135	-	0.083	-
			(2.29)		(2.67)	
regressive	0.261	**	-	0.286	-	0.165
	(8.91)			(6.61)		(3.11)

*- , **: see above.*

Table 5-1. Estimates of *b* (Extrapolative II)

(a) 1 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	-0.048 *	-0.083 *	-0.043	-0.048 *	-0.050 *
	(-3.53)	(-3.29)	(-0.97)	(-2.37)	(-2.28)
S & T	-0.060 *	-0.113 *	-0.049	-0.061 *	-0.027
	(-3.66)	(-3.65)	(-0.91)	(-2.47)	(-0.81)
EOC	0.003	-0.031	0.002	0.010	0.015
	(0.18)	(-1.28)	(0.05)	(0.45)	(0.50)
L & I	-0.015	-0.122 *	-0.091 *	0.025	0.053 *
	(-0.98)	(-3.88)	(-2.04)	(1.11)	(2.14)

**: Significant at the 5 percent level (t-test: b = 0).*

(b) 3 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	0.041 *	0.048	0.021	0.043	0.026
	(2.29)	(1.16)	(0.38)	(1.43)	(0.81)
S & T	0.088 *	0.116 *	0.052	0.098 *	0.067
	(3.81)	(2.32)	(0.59)	(2.94)	(1.50)
EOC	0.156 *	0.160 *	0.012	0.213 *	0.130 *
	(7.39)	(3.44)	(0.24)	(6.47)	(2.96)
L & I	0.116 *	0.056	0.031	0.149 *	0.165 *
	(5.78)	(1.15)	(0.63)	(5.36)	(3.87)

**: see above.*

(c) 6 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	0.169 *	0.167 *	0.125 *	0.204 *	0.130 *
	(8.16)	(3.19)	(2.18)	(6.10)	(3.60)
S & T	0.249 *	0.287 *	0.205 *	0.268 *	0.201 *
	(8.69)	(4.50)	(2.04)	(6.28)	(3.50)
EOC	0.284 *	0.215 *	0.282 *	0.346 *	0.255 *
	(9.76)	(3.24)	(3.84)	(8.13)	(3.76)
L & I	0.258 *	0.196 *	0.243 *	0.283 *	0.273 *
	(11.12)	(3.22)	(3.95)	(8.17)	(6.17)

**: see above.*

Table 5-2. Estimates of b (Adaptive)

(a) 1 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	-0.039 *	-0.076 *	-0.024	-0.043 *	-0.043 *
	(-2.94)	(-2.88)	(-0.59)	(-2.20)	(-2.00)
S & T	-0.041 *	-0.089 *	-0.048	-0.045	-0.006
	(-2.62)	(-2.83)	(-1.02)	(-1.96)	(-0.20)
EOC	0.005	-0.029	0.010	0.009	0.012
	(0.33)	(-1.19)	(0.28)	(0.41)	(0.41)
L & I	-0.010	-0.109 *	-0.077	0.027	0.060 *
	(-0.65)	(-3.67)	(-1.92)	(1.23)	(2.42)

**: Significant at the 5 percent level (t-test: b = 0).*

(b) 3 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	0.014	-0.012	-0.022	0.031	-0.022
	(0.80)	(-0.32)	(-0.41)	(1.10)	(-0.86)
S & T	0.043 *	0.103 *	0.020	0.021	-0.032
	(1.99)	(2.54)	(0.28)	(0.68)	(-0.95)
EOC	0.124 *	0.118 *	-0.067	0.204 *	0.056
	(5.81)	(2.95)	(-1.28)	(6.02)	(1.45)
L & I	0.084 *	0.053	0.026	0.078 *	0.067
	(4.25)	(1.23)	(0.49)	(2.93)	(1.82)

**: see above.*

(c) 6 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	0.119 *	0.172 *	0.020	0.156 *	0.051
	(5.76)	(4.26)	(0.32)	(5.05)	(1.97)
S & T	0.222 *	0.280 *	0.238 *	0.218 *	0.112 *
	(8.45)	(5.59)	(2.75)	(6.02)	(2.82)
EOC	0.266 *	0.313 *	0.338 *	0.337 *	0.160 *
	(10.12)	(5.62)	(3.56)	(8.70)	(3.24)
L & I	0.203 *	0.158 *	0.244 *	0.225 *	0.185 *
	(8.94)	(3.39)	(3.42)	(6.38)	(4.40)

**: see above.*

Table 5-3. Estimates of b (Regressive I)

(a) 1 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	-0.076 *	-0.069 *	-0.212 *	-0.056 *	-0.052 *
	(-6.91)	(-4.32)	(-8.99)	(-2.74)	(-3.37)
S & T	-0.108 *	-0.105 *	-0.205 *	-0.107 *	-0.067 *
	(-9.35)	(-5.40)	(-5.17)	(-4.73)	(-2.65)
EOC	-0.014	-0.038 *	-0.110 *	0.002	-0.008
	(-1.02)	(-2.21)	(-2.72)	(0.09)	(-0.36)
L & I	-0.043 *	-0.116 *	-0.182 *	0.004	0.025
	(-2.85)	(-4.43)	(-5.88)	(0.18)	(1.30)

**: Significant at the 5 percent level (t-test: b = 0).*

(b) 3 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	0.014	0.036	-0.119	0.033	-0.008
	(0.62)	(0.83)	(-1.67)	(0.90)	(-0.23)
S & T	0.089 *	0.125 *	-0.037	0.105 *	0.017
	(3.27)	(3.01)	(-0.40)	(2.68)	(0.38)
EOC	0.216 *	0.181 *	0.003	0.291 *	0.145 *
	(8.39)	(4.34)	(0.05)	(7.19)	(2.94)
L & I	0.149 *	0.083	0.021	0.158 *	0.118 *
	(5.92)	(1.74)	(0.31)	(4.73)	(2.57)

**: see above.*

(c) 6 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	0.223 *	0.304 *	0.082	0.253 *	0.138 *
	(8.46)	(6.82)	(1.00)	(5.98)	(3.35)
S & T	0.347 *	0.423 *	0.378 *	0.354 *	0.186 *
	(10.23)	(8.61)	(3.53)	(7.18)	(3.09)
EOC	0.464 *	0.465 *	0.502 *	0.548 *	0.354 *
	(14.32)	(7.31)	(6.16)	(12.03)	(4.78)
L & I	0.340 *	0.282 *	0.349 *	0.386 *	0.321 *
	(11.52)	(4.11)	(4.24)	(9.15)	(5.85)

**: see above.*

Table 6-1. Estimates of d (Extrapolative II)

(a) 1 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	-0.036	-0.068	-	-0.086	-0.159 *
S & T	-0.063	-0.113	-	-0.127	-
EOC	-	-	-	-	-
L & I	-	-0.119	-0.472 *	-	-0.050 *

**: Significant at the 5 percent level (c^2 test: $g = d = 0$).*

- : b is not significant at the 5 percent level.

(b) 3 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	0.074	-	-	-	-
S & T	0.120	-0.184	-	-0.062	-
EOC	0.284	-0.103	-	0.128 *	-0.159 *
L & I	0.209	-	-	0.100 *	-0.100 *

**, -: see above.*

(c) 6 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	-0.070	-0.625	-1.102	-0.598 *	-0.397 *
S & T	0.004	-0.424	-0.906	-0.543 *	-0.357 *
EOC	0.186	-0.417	-0.891	-0.380 *	-0.282 *
L & I	0.072	-0.558	-0.854	-0.455 *	-0.292 *

**: see above.*

Table 6-2. Estimates of d (Adaptive)

(a) 1 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	-0.005	-0.026	-	-0.048	-0.105 *
S & T	-0.025	-0.052	-	-	-
EOC	-	-	-	-	-
L & I	-	-0.038	-	-	-0.032 *

*: Significant at the 5 percent level (c^2 test: $g = d = 0$).

- : b is not significant at the 5 percent level.

(b) 3 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	-	-	-	-	-
S & T	0.008	-0.180	-	-	-
EOC	0.143	-0.187	-	-0.081 *	-
L & I	0.070	-	-	-0.165 *	-

*, -: see above.

(c) 6 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	0.018	0.011	-	-0.721 *	-
S & T	0.046	0.121	-0.586	-0.734 *	-0.482 *
EOC	0.180	0.204	-0.738	-0.620 *	-0.445 *
L & I	0.111	0.099	-0.512	-0.725 *	-0.438 *

*: see above.

Table 6-3. Estimates of d (Regressive I)

(a) 1 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	-0.043	-0.103	-0.527 *	-0.105	-0.272 *
S & T	-0.076	-0.139	-0.529 *	-0.168	-0.287 *
EOC	-	-0.080	-0.459 *	-	-
L & I	-0.026	-0.145	-0.497 *	-	-

**: Significant at the 5 percent level (c^2 test: $g = d = 0$).*

- : b is not significant at the 5 percent level.

(b) 3 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	-	-	-	-	-
S & T	-0.070	-0.235	-	-0.491 *	-
EOC	0.069	-0.183	-	-0.340 *	-0.608 *
L & I	-0.023	-	-	-0.411 *	-0.565 *

**, -: see above.*

(c) 6 month ahead

	Full	*Phase I*	*II*	*III*	*IV*
B & B	-0.127	-0.376	-	-1.118 *	-0.713 *
S & T	-0.081	-0.211	-1.262 *	-1.068 *	-0.680 *
EOC	0.119	-0.119	-1.184 *	-0.874 *	-0.588 *
L & I	-0.018	-0.318	-1.305 *	-1.011 *	-0.595 *

**: see above.*