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THE "EXCHANGE RISK PREMIUM," UNCOVERED INTEREST PARITY, AND THE TREATMENT OF EXCHANGE RATES IN MULTICOUNTRY MACROECONOMIC MODELS*

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* A portion of these notes was discussed at an American Economics Association session on "Analyses Using Foreign Exchange Rate Survey Data" at the annual meetings in Washington, DC on January 6, 1995. An initial version of the notes, prepared in 1991 and focused on the exchange risk premium, was stimulated by numerous discussions with Glenn Yamagata. I have also benefitted from conversations with Takatoshi Ito, Stanley Black, Graham Elliott, John McDermott, and modeling groups associated with the Brookings-sponsored projects on model comparison and evaluation.

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The scholarly literature on exchange markets and uncovered speculation conventionally defines the gap between the forward exchange rate and the expected future spot exchange rate as an "exchange risk premium." Authors attribute behaviorial significance to this gap. Numerous econometric studies try to explain it. I am skeptical that conventional presumptions about this "exchange risk premium" are analytically plausible. Empirical data on exchange rate expectations, such as those collected since 1985 by the Japan Center for International Finance (JCIF), have been the main catalyst for my skepticism. Part I of these working notes reviews existing interpretations of the exchange risk premium. After doing so, I present an alternative conceptual framework.

Part II of the notes revisits the issue of how to model the determination of exchange rates in empirical macroeconomic models. At the present time, the least inadequate multicountry models use the uncovered interest parity condition, combined with the assumption of model-consistent expectations, as the linchpin relationship determining exchange rates and cross-border interest differentials. This specification in turn critically influences the simulation properties of those models. Yet this treatment of exchange rates is inadequate. The notes use the JCIF data to underscore this conclusion. I reinforce the conclusion by reporting preliminary simulation results generated by introducing alternative assumptions about exchange rate expectations into a two-region abridgement of the IMF staff's empirical multicountry model.

Much of the empirical literature on exchange rates focuses on statistical issues -- in particular, whether the forward exchange rate is an unbiased predictor of the future spot rate, whether survey expectations produce unbiased predictions of actual changes in exchange rates, and whether a bias in the forward rate can be attributed to a time-varying risk premium. Part III of the notes addresses these issues, replicating some "standard" regressions reported in the literature. If the perspective I adopt in these notes is accepted, the conventional statistical literature has devoted excessive resources to estimation of these standard but not particularly revealing regressions.

I.
INTEREST PARITY AND THE "EXCHANGE RISK PREMIUM"

In these notes, Japan is treated as the "home" country and the United States is treated as the sole "foreign" country. The relevant world is assumed to contain only these two countries (thus all third-country complications are ignored). The thorniest exchange-rate issues arise even in a two-country, one-exchange-rate context. My presumption is that third-country complications can be handled relatively easily once the two-country case is better understood.

Definitions, Notation, and Working Assumptions

Exchange rates are measured as units of home currency per foreign currency -- here as yen per dollar. S_t is the spot exchange rate prevailing at time t. $F_{t,t+T}$ is the home-currency price of one unit of foreign currency in a forward contract entered into at time t for delivery at time t+T (T periods in the future). $R^J_{t,T}$ is the short-term interest rate that can be earned in Japan on yen-denominated assets for the period from t to t+T, and $R^U_{t,T}$ is the corresponding short-term interest rate in the United States on dollar-denominated assets.[1]

[1] An interest rate of 6 percent per annum would be expressed in decimal form as .06 (with the period t to t+T being 4 quarters, 12 months, 365 days, etc.). If expressed at a quarterly rate (T being 1 quarter, 3 months, 91 days, etc.), the number would be .014674; if expressed as a rate over two years, the number would be .1236. And so on. The notation here assumes that interest rates and the forward exchange rate are expressed over an identical time horizon, t to t+T.

Lower-case variables denote the natural logarithms of variables expressed in upper case; for example, $\boldsymbol{f}_{t,t+T} = \ln(\boldsymbol{F}_{t,t+T})$ and $\boldsymbol{s}_t = \ln(\boldsymbol{S}_t)$. For the typical range of values in which interest rates fall, the approximation $\boldsymbol{R} \approx \mathbf{ln(1+}\boldsymbol{R}\mathbf{)}$ holds fairly well; hence $\boldsymbol{r}^J_{t,T} \equiv \mathbf{ln(1+}\boldsymbol{R}^J_{t,T}\mathbf{)} \approx \boldsymbol{R}^J_{t,T}$ and $\boldsymbol{r}^U_{t,T} \equiv \mathbf{ln(1+}\boldsymbol{R}^U_{t,T}\mathbf{)} \approx \boldsymbol{R}^U_{t,T}$.

Define $\boldsymbol{S}_{i;t+T,t} = \boldsymbol{E}_t[\boldsymbol{S}_{i;t+T}]$ as the expectation, formed by investor i at time t, of the spot rate that will prevail in the future at time t+T (the same date to which the forward exchange rate applies). For the corresponding concept in natural logarithms, define $\boldsymbol{s}_{i;t+T,t} = \boldsymbol{E}_t[\boldsymbol{s}_{i;t+T}]$. Note that this last definition is <u>not</u> the same as $\boldsymbol{s}_{i;t+T,t} = \mathbf{ln(}\boldsymbol{E}_t[\boldsymbol{S}_{i;t+T}]\mathbf{)}$.[2]

For expositional purposes it is convenient to omit time subscripts. To simplify, therefore, assume unless stated otherwise that the discussion pertains to decisions made at time t over a standard time horizon three months long (T is 3 months). The variables at time t referring to the future date t+T which have identical values for all investors can then be written simply as $\boldsymbol{F}$ ($\boldsymbol{f}$), $\boldsymbol{R}^J$ ($\boldsymbol{r}^J$), and $\boldsymbol{R}^U$ ($\boldsymbol{r}^U$). The spot rate at time t will be written $\boldsymbol{S}$ ($\boldsymbol{s}$). As a reminder of the heterogeneity of expectations, the exchange rate expected at time t to prevail at future time t+T from the perspective of the individual investor i will be written with the agent subscript, as $\boldsymbol{S}_i$ ($\boldsymbol{s}_i$). Notation with additional features will be used when it is necessary to refer to the expectations of different agents or to the mean of the expectations of all investors.

For most of the exposition (except when I later introduce an

[2] By using the definition that $\boldsymbol{s}_{i;t+T,t} = \mathbf{ln(}\boldsymbol{E}_t[\boldsymbol{S}_{i;t+T}]\mathbf{)}$ is the expectation of the logarithm rather than the logarithm of the expectation, I am trying to avoid questions about the "Jensen-inequality" problems of exchange-rate reciprocals. To be candid, however, I become somewhat inconsistent later on in the notes. I initially drafted the argument here primarily in terms of the log variables rather than the level variables because most of the literature uses the logarithmic definitions and that format is hence more familiar to most readers. I now feel it is preferable to emphasize the level format instead, because that format avoids Jensen-inequality problems. Because this is an interim draft of working notes, I have not taken the time to rewrite the presentation exclusively in level format (and deleting the expressions in log format).

alternative conceptual framework), I neglect the transactions costs associated with sales or purchases of foreign exchange (spot and forward) and the transactions costs associated with purchasing or selling investments in interest-earning assets. In real life, such transactions costs are non-trivial and probably have a significant bearing on the arbitrage analyzed here.

<u>The Covered Interest Parity Condition</u>

A unit of home currency, one yen, invested at time t ("today") in interest-bearing yen assets in Japan will be expected to earn $(1 + R^J)$ yen over the three-month horizon assumed here. Alternatively, if the one yen is used today to purchase $1/S$ dollars in the spot exchange market, invested in the United States at the interest rate R^U, and sold forward today at the three-month contract rate of F, the expected earning over the three months will be $(1/S)(1 + R^U)F$ yen. Arbitrage by market investors will tend to make it true today that

$$(1 + R^J) \approx \frac{F}{S}(1 + R^U) \quad ; \tag{B-1}$$

alternatively,

$$\frac{(1 + R^J)}{(1 + R^U)} \approx \frac{F}{S} \quad . \tag{B-2}$$

Expressed in logarithmic form, this approximate equality is

$$r^J - r^U \approx f - s \quad . \tag{B-3}$$

The gap between the forward rate and the spot rate, expressed as a percent of the spot rate, is typically termed the "forward discount" (when $F > S$) or the "forward premium" (when $F < S$) on the home currency. The definition of the forward discount/premium -- stated for the standard time period assumed in these notes, but not stated at an annual rate or as a percentage -- is

$FDP = (F - S)/S$. Hence $F = S(1 + FDP)$, and in logarithms $f = s + \ln(1 + FDP)$. Since the approximation used earlier for interest rates is also relevant here, one has $fdp = \ln(1 + fdp) \approx FDP$ and hence $fdp = f - s$.[3]

The covered-interest-parity relationship can be interpreted as holding exactly rather than approximately if one introduces a "country premium" term, C:

$$\frac{(1 + R^J)}{(1 + R^U)} \equiv \frac{F}{S}(C) \; ; \qquad C \equiv \frac{(1 + R^J)}{\frac{F}{S}(1 + R^U)} \quad . \tag{B-4}$$

In logarithms:

$$r^J - r^U \equiv f - s + c \;\; ; \qquad c \equiv (r^J - r^U) - (f - s) \quad . \tag{B-5}$$

If c has a value greater than zero ($C > 1$), investors engaged in covered arbitrage might be said to require a somewhat greater return on Japanese yen assets than on US dollar assets (the numerator in the right-hand expression in (4) must be larger than the denominator). Analogously, if c has a value less than zero, investors could be said to require a somewhat greater return on US dollar than on Japanese yen assets.

In empirical practice, the country-premium discrepancy in covered interest parity relationships among industrial-country currencies in recent years has been very small. In Eurocurrency-market comparisons between yen and US dollar assets in the 1990s,

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[3] Terminology about the forward discount/premium can be confusing, in part because the exchange rate can be expressed as home-currency units per unit of foreign currency or foreign-currency units per unit of home currency. In my notation, where the exchange rate is yen per dollar, when the forward rate for the home currency is depreciated relative to the spot rate ($F > S$), one speaks of the home currency being "at a discount" (and vice versa "at a premium" for $F < S$). In some sources, for example the International Financial Statistics publication of the IMF, the preferred language is to speak of a forward discount on the home currency as a negative rather than positive number (and a forward premium as a positive rather than negative number). Another complication when matching the concepts to empirical data stems from the business practice of quoting forward discounts/premia at an annual rate, for a 360 day year, but without any compounding.

the discrepancy is usually small enough to be negligible.[4] Foreign-exchange traders are now even said to use the covered parity relationship, with $\boldsymbol{c}$ assumed to be zero, as a basis for determining the forward exchange rates they will quote for customers.[5]

When $\boldsymbol{c}$ is small and does not vary much over time, the covered parity relationship ensures that there is a well-defined and tight correlation between the interest differential and the forward discount/premium. Abstracting from a small nonzero value for $\boldsymbol{c}$, if the Japanese yen interest rate is above the US dollar interest rate, $\boldsymbol{f}$ will be correspondingly greater than $\boldsymbol{s}$; in other words, the forward exchange rate will embody a depreciation of the yen sufficient to offset the higher yen interest rate (the forward yen will be "at a discount"). Conversely, when $\boldsymbol{r^J}$ is below $\boldsymbol{r^{UJ}}$, $\boldsymbol{f}$ will be less than $\boldsymbol{s}$ (the forward rate will embody an appreciation of the yen).

<u>Uncovered Interest Parity</u>

The variables in the covered interest parity relationship are market "prices" observable by and identical for all agents.[6] The <u>uncovered</u> interest parity relationship, although it closely resembles covered parity in several ways, differs fundamentally in that it pivots on an expectation of the exchange rate, a variable not directly observable and not identical across individual investors.

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[4] In earlier decades when capital-market restrictions in Japan significantly impeded arbitrage between yen and dollar assets, a significant "country premium" was observed; see, for example, Ito (1988) and Marston (1993).

[5] See the discussion in Isard (1995, chap. 5 sec. 2), which includes the following passage: "...foreign exchange traders at marketmaking banks use interest rates on bank deposits denominated in different currencies to determine the forward exchange premiums or discounts that they quote to customers. At the same time, decisionmakers in other parts of the banks use the spreads between forward and spot exchange rates to set the interest rates they offer on foreign currency deposits relative to those on domestic currency deposits" (MS page 105).

[6] Abstracting of course from transactions costs (which may vary for individual agents) and from any non-negligible value of the country premium.

As before, one yen invested today in interest-bearing yen assets in Japan will be expected to earn ($1 + R^J$) yen over the next three months. Alternatively, if the one yen is used to purchase $1/S$ dollars in today's spot exchange market, invested in the United States for three months at the interest rate R^U, with the investor expecting to sell the dollar proceeds after the three months in the spot market at the then-expected spot rate $\mathcal{S}_i$, the comparison of the expected returns on the two options is

$$(1 + R^J) \quad ?? \approx ?? \quad \frac{\mathcal{S}_i}{S}(1 + R^U) \quad . \tag{B-6}$$

Unlike in the case of covered parity, there is no reason to believe that market arbitrage should necessarily drive the expected returns on these two options to equality. The expected return on investing in foreign-currency assets, after all, is dependent on the expectations of the particular investor i, which might differ substantially from the average expectation of all investors.

By analogy with the country-premium term in the covered parity relationship, it is instructive to assume a "wedge" term that, by definition, causes the two expected returns in (6) to be equal. This wedge, call it Z_i, will obviously be specific to the individual investor and contingent on his particular expectation $\mathcal{S}_i$:

$$\frac{(1 + R^J)}{(1 + R^U)} \equiv \frac{\mathcal{S}_i}{S}(Z_i) \; ; \qquad Z_i \equiv \frac{(1 + R^J)}{\frac{\mathcal{S}_i}{S}(1 + R^U)} \quad . \tag{B-7}$$

In logarithms the wedge term is:

$$z_i \equiv (r^J - r^U) - (s_i - s) \quad . \tag{B-8}$$

For a given expectation of the future spot exchange rate, if z_i has a value greater than zero ($Z_i > 1$), the investor considering this speculative (uncovered) arbitrage could be described as requiring a somewhat greater return on Japanese yen assets than on US dollar assets (the numerator in the right-hand expression in (7) must be larger for him than the denominator). Analogously, if z_i has a value less than zero, the speculative investor could be said to require a somewhat greater return on US dollar than on Japanese yen assets.

As seen from (5), the covered-parity identity can be rewritten as $r^J - r^U + s \equiv f + c$. When $f + c$ is substituted for $r^J - r^U + s$ in (8), it becomes clear that the total wedge term in the uncovered-parity relationship appropriate for an individual investor is the sum of two components, the country premium and an investor-specific gap between the forward rate and the expected future spot rate:

$$z_i \equiv c + (f - s_i) \quad . \tag{B-9}$$

The conventional definition of the "exchange risk premium"[7] facing an individual investor, here labelled K_i, is:

$$K_i \equiv \frac{F}{S_i} \tag{B-10}$$

or, in logarithms,

$$k_i \equiv f - s_i \quad . \tag{B-11}$$

Thus, given this conventional definition, the (logarithm of the) total wedge in the uncovered-parity relation, z_i, is the sum of the (logarithms of) the investor's "exchange risk premium" and the general country premium:

$$Z_i \equiv K_i C \;; \qquad z_i \equiv k_i + c \quad . \tag{B-12}$$

[7] See, for example, Isard (1988, 1995), who in turn cites numerous other references.

Because c can be treated as small and having little variability, the value and variability of the wedge in the uncovered-parity relation can be associated predominantly with kK_i. Indeed, to simplify the remainder of the exposition, I will now <u>assume</u> that $c = 0$ ($C = 1$) and hence that variation in the z_i wedge can be attributed exclusively to variation in $f - s_i$.

I do not believe, for reasons given below, that the conventional labeling of K_i or kK_i as an "exchange risk premium" is enlightening. The concept, and especially its empirical definition, needs to be approached with more care than it often receives. Note also that this conventional definition is not necessarily coterminous with other definitions of exchange risk premium encountered in the literature. For example, the risk premium derived from mean-variance analysis of a portfolio-balance theoretical model -- such as in Frankel (1982) or Fukao (1983, 1987, 1989) -- cannot be assumed identical to the conventional definition kK_i.[8]

<u>Summary Arithmetic of Arbitrage Incentives</u>

I now review the conventional account of arbitrage incentives that are said to exist when f and s_i differ from each other (z_i wedge is nonzero). I take the perspective of some particular investor i, whose expectations of the future spot rate are embodied in the value s_i. Later, I consider the implications for market activity as a whole.

Consider first the expositionally simplest case where, at a "pre-disturbance" initial equilibrium in asset markets, the individual's expectation s_i is assumed equal to f, which is simultaneously equal to the spot rate s.[9]

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[8] Family resemblances exist, of course, among the different definitions. But it would be a mistake to treat them all as identical, especially as implemented in empirical research. It would be a useful exercise -- but not one I attempt here -- to carefully spell out the similarities and differences among alternative definitions.

[9] Of course if $f = s$ in the initial conditions, the interest rates of comparable maturity in the two countries will also be equal (assuming $C = 0$). And because f and s are market prices facing all investors, all investors

Suppose that these initial conditions are disturbed because the investor receives new information that leads him to expect the yen to depreciate in the future (s_i to rise from its initial market value today to a new value $s_i' \succ\succ s_i$). Suppose in the first instance that the rest of the market does not receive the same information, so that for the time being the market rates remain at the initial values s and f. As perceived by the investor i, a "negative gap" opens up: $f - s_i' \prec 0$ and also $s - s_i' \prec 0$. Because of the negative gap, the arbitraging investor may wish to sell the yen spot and/or sell the yen forward (buy the dollar spot or forward).[10]

If the investor receives information leading him to expect the yen to appreciate rather than depreciate in the future, the reverse arithmetic applies. If the market s and f are unchanged, while the arbitraging investor's s_i has fallen to s_i''', a "positive wedge" $f - s_i''$ opens up and he will wish to buy the yen spot and/or buy the yen forward (sell the dollar spot or forward).[11]

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will be similarly placed vis-a-vis the initial zero forward discount/premium on the currency.

[10] Suppose the investor sells 100 yen forward. The forward contract is worth $100(1/f)$ in dollars; at the maturity of the contract, the investor must deliver 100 yen and will receive $100(1/f)$ dollars. The investor expects the spot rate at the future date when the forward contract matures to be s_i' yen per dollar ($1/s_i'$ dollar per yen). He plans to purchase the 100 yen he will need to deliver on the forward contract by entering the spot market three months in the future; he expects to pay $100(1/s_i')$ dollars in order to purchase the yen. Measured in dollars his expected "outgo" is $100(1/s_i')$. (Measured in yen, the expected outgo is 100 yen.) The dollar amount of the investor's "receipts" from the forward contract is $100(1/f)$. (Measured in yen, the receipts are expected to be worth $100(1/f)s_i'$.) The expected profits from the arbitrage transaction, measured in dollars, are therefore $100[(1/f) - (1/s_i')]$. Alternatively, if measured in yen, the profits are $100[(s_i'/f) - 1]$. With s_i' larger than f, these expected profits are clearly positive. An analogous arithmetic applies to spot sales of yen at today's market rate s to take advantage of the expected depreciation of the yen to s_i' in the future.

[11] Suppose the investor decides to sell 100 dollars forward. At the maturity of the contract, the investor will deliver 100 dollars and will receive $100f$ yen. He expects to be able to enter the spot market at the future date and purchase the 100 dollars he will need to deliver on the forward contract at the rate s_i''. His "outgo" in the spot market then, as he purchases the dollars, is expected to be $100(s_i'')$ yen (or 100 measured in dollars). The investor's "receipts" from the forward contract measured in yen are $100f$; his expected "payments" are $100(s_i'')$. The expected profits from

Whether the investor will in fact want to act on newly formed expectations such as $\boldsymbol{s}_i' > \boldsymbol{s}_i$ or $\boldsymbol{s}_i''$ will depend, in practice, both on transactions costs and on (see below) how confidently he holds the changed expectations and how risk averse he is. At a minimum, the expected profit has to be large enough to more than cover any transactions costs.

The preceding examples assumed that the investor's expected future spot rate changed while the spot and forward rates observed in today's market remained unchanged. An analogous arbitrage arithmetic is applicable, of course, if the investor's $\boldsymbol{s}_i$ stays unchanged while the market rates $\boldsymbol{f}$ and $\boldsymbol{s}$ are altered. If the yen depreciates in the market today, with $\boldsymbol{f}$ and $\boldsymbol{s}$ both rising to higher values $\boldsymbol{f}'$ and $\boldsymbol{s}'$, from the perspective of the individual investor a "positive wedge" ($\boldsymbol{f}' - \boldsymbol{s}_i > 0$) will have emerged; the investor may then envisage a profit from buying the yen spot and/or buying the yen forward today and selling the yen three months hence at the expected spot rate $\boldsymbol{s}_i$. Similarly, if the forward and spot rates in the market today should appreciate, with $\boldsymbol{f}$ and $\boldsymbol{s}$ both declining to new values $\boldsymbol{f}''$ and $\boldsymbol{s}''$, the arbitraging investor will perceive a "negative wedge" ($\boldsymbol{f}'' - \boldsymbol{s}_i < 0$) and the possibility of a profit from selling the yen spot or forward today and repurchasing it three months hence at the expected rate $\boldsymbol{s}_i$.

<u>Preferred Habitats and Exchange Risk Premiums?</u>

For the preceding illustrations of arbitrage arithmetic, I assumed a special set of initial conditions, namely that $\boldsymbol{f} = \boldsymbol{s} = \boldsymbol{s}_i$ (with $\boldsymbol{f} = \boldsymbol{s} = \boldsymbol{s}_i$ and $\boldsymbol{c} = \boldsymbol{0}$ together implying that $\boldsymbol{r}^J = \boldsymbol{r}^U$). Now consider a more general and interesting set of initial conditions in which $\boldsymbol{f} \neq \boldsymbol{s}_i$. (For expositional simplicity, continue to assume that $\boldsymbol{f} = \boldsymbol{s} = \boldsymbol{s}_i$ and hence $\boldsymbol{r}^J = \boldsymbol{r}^U$.)

Can an individual investor be in a position where his $\boldsymbol{s}_i$ differs significantly from the forward rate $\boldsymbol{f}$ and yet simultaneously be in a desired "equilibrium"? Traditionally,

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the arbitrage transaction, measured in yen, are $100(\boldsymbol{f} - \boldsymbol{s}_i'')$. Measured in dollars, the expected profits are $100(\boldsymbol{f} - \boldsymbol{s}_i'')(1/\boldsymbol{s}_i'') = 100[(\boldsymbol{f}/\boldsymbol{s}_i'') - 1]$.

analysts have answered this question yes by appealing to risk aversion, "risk premium," and "preferred currency habitat" arguments. For example, it can be argued that if the investor were to arbitrage merely in response to a nonzero wedge between $\boldsymbol{f}$ and $\boldsymbol{s}_i$, he would acquire an "open" position in the currencies that would differ from, and might be riskier than, his "normal" position; he thus might be unwilling to take on this additional risk if the inducement/expected return were insufficiently large.[12]

For example, consider an investor who expects the future spot rate to be higher than suggested by today's forward rate but who is nonetheless at a point of indifference/equilibrium. (For that investor, $\boldsymbol{f} - \boldsymbol{s}_i < 0$ so the yen is expected to depreciate relative to today's forward rate.) The usual language offered to describe this investor's behavior is that he requires, ceteris paribus, a somewhat higher expected return on dollar-denominated assets than on yen-denominated assets. For this investor, the "exchange risk premium" is negative. Alternatively stated, this investor biases the currency composition of his total portfolio toward yen-denominated assets. Were it not for this bias, because of the arbitrage incentive $\boldsymbol{f} - \boldsymbol{s}_i < 0$ the investor would try to make profits by selling the yen (buying the dollar).

Conversely, consider an investor assumed to be "in equilibrium" for whom $\boldsymbol{f} - \boldsymbol{s}_i > 0$. The literature speaks of this investor demanding a positive "exchange risk premium" and describes him as requiring a higher expected return on yen-denominated than on dollar-denominated assets. Without this bias against yen-denominated assets (in the absence of this preferred habitat for dollar-denominated assets), the investor would take the arbitrage incentive $\boldsymbol{f} - \boldsymbol{s}_i > 0$ as a signal to buy the yen (sell the dollar).

Once the preceding illustrations are adjusted to start from initial conditions in which the $\boldsymbol{f} - \boldsymbol{s}_i$ wedge is nonzero, the arbitrage arithmetic is essentially the same.

For example, consider an initial equilibrium in which the

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[12] The application and interpretation of the terms "risk premium" and "preferred currency habitat" is problematic, as I argue later on. At this point, I am simply trying to summarize what has been conventionally assumed.

investor i experiences a positive wedge $\boldsymbol{f} - \boldsymbol{s}_i = \zeta\varphi_i > 0$; that is, he expects the yen to appreciate somewhat in the future, whereas the market does not (market rates today are showing $\boldsymbol{f} = \boldsymbol{s} = \boldsymbol{s}_i$). By assumption, the investor is in equilibrium and therefore has no incentive to buy the yen spot or forward. The investor's "normal" state of affairs is for the $\boldsymbol{f} - \boldsymbol{s}_i$ wedge to be positive because he has a preferred habitat for dollar-denominated assets. In other words, the investor's $\boldsymbol{s}_i$ must normally be somewhat below $\boldsymbol{f}$ before the investor will be indifferent between holding assets denominated in the two currencies.

Now suppose again that the investor acquires information leading him to expect the yen to appreciate even more in the future ($\boldsymbol{s}_i$ to fall even further, to $\boldsymbol{s}_i'' < \boldsymbol{s}_i$). With an even bigger positive wedge than in equilibrium, the investor does now have an incentive to arbitrage, buying the yen spot or forward.

Suppose instead that the investor acquires information causing him to believe that the yen will depreciate relative to his initial expectation (so that now $\boldsymbol{s}_i' > \boldsymbol{s}_i$). With a smaller positive wedge than his $\zeta\varphi_i$ in equilibrium (or a fortiori if the wedge $\boldsymbol{f} - \boldsymbol{s}_i$ should turn negative), the investor now has arbitrage incentives to sell the yen spot or forward.

Similarly, if the market forward rate today should change to a more depreciated value $\boldsymbol{f}''$ while the investor's expected future spot rate remains unchanged, the investor will have a speculative arbitrage incentive to buy the yen spot or forward today and plan to sell the yen three months hence at the expected spot rate $\boldsymbol{s}_i$.

More generally, from an investor's initial point of indifference/equilibrium, any movement in the $\boldsymbol{f} - \boldsymbol{s}_i$ wedge that makes its value algebraically larger (more positive or less negative) gives the investor incentives to buy yen spot or forward. And any movement in $\boldsymbol{f} - \boldsymbol{s}_i$ that reduces its algebraic value (making it less positive or more negative) gives the investor incentives to sell yen spot or forward.

JCIF Data for Exchange Rate Expectations: Basic Features

Many of the hypotheses about exchange risk premia and exchange-rate expectations cannot be adequately tested without actual data for expectations. Among the data sets available, potentially the most useful in many respects is a set of survey data about the yen-dollar exchange rate compiled by the Japan Center for International Finance (JCIF) in Tokyo.

Beginning in May 1985, the JCIF has conducted telephone survey interviews twice a month, in the middle and at the end of the month on a mid-week day (usually a Wednesday or a Tuesday). The period between survey days is normally two but is sometimes three weeks (with 22-24 surveys taken each year). The sample of respondents has been largely unchanged for each survey, so that the data are a combined cross-section, time-series panel.[13] Of the total 43 [44?] respondents, 15 are banks and brokers, 4 are securities companies, 5 [6?] are trading companies, 9 are "export-oriented" companies, 5 are "import-oriented" companies, and 5 are insurance companies. All of the participating firms are large in size. A foreign-exchange expert in each firm is asked to forecast the future yen-dollar exchange rate 1 month, 3 months, and 6 months beyond the survey date.

The JCIF has made data available to me, for each survey date, for the mean, maximum, minimum, and standard deviation for all respondents. The individual-respondent data have been made available to Takatoshi Ito, who has conducted several analyses using them.[14] Ito has made available to me the data he collected on Tokyo-closing forward and spot exchange rates for the survey dates through the summer of 1993. In the fall of 1994, I updated my data set through September 1994.[15]

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[13] A few unfortunate gaps exist. Because of Japanese holidays, surveys were not taken in mid-August in 1989, 1990, 1991, 1992, and 1994 and at the end of December for 1991, 1992, and 1993. A few observations are missing for individual respondents. On the whole, however, the data set appears to be more complete and carefully collected than other sets of survey data for exchange-rate expectations.

[14] See Ito (1990), Ito and Elliott (1994), and Froot and Ito (1989).

[15] Data for forward exchange rates on survey dates in 1993-94 were collected from the Nikkei Japan Economic Weekly newspaper. Gaps in Ito's 6-month forward-rate data for 1991-93 were also filled from this source.

As with any survey data, questions can be asked about what is really being measured in the JCIF surveys and about the reliability of the responses. For example, do respondents have significant incentives to misrepresent their beliefs, or do the respondents' institutions actually behave in accordance with the responses given in the surveys? Ito (1990) provides evidence that a systematic bias existed for some individual respondents during the initial years of the survey; in particular, relative to the average expectations of all respondents, exporters exhibited wishful thinking by predicting yen depreciation while importers had the opposite bias by predicting yen appreciation.[16] On the whole, however, the JCIF survey data are probably collected more carefully than other survey data on exchange-rate expectations and the sample averages for all respondents are at least as reliable and systematic as other data sources.[17]

The charts labeled Figure 1 convey some salient features of the all-respondent data. Each panel plots the survey data for a subperiod of the May 1985 to September 1994 total period, with the subperiods in chronological order. The spot rate is shown as a solid curve, with the observations plotted on the actual dates of surveys. For that date the chart also plots the mean value for the 1-month expectation from the survey taken 2 surveys ago (usually 4 weeks previous), the mean value for the 3-month expectation from the survey taken 6 surveys ago (usually 12 weeks previous), and the mean value for the 6-month expectation from the survey taken 12 surveys ago (usually 24 weeks previous). Thin lines connect the future rates expected on a survey date with the actual spot rate on the date the survey was taken. Many interesting features of the data can be read directly off this series of charts.

The period from the late spring of 1985 (when the surveys were

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[16] Elliott and Ito (1995) confirm the earlier conclusions about systematic bias.

[17] Other data sources include surveys taken by Money Market Services, the Amex Bank Review, the Economist Financial Report, and Currency Forecasters' Digest. For description and analysis of these other data, see Frankel and Froot (1987a, 1987b), Froot and Frankel (1989), and Chinn and Frankel (1993, 1995).

first taken) through the summer of 1986 was a period of sharp appreciation of the yen against the dollar (Figure 1a). A further appreciation, but milder and more erratic, occurred between the summer of 1986 and early 1988 (Figure 1b). A period of yen depreciation began in late 1988 and continued through the spring of 1990, with the yen back above 150 yen to the dollar after March 1990 (Figures 1c and 1d). Appreciation to a rate below 130 yen had occurred by October 1990 (Figure 1e). A milder trend appreciation took place from the summer of 1991 through the fall of 1993, but with some notable ups and downs (Figures 1f and 1g). Further appreciation occurred in 1994, carrying the yen below 100 to the dollar (Figure 1h).

Negative Correlation between the Expected Change in the Spot Rate and the Exchange Risk Premium

Several features of the JCIF survey data on exchange rate expectations are broadly similar to data generated from other survey sources for exchange rate expectations. Most notable, in my view, is a robust inverse relationship between the expected change in the spot rate and the wedge between the expected spot rate and the forward rate ("risk premium" as conventionally defined).

As before, let f and s_i represent the forward rate and a respondent's expected future spot rate (both pertaining to the same date in the future). For the JCIF survey data, aggregated across all N respondents, define $\bar{s} = \frac{1}{N}\sum_{i=1}^{N} s_i$ as the mean of the expected future spot rates.[18]

Consider the identity

$$\frac{F}{S} \equiv \frac{\bar{S}}{S} \cdot \frac{F}{\bar{S}} \qquad \textbf{(13a)}$$

[18] Because the JCIF surveys have data for 1-month, 3-month, and 6-month expectations, there are actually three different measures of $\bar{s}$, and three measures of f corresponding to the three different time horizons.

written in level format, or alternatively the version in log format:

$$(f - s) = (\bar{s} - s) + (f - \bar{s}) \quad . \tag{13b}$$

The left hand side is the forward discount/premium. The first term on the right hand side is the (mean of respondents') expected change in the spot rate. The second right-hand term is, by the conventional language, the (mean of the respondents') exchange risk premium.

The measure of $f - s$ in empirical data is normally a relatively smooth series with only moderate variability. The interest differential $r^J - r^U + s \equiv f + c$. typically changes only moderately from short-run period to short-run period, which in turn means that $f - s$ also has only moderate variability. On the other hand, both ($(\bar{s} - s$) and ($f - \bar{s}$) have markedly higher variability than $f - s$. Accordingly, there exists a powerful inverse correlation between ($(\bar{s} - s$) and ($f - \bar{s}$). This correlation is highly significant statistically.

For example, Figure 2 shows data from the JCIF surveys for the 3-month horizon. Each of the three series in the identity (13) is plotted: the log forward discount, the expected change in the log spot rate, and the correspondingly defined log "exchange risk premium." The scissors movement of ($f - \bar{s}$) against ($(\bar{s} - s$) is apparent in the figure. The inverse correlation of these two series is even more apparent in Figure 3, which is a scatter diagram of ($(\bar{s} - s$) against ($f - \bar{s}$).[19]

The negative correlation between the so-called exchange risk premium and the expected change in the spot rate is a prominent feature of most if not all other sources of data on exchange rate expectations. Evidence of the negative correlation was noticed by Fama (1984) and was subsequently commented on by, among others, Hodrick and Srivastava (1986). It has been observed in studies of

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[19] The inverse correlation between the expected change in the spot rate and the measured exchange risk premium is just as striking in the data for the 1- and 6-month horizons as it is for the 3-month horizon.

exchange-rate expectations from other survey sources; see, for example, Frankel and Froot (1987b; see Figure 1)[20], Froot and Frankel (1989), and Isard's survey (1988).

Why the Negative Correlation?

The more one reflects on the negative, high-frequency correlation in the empirical survey data between (($\bar{s} - s$) and ($f - \bar{s}$), the more difficult it becomes to interpret time-series variation in ($f - \bar{s}$) as time-series variation in an "exchange risk premium" characterizing "preferred habitat" behavior.

If an individual investor requires a somewhat higher expected return on yen-denominated assets because of exchange-risk/preferred-habitat motivations (that is, would be "in equilibrium" when the $f - s_i$ wedge for him is positive), might we not expect changes in this "risk premium" to occur relatively smoothly over time? Among the factors that might influence this behavior, high-frequency changes in such determinants are probably the most difficult to imagine. To be sure, if some dramatic change in one of the countries' economic or political circumstances were to occur or if a "regime switch" in a government's policies were to be announced, then one might expect to see a sudden, large movement in individual investors' $f - s_i$ and thus in the market average $f - \bar{s}$. But dramatic changes of this type would presumably be the exception, not the rule (at least for countries such as Japan and the United States). Therefore <u>if</u> agents' behavior and market outcomes in normal times were dominated by arbitrage incentives attributable to incipient changes in the individual wedges $f - s_i$ which in turn were due to risk aversion and preferred-habitat decisions, one would conjecture that $f - \bar{s}$ would not vary from short run to short run by large amounts.

More troublesome still, why would one expect a behavioral risk premium to vary <u>inversely</u> with the expected change in the spot rate? Imagine an initial equilibrium where s, f, and $\bar{s}$ are not

[20] The curves in the printed version of Figure 1 of Frankel and Froot (1987b) were inadvertently mis-identified in the legend for the figure.

changing. Now imagine some piece of news that leads investors to expect the yen to depreciate relative to the initial equilibrium ($\bar{s}$ to rise, and hence also s and f to rise). How might the inverse correlation arise?

As already discussed, the forward discount $f - s$ is tied closely to the relative levels of home and foreign interest rates, which may not change rapidly. So even when the levels of f and s change by significant amounts, which they typically do from one shorter-run period to the next, f and s must still move fairly closely together. Indeed, this close co-movement of f and s is strongly evident in empirical data.

Focus again on the identity (13) and postulate that f and s do tend to move by equivalent or nearly equivalent amounts. And now consider two classes of response to the newly expected depreciation of the yen, one in which $\bar{s}$ increases by <u>more</u> than f and s, and the other in which $\bar{s}$ rises <u>less</u>.

When $\bar{s}$ rises by more than f and s so that ($f - \bar{s}$) falls algebraically, investors will have increasing incentives to sell the yen spot and forward. But the language of "risk premium" and "preferred habitat" asserts that, when the wedge ($f - \bar{s}$) falls, investors are now requiring a higher return than before on <u>dollar</u> assets relative to yen assets (speaking loosely, tend to prefer yen assets more than before). But such a claim about the risk premium would be puzzling at best. Why, if the yen is now suddenly expected to depreciate, would investors tend to require a higher return on dollar assets? Why would they "favor the yen" more than before? It seems more plausible to argue that most changes in the economic environment triggering an expected depreciation of the yen would lead to the opposite behavior, namely favoring the yen <u>less</u> than before.

If I strain, perhaps I can concoct a case why the "risk premium" ($f - \bar{s}$) should <u>fall</u> when s, $\bar{s}$, and the difference (($\bar{s} - s$) are rising, thereby giving rise to the inverse correlation observed in the empirical data. Suppose the shock that disturbs the initial equilibrium is some news that the United States will run a much bigger government budget deficit than before, adding greatly to the stock of dollar-denominated bonds that the world private sector will have to hold. Most empirical macroeconomic models predict that, with unchanged monetary policies in the United States and abroad, this shock will lead to a shorter-run appreciation of the dollar (depreciation of the yen), even though the shock may increase the riskiness of holding dollar assets over a longer run and hence have longer-run bearish implications for the exchange value of the dollar. So perhaps in this case one can conceivably imagine short-run inverse changes for (($\bar{s} - s$) and ($f - \bar{s}$), with the former rising and the latter falling.

However, the argument in the preceding paragraph seems strained to me. And in any case, one can imagine a variety of other shocks that would lead to a depreciation of the yen -- with $\bar{s}$ rising more than s -- which would not plausibly lead to a fall in ($f - \bar{s}$) if that gap is interpreted as a measure of risk-averting/preferred-habitat behavior.

Now consider the other class of cases, in which $\bar{s}$ rises by less than f and s (which rise by roughly similar amounts). (One interpretation of these cases might label them an "overreaction" of the spot and forward rates.) After the initial jumps in s, f, and $\bar{s}$, the term (($\bar{s} - s$) would fall algebraically and the gap ($f - \bar{s}$) would turn positive. The two terms would move inversely. And in these cases the "risk premium" would at least be moving in a plausible direction: the increase in ($f - \bar{s}$) would suggest that investors were "requiring a somewhat higher expected return" than before on yen assets, which would seem consistent with the expected depreciation of the yen.

The preceding observations suggest that it is not fruitful to define the entire amount of the wedge ($f - \bar{s}$) as a behavioral "exchange risk premium." Rather, the greater part of the observed variation in ($f - \bar{s}$) may have little to do with "exchange-risk-premium" behavior and may be merely a byproduct of high-frequency variation in f, s, and (perhaps to a smaller extent) $\bar{s}$.

Merely because of the identity (13), co-movements in f and s combined with movements in $\bar{s}$ that either are significantly greater or significantly less than the movements in $\boldsymbol{f}$ and $\boldsymbol{s}$ will mechanically produce an inverse correlation between (($\bar{\boldsymbol{s}} - \boldsymbol{s}$) and ($\boldsymbol{f} - \bar{\boldsymbol{s}}$). Perhaps some component of ($\boldsymbol{f} - \bar{\boldsymbol{s}}$) -- a smoothly changing, lower-variance component -- can be associated with the existence of a systematic behavioral risk premium (for the average of investors). But the higher-frequency, more erratic movements in ($\boldsymbol{f} - \bar{\boldsymbol{s}}$) seem to cry out for a different sort of interpretation and analysis.

In a footnote in his survey article, Isard (1988, p. 186) points the way to such an interpretation. Referring to Fama (1984), who found the negative correlation puzzling, Isard notes that Fama "seems to have overlooked the possibility that central bank behavior tends to hold interest rates and hence the forward premium relatively constant, while variation occurs in the underlying uncertainties that matter to exchange market participants. This generates larger changes in the exchange risk premium than in the forward premium, which can happen only if the expected change in the exchange rate declines (increases) whenever the risk premium increases (declines)."

Arbitrage with Uncertainty and "Limited Rationality"

Typically, investors are quite uncertain about their exchange rate expectations and the underlying forces that determine exchange rates. Once an emphasis on uncertainty is brought into the analysis of uncovered arbitrage, the notions of an exchange risk premium and a preferred habitat can be put into clearer perspective. In what follows, therefore, I amend the earlier exposition to stress uncertainty. In doing so, I draw heavily on insights due to De Grauwe (1989a, chap. 9; 1989b).[21]

When a risk-averse investor contemplating exchange arbitrage is uncertain about the future exchange rate $\bar{\boldsymbol{s}}_i$, his optimal arbitraging position will depend not only on the mean expected return from the arbitrage (positively) but also on the variance of

[21] When I first developed the ideas in these notes, I was not aware of De Grauwe's work. Stanley Black alerted me to the De Grauwe references, which have considerably clarified my exposition of the ideas.

the expected return (negatively). This result is the familiar Markowitz-Tobin conclusion about an optimal portfolio in a mean-variance framework.

De Grauwe (1989a, pp. 159-63) develops the exposition in the context relevant for the discussion here. Given uncertain expectations about $\mathbf{s}_i$ and given significant costs in making investment decisions (not merely transactions costs narrowly defined but also costs in collecting information and making decisions on how to use it), a small change in the expected return from arbitrage will not yield enough of an increment in expected utility to justify an actual change in the existing portfolio of assets and liabilities. In effect, within some zone of uncertainty the investor will not act. He can be induced to engage in actual transactions only if the expected gain becomes large enough to move him outside this zone. This zone constitutes a "band of indifference."[22] A decision by the investor not to act when his $\mathbf{s}_i$ varies only within his band of indifference can be described as an example of near-rational behavior ("limited rationality") in the sense of Akerlof and Yellen.[23]

These ideas can be made more precise with some further definitions and diagrams. First, imagine something analogous to a "confidence interval" around the investor's mean expectation of the future exchange rate. Denote the upper and lower boundaries of this interval as $\mathbf{s}_i + \lambda_i$ and $\mathbf{s}_i - \lambda_i$. The parameter λ_i, in a manner to be described shortly, is conditioned by both the uncertainty (expected variance) associated with the expected exchange rate and

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[22] De Grauwe's term is a "range of agnosticism."

[23] Akerlof and Yellen (1987, pp. 138-39) summarize near-rational behavior as agents having "relatively wide latitude for deviating from full optimization without incurring significant losses. In mathematical terms, this is a consequence of the envelope theorem which states, in effect, that the impact of an exogenous shock on a fully maximizing agent is identical, up to first-order of approximation, whether he optimally changes his decision variable in response to a shock, or instead responds inertially. Stated differently, inertial, or rule-of-thumb behavior typically imposes losses on its practitioners, relative to the rewards from optimizing, which are second-order."

by the costs of making decisions.[24]

Given the confidence interval around s_i, the composite wedge variable $f - s_i$ will also have a corresponding band around its mean, defined by $(f - s_i) - \lambda_i$ and $(f - s_i) + \lambda_i$.

Now suppose that a different interpretation is given to the definitional ("measured") wedge z_i in the uncovered parity relationship. As before, $z_i \equiv c + k_i$ and $k_i \equiv (f - s_i)$ and, with the assumption that $c \approx 0$, $z_i \approx (f - s_i)$. But now suppose that this measured wedge is itself interpreted as the sum of two components. Define one as a "systematic risk premium" about which the investor makes an explicit decision, influenced by his preferred currency habitat. Let φ_i refer to this systematic component. Then define u_i as a residual term, everything else in the measured wedge other than the systematic risk premium:

$$(f - s_i) \equiv \varphi_i + u_i \; ; \quad u_i \equiv (f - s_i) - \varphi_i \; . \tag{B-14}$$

The investor can be imagined as choosing his preferred φ_i and forming his mean expectation s_i, together with the uncertainty parameter λ_i. Then, given the observed value for the forward rate f in the market today (which depends via covered interest parity on r^J, r^U, and the spot rate s), the residual value of the u_i term is determined. Any change by the investor in his mean expectation s_i produces a change in u_i. At least as important, any change in the observed market rate f -- a matter over which the individual investor has no control -- causes a change in u_i.

When the value of u_i is zero -- when $f - s_i$ is exactly equal to φ_i -- the investor has no incentive to arbitrage, for the reasons summarized earlier. If u_i has a nonzero value, the investor may have an incentive to arbitrage. As in the earlier exposition, the size of the difference between $f - s_i$ and φ_i is the

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[24] For simplicity, I assume that the confidence interval is symmetric about the mean expectation. In real life, it often may not be. Although the time subscript on λ_i is not shown explicitly (just as it is not shown on s_i), the uncertainty associated with the investor's expectations and his costs of making investment decisions can, and often may, vary over time.

appropriate gauge of the size of the expected gain. The crucial additional element, however, is that the investor will not act on the arbitrage incentive unless $\boldsymbol{u}_i$ is large enough to move him outside his band of indifference. The criterion for "large enough" is that the absolute value of $\boldsymbol{u}_i$ must exceed λ_i.

Figure 4 depicts how the investor's expected utility from an optimal arbitrage position varies with changes in the mean expected return. The relationship between the two is shown as the curve EU in Figure 4a. When the wedge $\boldsymbol{k}_i = \boldsymbol{f} - \boldsymbol{s}_i$ is equal to φ_i, the expected utility from arbitrage is zero. A nonzero expected return, indicated by either a positive or negative gap between $\boldsymbol{k}_i$ and φ_i, causes expected utility to be positive. The relationship is drawn as nonlinear, so that expected utility increases more than proportionately as the gap between $\boldsymbol{k}_i$ and φ_i gets larger and larger. In the neighborhood of the point where $\boldsymbol{k}_i = \varphi_i$, the expected-utility gains from arbitrage are small enough to be treated as second order; when $\boldsymbol{k}_i$ differs from φ_i by a large amount, the expected-utility gains are of first-order importance.

Suppose the investor incurs costs in changing his portfolio (decision costs in acquiring and processing information as well as transactions costs more narrowly defined) that are equivalent in expected utility to the vertical distance $\boldsymbol{OX}_i$ in Figure 4a. Then within a band centered around φ_i, indicated by the upper and lower bounds $\boldsymbol{k}_i^U$ and $\boldsymbol{k}_i^L$ (the distance AB in the diagram), variations in $\boldsymbol{k}_i$ will give rise to changes in expected utility too small to make it worthwhile to change the portfolio. In effect, the investor has a band of indifference around his systematic risk premium, defined by $\varphi_i \pm \lambda_i$, where λ_i is one half the distance AB. Within this band, the investor does not have an incentive to act on his mean expectation of the future exchange rate.

The value of λ_i depends both on the investor's degree of uncertainty about $\boldsymbol{s}_i$ and on the costs he incurs in engaging in an arbitrage transaction. Suppose the investor becomes more uncertain, in the sense that the variance of $\boldsymbol{s}_i$ increases. For any given mean expected return, he will now have lower expected utility. The EU curve will change, as shown in Figure 4b, from EU_o

to EU_1. This change entails an increase in λ_i (from one half the distance AB to one half of CD). Suppose in addition that the investor experiences an increase in the costs of arbitrage transactions, so that OX_i^o rises to OX_i^1. If the size of the band of indifference had been CD prior to the increase in costs, it will now widen to the larger distance EF. The band of indifference changes in the opposite direction -- λ_i will fall -- if there is a decrease in the variance of the investor's exchange-rate expectations or if there is a reduction in his costs of engaging in arbitrage transactions.[25]

In principle, the investor's preferred value of φ_i, the systematic risk premium, can vary over time, either gradually and smoothly or in a discrete jump. In what follows, I make the simplifying assumption that φ_i does not change over the shorter run, staying constant at the value $\bar{\varphi}_i$.

Now consider a second related diagram, shown in Figure 5. The measured wedge term for the investor, shown on the horizontal axis in Figure 4, is now shown on the vertical axis. The band of indifference for the investor, $\bar{\varphi}_i \pm \lambda_i$, is indicated by the three horizontal lines.[26] The horizontal axis indicates the volume of the investor's arbitrage transactions. Purchases of yen are measured to the right and sales of yen to the left of the zero point on this axis. The investor's effective demand curve is plotted with the heavy line.

Consider the point G in Figure 5. At that point, the value of u_i, the "non-systematic" component of the investor's measured wedge term, is smaller in absolute value than λ_i. So even though $f - s_i$ is less than $\bar{\varphi}_i$, the investor does not have a sufficient incentive to sell yen (either forward or spot) to make an arbitrage

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[25] Strictly speaking, the band of indifference will not exist unless the costs associated with making decisions are nonzero (the distance OX in Figures 4a and 4b). Even with very low decision costs, however, the gains to expected utility from acting on small deviations in the wedge around φ_i will yield second- rather than first-order expected profits.

[26] The point on the vertical axis at which the measured wedge term for investor i is equal to zero is not shown in Figure 5. This zero point in fact has no relevance for the individual investor i; his band of indifference is centered on the point $\bar{\varphi}_i$.

profit. He does not act on his mean expectation because he is within the band of indifference, being sensitive to the risk stemming from uncertainty and recognizing that he incurs costs in making decisions. However, consider the point H. If the investor's measured wedge term is negative by a large amount relative to $\bar{\varphi}_i$, the value of $\boldsymbol{u_i}$ is substantially greater in absolute value than λ_i and in that situation the investor does have a sufficient incentive to sell yen to make an expected arbitrage profit.

Analogous reasoning applies if the measured wedge term for the investor should take on the values shown at points J and K in the diagram. At point J the investor, being within his band of indifference, would not purchase yen (forward or spot). But at point K, the incentive would be great enough to put him outside his band of indifference, and he would do so.

In general, as the demand curve drawn in the diagram shows, the investor does not engage in arbitrage when the absolute value of $\boldsymbol{u_i}$ is less than λ_i, but does begin to conduct transactions when the absolute value of $\boldsymbol{u_i}$ begins to exceed λ_i, with the volume of his transactions increasing more than proportionately as $\boldsymbol{u_i}$ exceeds λ_i by larger amounts.

Imagine an initial set of conditions in which the investor i is content with his portfolio of assets and liabilities and then assume that the investor acquires some information that other market participants do not. Suppose the investor changes his mean expectation of the future spot rate. If the resulting change in $\boldsymbol{u_i}$ is not large enough to move the investor outside the band $\bar{\varphi}_i \pm \lambda_i$, his new expectation will not induce him to carry out transactions and hence his new expectation will not have any effect on today's market rates for $\boldsymbol{f}$ and $\boldsymbol{s}$. If $\boldsymbol{u_i}$ changes by enough so that the new value exceeds λ_i, on the other hand, the investor will initiate transactions which will in turn cause changes in the market $\boldsymbol{f}$ and $\boldsymbol{s}$. If the individual investor is small in relation to the market as a whole, the changes in $\boldsymbol{f}$ and $\boldsymbol{s}$ will presumably be small. Yet it is of interest that changes in $\boldsymbol{f}$ and $\boldsymbol{s}$ due to the investor's transactions, to the extent that such changes do occur, will be in the direction of the change in the investor's $\boldsymbol{s}_i$ (thus incidentally bringing the value of $\boldsymbol{u}_i$ back towards the investor's band of indifference).

Alternatively, consider the case where other investors change their views of the future but in the first instance investor i's $\boldsymbol{s}_i$ does not change. The changed views of some of the other investors will probably give rise to market transactions (for those investors who are moved outside their bands of indifference), which in turn will change the market values of $\boldsymbol{f}$ and $\boldsymbol{s}$. The change in $\boldsymbol{f}$ will result in a change in investor i's $\boldsymbol{u}_i$ and hence in the mean value of his incentive to arbitrage. The investor will not respond with arbitrage transactions if the change in $\boldsymbol{u}_i$ leaves him within his band of indifference. A large enough change in $\boldsymbol{u}_i$, however, will induce a response. For example, if $\boldsymbol{f}$ has increased (the forward yen has depreciated) sufficiently to make the absolute value of $\boldsymbol{u}_i$ exceed λ_i, investor i will purchase yen forward or spot. To the degree that investor i's transactions have an influence on market rates, they will dampen the rise in $\boldsymbol{f}$ that would otherwise occur.

In general, if investor i responds with arbitrage transactions to movements in the market rate $\boldsymbol{f}$, he marginally dampens the movement of $\boldsymbol{f}$ away from his own mean expectation $\boldsymbol{s}_i$. Of course, the other alternative is for the investor to respond by changing his $\boldsymbol{s}_i$. If he does change $\boldsymbol{s}_i$, the change will presumably be in the same direction as the market change in $\boldsymbol{f}$ (and $\boldsymbol{s}$). Thus the alteration in his own expectation tends to bring back his $\boldsymbol{u}_i$ toward the band of indifference.

It is a key implication of the preceding analysis that when individual investors are quite uncertain about their expectations of the future spot rate, sizable variations can occur in the market rates $\boldsymbol{f}$ and $\boldsymbol{s}$ without triggering a large volume of arbitrage transactions. And of course to the degree that individual investors choose to adjust their mean expectations $\boldsymbol{s}_i$ in response to the most recent observed changes in the market rates $\boldsymbol{f}$ and $\boldsymbol{s}$, they have still less reason to initiate arbitrage transactions (because the induced changes in their $\boldsymbol{s}_i$ will have partially closed the incipient arbitrage wedge).

As before one can aggregate across individual investors and think in terms of total-market averages. Again define the average of expectations across all investors, $\bar{s}_t = \frac{1}{N}\sum_{i=1}^{N} s_{i,t}$. This expectation will exist for a variety of future time horizons; in the JCIF survey data, one has three different averages across individual investors: $\bar{s}^{1\text{-}month}$, $\bar{s}^{3\text{-}month}$, and $\bar{s}^{6\text{-}month}$. In principle, one can similarly define an average across all investors of a systematic risk premium: $\bar{\varphi}_t = \frac{1}{N}\sum_{i=1}^{N} \bar{\varphi}_{i,t}$.

The preceding analysis of micro investor behavior provides a sounder basis for interpreting the negative, high-frequency correlation between the total-market measured wedge ($f - \bar{s}$) and the total-market average expected change in the spot rate ($\bar{s} - s$). Over any short run, one will observe substantial variation in f and s, and also substantial variation in the individual s_i -- and hence also in the market average $\bar{s}$. If the forward discount on the currency, $f - s$, does not change much in the shorter run (because the differential between interest rates at home and abroad changes little), then it will necessarily be true -- recall the identity (13) -- that the measured wedge ($f - \bar{s}$) will move inversely with ($\bar{s} - s$). Yet a large part, perhaps almost all, of the variation in the measured wedge may have had nothing to do with time variation in the underlying systematic risk premia of individual investors (the $\varphi_{i,t}$), and hence with time variation in the total-market average $\bar{\varphi}_t$.

At the least, the preceding analysis cautions against interpreting time variation in ($f - \bar{s}$) as time variation in a market average of the systematic exchange-risk premia of investors. Instead, it will be much more fruitful to try to interpret time variation in ($f - \bar{s}$) -- and in f, s, and $\bar{s}$ individually -- as the interaction of many heterogenous individuals who have different φ_i and different methods of forming the expectation s_i.

Country Differences in Preferred Habitats?

As an example of heterogeneity across investors, imagine that the systematic risk premium for Japanese investors differs from that for U.S. investors. This could be true if preferred currency habitats in normal circumstances are significantly different between the two countries, with most Japanese residents having the bulk of their transactions denominated in yen and preferring to denominate the greatest part of their asset/liability portfolios in yen while U.S. residents primarily engage in dollar-denominated transactions and hold most of their assets and liabilities in dollars.

If we postulate that the systematic risk premia for Japanese investors φ_i^{Jap} differ in a predictable way from the systematic risk premia of US investors φ_i^{US}, the values of φ_i^{Jap} might on average be less than zero whereas the values of φ_i^{US} might typically be greater than zero. The rationale for this presumption would be that Japanese investors typically require a somewhat higher return on dollar-denominated assets before being willing to hold dollar assets, whereas the opposite bias exists for US investors who typically prefer dollar-denominated assets. If such conditions prevail generally, one would observe that the average value of the center of the band of indifference for Japanese investors would be negative, in normal circumstances, whereas the corresponding average value for U.S. investors would have the opposite sign, $\overline{\varphi}^{US} \succ 0$.

This hypothesis is portrayed graphically in Figure 6, an extension of Figure 5. The hypothesis has an interesting implication about the relative importance of Japanese and U.S. investors for different market conditions. At a time in which the mean value of the expected exchange rate $\bar{s}$ is less than the market forward rate (the wedge $f - \bar{s}$ is positive), one would expect Japanese investors to be much more actively engaged in uncovered arbitrage than U.S. investors. For example, with the wedge taking on a value of A, most U.S. investors might still be within their bands of indifference and would thus be inactive (point A^{US}) but many Japanese investors would have strong enough incentives to engage in significant arbitrage purchases of yen (point A^{Jap}). Conversely, with negative values of the wedge, such as B in Figure 6, many U.S. investors might be active in selling the yen forward or spot (point B^{US}) whereas most Japanese investors might be within their bands of indifference and hence inactive.

Data differentiating expectations of the exchange rate by nations or plausible currency habitats would be required to conduct empirical tests of the differences in groups' systematic risk premiums of the sort postulated in Figure 6.

Heterogeneity of Exchange Rate Expectations

Although there may exist systematic differences between the preferred currency habitats of Japanese and U.S. investors, many other types of heterogeneity among investors are also likely to be important. The values of $\boldsymbol{s}_i$ for individual investors can diverge widely, so that the wedge $\boldsymbol{f} - \boldsymbol{s}_i$ also varies widely across investors. This heterogeneity is illustrated clearly in the JCIF data for exchange rate expectations. For this data source, all the respondents are located in Japan.

Figure 7 gives one indication of the range between the maximum and minimum expectations. Time series are calculated for the maximum and minimum, expressed as a percent of the mean expectation. These maximum and minimum series are plotted in the figure, with the space in between them shaded black. For the three-month expectations, the range as a percent of the mean is typically at least plus and minus 5 percent and for occasional survey dates exceeds plus and minus 10 percent.[27] A qualitatively similar story holds for the 1-month and 6-month horizons.

Figures 8a and 8b plot the standard deviations of the expectations, measured in numbers of yen, for all three of the horizons (1-month data shown with the line of smallest width, 3-month with the line of intermediate width, and the 6-month with the

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[27] The mean expectation is represented in the figure, in effect, by a horizontal line at the zero point on the vertical scale. For the bimonthly dates when a survey was not taken, no data are available and hence the range for those dates in the graph appears to fall to zero.

heaviest line). The standard deviation for the 1-month data is typically smaller than that for the 3-month horizon, which in turn is typically smaller than that for the 6-month data. These features of the expectations data presumably reflect the tendency for uncertainty to increase with the length of the horizon.

Figure 9 shows a still more impressive manifestation of the heterogeneity of expectations. In that figure, for the 3-month data, I have calculated the (log) exchange risk wedge ($f - \bar{s}$) using not only the mean expectation but also the maximum and minimum expectation. The middle curve (closest to the zero line) is the series for the "exchange-risk-premium" wedge resulting from the mean expectation, shown before in Figure 2 (there the curve with inverted triangles). If either the maximum or minimum expectation is used instead, the absolute size of the calculated wedge is much larger. Moreover, for any given survey date even the sign of the wedge can differ depending on which respondent's expectation is used for the calculation.

Systematic Differences in Expectations Across Different Horizons

How much weight do investors and traders put on the immediate past when forming their expectations of future exchange rates? Is behavior consistent with some variant of a "random walk" model, in which investors believe they cannot do better than just extrapolating today's exchange rate as their best guess for next period's exchange rate?[28] Is there evidence that investors and traders form "bandwagon" expectations, predicting that exchange rates will change in the future in the same direction as in the recent past? Are such bandwagon effects more in evidence for short-horizon than for longer-horizon expectations? Over longer horizons, is there a tendency for expectations to be "mean reverting" in the sense that a recent change away from a "normal" rate will be expected to get partially or wholly reversed in the future? What analytical alternatives exist for defining such a

[28] The well-known work of Meese and Rogoff (1983a and 1983b, see also 1988) is the best known discussion of a random-walk model.

"normal" long-run exchange rate?

Several of these important questions have been examined by Ito (1990, 1994) using the JCIF survey data. The survey by Takagi (1991) also considers them in connection with the JCIF data. Frankel-Froot (1987a, 1987b), Froot-Frankel (1989), and Chinn-Frankel (1993, 1995) have done extensive work on other sources of expectations data. Also relevant here is the exploration by Frankel and Froot (1986) of the hypothesis that participants in the exchange market can be classified as "chartists" or "fundamentalists," with the former extrapolating short-run trends and the latter trying to discern longer-run, fundamental economic forces.

The JCIF data, and other survey data as well, do suggest that shorter-horizon expectations have "bandwagon" elements that are missing from, or at least less prominent in, longer-horizon expectations. In particular, exchange-rate expectations formed over short horizons appear to react to recent lagged movements in the spot rate in the same direction as those movements, perhaps moving away from rate levels that would characterize long-run "equilibrium." Expectations formed over longer horizons appear to respond in an opposite direction to recent lagged movements in the spot rate, perhaps reverting towards longer-run "equilibrium" values.

Ito (1994) explores this question with detailed regression analysis. He relates the JCIF survey data for expected change over the 1-, 3-, and 6-month horizons to several different measures of past change in the spot rate (change in the preceding 2 weeks, in the preceding 1 month, and in the preceding 3 months).

The flavor of his main conclusion is conveyed visually in Figures 10 and 11. The relationship of the 1-month horizon data to the past 1-month change in the spot rate is shown in Figure 10a; Figures 10b and 10c are the corresponding scatter diagrams for the 3-month-horizon and the 6-month-horizon data. Figure 11a superimposes the data for the three horizons on the same scatter. Figure 11b then indicates the slope of the simple regression lines obtained by estimating the slope coefficient separately for the three different horizons.

At the 1-month horizon, the JCIF respondents tend to extrapolate recent changes in exchange rates, albeit with a coefficient much less than unity. For the 6-month horizon, the coefficient has the opposite sign. If the yen has appreciated in the recent past, respondents tend to predict yen depreciation over the forthcoming 6 months (and vice versa for a recent depreciation).

It could be valuable to do further research on this aspect of expectations formation, both with the JCIF data and with other survey data.[29] Such research could refine our understanding of short-run fluctuations in exchange rates -- for example, the degree to which chartists and noise traders dominate short-run fluctuations and whether it is analytically helpful to characterize short-run exchange rates as "excessively volatile."

The JCIF data for individual respondents represent a potentially fertile ground in which to test alternative hypotheses about the formation of individual investors' expectations -- and in particular, about the heterogeneity of these expectations. In future research, I hope to be able to work with these individual-respondent data.

II.
UNCOVERED INTEREST PARITY, EXCHANGE RATE EXPECTATIONS, AND THE TREATMENT OF EXCHANGE RATES IN MULTICOUNTRY MACROECONOMIC MODELS

Part I of these notes tries to refine understanding of the

[29] Though Ito's regression results for recent past changes in the spot rate are relatively robust, he was not able to include a variable in the regressions adequately capturing the longer-run equilibrium level of the exchange rate (or deviations of the current rate from such an equilibrium). Chinn and Frankel (1995) have recently analyzed expectations data spanning a five-year horizon (obtained from surveys summarized in the Currency Forecasters Digest); although these data provide a small amount of support to the hypothesis that longer-horizon expectations data exhibit some mean reversion, the Chinn-Frankel results for these data are less supportive than I would have anticipated.

exchange-risk-premium wedge in the uncovered interest parity condition. That subject is worthy of attention in its own right. Even so, I probably would not have struggled with it had I not been keenly interested in improving the modeling of exchange rates in empirical macroeconomic models.

The "failure" of the empirical modeling of exchange rates, emphasized in 1988 in Empirical Macroeconomics for Interdependent Economics (Bryant, Henderson and others, 1988, especially the chapter by Isard), has not been rectified in subsequent years. Subsequent comparisons and evaluations of simulations from empirical models have continued to point to the exchange-rate/interest-rate nexus as a major area of model inadequacy (Bryant, Helliwell, and Hooper, 1989; Bryant, Hooper, and Mann, 1993).

Current Treatments in Models with Forward-Looking Expectations

Virtually all analysts now using empirical models believe it is essential to try to incorporate forward-looking exchange-rate expectations in the models. So far, however, the least inadequate attempts to treat expectations in a forward-looking manner are remarkably primitive. The essence of the approach currently in favor is to ignore the exchange-risk-premium wedge and to impose the assumption of model-consistent expectations on the uncovered interest-parity relationship.

Some of the implications of the currently fashionable approach can be readily identified in terms of the notation used earlier. Write the uncovered parity condition of (7) as follows, where next period's expected exchange rate, $\bar{\mathcal{S}}$, is the expectation $\mathcal{S}_i$ averaged across all investors, and where the definitional wedge $\bar{Z}_i$ is the corresponding mean of the individual wedges Z_i :[30]

$$\frac{(1 + R_t^J)}{(1 + R_t^U)} \equiv \frac{\bar{\mathcal{S}}_t}{S_t}(\bar{Z}_t) \quad . \tag{B-15}$$

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[30] Here I conduct the exposition with variables in level, not logarithmic, form.

The identity can then be renormalized to show the current-period's spot rate as the left-hand variable:

$$S_t \equiv \frac{(1 + R_t^U)}{(1 + R_t^J)} (\bar{S}_t)\, \bar{Z}_t \quad . \tag{B-16}$$

The builders of empirical multicountry models use (16) as the foundation for an equation determining the current period's exchange rate. But they impose two critical assumptions to generate the equation specification actually appearing in the models. First, they assume that the wedge term $\bar{Z}_t$ can be ignored (in other words, can always be assumed equal to unity). Second, they assume that the average exchange-rate expectation of all investors for the next period is completely model-consistent ("rational").

For the basic exchange-rate equation they thus write simply:

$$S_t = \frac{(1 + R_t^U)}{(1 + R_t^J)} (S_{t+1}) \quad . \tag{B-17}$$

The full equation in the models will typically include a residual term, either multiplicative or additive (the multiplicative version shown here):

$$S_t = \frac{(1 + R_t^U)}{(1 + R_t^J)} (S_{t+1})(U_t) \quad . \tag{B-18}$$

But this residual term plays no role in analysis carried out with the model.[31] The transformation of (16) into the specification (18) has profound implications.

As is well known, equation (18) implies that the exchange rate

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[31] For the multiplicative-residual case shown in the text, U_t in the baseline dataset is either assigned a value forcing the equation to hold exactly for observations of the variables (for historical periods) or else is assigned a value of unity (for periods outside the historical sample for which data are available). When the model is used for analysis, the simulation paths for U_t are kept identical to the baseline path.

in the current period depends solely on two considerations: (i) the string of interest differentials beginning today and extending out to the analytical horizon, and (ii) a terminal condition for the exchange rate just beyond the analytical horizon. This implication can be seen directly by iterative substitutions for next period's exchange rate in (18), which yields:

$$S_t = \frac{(1+R_t^U)}{(1+R_t^J)} \cdot \frac{(1+R_{t+1}^U)}{(1+R_{t+1}^J)} \cdot \frac{(1+R_{t+2}^U)}{(1+R_{t+2}^J)} \cdot \cdot \cdot \cdot \cdot \frac{(1+R_{t+T}^U)}{(1+R_{t+T}^J)} (S_{t+T+1}) \quad . \tag{B-19}$$

Analysts using such a specification sometimes speak of S_{t+T+1} as the "long-run equilibrium exchange rate." Whether that presumption is plausible depends on whether the value for S_{t+T+1} used as a terminal condition in the algorithm for solving the model has been chosen to be consistent with a carefully defined long-run (steady-state) solution for the model. In any event, analysts must impose an exogenously chosen value of S_{t+T+1} for purposes of solving the model. This exogenous choice for S_{t+T+1} can have a decisive influence on the properties of model simulations.

A second notable implication of (18) and (19) is the manner in which a given-sized interest differential expected to occur far in the future has an effect on S_{t+T+1} equivalent to that of the same sized interest differential occurring in the current period. This feature of the specification, directly attributable to the assumption of model-consistent expectations, seems implausible to me. Just as agents are presumably uncertain about direct expectations of future exchange rates, they must also be quite uncertain about the future paths of interest rates at home and abroad. Thus an interest differential of 50 basis points expected to prevail five years from now (with a large band of uncertainty associated with the mean estimate of 50 basis points) would presumably be much less consequential for actual investment decisions than a differential of 50 basis points observed today and expected to continue over the next few months.

Inferences from the JCIF Survey Data

Do market participants sometimes, perhaps typically, form expectations of exchange rates that turn out to differ greatly from actual market outcomes and are systematically wrong (i.e., the errors are serially correlated)? Even a cursory examination of the JCIF data suggests that the answer, for the JCIF sample of Tokyo respondents, is a resounding yes. The panels of Figure 1, for example, vividly illustrate the point. Other sources of survey data exhibit similar patterns.

It strains credulity to contend that expectations of the type reported in the JCIF data are compatible with strong forms of the rational expectations hypothesis. For example, the tests conducted by Ito (1990) and Froot and Ito (1989), or those conducted on other survey data by Frankel and Froot (1987a), do not support the rational expectations hypothesis.

The JCIF data can be readily displayed in a manner strongly suggesting that survey expectations are incompatible with model-consistent expectations derived from equations (18) and (19). Figure 12 uses the data for the 3-month horizon, plotting two points for each survey date from mid-1985 through September 1994. The points connected with the solid line show the (average) expected change between the current survey date and the survey date three months in the future. The points shown with inverted triangles, calculated from the ex post data for the change in the spot rate, show the change between the two dates that actually occurred. The expected change has a much smaller variance than the actual change. Even more notable, the actual change tends to fall -- alternately but systematically -- on one side or the other of the expected change. Respondents for a succession of survey dates persistently expect the yen to be less strong than it turns out to be (e.g., in the fall of 1985 and the first half of 1993 they expect too little yen appreciation), and then subsequently they err in the opposite direction by persistently expecting the yen to be stronger than it in fact turns out to be (e.g., first half of 1989 and the fall of 1993). The expected change itself exhibits a substantial degree of serial correlation.

Figure 13 is constructed in the same manner as Figure 12, except that the data in Figure 13 are for the 6-month rather than 3-month survey horizon. Diagrams for the 1-, 3-, and 6-month horizons have qualitatively similar patterns. Not surprisingly, actual changes over the 6-month horizon have a significantly larger standard deviation than the corresponding statistic for actual changes at the 3-month horizon, which in turn is larger than the standard deviation for the 1-month horizon changes.

In the form of a scatter diagram, Figure 14 plots the same 3-month-horizon data shown in Figure 12. The two series, the expected change and the actual change, are very weakly correlated. This diagram, too, serves to emphasize the point that the variation in actual ex post changes is an order of magnitude greater than the variation in changes in the expected rate.[32]

From Figures 12-14 and the associated evidence in the literature (also briefly discussed in Part III below), I draw the inference that analysts should have little confidence in a model specification setting $\mathcal{S}$ exactly equal to the next-period value of $\mathcal{S}$ that the model itself will generate. For virtually any class of model that can be imagined, and especially for those with plausible long-run steady-state properties, model-consistent expectations driven by the specification (18) presume a type of forward-looking behavior that is not consistent with survey data on expectations. The expectations data themselves could mislead us. Much research remains to be done on the processes by which agents actually do form their exchange rate expectations. Perhaps actual expectations are themselves not compatible with models having plausible long-run steady-state properties. But none of those last observations constitutes a convincing rationale for the specification (18).

<u>Some Initial Experiments with a Simulation Model</u>

To begin to gather a sense of the quantitative implications of

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[32] Part III below discusses the values of slope coefficients resulting from various "standard" regressions of the type prevalent in the literature, including the slope coefficient from a simple regression of the actual change on the expected change (the data plotted in Figure 14)..

alternative model specifications for exchange-rate expectations, in recent weeks I have briefly experimented with the exchange-rate and interest-rate equations in an abridged version of the IMF staff's MULTIMOD model.

MULTIMOD is a multicountry macroeconomic model developed by the staff of the IMF Research Department. The model is a pioneering and thoughtful effort to capture systematically the main features of macroeconomic interactions among the largest countries in the world economy. The model is used primarily for policy simulation, not for forecasting. Together with a closely related model developed by a team of economists at the Canadian Department of Finance and the Bank of Canada, MULTIMOD is noteworthy among the small number of analytical efforts to build multicountry models that incorporate innovations at the frontier of the discipline's knowledge and techniques.

During the autumn of 1993 and the first half of 1994, Long Zhang and I successfully constructed a two-region, abridged model that mimics the main macroeconomic properties of MULTIMOD.[33] To develop our abridgement, we extracted the block of equations for the United States from MULTIMOD to use as a basis for a first region (a home country). We then developed a "mirror image" of that set of equations to serve as the other region (foreign country). Careful attention was paid to the balance-of-payments behavioral relationships and accounting identities that would apply in a two-region world. Like full MULTIMOD, the two-region model is neoclassical in the long-run, but displays Keynesian properties in the short-run. It has about 86 equations (including identities).[34]

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[33] References to MULTIMOD include Masson and others (1988, 1990); "Changes to MULTIMOD Since the July 1990 Occasional Paper # 71," mimeo (July 1991); Guy Meredith, "A Steady-State Version of MULTIMOD," (July 1991); see also Haas and Masson (1986). The staff members of the International Monetary Fund who developed MULTIMOD -- in particular Paul Masson, Steve Symansky, and Guy Meredith -- have been generous in helping me to use and understand the model. But they cannot be held accountable for the modifications that Long Zhang and I have made to its structure. The economics profession owes a major debt to the far-sighted IMF policy that has permitted public dissemination and encouraged analytical criticism of this important research tool.

[34] When taking the US equations as the basis for both regions, we could not simply adopt all of the existing equations as used in the full MULTIMOD.

Simulation exercises with the two-region abridgement show that the US equations in the abridged model behave very similarly to the US block in full MULTIMOD as a macroeconomic description of the US economy. Thus, one can successfully simulate the impacts of most shocks on the US economy with the two-region model without having to simulate the much larger full model.

The basic specification for the exchange-rate equations in full MULTIMOD, and hence also for the exchange-rate equation in the two-region abridgement, is as shown above in (18). My recent experimentation has started from this specification. Instead of always enforcing full model-consistent expectations, however, I have assumed that the expectation formed this period of next period's exchange rate, $\bar{S}_t = \bar{E}_t[S_{t+1}]$, is a weighted average of the forward-looking, model-consistent rate and a backward-looking expectation formed adaptively. Hence the experimental exchange-rate equations are specified as:

A small number of the existing equations, for example, are inconsistent with creation of a complete steady-state model. Where necessary, we made modifications so that: (a) every equation in our two-region version had dynamic and steady-state properties that could be defended on theoretical grounds; (b) the model had a well defined steady state; (c) all residual terms were zero except for historical periods (or when present to account for statistical discrepancies); and (d) the baseline data set was fully model consistent.

$$S_t = \frac{(1 + R_t^U)}{(1 + R_t^J)} (\bar{S}_t)(U_t) \tag{B-20}$$

$$\bar{S}_t = \lambda_t(\bar{S}_t^b) + (1-\lambda_t)(\bar{S}_t^f) \tag{B-21}$$

$$\bar{S}_t^f = S_{t+1} \tag{B-22}$$

$$\bar{S}_t^b = \bar{S}_{t-1}^b + \theta(S_t - \bar{S}_{t-1}^b) \tag{B-23}$$

The parameter λ_t can take on values between zero and unity. The fully-model-consistent case, the standard method used in MULTIMOD simulations, imposes the assumption that $\lambda_t = 0$ for all t. My experiments with alternative specifications have imposed weights as small as 0.25 on the forward-looking, model-consistent expectation ($\lambda_t = 0.75$).[35]

The specification of the backward-looking expectation in (23) is mechanical but allows for different degrees of sluggishness in the adaptation of expectations to past changes in the spot rate. A low value for θ, for example in the range 0.2 to 0.4, makes the backward-looking expectation dependent (with geometrically declining weights) on a long string of past values for the spot rate. A high value of $\theta = 1.0$ represents the random-walk case in which the current exchange rate is extrapolated to the next period and no weight at all is given to the observed exchange rate in past periods.

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[35] In my initial experimentation, I have so far merely assumed λ_t to be a time-invariant constant. But the logical next steps are to allow for time variation (as suggested by the subscript) and -- even more important -- to consider specifications that determine λ_t endogenously in terms of other variables in the model.

The potential importance of alternative assumptions about the modeling of exchange-rate expectations is illustrated in Figures 15 and 16 by comparing several different simulations with the two-region abridgement of MULTIMOD. The panels of Figure 15 plot results, for the exchange rate and three other variables, for a hypothetical U.S. fiscal expansion; real U.S. government expenditures are permanently increased above baseline by 1 percent of real GDP and the target stock for U.S. government debt in the model's fiscal reaction function is gradually (over a period of twenty years) increased above the baseline path by 50 percent. The panels in Figure 16 pertain to a U.S. monetary expansion (a permanent increase in the U.S. central bank's target money stock of 5 percent of the baseline target).

Each of the panels in Figures 15 and 16 show results for the simulations under three alternative assumptions about exchange-rate expectations. The curves plotted with circles are the case of fully model-consistent expectations ($\lambda_t = 0$ throughout). The curves plotted with squares represent a case in which backward-looking expectations have a large weight and agents are assumed to adjust these expectations sluggishly to the current spot rate ($\lambda_t = 0.75$ and $\theta = 0.33$). The curves plotted with triangles pertain to a case in which backward-looking expectations are given a large weight but agents are assumed to pay primary attention to the current spot rate ($\lambda_t = 0.75$ but $\theta = 0.90$).

As the two figures show, different assumptions about exchange-rate expectations can have a major bearing on the outcomes for key macroeconomic variables. To be sure, some variables are affected much less than others and the qualitative pattern of their time variation does not differ strongly across the different assumptions; the results for the short-term nominal interest rate (lower right panels in the figures) are an example. But for many variables -- the exchange rate itself of course, and variables such as imports, exports, investment, absorption and the corresponding price indices -- the differences are much too large to be treated as inconsequential.

These preliminary experiments, taken together with the evidence on actual expectations available from survey data, suggest to me a major need for builders and users of empirical macroeconomic models to reevaluate the models' treatment of exchange-rate expectations. No doubt some variant of the uncovered interest parity relationship has a useful role to play in the models. And expectations must to some degree be forward-looking. But to make the exchange-rate equations more representative of real-life behavior, analysts must get beyond the highly simplified approach of combining a no-wedge variant of uncovered interest parity with model-consistent expectations.

III.
AN AGNOSTIC VIEW OF "STANDARD" REGRESSIONS REPORTED IN THE EXCHANGE RATE LITERATURE

The preceding analysis has been unconventional. I have not discussed the issues that have most preoccupied authors of the empirical literature on exchange rates and exchange risk premiums. Notably, I have not commented on whether forward rates and survey data for exchange-rate expectations are unbiased predictors of future spot rates, and on whether a bias in forward rates can be attributed to a time varying risk premium. Scores of journal articles, if not several hundred, have focused on those issues.

It is not feasible here to provide a careful discussion. But it will be instructive to explain why I am less interested in the traditional preoccupations. In particular, I will report several regressions with my data set that mimic regressions flooding the literature and indicate why I doubt that we have learned much from such regressions.

Recall that the JCIF data are roughly fortnightly in frequency. As explained earlier, however, the surveys are taken only 24 rather than 26 times per year. Hence the period between a few of the surveys has been three rather than two weeks. Worse still, survey data are not available for a small number of particular dates falling into holiday periods (dates for which a survey would have been taken in the absence of the holiday). These omitted surveys pose a thorny problem for careful regression analysis.[36]

My limited purpose is to illustrate broad similarities between results from my JCIF data set and analogous results in the literature. In the regressions reported below, I accordingly use only the 3-month-horizon data for illustration and deal with the potentially serious econometric difficulties in only a rough and ready way. In particular, I ignore the occasional 3-week interval between survey dates, treating all observations as though they pertain to the same 2-week frequency. And in order to work with a continuous data set for illustrative purposes, I have created rough estimates of the data for the missing survey dates (interpolating between surrounding data, and using the movements of the spot rate for calibration). If a careful regression study were conducted, it would be necessary to deal with the missing-observation and irregular-frequency problems in a more thoughtful way.

<u>Tests of Unbiasedness of the Forward Rate</u>

The most discussed issue in the literature, whether the forward rate is an unbiased predictor of the future spot rate, has been "tested" over and over again by means of one or both of the following simple regression specifications:[37]

$$s_{t+k} = \alpha^L + \beta^L (f_{t,t+k}) + \varepsilon^L_{t+k} \qquad \text{(B-24)}$$

$$s_{t+k} - s_t = \alpha^D + \beta^D (f_{t,t+k} - s_t) + \varepsilon^D_{t+k} \quad . \qquad \text{(B-25)}$$

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[36] An earlier footnote indicates the 8 holiday occasions between May 1985 and September 1994 when surveys were not taken. If the normal schedule of two surveys per month had been followed, 224 surveys would have been available; the actual number available is 216.

[37] Since the JCIF survey data are not needed for estimating either of the following equations with my data set, the problem of the missing survey observations does not affect the regression results for (24) and (25).

The variable $\boldsymbol{f_{t,t+k}}$ is the k-period forward exchange rate observed at time t (in the illustrations here the 3-month forward rate, so that in the fortnightly data k is 6) and $\boldsymbol{s_{t+k)}}$ is the actual spot rate measured k periods ahead of time t (3 months). The coefficients α and β are shown with a superscript L or D depending on whether the specification is in the "level" form of (24) or the "differenced" form of (25). Authors have assumed that the null hypothesis of β equal to unity adequately represents the case of unbiasedness and hence accept or reject the null hypothesis according to whether the estimated value of β is significantly different from 1.0.[38] If the true value of β were equal to 1.0, the two specifications would be equivalent.

The dilemma for researchers -- excruciatingly familiar from its repeated discussion -- is that estimates of β^L from (24) appear to support the unbiasedness hypothesis whereas estimates of β^D from (25) strongly reject it. Notably, estimates of β^L are typically positive and often differ from 1.0 by one standard error or less. But estimates of β^D are typically negative, often in the range -1 to -3, and even though the estimated standard errors are often large, researchers decisively reject the hypothesis that $\beta^D = 1.0$.[39] For references discussing this discrepancy in estimates, see for example Hodrick (1987), Meese (1989), McCallum (1994), Isard (1995), and Chinn and Frankel (1995).[40]

My twice monthly data set for the spot and forward yen-dollar exchange rates exhibits the same general discrepancy. The

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[38] In some articles authors also test whether the coefficient α is zero, but it has been more common to interpret a nonzero value of α as consistent with the unbiasedness hypothesis.

[39] The regression (25) is very similar in all important respects to a regression of the left-hand variable in that equation on the interest differential between the two countries (since, as observed earlier, the covered parity condition holds almost exactly).

[40] McCallum (1994) observes that Tryon (1979) pointed out the discrepancy many years ago. Other references that report one or both of the regression equations (24) or (25) include Bilson (1981), Longworth (1981), Fama (1984), Hodrick and Srivastava (1986), Froot and Frankel (1989), and Chinn and Frankel (1994).

following regressions pertain to the entire period May 1985 through July 1994 (222 observations):[41]

Coefficient	Estimated Value	Standard Error	t-statistic
"Level" form, specification (24):			
α^L	0.662	0.097	6.83
β^L	0.861	0.020	43.79

R-squared: 0.897
Durbin-Watson statistic: 0.278

Coefficient	Estimated Value	Standard Error	t-statistic
"Differenced" form, specification (25):			
α^D	-0.031	0.004	-6.25
β^D	-1.860	0.841	-2.21

R-squared: 0.021
Durbin-Watson statistic: 0.273

Which regression is appropriate to emphasize, (24) or (25)? For a time in the 1980s and early 1990s, the majority view was that the differenced form of the regression was correct and that, relying on estimates of (25), one could decisively reject the unbiasedness hypothesis. Hodrick (1987) and Meese (1989), cited favorably by Isard (1995), emphasize the point that the variables in (24) are not stationary and that the preferred regression is (25). More recently, the validity of the differenced regression has also been questioned -- see for example Elliott (1994) and McCallum (1994).[42] Elliott suggests that (25) may be an

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[41] In reporting these ordinary least squares (OLS) estimates, I eschew sophisticated econometric adjustments for problems such as serial correlation or heteroskedasticity in the regression error term. Such adjustments in principle are warranted. As can be seen merely by inspection of the Durbin-Watson statistics, the standard errors of the regression coefficients are not reliable. I have had not an incentive here to implement refined econometric techniques, however, because I doubt the reliability of the regression estimates with or without sophisticated adjustments of the standard errors or test statistics.

[42] McCallum cites a Barnhart-Szakmary (1991) article I have not seen. John McDermott has called my attention to the existence of De Vries (1994), which McDermott tells me takes the position that (24) is a useful regression.

uninformative regression if the exchange rate behaves approximately as a random walk, so that (25) comes close to being a regression of noise on noise (approximately a regression of the first difference of a random walk on the first difference of a random walk).

I do not myself feel driven to make a choice between the level and the differenced specification. My conjecture is that neither regression is of great interest and that neither can decisively settle the issue of whether the forward rate is an unbiased predictor of the future spot rate.[43]

Consider the scatter diagrams of the data for the two regressions as estimated for my data set, Figure 17 (corresponding to the differenced specification) and Figure 18 (the level specification). Figures plotting the regression lines for the two scatters are also shown. Visual inspection of these scatters is alone sufficient to generate skepticism. The regression from Figure 17, even with its slope coefficient of -1.86 with a t-statistic apparently larger than 2, scarcely seems worth writing home to grandmother about once one has looked at the scatter diagram. Because the two variables in Figure 18 are so obviously non-stationary during this sample period (immediately evident if adjacent observations are connected with lines), there is also doubt about what one learns from that figure. The qualitative patterns in Figures 17 and 18 are broadly replicated in data sets for other exchange rates and other time periods.[44]

What one really learns from relating these variables to each other, in my view, scarcely requires estimated regressions. The main inference to be drawn is that little if any of the time variation in exchange rates that actually occurs (the ex post, observed change in the exchange rate between two dates) can be

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[43] The estimated coefficient in the differenced regression is unstable (in the sense of being very sensitive to the choice of sample period). For example, the estimated value of β^D in (25) is -10.81 (OLS standard error of 1.63) for the subperiod May 1985 through July 1989 whereas the estimate is +1.52 (OLS standard error of 1.45) for the subperiod July 1990 through July 1994.

[44] McCallum (1994) and Flood and Rose (1994) both show analogous scatter diagrams for their data sets, which in turn lead them to a more skeptical position than most other researchers have espoused.

attributed to time variation in the forward discount/premium. Moreover, since covered interest parity holds fairly closely, the point applies equally strongly to interest differentials: variation over time in interest differentials can explain, at best, only a small part of the time variation in actual exchange rates.

The route of exploration that McCallum (1994) follows is substantially more interesting than merely estimating the simple two-variable regressions in (24) or (25). McCallum formulates a theoretical model and focuses on the monetary-policy decisions that lie behind interest-rate movements. He then tries to discern a structural explanation for why the simple regressions for the level and differenced specifications turn out as differently as they do.

Tests of Conditional Bias in Survey Data for Expectations

In articles in the literature that have examined survey data for expectations, one typically finds another "standard" regression. This standard specification regresses the actual, ex post change in the exchange rate on the ex ante expected change for the same period:

$$s_{t+k} - s_t = \gamma + \delta(\bar{s}_{t+k,t} - s_t) + u_{t+k} \quad . \tag{B-26}$$

The variable $\bar{s}_{t+k,t}$ is the average of survey respondents' expectations, formed at period t, of the spot rate that will prevail at period t+k. The null hypothesis that expectations are an unbiased predictor of the future rate is presumed to be testable by examining whether the slope coefficient δ is significantly different from unity -- see, for example, Frankel and Froot (1987a) and Chinn and Frankel (1995).

Again it is instructive to look at a scatter diagram of the actual data -- already presented above in Figure 14. The corresponding OLS regression is:

Coefficient	Estimated Value	Standard Error	t-statistic
γ	-0.022	0.005	-4.78

δ	0.309	0.274	1.13

R-squared: .0057
Durbin-Watson statistic: 0.252

(A chart plotting the regression line for Figure 14 is also shown in the package of charts, prior to Figure 19.)

The regression from Figure 14 is again not one to send home proudly to grandmother. The estimated slope of 0.3 might appear to be significantly different from 1.0. We know from other survey-data samples and periods that estimates of δ are often insignificantly different from zero, and can even be negative, especially if high-inflation countries' exchange rates are not in the sample (Chinn and Frankel, 1995). But one can reasonably wonder whether there is enough of a signal relative to noise in such regressions to permit reliable statistical inference.

I am inclined to believe that one cannot learn anything more from these regressions than what is already visually evident in Figures 12-14, namely, that the average ex ante expected change in the exchange rate tends to be very much smaller than the actual change. Exchange-rate expectations are changed much more sluggishly than actual rates are changed, which of course means that errors in expectations also have a larger variance than do the expected changes.

<u>Supposed Tests for a Time-Varying Risk Premium</u>

Consider finally another set of regressions that have been widely reported in the literature:

$$(\bar{s}_{t+k,t} - s_t) = \mu_1 + \varphi(f_{t,t+k} - s_t) + v_{t+k} \tag{B-27}$$

$$(f_{t,t+k} - \bar{s}_{t+k,t}) = \mu_2 + \psi(f_{t,t+k} - s_t) + w_{t+k} \ . \tag{B-28}$$

The variables are as defined before. These regressions have been interpreted as if they are capable of distinguishing whether "the bias in the forward discount" (that is, the coefficient β^D in (25) being closer to zero than to positive unity) is "due to expectational errors or a time-varying risk premium" (Froot and Frankel, 1989; Chinn and Frankel, 1995). For example, researchers have tested the null hypothesis that ϕ in (27) is zero and have interpreted rejection of that null as evidence that "at least some of the variation in the forward discount must be due to expected depreciation" rather than a time-varying risk premium (Chinn and Frankel, 1995, p. 10). An estimated value for ϕ of unity has been supposed to indicate that none of the variation in the forward discount is attributable to a time-varying risk premium. Emphasis has even been placed on whether the estimated value of ϕ is greater or less than 0.5. Fama (1984) and Hodrick and Srivastava (1986) took the view that the variance of the expected change in the exchange rate was less than the variance of a time-varying risk premium; Froot and Frankel (1989) and Chinn and Frankel (1995) interpret estimates of ϕ greater than 0.5 to suggest that the variance of expected change is larger, not smaller, than the variance of the risk premium.

For the 1985-94 period, using the JCIF survey data for the average of expectations (still for the 3-month horizon), the OLS regressions corresponding to (27) and (28) are:

Coefficient	Estimated Value	Standard Error	t-statistic
Expected change on forward discount/premium (27):			
μ_1	-0.003	0.001	-2.574
ϕ	1.714	0.174	9.841

R-squared: 0.306
Durbin-Watson statistic: 0.552

Coefficient	Estimated Value	Standard Error	t-statistic
"Exchange-risk" wedge on forward discount/premium (28):			
μ_2	0.003	0.001	2.574
ψ	-0.714	0.174	-4.098

R-squared: 0.071
Durbin-Watson statistic: 0.552

One unsettling feature of the regression specifications (27) and (28) that ought to have been apparent to researchers but seems to have been ignored is that the three variables -- the forward discount, the expected change, and the "exchange-risk" wedge -- are locked together in a simple identity. This identity -- (13a) when the variables are in level form or (13b) when they are, as in (27) and (28), in logarithmic form -- was shown in Figure 2 and emphasized earlier in Part I above. Because of the identity, it follows inevitably as a matter of OLS arithmetic that the estimated values of ϕ and ψ from (27) and (28) will sum exactly to unity.

The variation in the forward discount/premium is very much less than the variation in <u>either</u> the expected change or the exchange-risk wedge -- see again Figure 2. The same fact can be seen from a different visual perspective in Figures 19 and 20, scatter diagrams which correspond exactly to the regressions (27) and (28). The third scatter diagram relating two of the three variables in the identity was already shown as Figure 3. If one conducts the regression corresponding to Figure 3, the results are:

Coefficient	Estimated Value	Standard Error	t-statistic
constant	-0.003	0.0003	-8.57
slope	-1.099	0.024	-45.33

R-squared: 0.90
Durbin-Watson statistic: 0.275

This last regression merely confirms what is evident in Figure 2: the most striking correlation among the three variables in the identity (13b) is the inverse relationship between the exchange-risk wedge and the expected change, not the correlation between either one of those variables and the forward discount/premium. (For completeness, I include charts which plot the regression lines for Figures 19 and 20 and for Figure 3.)

My agnosticism again prompts me to doubt whether we learn much from carrying out regressions such as (27) or (28) -- for any of the data samples and periods for which they have been estimated. I doubt in particular whether we have learned anything of value about time variation in the "exchange risk premium." The forward discount/premium for an exchange rate tends to have a (relatively) small variance because it is closely tied, through the covered parity condition, to the short-term interest differential between the two countries, which in turn is largely determined by monetary policy in the two countries. Loosely speaking, therefore, (relative) monetary policies determine variation in the forward discount. Little if anything is learned by postulating that either the expected exchange-rate change or the exchange-risk wedge is "determining" the forward discount. Similarly, it is not very helpful to suppose that the forward discount is the major causal factor in determining time variation in the exchange-risk wedge or the expected exchange-rate change.

Future Empirical Research

I conclude by emphasizing the most important reason for agnosticism about the usefulness of all the regression specifications discussed above.

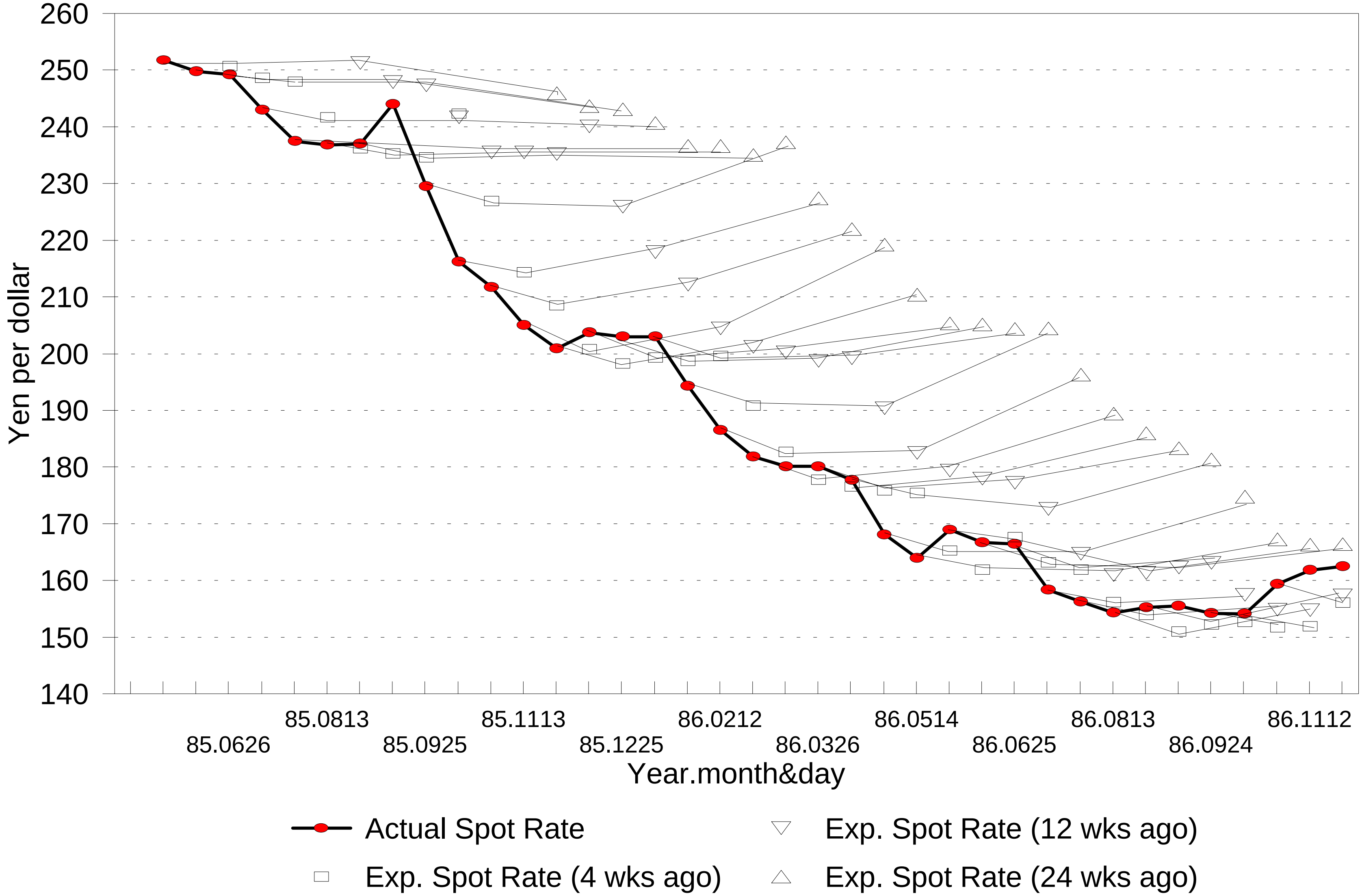
Such regression equations tend to deflect attention from the heterogeneity of expectations and the implications of uncertainty for investors' arbitrage and investment decisions. As emphasized in the discussions of Figures 4, 5, and 6, uncertainty may lead to possibly wide "bands of indifference" for individual agents within which they may not respond to the arbitrage incentives conventionally assumed. The market as a whole, the interaction of many heterogenous institutions and individuals using probably different methods of forming expectations, may thus be characterized by quite noisy behavior.

The spot rate, the forward rate, and the expected future spot rate each may behave erratically from day to day or week to week. The forward discount/premium, because tied down fairly closely by relative monetary policies, will behave much less erratically. To better understand the short-run behavior of the spot rate and the forward rate themselves -- their levels, not the spread between them -- future research will have to dig more deeply into the heterogeneity of expectations and the manner in which individual agents process new information.

Figure 1a

Actual Spot and Expected Spot Rates

JCIF data, 1-,3-, and 6-month



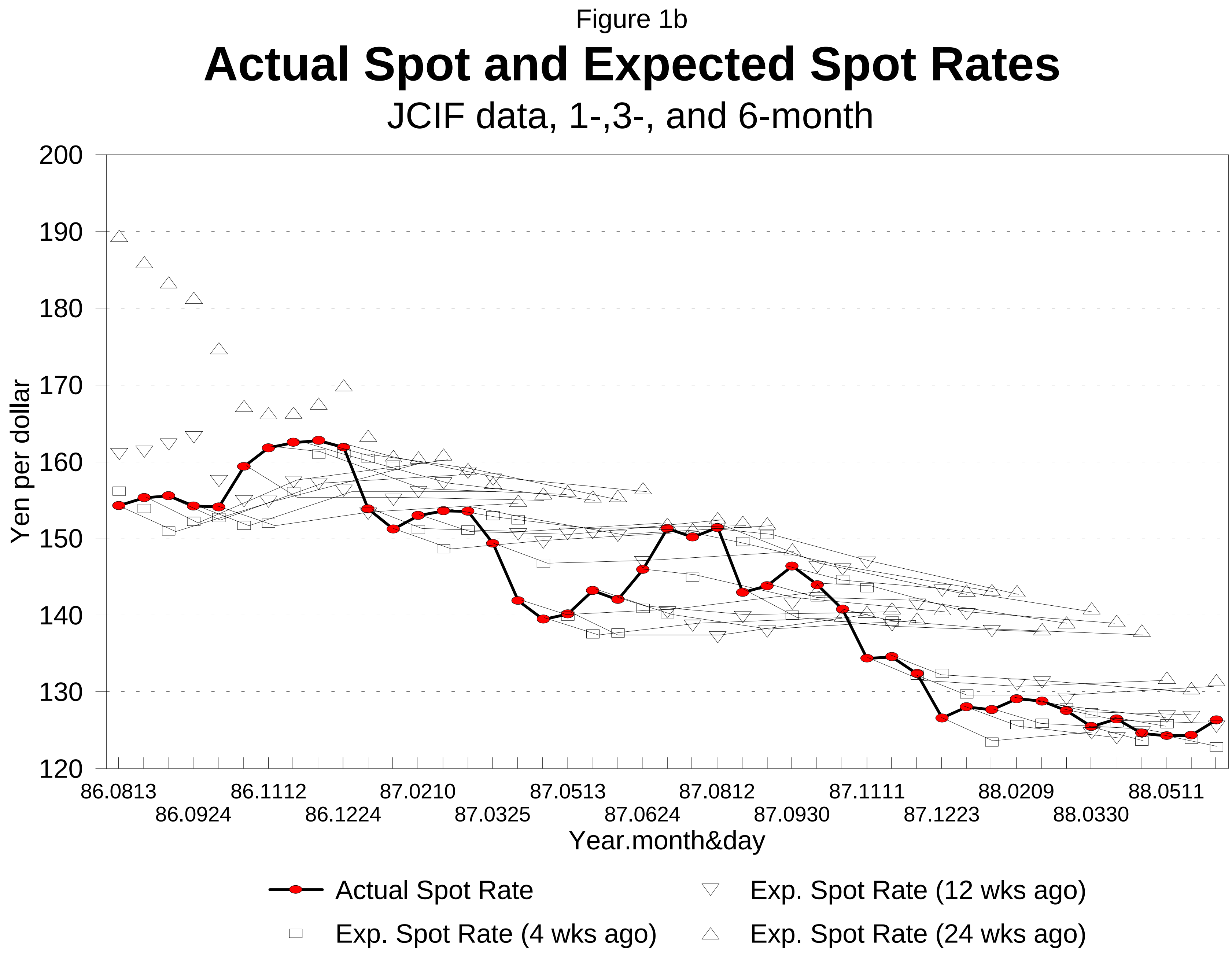


Figure 1b
Actual Spot and Expected Spot Rates
JCIF data, 1-,3-, and 6-month
Yen per dollar
200
190
180
170
160
150
140
130
120
86.0813
86.0924
86.1112
86.1224
87.0210
87.0325
87.0513
87.0624
87.0812
87.0930
87.1111
87.1223
88.0209
88.0330
88.0511
Year.month&day
Actual Spot Rate
Exp. Spot Rate (4 wks ago)
Exp. Spot Rate (12 wks ago)
Exp. Spot Rate (24 wks ago)

Figure 1c

Actual Spot and Expected Spot Rates

JCIF data, 1-,3-, and 6-month

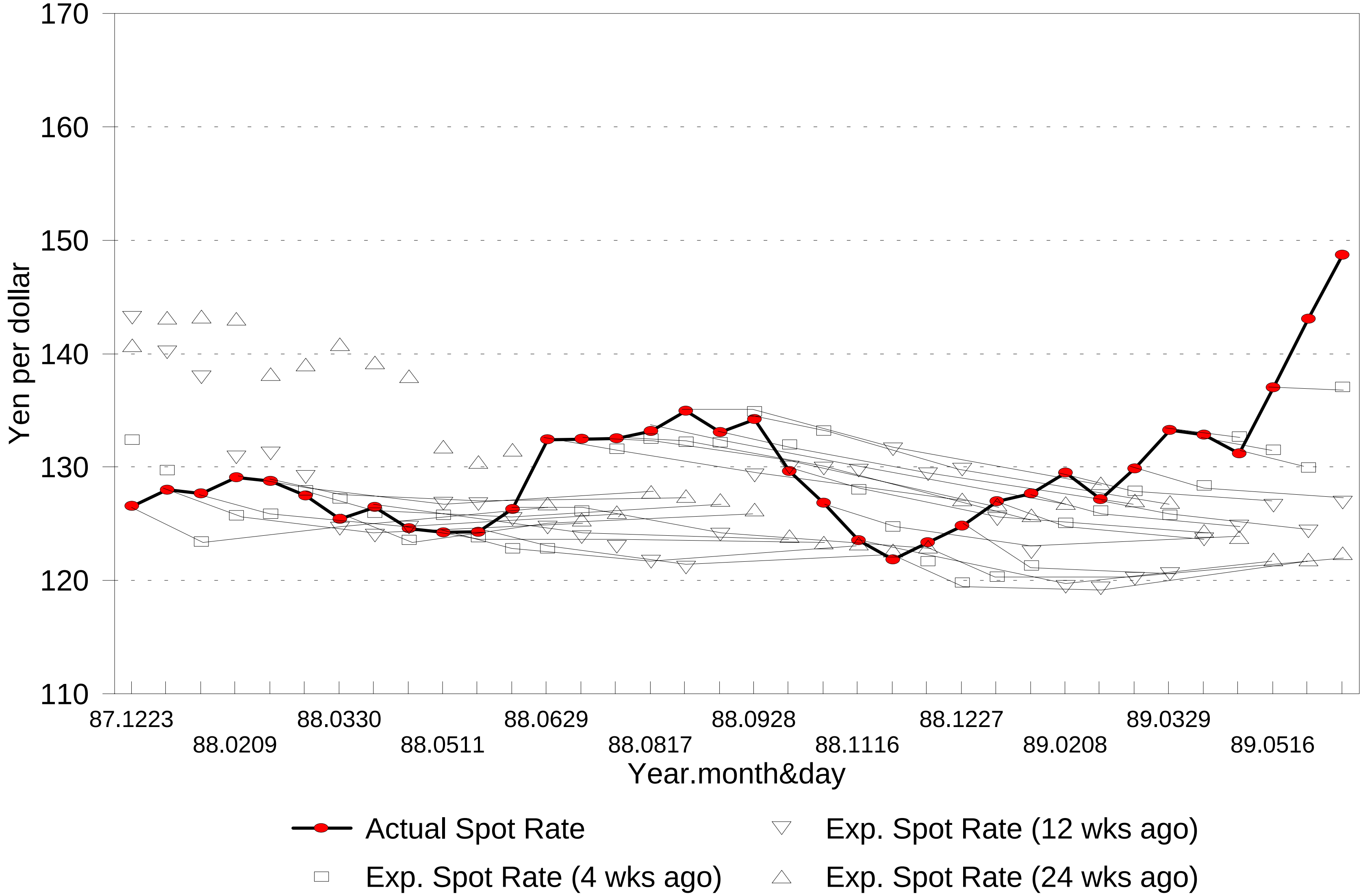


Figure 1d

Actual Spot and Expected Spot Rates

JCIF data, 1-,3-, and 6-month

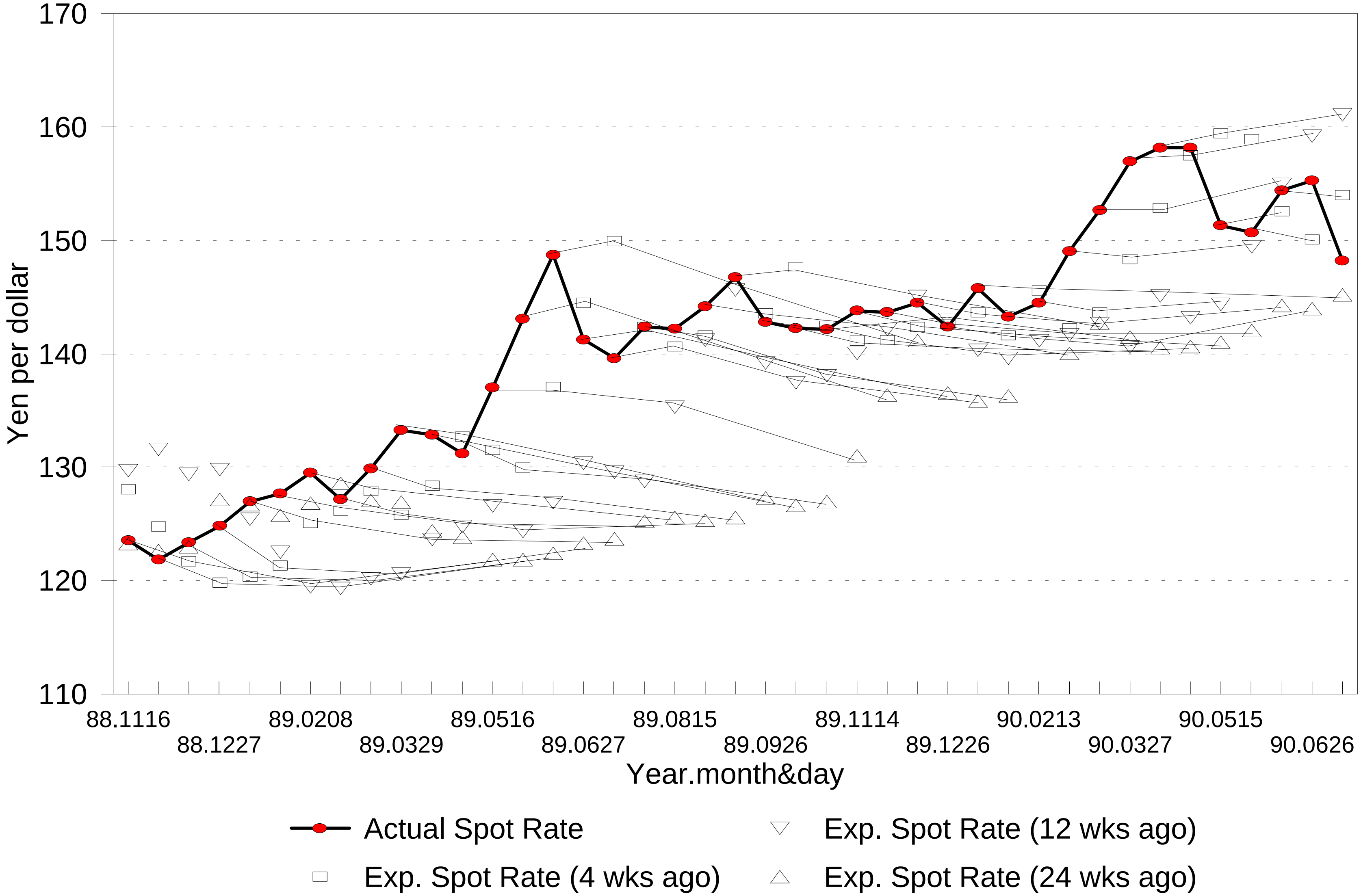


Figure 1e

Actual Spot and Expected Spot Rates

JCIF data, 1-,3-, and 6-month

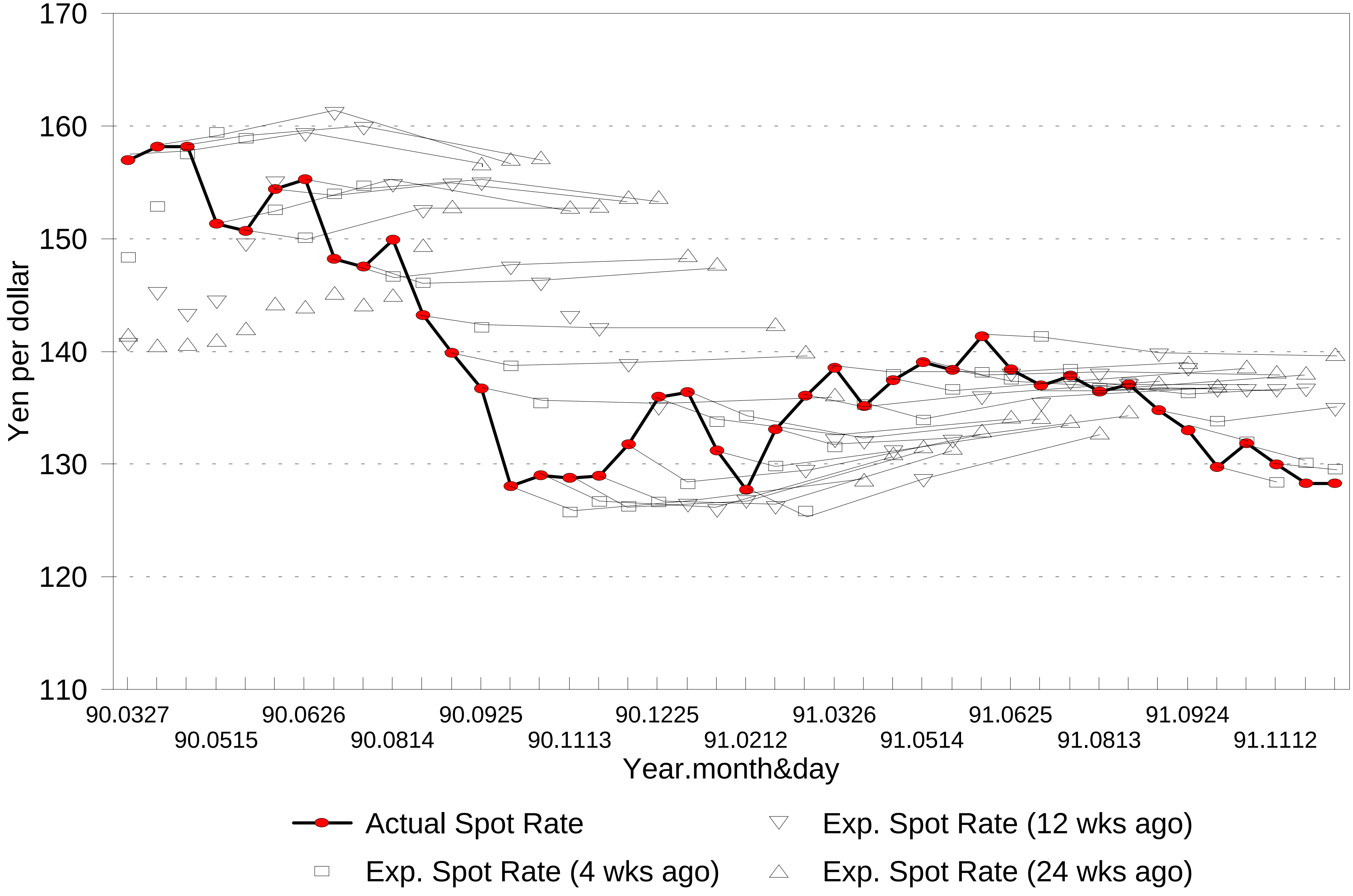


Figure 1f

Actual Spot and Expected Spot Rates

JCIF data, 1-,3-, and 6-month

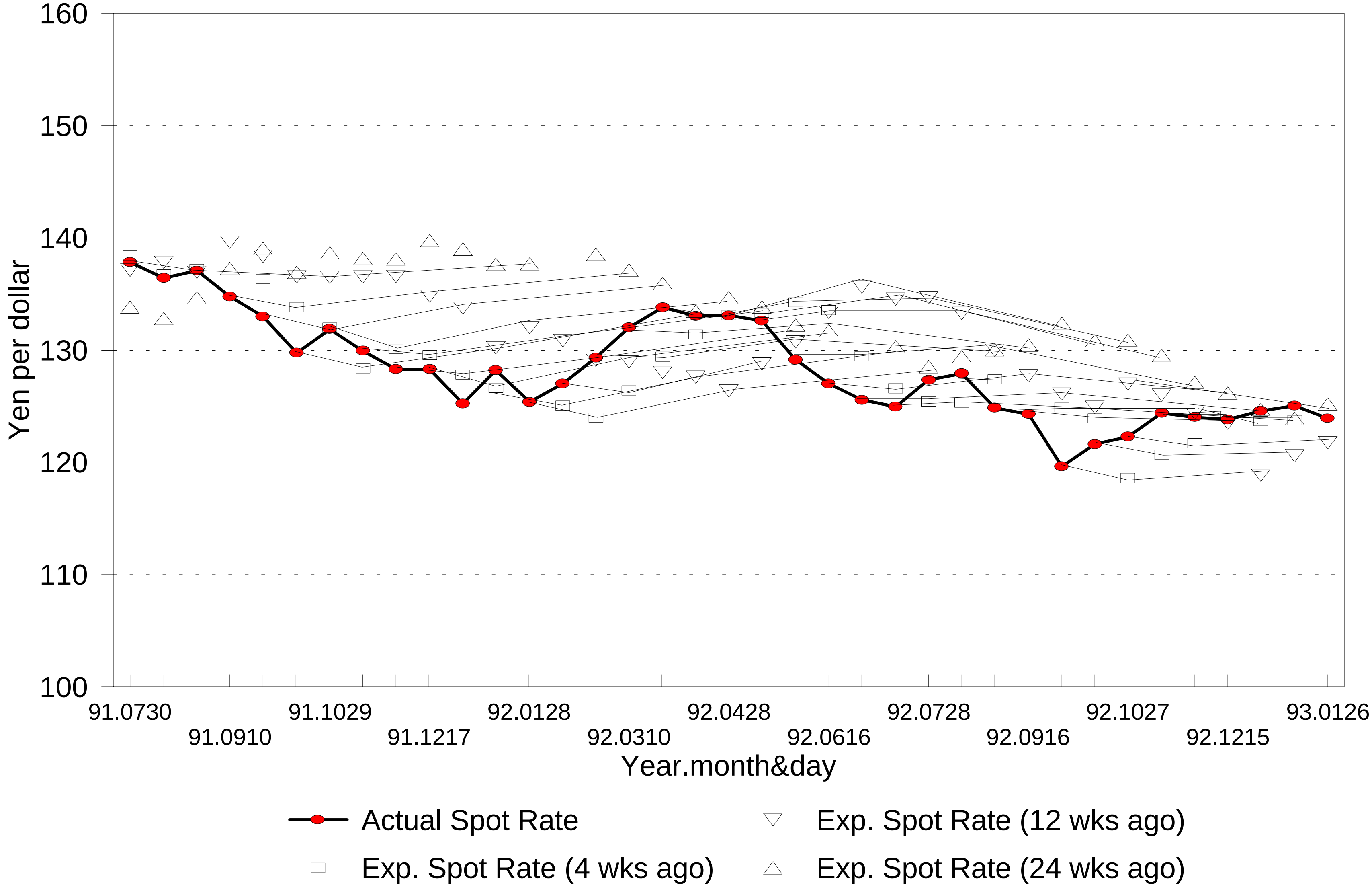


Figure 1g

Actual Spot and Expected Spot Rates

JCIF data, 1-,3-, and 6-month

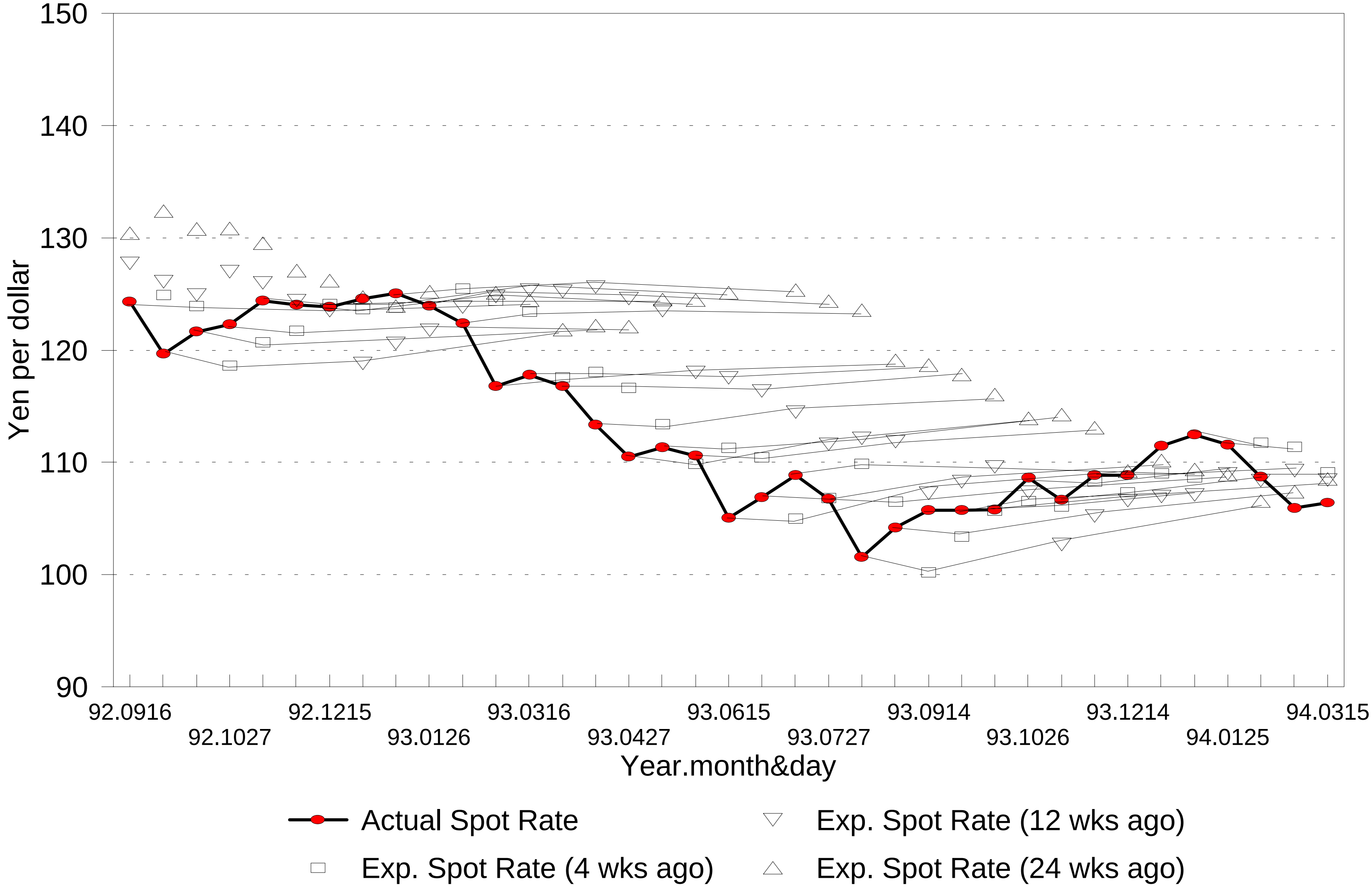


Figure 1h

Actual Spot and Expected Spot Rates

JCIF data, 1-,3-, and 6-month

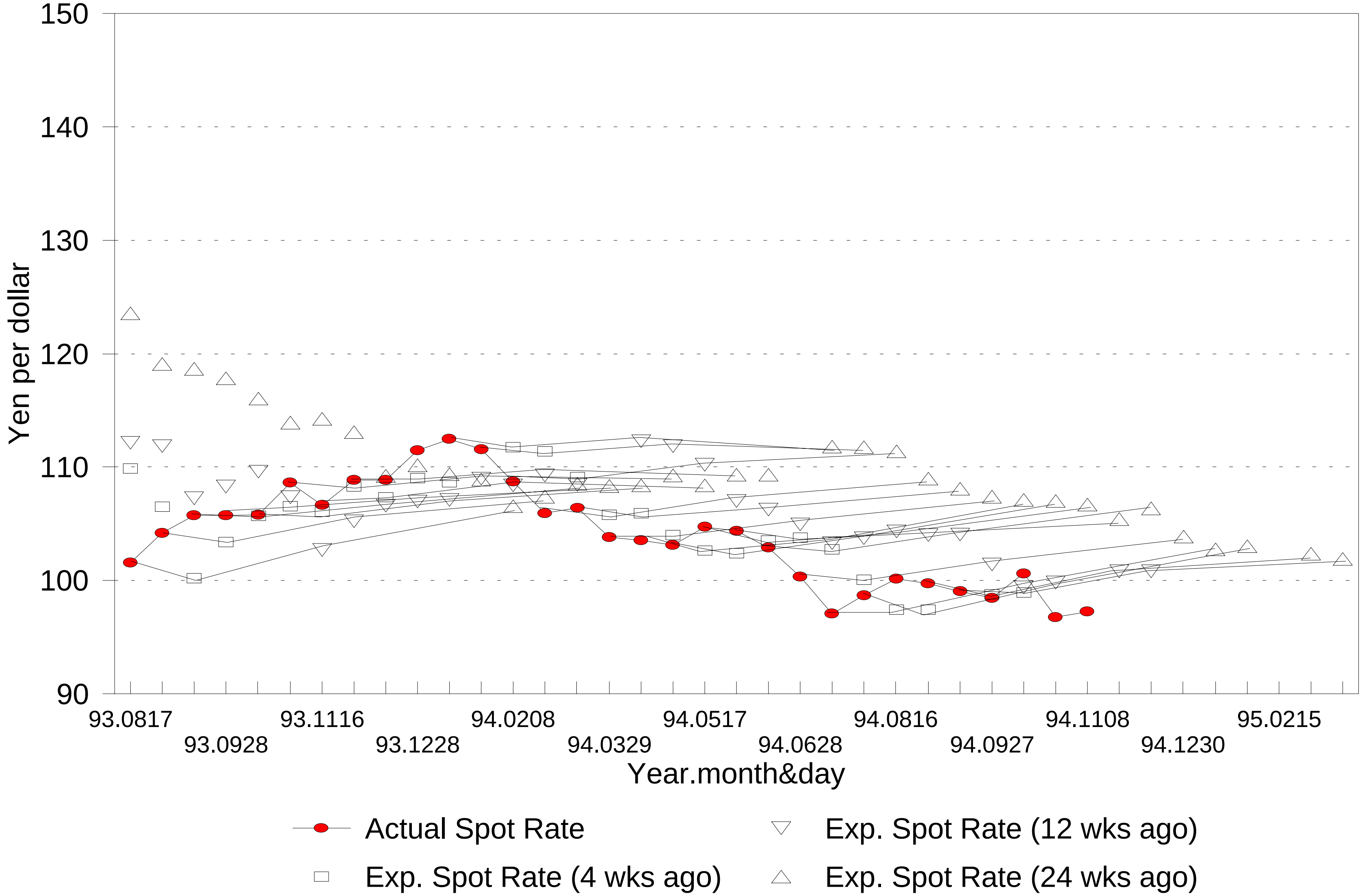


Figure 2

Forward Discount, "Exchange Risk Premium," Change in Expected Spot Rate

JCIF Data, 3-month horizon, 1985-94

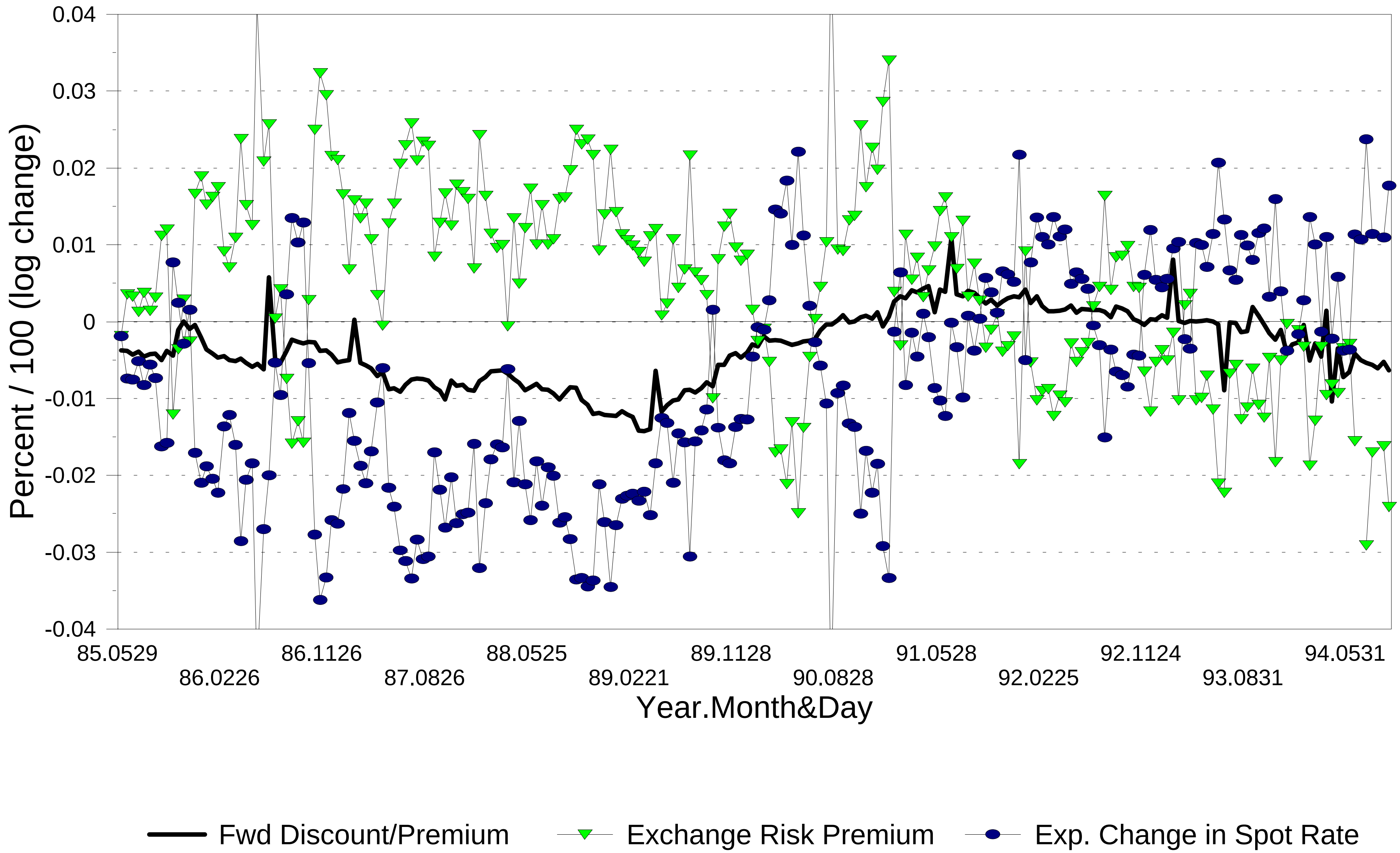


Figure 3

Expected Change in Spot Rate vs Exchange Risk Premium

JCIF data, 3-month horizon, 1985-94

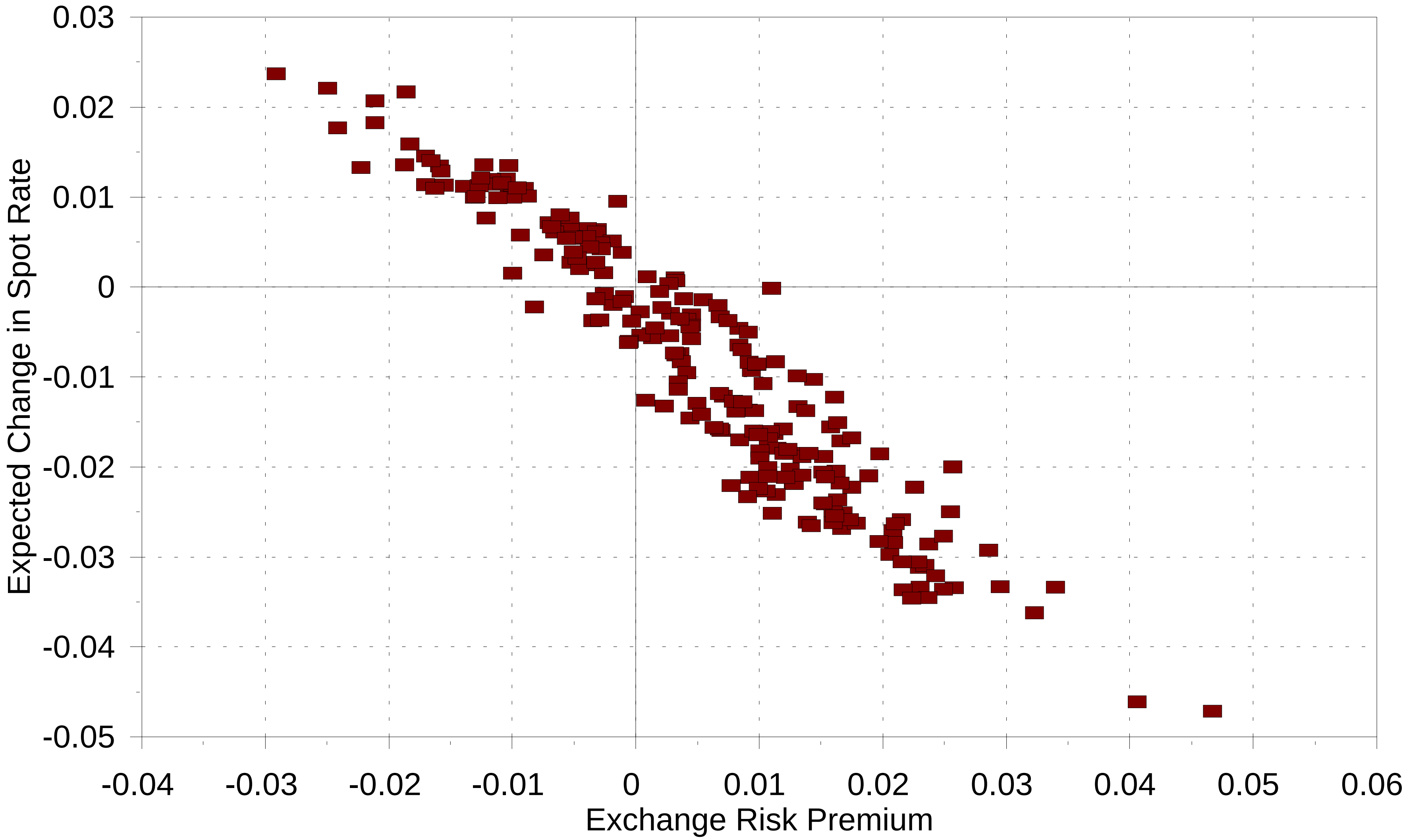


Figure 3 -- Regression Line

Expected Change in Spot Rate vs Exchange Risk Premium

JCIF data, 3-month horizon, 1985-94

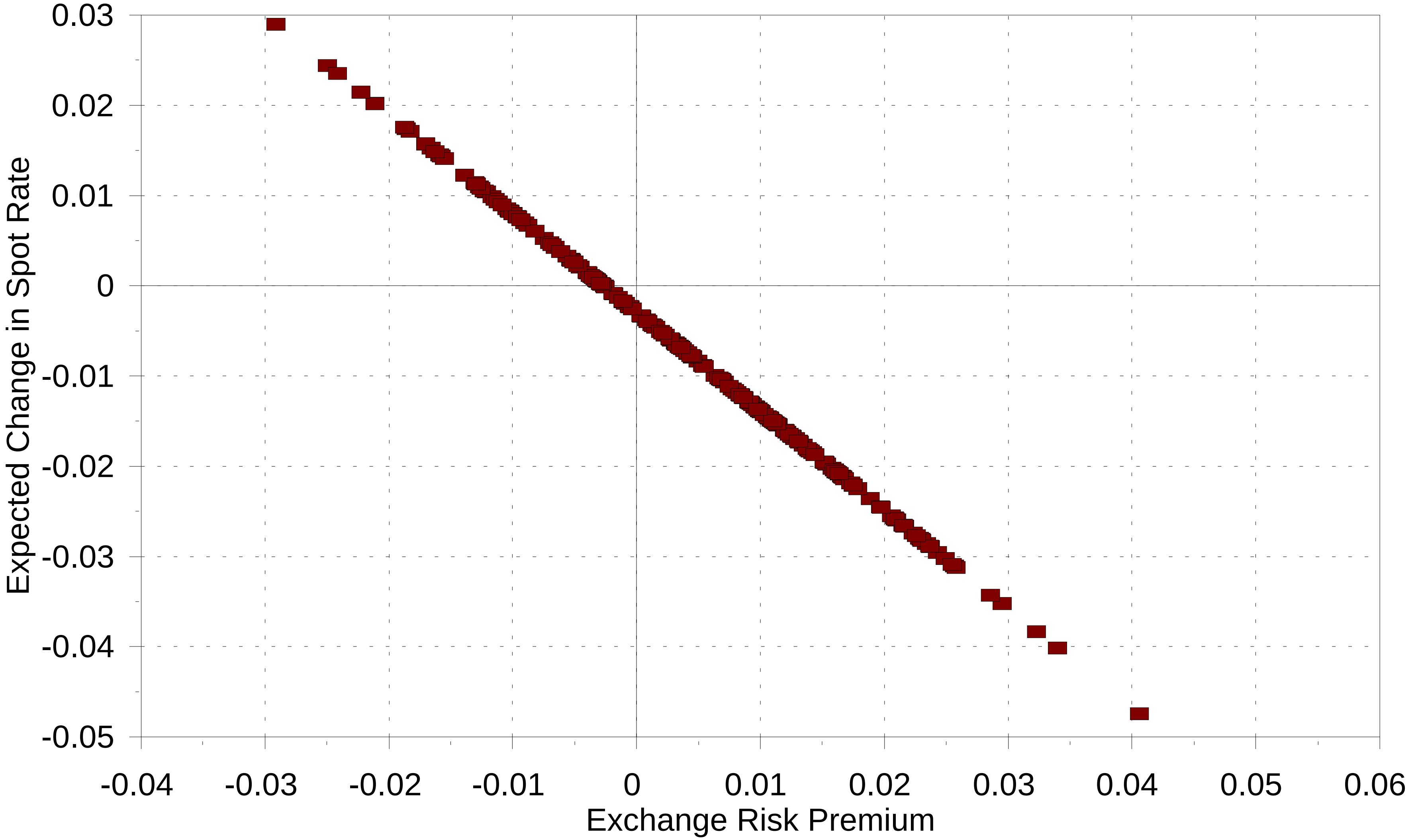


Figure 4a

Expected Utility from Exchange Arbitrage and The Band of Indifference

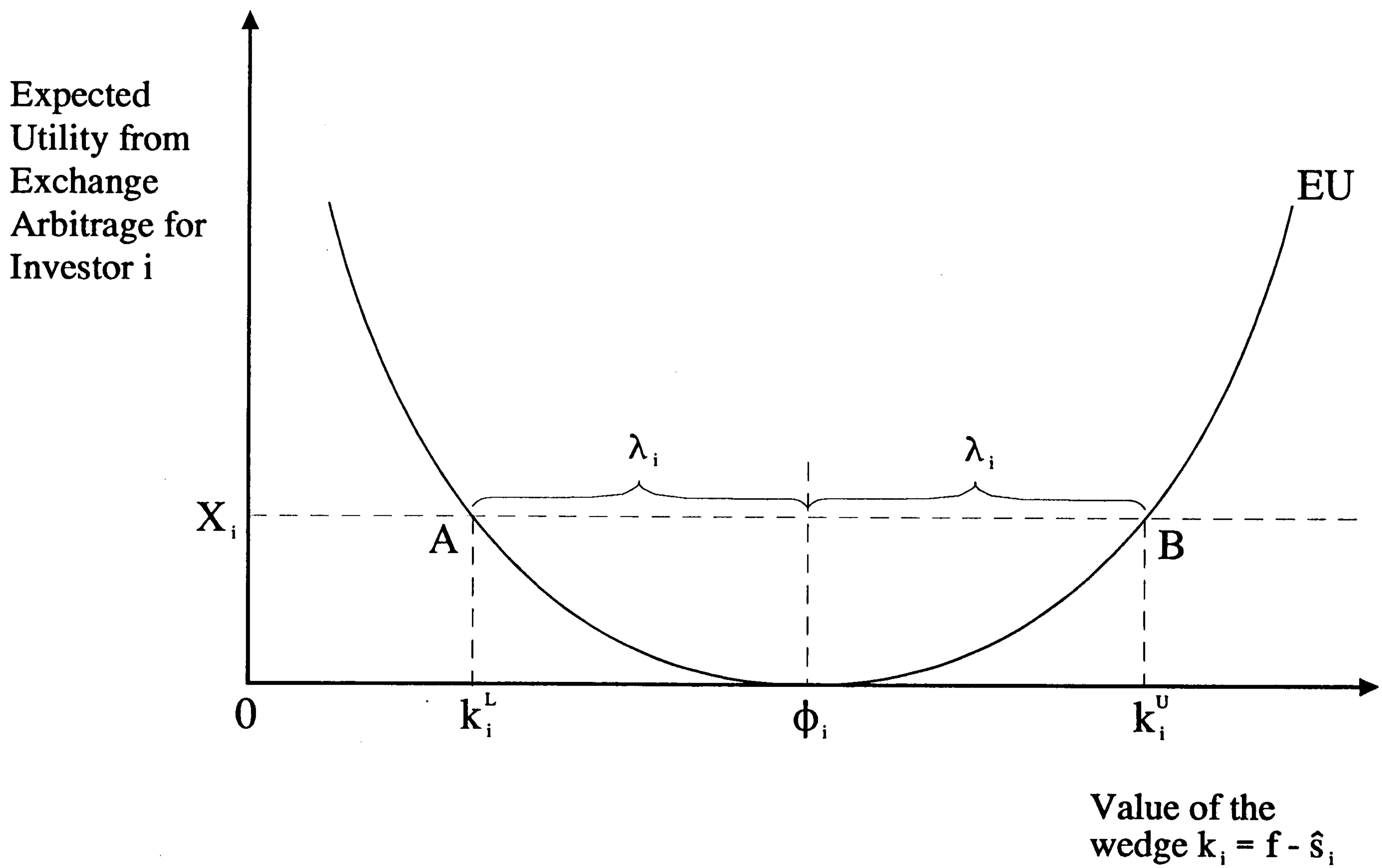


Figure 4b

Variations in The Band of Indifference from Changes in Uncertainty and from Changes in Arbitrage Costs

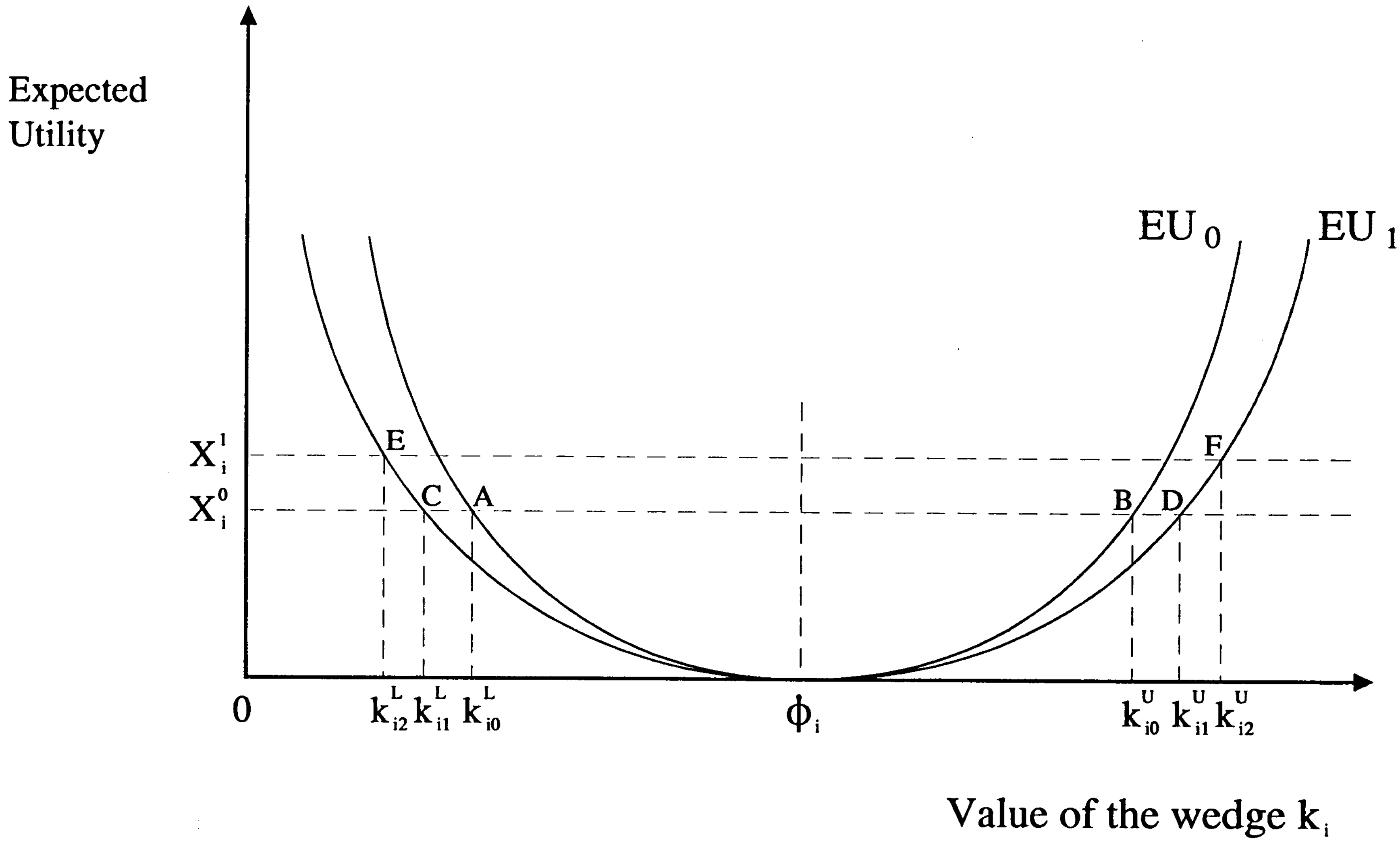


Figure 5

Demand Curve for Arbitrage Transactions of Investor i

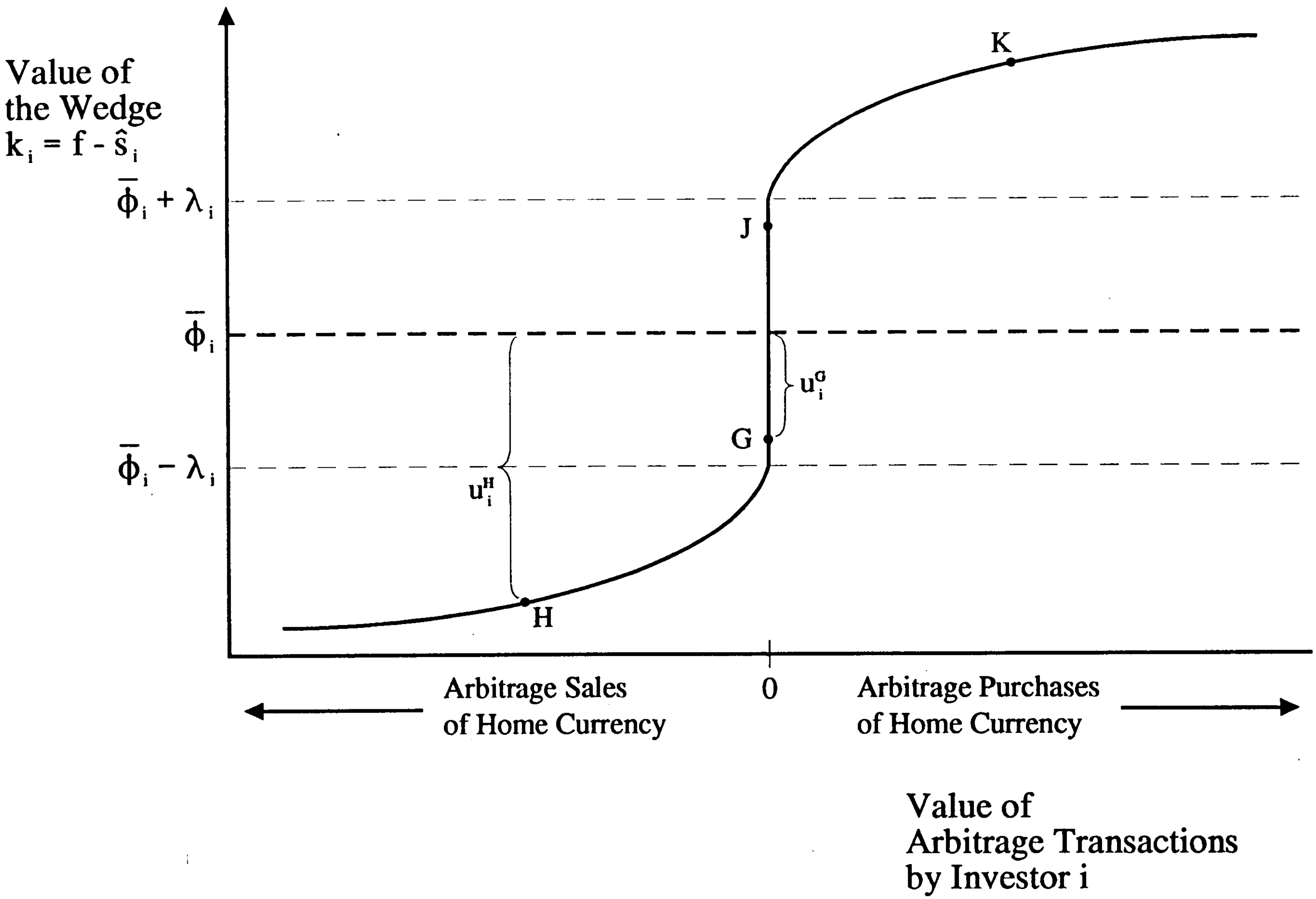


Figure 6

Possible Differences in Demand Curves for Arbitrage Transactions Between Japanese and U.S. Investors

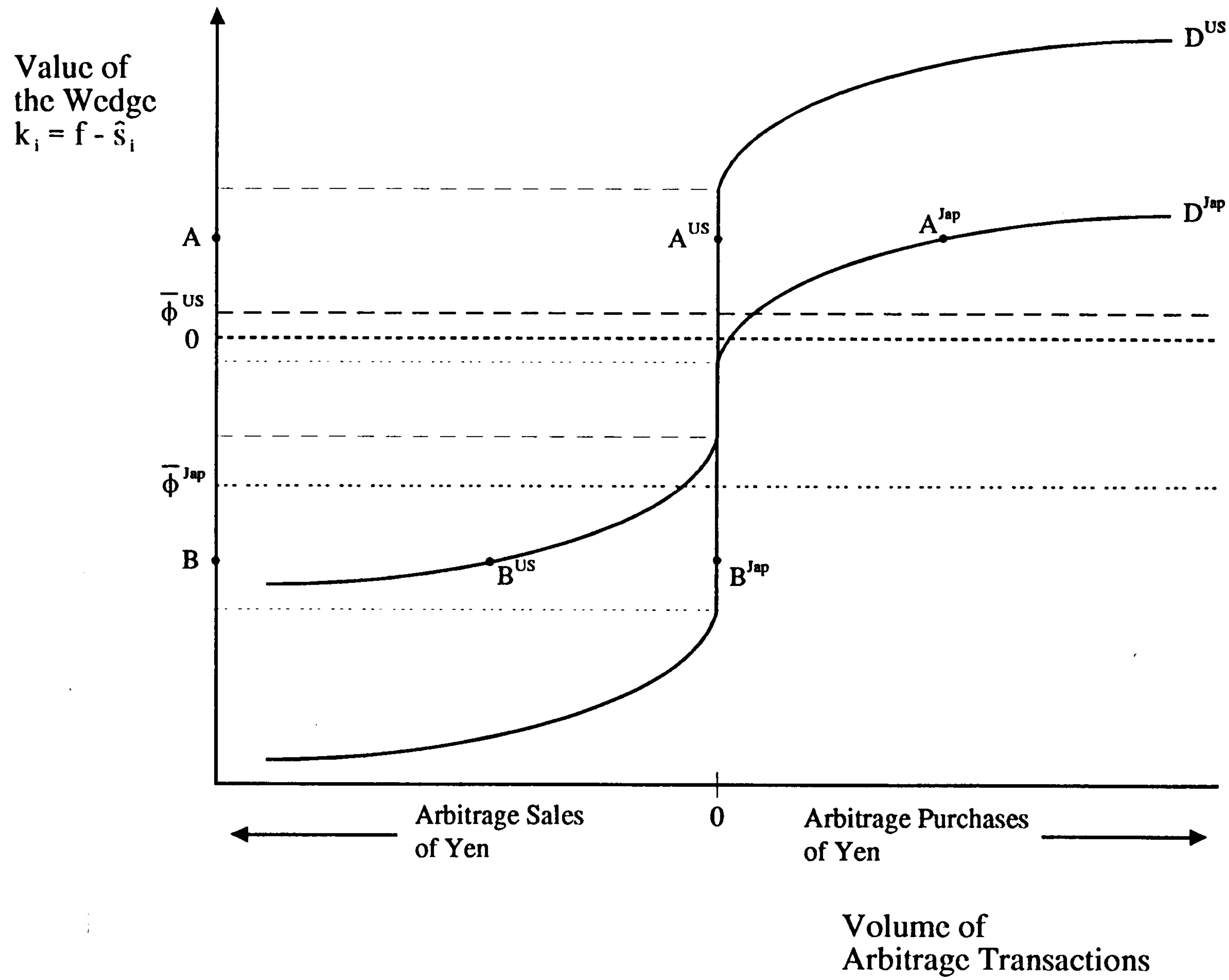


Figure 7

Range of Expected Rates as Percent of Mean Expectation

JCIF data, 3-month horizon, 1985-1994

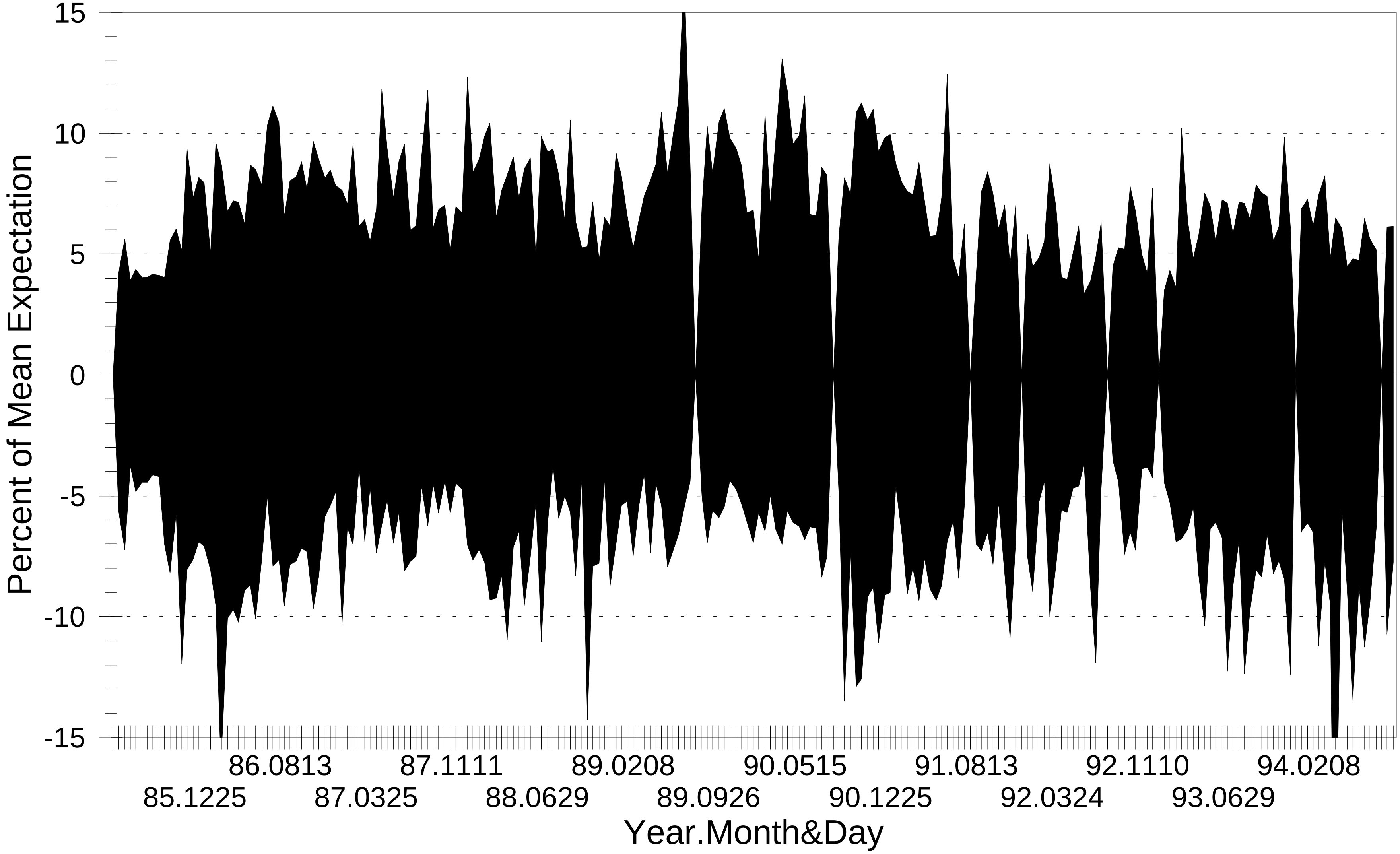


Figure 8a

Standard Deviations of Expected Rates

JCIF Survey Data, 1-, 3-, and 6-month, 1985-1990

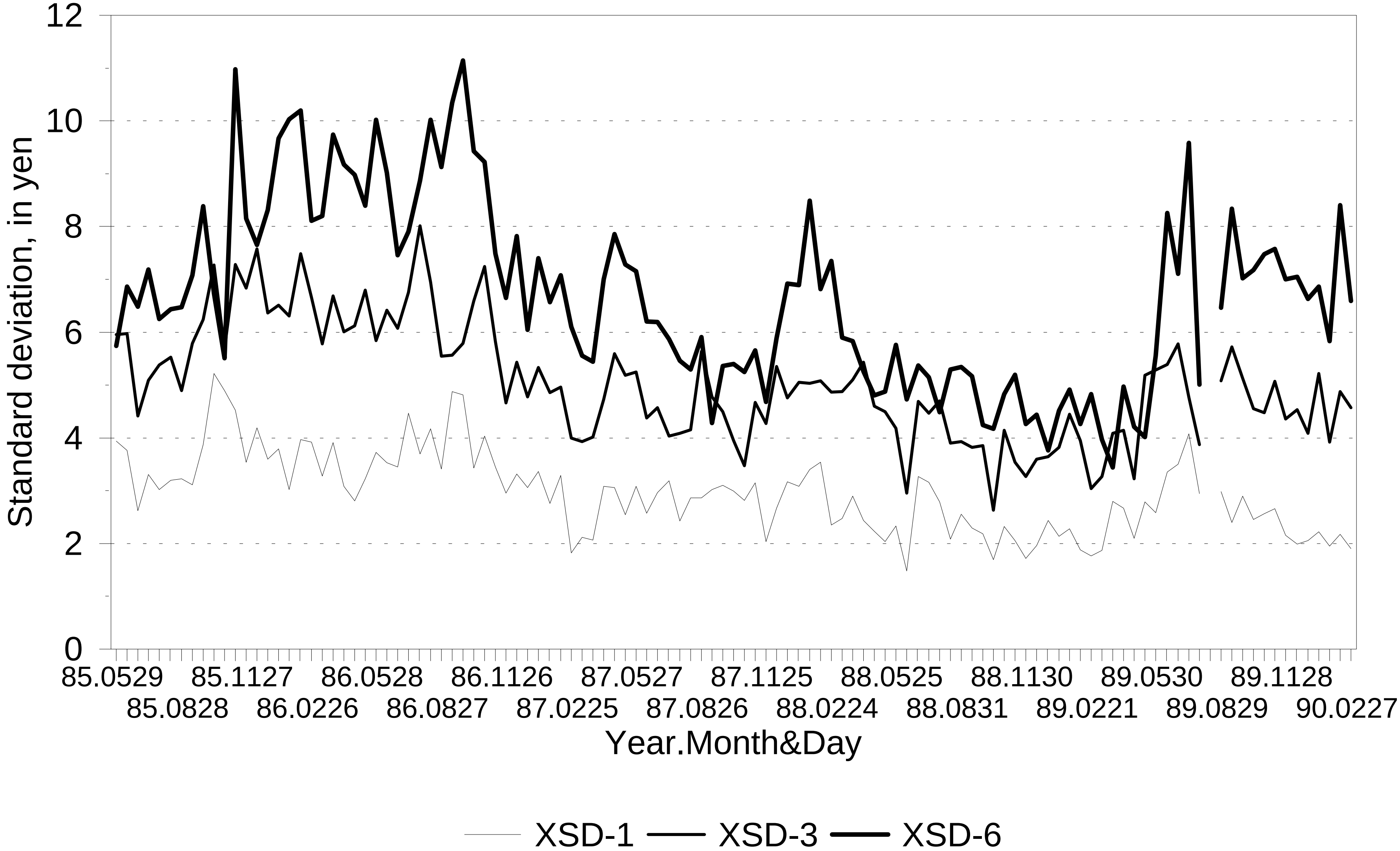


Figure 8b

Standard Deviations of Expected Rates

JCIF Survey Data, 1-, 3-, and 6-month, 1990-1994

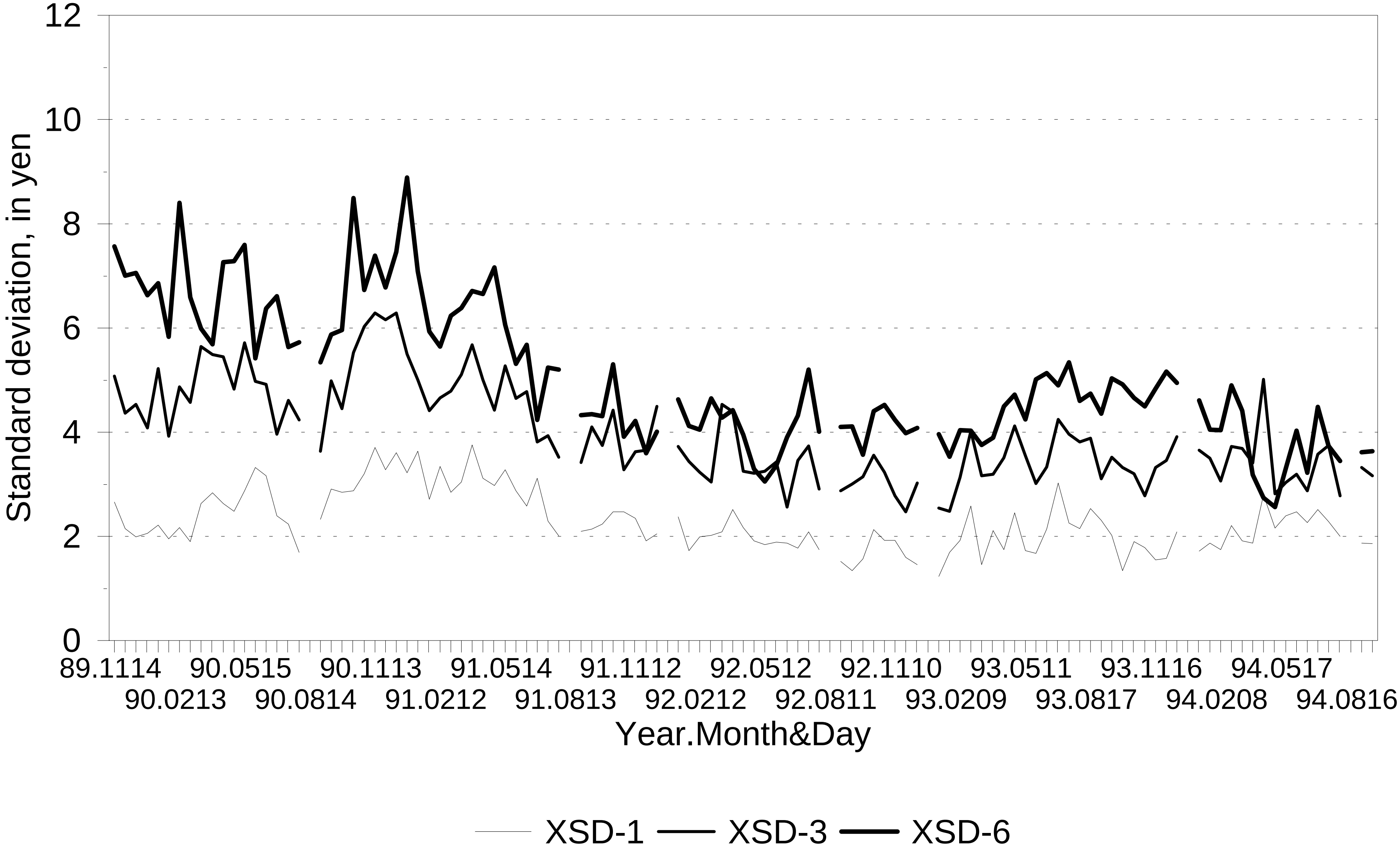


Figure 9

"Exchange-risk" Wedge Using Avg, Max, & Min of Expected Rate (3-month horizon)

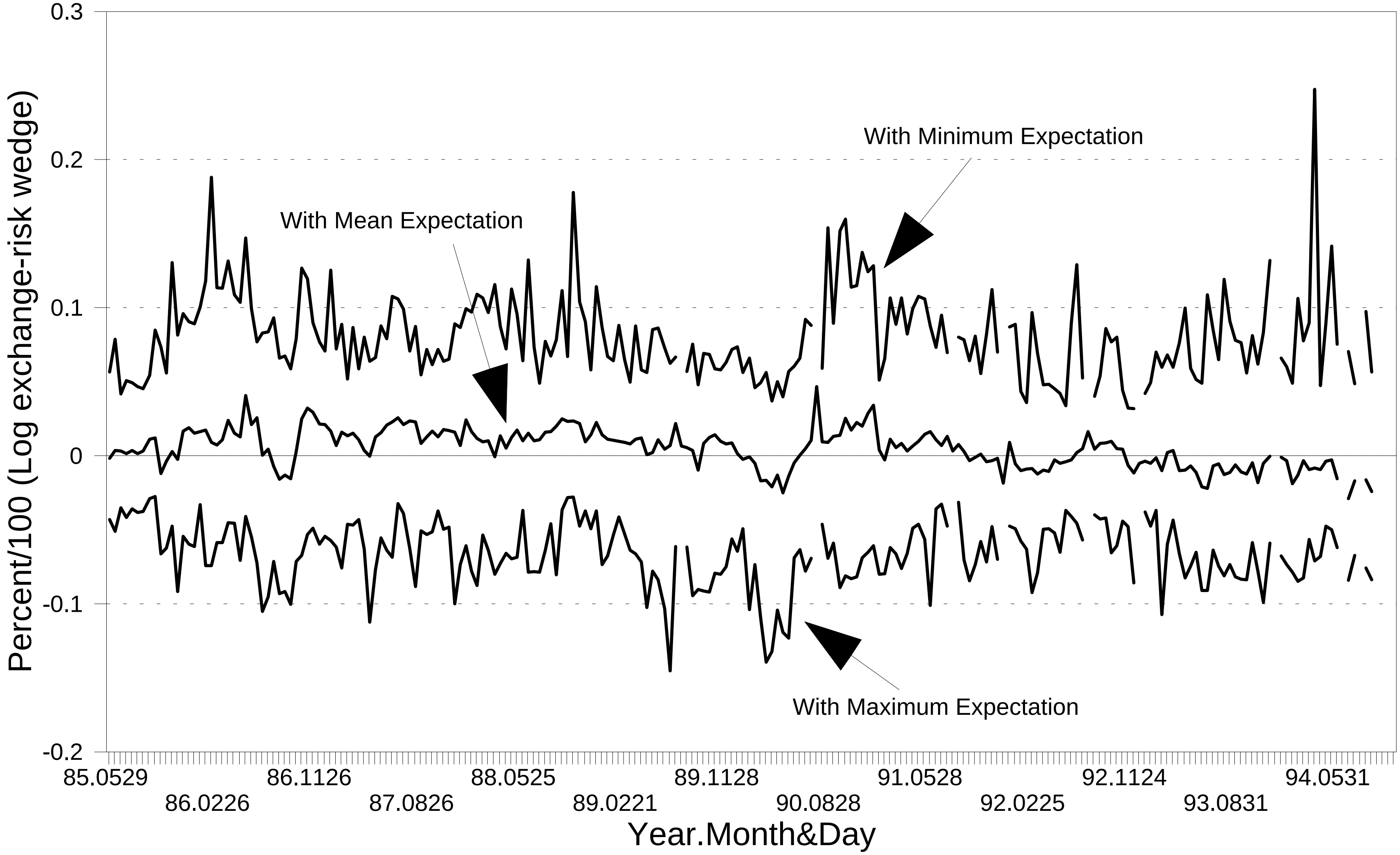


Figure 10a

Expected Change vs Actual Recent Change

Data for 1-month ahead expectations

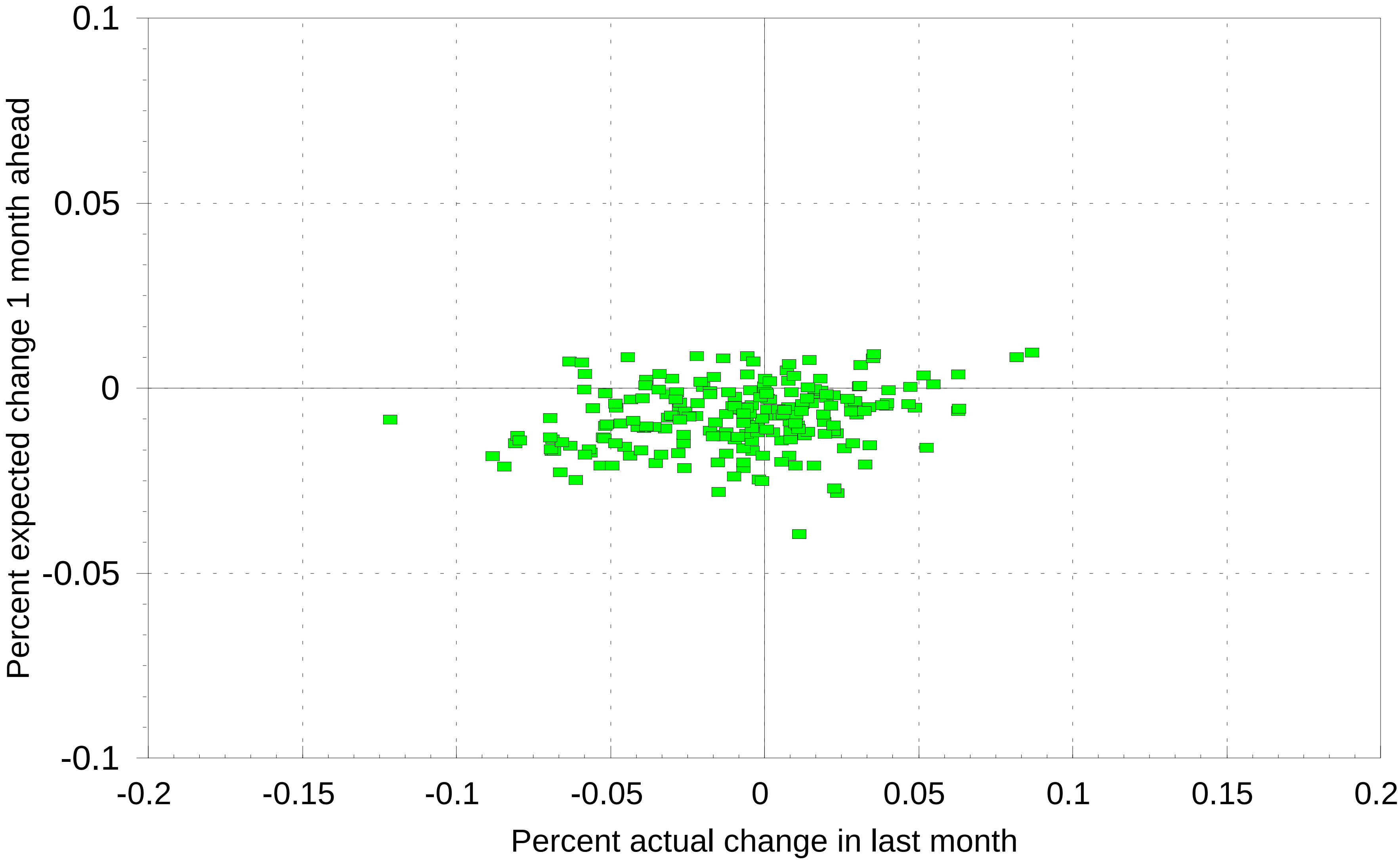


Figure 10b

Expected Change vs Actual Recent Change

Data for 3-month ahead expectations

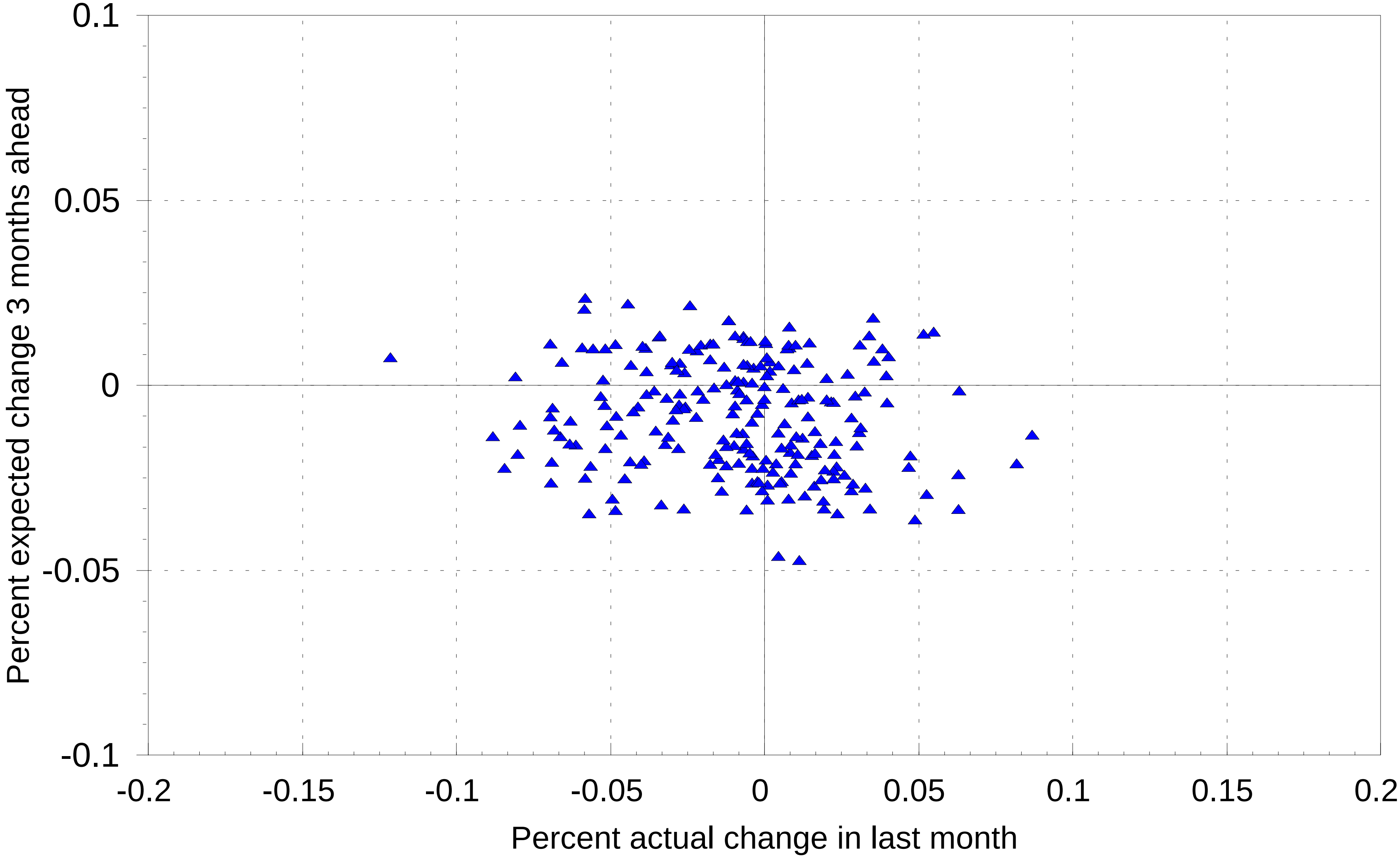


Figure 10c

Expected Change vs Actual Recent Change

Data for 6-month ahead expectations

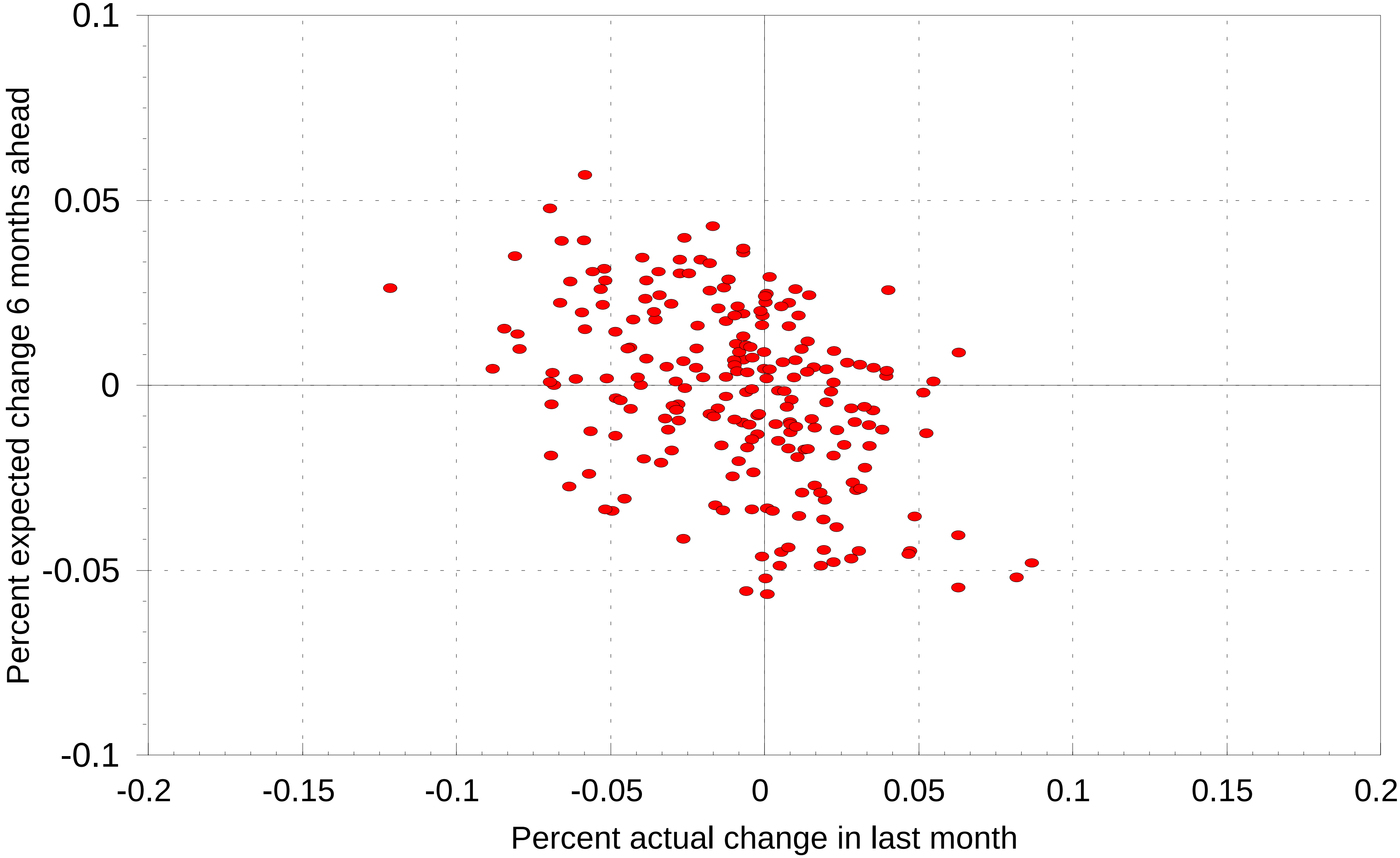
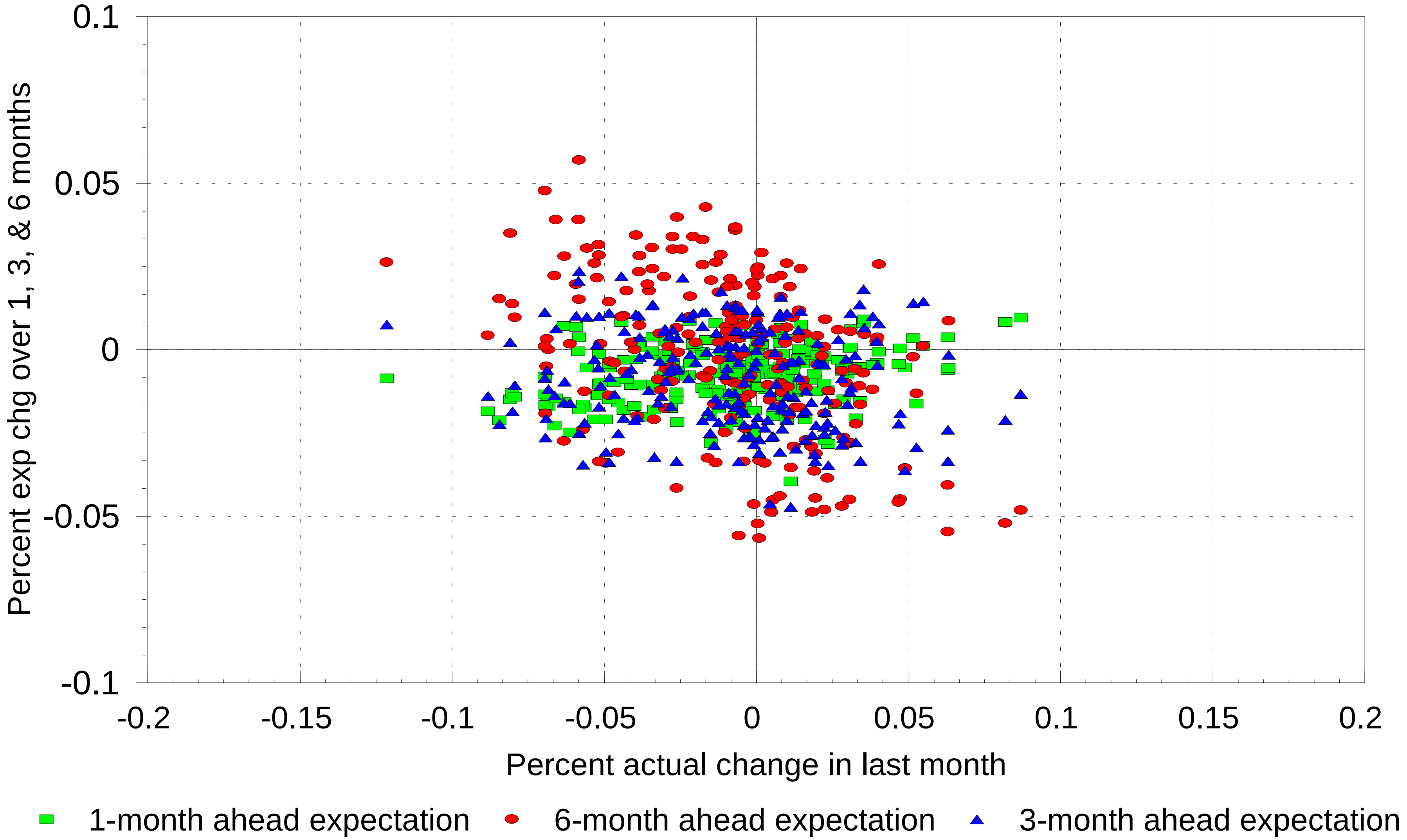


Figure 11a

Expected Change vs Actual Recent Change

Data for all 3 survey horizons plotted together



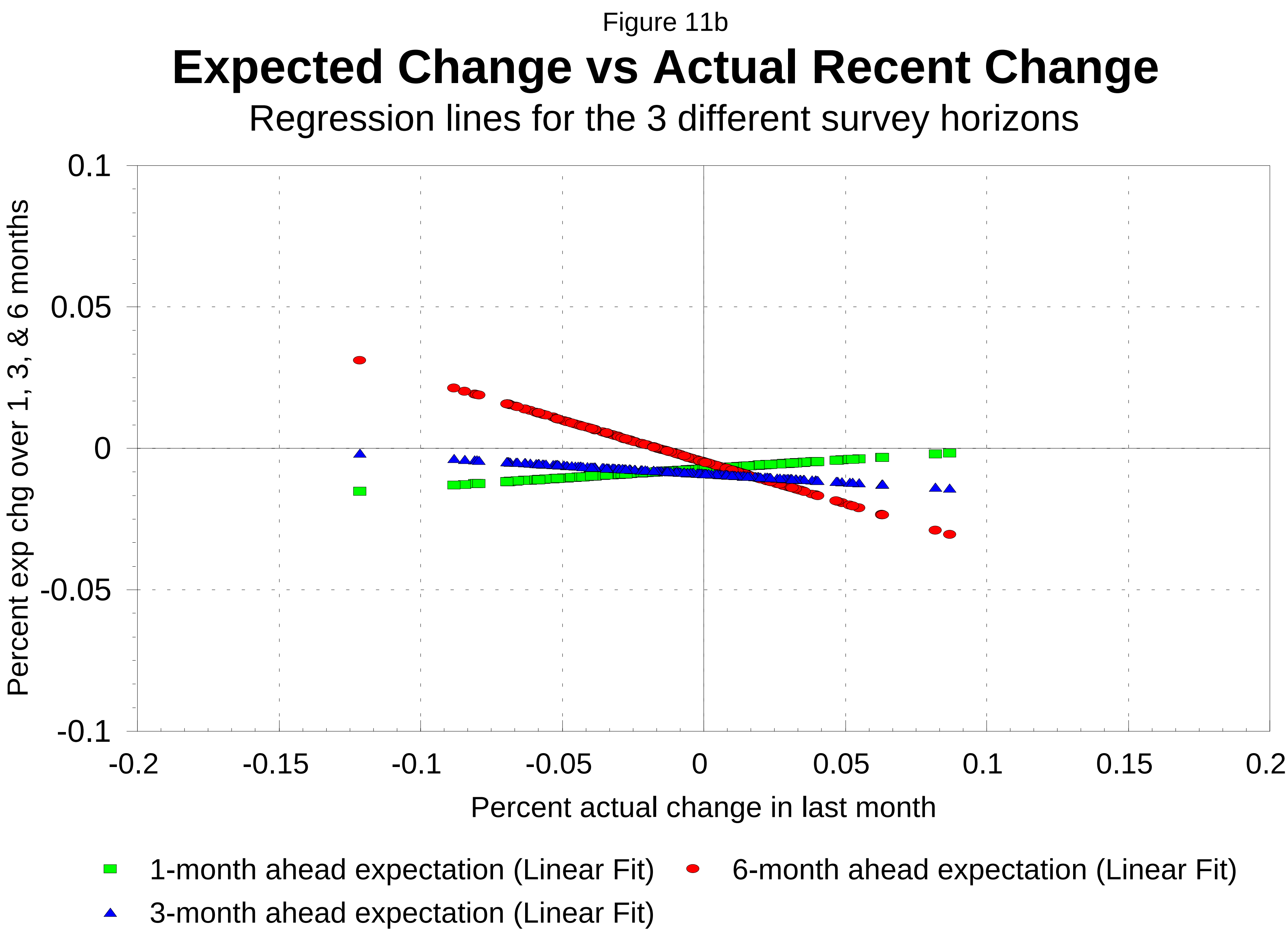


Figure 11b
Expected Change vs Actual Recent Change
Regression lines for the 3 different survey horizons
0.1
0.05
0
-0.05
-0.1
Percent exp chg over 1, 3, & 6 months
-0.2
-0.15
-0.1
-0.05
0
0.05
0.1
0.15
0.2
Percent actual change in last month
1-month ahead expectation (Linear Fit)
6-month ahead expectation (Linear Fit)
3-month ahead expectation (Linear Fit)

Figure 12

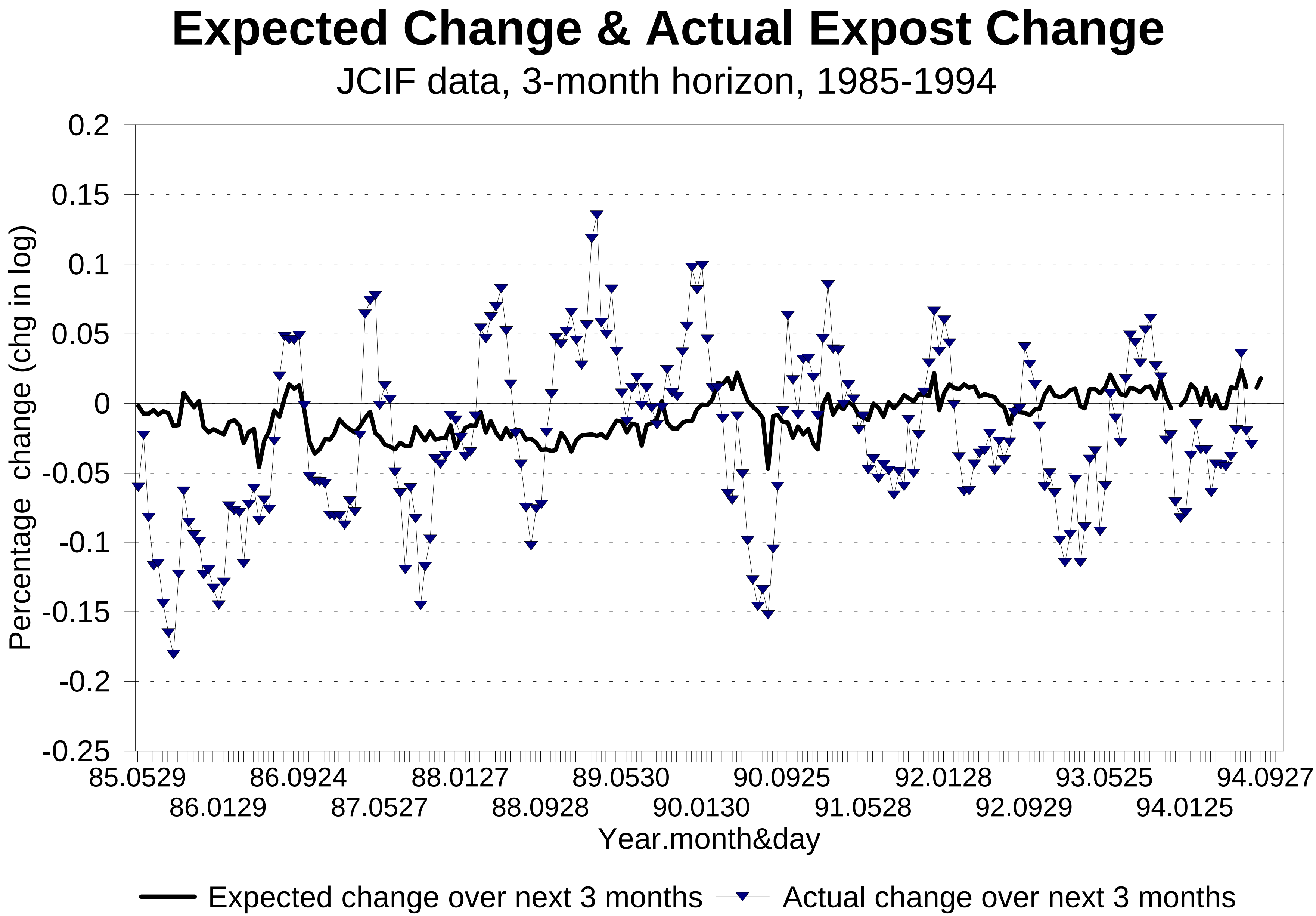

Expected Change & Actual Expost Change
JCIF data, 3-month horizon, 1985-1994
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
Percentage change (chg in log)
85.0529
86.0129
86.0924
87.0527
88.0127
88.0928
89.0530
90.0130
90.0925
91.0528
92.0128
92.0929
93.0525
94.0125
94.0927
Year.month&day
Expected change over next 3 months
Actual change over next 3 months

Figure 13

Expected Change & Actual Expost Change

JCIF data, 6-month horizon, 1984-1994

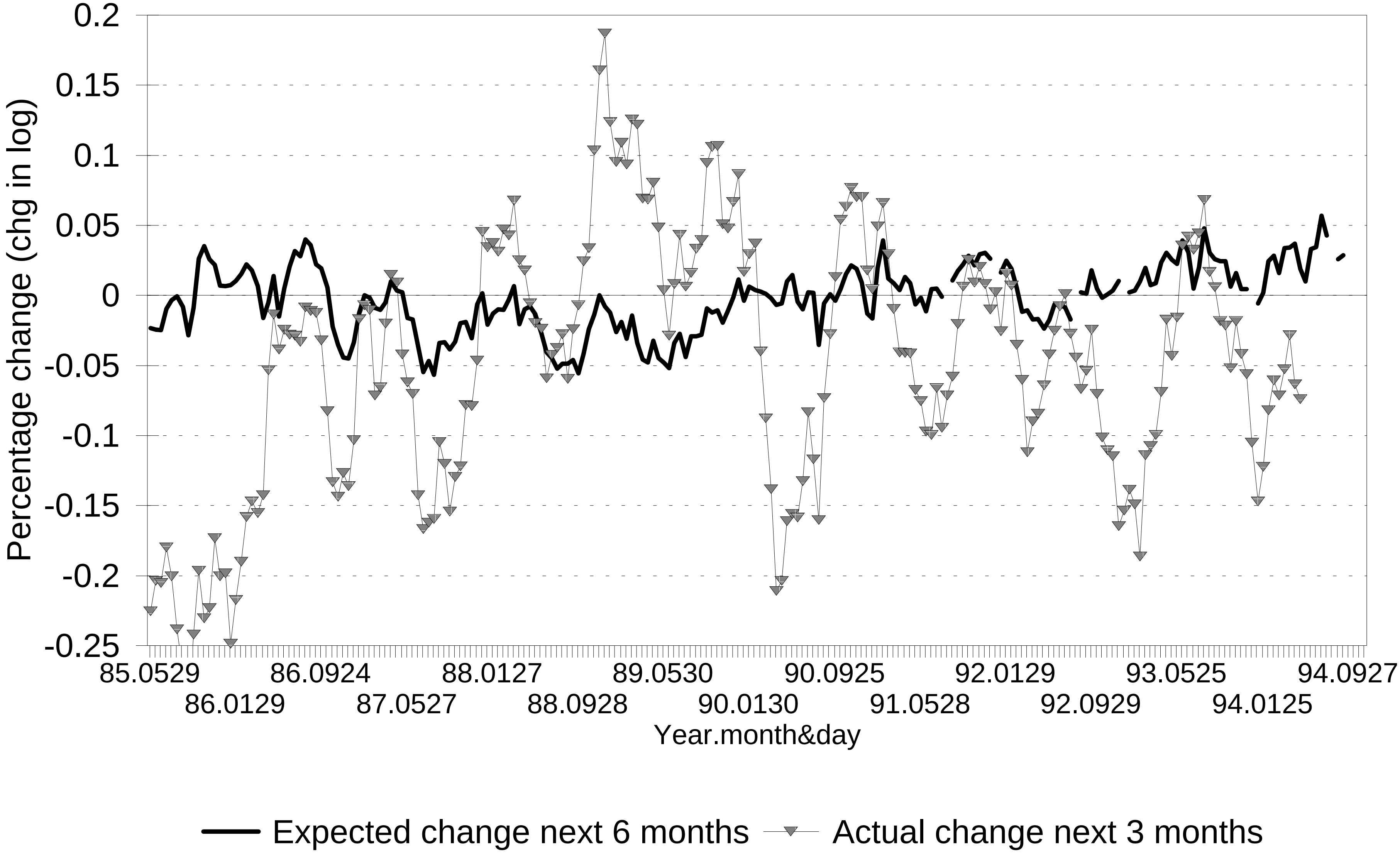


Figure 14

Actual Change vs Expected Change

JCIF data, 3-month horizon, 1985-1994

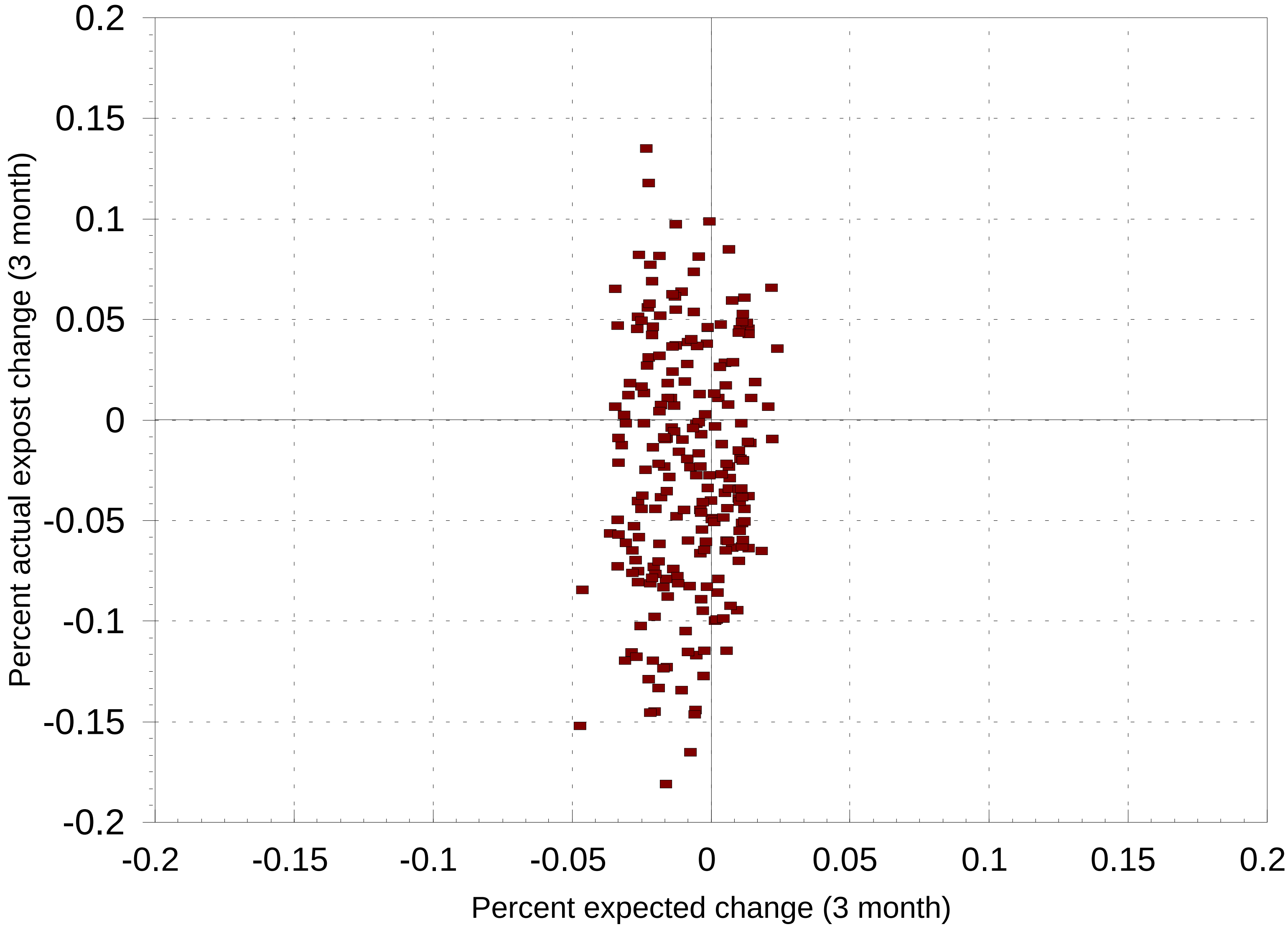


Figure 14 -- Regression Line

Actual Change vs Expected Change

JCIF data, 3-month horizon, 1985-1994

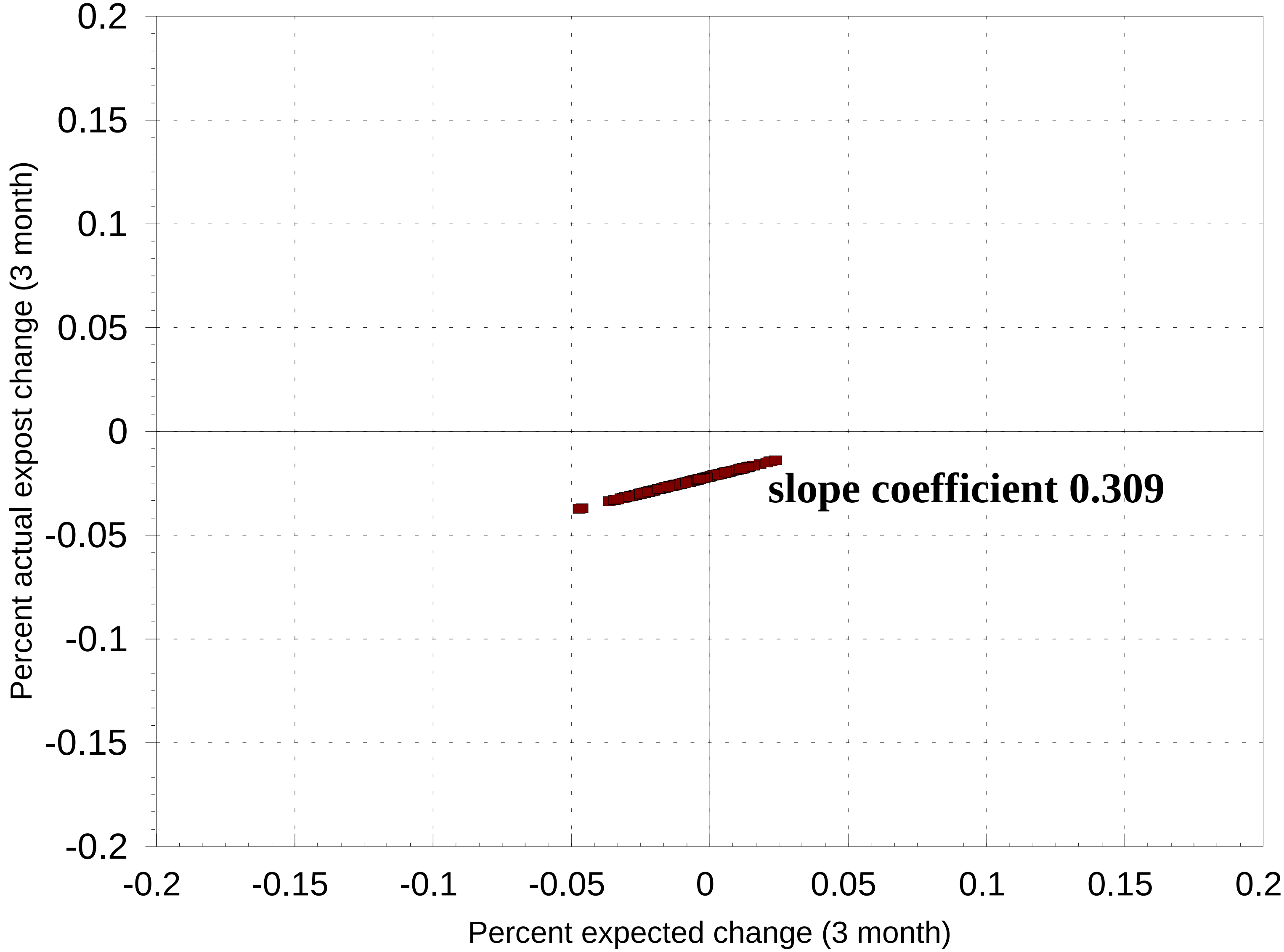


Figure 15

Alternative Specifications for Exchange Rate Expectations: Simulation Results for a U.S. Fiscal Expansion

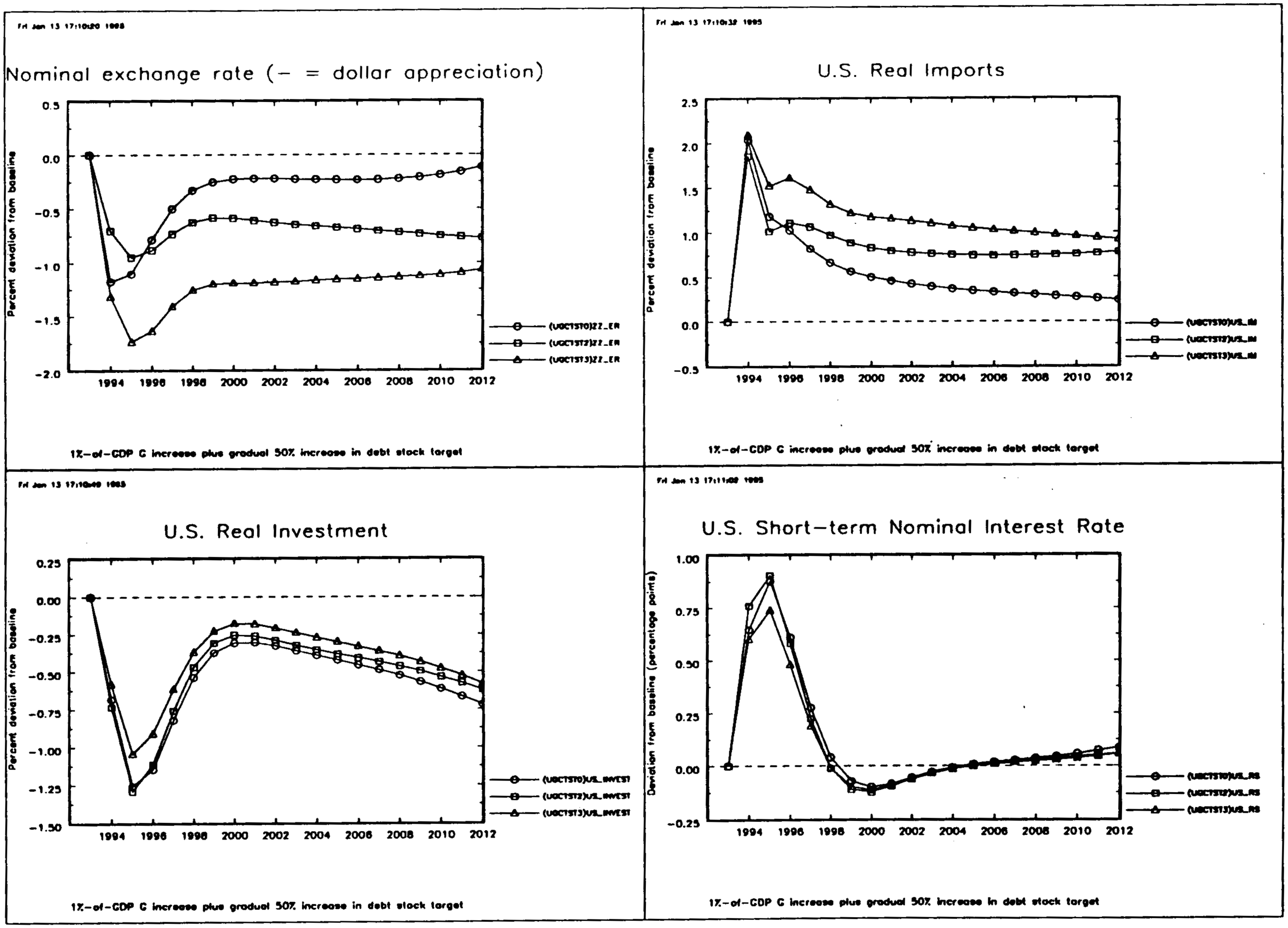


Figure 16

Alternative Specifications for Exchange Rate Expectations: Simulation Results for a U.S. Monetary Expansion

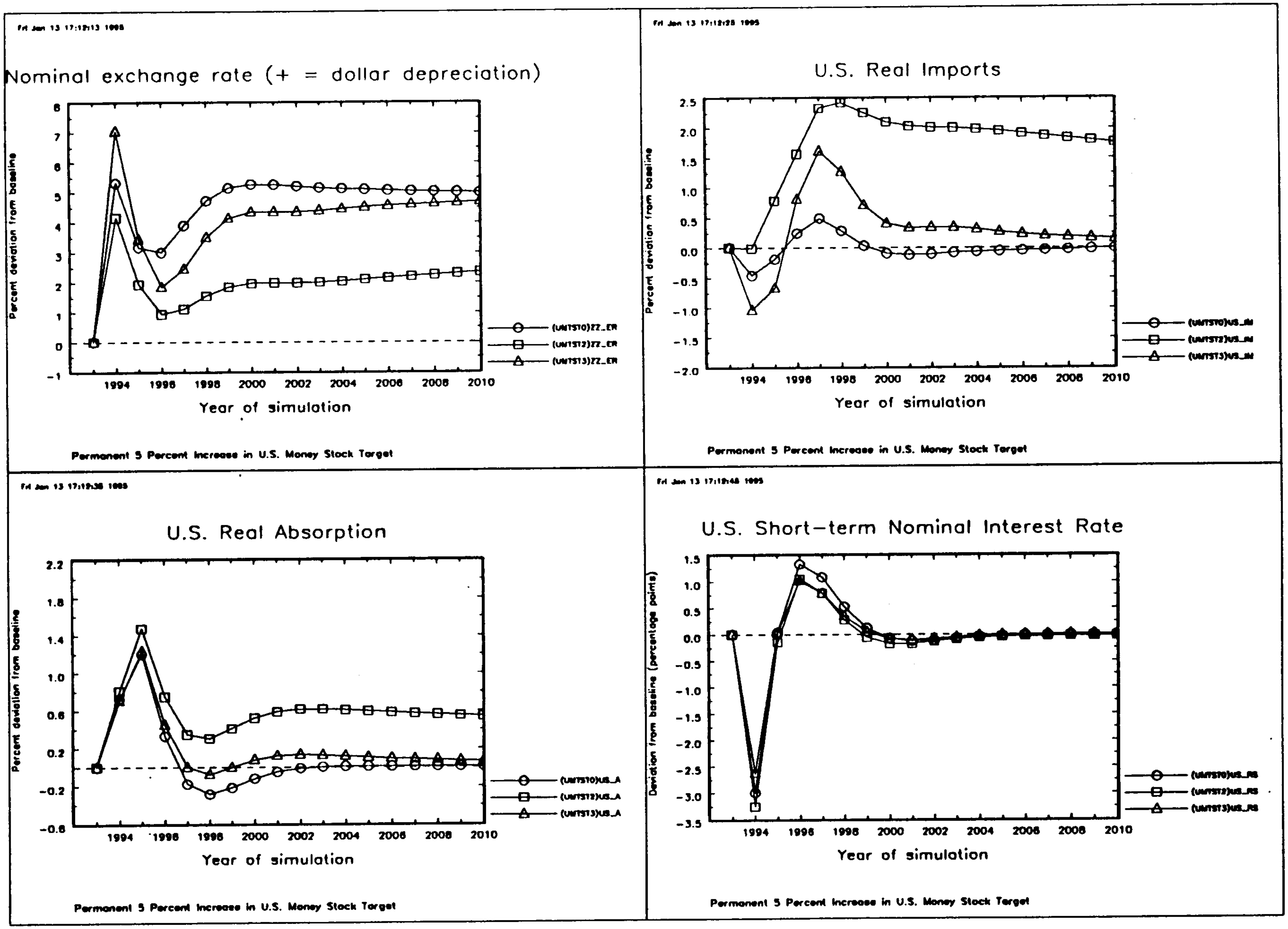
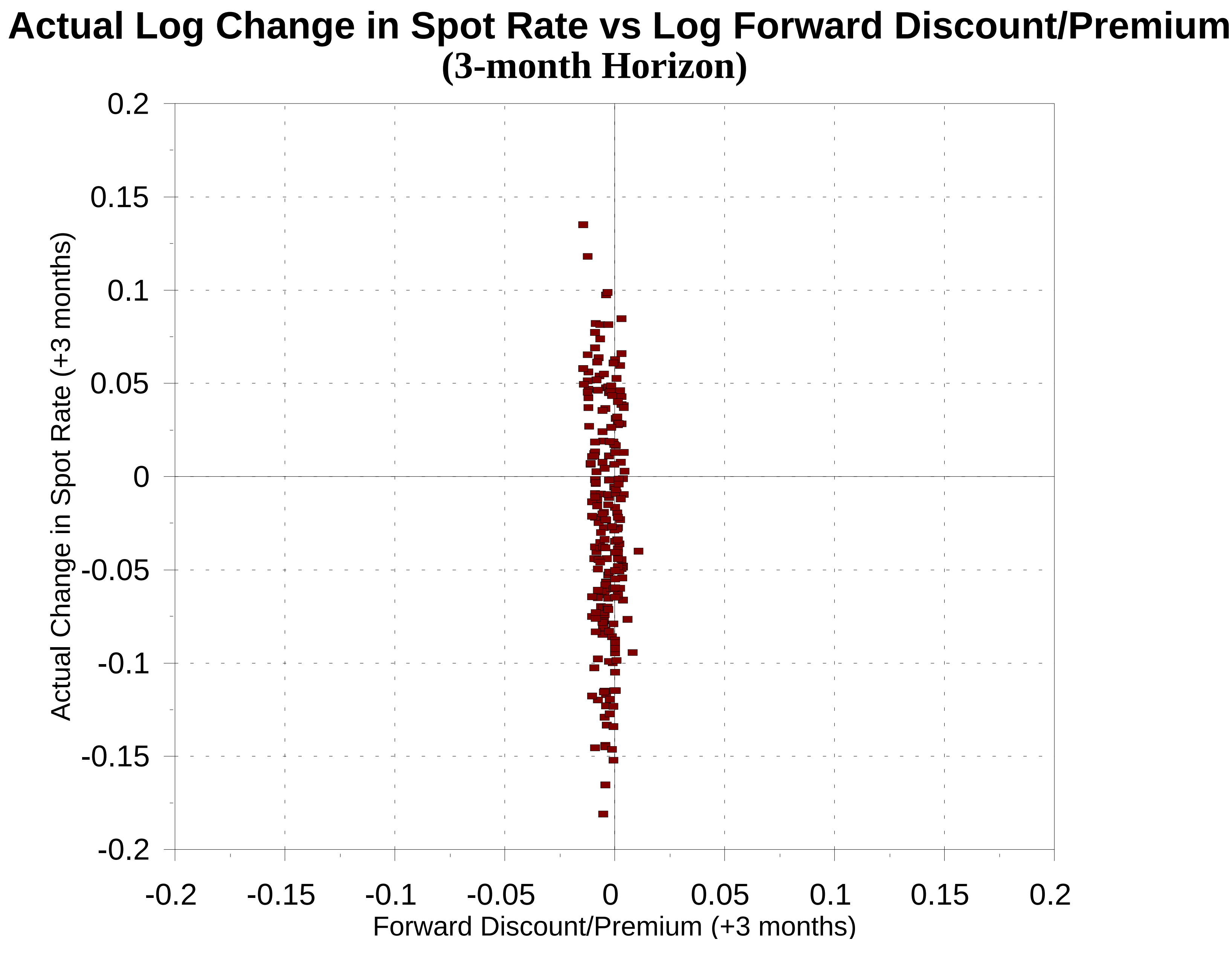


Figure 17



Actual Log Change in Spot Rate vs Log Forward Discount/Premium
(3-month Horizon)
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
Actual Change in Spot Rate (+3 months)
-0.2
-0.15
-0.1
-0.05
0
0.05
0.1
0.15
0.2
Forward Discount/Premium (+3 months)

Figure 17 -- Regression Line

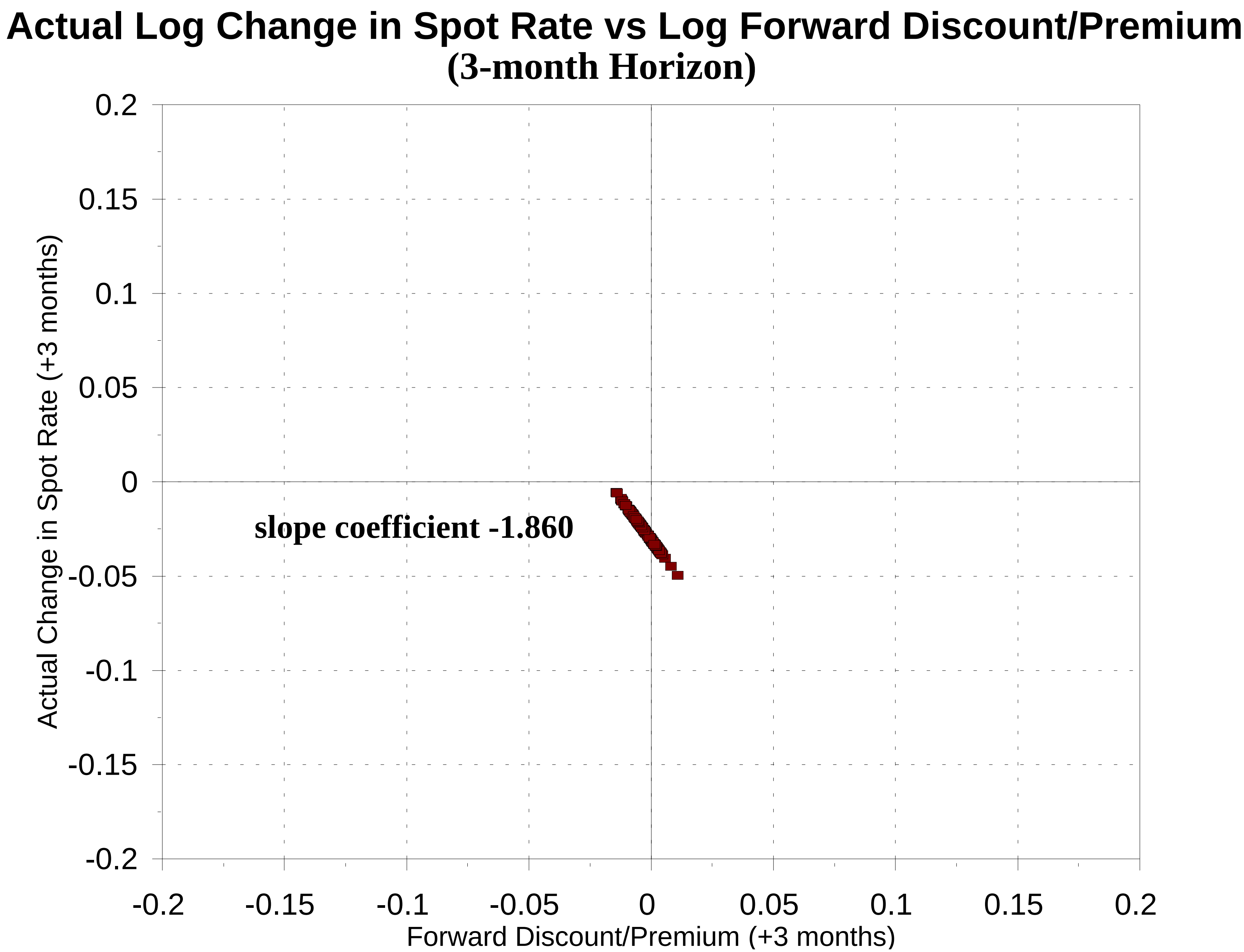


Figure 18

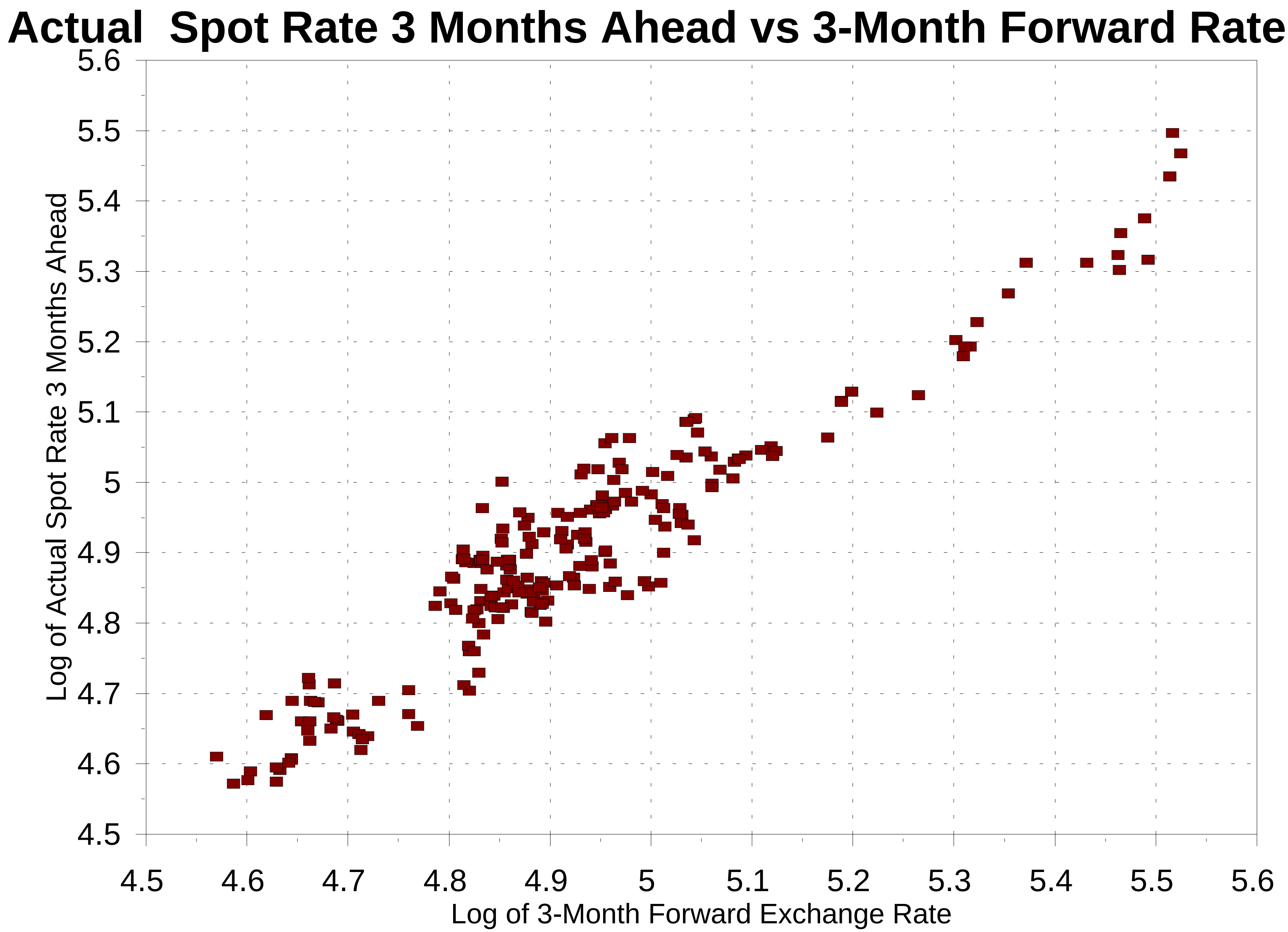

Actual Spot Rate 3 Months Ahead vs 3-Month Forward Rate
Log of Actual Spot Rate 3 Months Ahead
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.5
4.6
4.7
4.8
4.9
5
5.1
5.2
5.3
5.4
5.5
5.6
Log of 3-Month Forward Exchange Rate

Figure 18 -- Regression Line

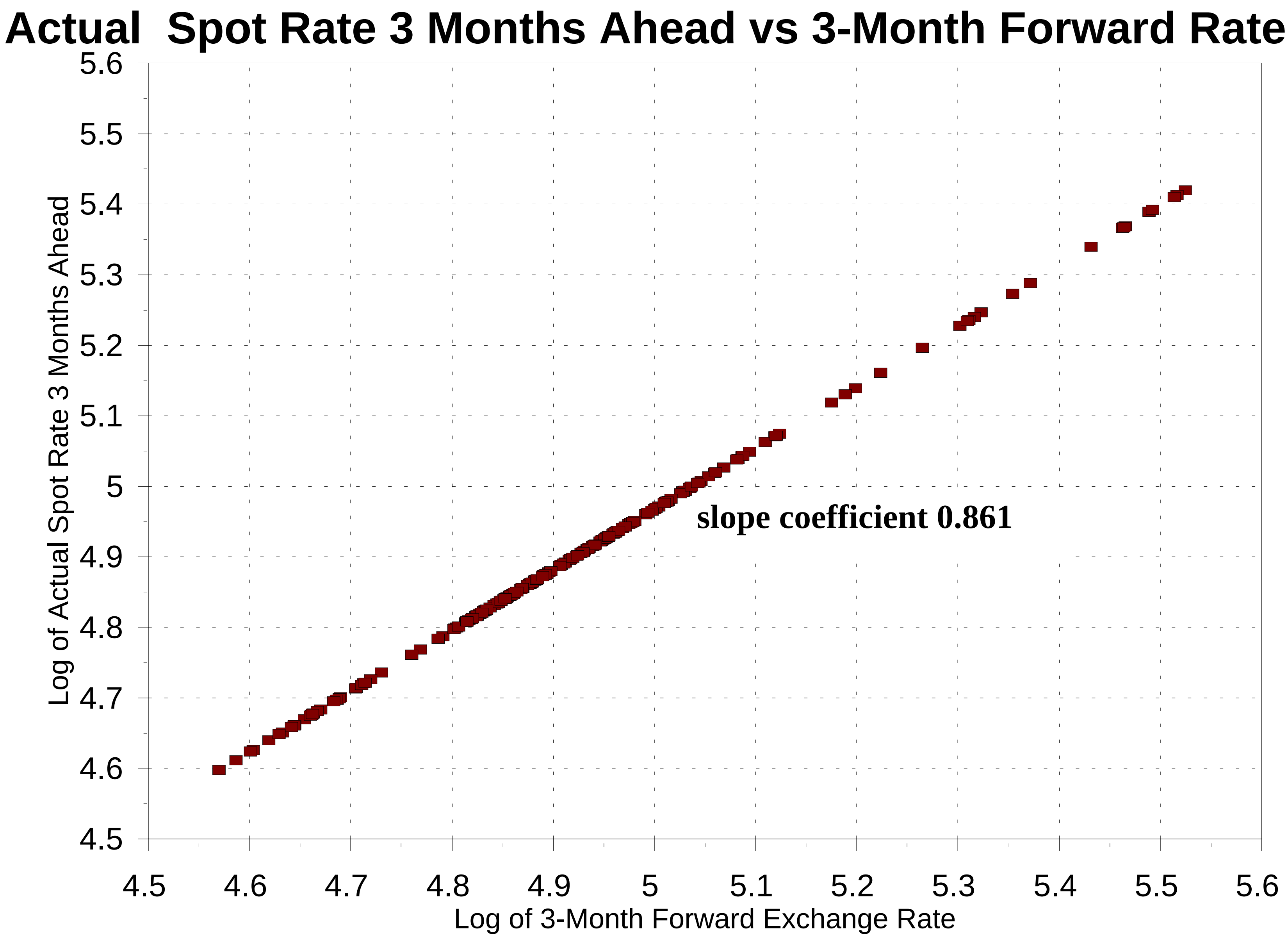
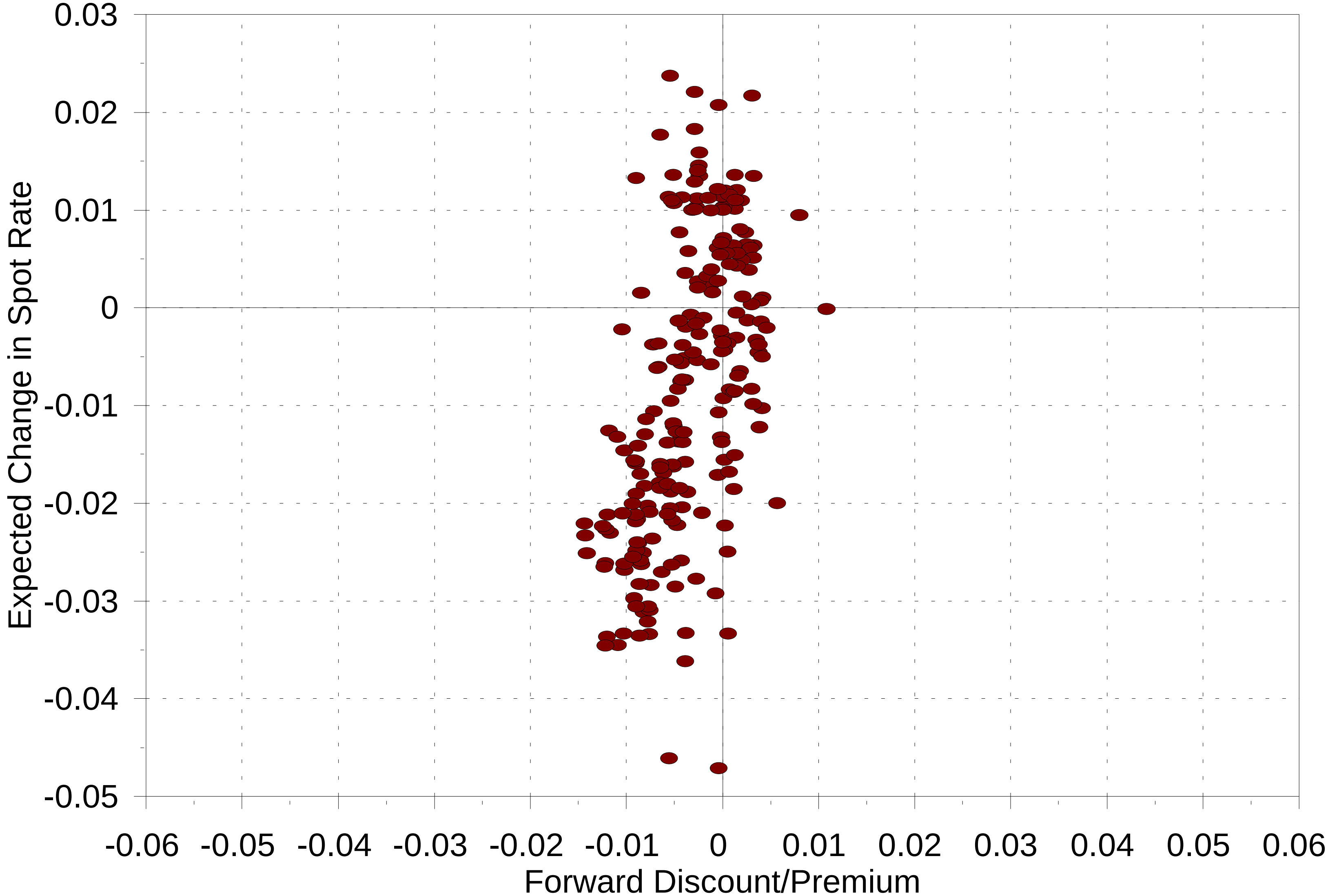


Figure 19

Expected Change in Spot Rate vs Forward Discount/Premium

JCIF data, 3-month horizon, 1985-94



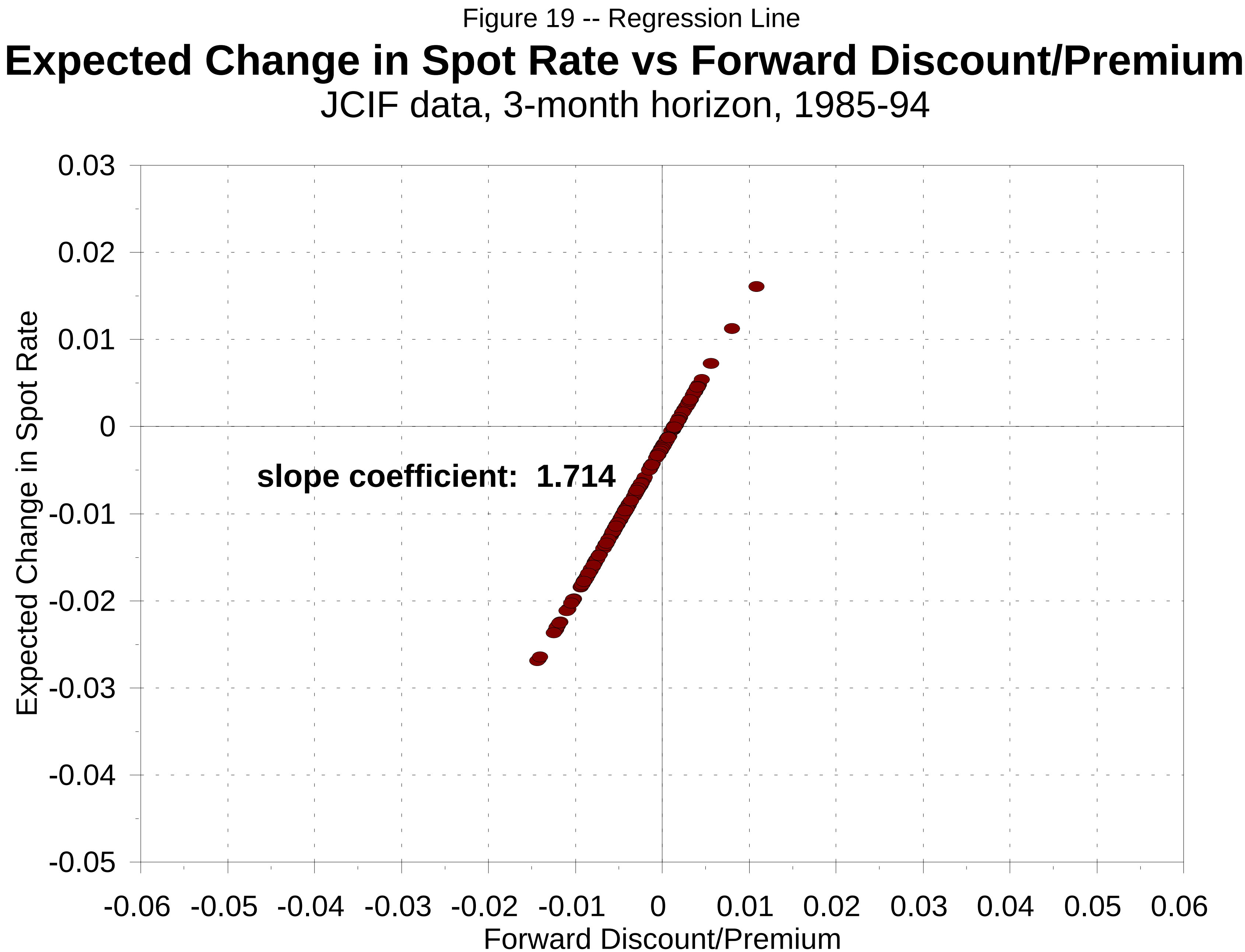


Figure 19 -- Regression Line
Expected Change in Spot Rate vs Forward Discount/Premium
JCIF data, 3-month horizon, 1985-94
slope coefficient: 1.714
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
Expected Change in Spot Rate
-0.06 -0.05 -0.04 -0.03 -0.02 -0.01 0 0.01 0.02 0.03 0.04 0.05 0.06
Forward Discount/Premium

Figure 20

Exchange Risk Premium vs Forward Discount/Premium

JCIF data, 3-month horizon, 1985-94

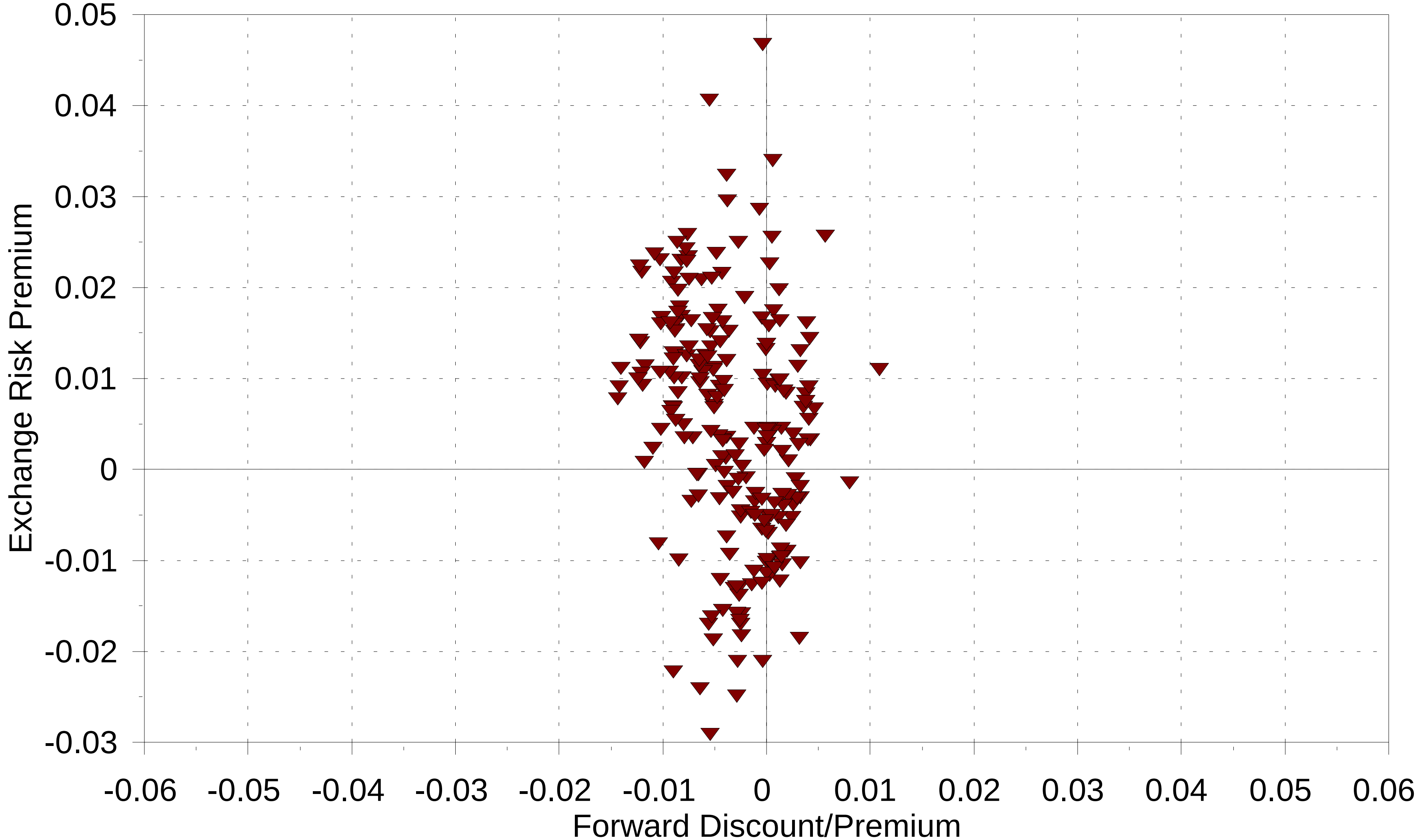
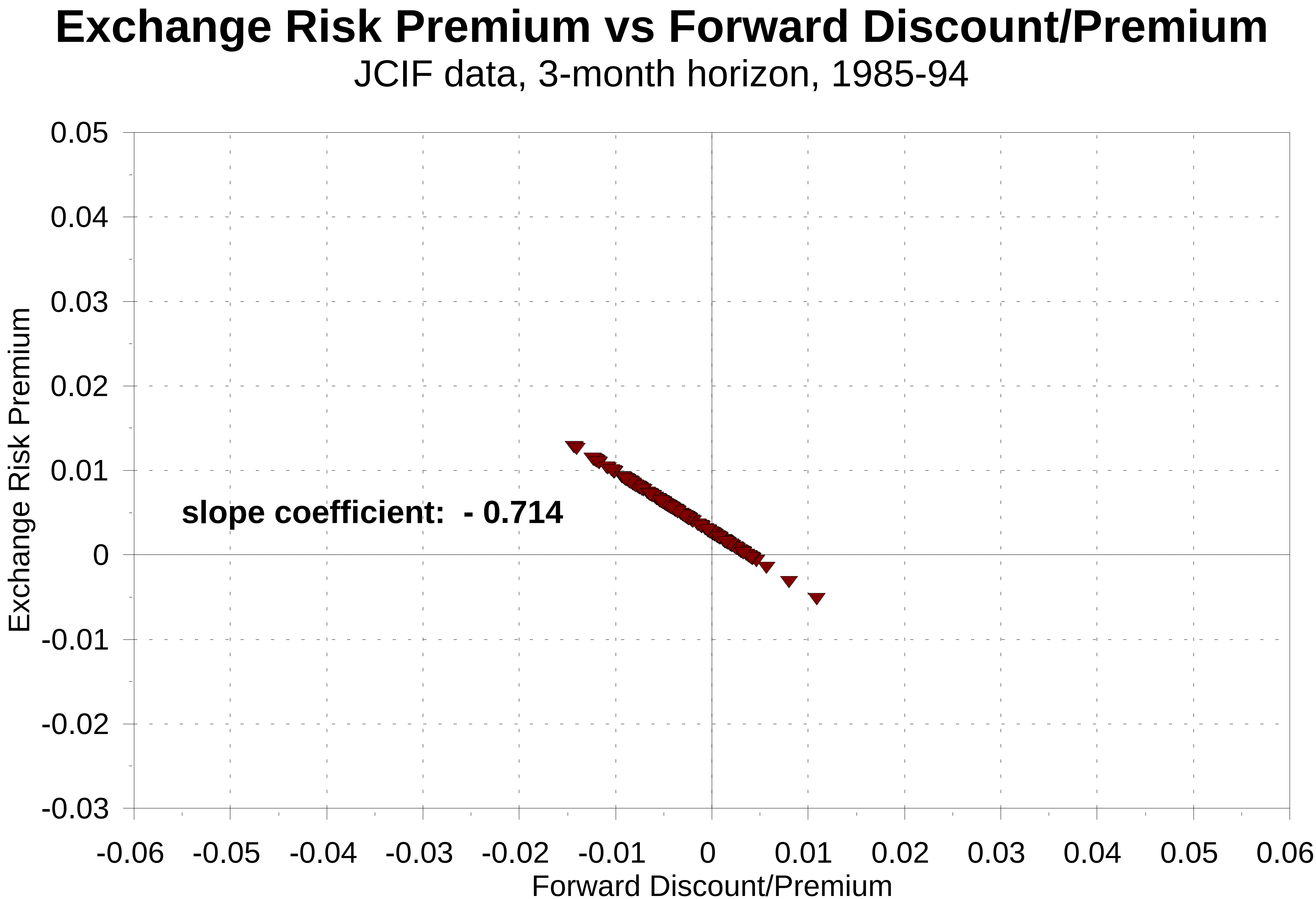


Figure 20 -- Regression Line



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