Long Horizon Movements in Exchange Rates:
Great Expectations

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I. Introduction

With the adoption of floating exchange rate systems by major industrialized nations, theories of exchange rate determination have been influenced by "asset models" in which exchange rates are determined similar to other asset prices. In particular, Mussa (1979) showed that fluctuations in exchange rates appear to be well described by random walks. That is, the best forecast of a future exchange rate is the current rate; actual changes are drawn independently from a probability distribution with a zero mean. Any changes, therefore, in exchange rates can be viewed as permanent: effects of a shock are not reversed over time.

The implications of such random walk conclusions for the short run are interesting. If shocks are indeed permanent, general belief in existing exchange rate models seems unsupported. For instance, a random walk is inconsistent with the notion that "overshooting" models and Purchasing Power Parity ("law of one price") are a useful guide for long run exchange rate movements.

Results in this paper show that applying specific techniques designed to analyze long run behavior of time series variables provides evidence that long run movements in exchange rates differ from random walks. Long run behavior, for both the DM/$ and ¥/$ spot rates, exhibit a rather substantial mean reverting

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2 "Overshooting" notion is a variation of the monetary model. For instance, an unanticipated increase in the money supply will cause the exchange rate to fall by an amount greater than required in the long run. Exchange rates will then slowly appreciate back towards the long run equilibrium value. In its most simplified form, Purchasing Power Parity asserts that nominal exchange rates are determined by the ratio of domestic and foreign prices, so that a standardized basket of goods cost the same in both countries. See Baillie and McMahon (1989), p.221 for an overview of empirical studies.
component, a temporary component similar to that found in stock prices (Fama and French [1988]; Poterba and Summers [1988]). That is to say, a divergence of observed market values from fundamental values cannot simply be interpreted as support for models of inefficient markets. Rather, these divergences may be temporary swings away from fundamental values. Over some range, these swings are eliminated and values return to their mean. Such temporary swings and their subsequent reversion to the mean can be translated into the statistical hypothesis that exchange rates contain a slowly decaying stationary (or transitory) component. With such a transitory series, the effects of a given shock are reversed over time.

If nominal exchange rates exhibit mean reverting tendencies (and information of this behavior is readily available to market participants), then it would seem plausible that expectations of future exchange rates should also differ from random walks. Recently, Frankel and Froot (1987, 1988) provided evidence which rejects random walks in expectations of future spot rates. Using survey data of forecasts, they found that short run expectations seem to based on recent trends in the spot rate. Such "extrapolative" expectations are different from the long run "regressive" ones in which exchange rates are expected to return to an equilibrium value such as Purchasing Power Parity.

Estimating expectations models similar to those used by Frankel and Froot (1988), I find that expectations for both the one week and one month horizon seem

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3 Both the Fama and French (1988) and Poterba and Summers (1988) find that over long horizons stock returns exhibit mean reverting behavior which is consistent with stock prices containing a stationary component. Though the two studies use different statistical methods, both find that variations due to mean reversion can account for a part of the return variances for long horizon returns. Using similar tests, Huizinga (1987) detected mean reversion in monthly real exchange rates.

4 For stock prices, one measure of fundamental value is the present discounted value of future dividends. Calculating a "fundamental" value for exchange rates is also subject to different theories such as Interest Rate or Purchasing Power Parity.

5 Random walk or static expectations implies that the expected value for a future spot rate is the current spot rate, \( s_{t+1} = s_t \), since any changes in the expected value are caused by a random error term.
consistent with what are implied by the actual long run movement in exchange rates. Namely, with the long run predictability implied by mean reversion, a given appreciation in a currency should lead investors to expect a future depreciation, and a given depreciation should lead to an expected appreciation.\textsuperscript{6} This contradicts Frankel and Froot's (1988) finding that forecasters tend to "extrapolate" recent trends for one week and one month horizons.

Such a contradiction can be explained once the different sample periods are examined. Whereas Frankel and Froot's (1988) data set covered only the period between 1984 and 1986, the data used in this paper extend from 1984 through 1989. As such, there is no \textit{a priori} reason to believe that the way in which forecasters formed their expectations remained consistent between the two sub-periods, 1984 - 1986 and 1987 - 1989.

This assertion that the way expectations were formed did not remain constant between 1984 and 1989 can be supported if we consider the international monetary climate during the mid 1980's. In the wake of the extreme appreciation and depreciation of the dollar between 1984 and 1986, finance ministers from the G7 publicly committed themselves during their famous Louvre Accord (February 1987) to stabilize the dollar in order to prevent future volatility.\textsuperscript{7} Presumably, such public announcements (if believed to be credible) could cause changes in the way market participants formed their expectations. Simple Chow tests reveal that, indeed, there is no reason to believe that regression coefficients of the expectations models remained constant throughout the sample period.

\textsuperscript{6} Questions concerning the rationality of this behavior is not addressed in this paper. For the sake of brevity, whether or not the specifications for expectations used in this paper are rational is not a primary focus. These expectations mechanisms are only intended to provide a glimpse as to how expectations may be formed. Dominguez (1986) rejects rationality in the MMS data set from 1983 through 1985. Tests of rationality for the current data set could be a focus for future research.

\textsuperscript{7} Actually, the dollar began appreciating as early as 1981. Members of the G7 include the United States, Japan, Germany (then West Germany), France, Britain, Italy, and Canada.
Section II uses Fama and French's (1988) model for stock prices to outline an exchange rate model that is composed of a transitory and a permanent (random walk) component. This section also shows that standard random walk tests may not be able to distinguish between a series composed of a random walk and another series composed of a random walk plus a transitory component. Section III contains a discussion of the data used. I provide in Section IV results which suggest that both the DM/$ and Y/$ spot rates contain a slowly decaying transitory component. Section IV also outlines possible explanations for the source of temporary components, particularly the implications of coordinated exchange rate policy. Section V examines some specifications of the way expectations are formed, and whether or not these specifications produce results which are consistent with actual movements in exchange rates. I conclude with final remarks in Section VI.

II. Simple Model of Exchange Rates

Long-horizon predictability contradicts empirical findings that movements in log exchange rates appear to be well captured by random walks. An accepted test of the random walk hypothesis focuses on unit roots in autoregressive specifications (i.e., tests for a coefficient of one in an autoregressive process). However, as Huizinga (1987) notes, such a “random-walk’ univariate process merely indicates that lagged values of the variable itself cannot be used to predict future changes.” (p.150) Modeling exchange rates in a similar fashion as Fama and French (1988) modeled stock prices, it can be shown that if exchange rates contain both a transitory and a permanent component, observing unit roots cannot be interpreted as supporting a pure random walk hypothesis.

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8 This section draws extensively from Fama and French (1988), pp.248-252.
Suppose that the spot rate, $s_t$, is composed of a stationary (transitory) component, $\zeta_t$, and a permanent random walk component, $\psi_t$, with $\zeta_t$ as an AR(1) process.

\begin{align*}
(1) \quad \zeta_t &= \rho \zeta_{t-1} + \eta_t \\
(2) \quad \psi_t &= \psi_{t-1} + \mu + \varepsilon_t
\end{align*}

where $\mu$ is the drift, $|\rho|<1$, and $\eta_t$ and $\varepsilon_t$ are white noise. We can then let $s_t$ be a weighted average of the random walk and transitory terms:

\begin{equation}
(3) \quad s_t = \alpha \psi_t + (1-\alpha) \zeta_t, \quad 0<\alpha<1.
\end{equation}

Substituting in (1) and (2) into (3), we get

\begin{equation}
(4) \quad s_t = \alpha \psi_{t-1} + (1-\alpha) \rho \zeta_{t-1} + \alpha \varepsilon_t + (1-\alpha) \eta_t + \alpha \mu
\end{equation}

Since $s_{t-1} = \alpha \psi_{t-1} + (1-\alpha) \zeta_{t-1}$, or $\alpha \psi_{t-1} = s_{t-1} - (1-\alpha) \zeta_{t-1}$, we can substitute into (4) to get

\begin{align*}
(5.a) \quad s_t &= s_{t-1} - (1-\alpha)(1-\rho) \zeta_{t-1} + \alpha \varepsilon_t + (1-\alpha) \eta_t + \alpha \mu, \quad \text{or} \\
(5.b) \quad s_t - s_{t-1} &= \alpha \varepsilon_t + (1-\alpha) \eta_t + (1-\alpha)(\rho-1) \sum_{i=1}^{\infty} \rho^{i-1} \eta_{t-i} + \alpha \mu
\end{align*}

Equation (5.a) implies that if exchange rates are composed of both permanent and transitory components, the spot rate at time $t$ is equal to the spot rate at time $t-1$ plus a collection of white noises and drift. So, in such a series, we should expect to observe unit roots: the coefficient from regressing $s_t$ on $s_{t-1}$ should be insignificantly different from one.

If exchange rates contain a transitory component, then mean reverting behavior can be explained by examining the decaying autocorrelation of this component. If we let $\varphi_k$ be the autocorrelation of the $k$-period difference in the
transitory component, i.e., \((\xi_t + k^{-} \xi_t) = \varphi_k (\xi_t^{-} \xi_t^{-} k)\), then, as Fama and French (1988) show, \(\varphi_k\) approaches \(-\sigma^2_\xi^2 / 2\sigma_\xi^2\), or \(-1/2\), for large \(k\) (p.250).\(^9\) They note that although the transitory component cannot be observed directly, we can infer the existence of this term and its properties by regressing \((s_t + k^{-} s_t)\) on \((s_t^{-} s_t^{-} k)\), where a negative coefficient implies mean reversion. If changes in the random walk and transitory components are uncorrelated, Fama and French (1988) show that:

\[
(6.a) \quad (s_t + k^{-} s_t) = \beta_k(s_t^{-} s_t^{-} k) + \gamma_t
\]

where \(s_t\) is composed of a random walk and a transitory component as in equations (3) through (5), \(\gamma_t\) is an error term, and

\[
(6.b) \quad \beta_k = - \sigma^2 [E_t(\xi_t + k^{-} \xi_t) - \xi_t] / \sigma^2[s_t^{-} s_t^{-} k]
\]

The coefficient, \(\beta_k\), in (6.b) measures the proportion of the variation in \(k\)-period difference of exchange rates which is explained by the mean reversion of the decaying transitory component, \(\xi_t\). If exchange rates do not contain a transitory component, \(\beta_k\) in (6.a) is equal to zero. On the other hand, if exchange rates contain only a transitory component, \(\beta_k=\varphi_k\) and \(\beta_k\) approaches \(-1/2\) for large \(k\).\(^{10}\)

Thus, mean reversion of the transitory portion tends to push \(\beta_k\) towards \(-1/2\) as \(k\) increases, while the white noise term in the random walk tends to push it towards zero. Fama and French (1988) show that since the variance of the error term in the random walk component grows with \(k\), the white noise component eventually dominates. This implies that if exchange rates contain both a random walk and a transitory component, the coefficient \(\beta_k\) in (6.a) might form a U-shaped pattern as \(k\) increases.

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\(^9\) If there is no transitory component, then \(\varphi_k=0\).

\(^{10}\) Using monthly returns for NYSE stocks, Fama and French (1988) find significant mean reversion past the one year horizon.
III. Data

The average of Friday closing bid and offer prices for the DM/$ and Y/$ spot rates are used as proxies for the weekly closing price. This weekly series extending from January 1984 through August 1989 was provided by the Federal Reserve Bank of Cleveland. Using weekly data captures short run movements better than other studies which used monthly or yearly exchange rates; and five full years of weekly data covers a longer horizon than other studies which use weekly or monthly data for three years (Frankel and Froot [1988]). In addition, the series beginning in 1984 includes the extreme appreciation (and the subsequent depreciation) of the dollar between 1984 and 1986. If exchange rates do indeed contain a transitory component, behavior during this period should contribute to the “long” horizon predictability.\textsuperscript{11} The sample period also coincides with increasing investors’ perception of the Fed’s credibility in maintaining a stable monetary growth policy, thus suggesting possible corrective stabilization of fluctuations.\textsuperscript{12}

Table I contains brief descriptive statistics for weekly percentage changes in the Y/$ and DM/$ spot rates. During the sample period, the DM/$ spot rate changed, on average, .1273\% (in absolute terms) per week: the Y/$, .1745\% per week. The largest one week appreciation for both the DM/$ and Y/$ spot rates was almost equal at 4.159\% and 4.693\%, respectively. As for the largest one week fall in spot rates, the DM/$ witnessed an 8.304\% plunge compared to the Y/$’s sharpest decline of 6.779\%.

\textsuperscript{11} What is considered as a “long” horizon in this paper may not be acceptable to many who believe that “long horizon” entails several decades. Nevertheless, in terms of weekly movements, five years seems to constitute a relative long – if not medium – horizon.

\textsuperscript{12} After October 1979, the Federal Reserve emphasized a stable monetary growth target. For a discussion see Urich and Wachtel (1981).
Table I

Descriptive Statistics for Weekly Percentage Changes in ¥/$ and DM/$ Spot Rates
(January 1984-August 1989)

<table>
<thead>
<tr>
<th></th>
<th>Obs.</th>
<th>Abs. Mean % change</th>
<th>Max.</th>
<th>Min.</th>
<th>Std. Error of Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>¥/$</td>
<td>287</td>
<td>.1745</td>
<td>4.693</td>
<td>-6.779</td>
<td>.0895</td>
</tr>
<tr>
<td>DM/$</td>
<td>287</td>
<td>.1273</td>
<td>4.159</td>
<td>-8.304</td>
<td>.0998</td>
</tr>
</tbody>
</table>

Figure I depicts weekly movements in the DM/$ and ¥/$ spot rates. For both the ¥/$ and DM/$, a clearly observable pattern emerges. From the beginning of 1984 through early 1985, the DM/$ and ¥/$ spot rates increased; the dollar appreciated approximately 20% to reach its peak of DM 3.38 and ¥ 262 in February.
of 1985. After this, the dollar steadily depreciated and has remained relatively stable since early 1987.

Calculating investors' expectations regarding exchange rates is a difficult task. The established method of estimating expectations using forward rates poses serious problems. The apparent risk premium contained in forward rates creates a gap which separates forward rates from expectations of future spot rates.

Under the assumption of forward market efficiency, expectations of future spot rates are assumed to be rational; that is, \[ E_t S_{t+n}/\Omega_t = S_{t+n} \], where \( E_t S_{t+n} \) is the expected spot rate for time \( t+n \) based on the information set available at time \( t \), \( \Omega_t \). In addition, forward rates are assumed to be unbiased estimators of expected future spot rates, i.e., \( f_{t,n} = E_t S_{t+n}/\Omega_t \), where \( f_{t,n} \) is the \( n \)-period away forward rate at time \( t \). If the forward market efficiency hypothesis were true, the difference between \( f_{t,n} \) and \( S_{t+n} \) should have a zero mean and not be serially correlated. Therefore, expected changes in exchange rates, as reflected in the forward discount \( (f_t - s_t) \), should be equal to the actual change \( (s_{t+1} - s_t) \). A common test for forward market efficiency is to estimate \( \lambda \) in the following regression:

\[
(7) \quad s_{t+1} - s_t = \alpha + \lambda (f_t - s_t) + \varphi_{t+1}
\]

where \( s_{t+1} \) is the log of the spot rate in \( t+1 \), \( f_t \) is the log of the forward rate in \( t \), \( \varphi_{t+1} \) is a random error term, and efficiency implying \( \alpha = 0, \lambda = 1 \).

That is, regress the \textit{ex post} change in the spot rate against the forward discount at the beginning of the period. Under the null hypothesis that forward discounts are equal to actual changes, the coefficient should be unity. Fama (1984) reports \( \lambda \) significantly less than unity. And as he notes, it is recognized that \( \lambda \) different from one can result from time varying risk premia in the forward rate (p. 321); for
instance, coefficient less than one can be interpreted as suggesting that the expected appreciation of the dollar as reflected in the forward rate is greater than the ex post appreciation of the dollar.  

A better measure of expected exchange rates can be obtained through surveys of forecasts by market participants. These surveys serve as a proxy for expectations without the interference from risk premia. Expectations (forecasts) for one week and one month horizons were obtained from Money Market Services of Belmont, California. Each week MMS conducts direct phone surveys with approximately 30 professional exchange rate forecasters and reports their median response. Data on weekly surveys for one week forecasts are available from November 1984 through September 1990. Surveys for one month forecasts were conducted on a bi-weekly basis from 1984 through the early months of 1985, after which they were conducted weekly.

Survey data on expected exchange rates for longer horizons are available from the *Financial Report* (for three, six, and twelve month horizons) and *Amex Bank Review* (for six and twelve month horizons). Though these data may be useful measures of longer-horizon expectations, I use only the MMS data. The shortcoming of the other two surveys is the relatively limited number of observations. The *Amex Bank Review* conducted only twelve surveys between January 1976 and July 1985: the *Financial Report* only 38 between June 1981 and December 1985.  

13 Simple efficiency can be outlined as: $f_{t,n}=\frac{[\hat{E}_t S_{t+n}/\Omega_t]}{[S_{t+n}]}$ and $\frac{[\hat{E}_t S_{t+n}/\Omega_t]}{[S_{t+n}]} = [S_{t+n}]$. A more general outline of efficiency is: $f_{t,n}=\frac{[E_t S_{t+n}/\Omega_t] + R_{P_{t,n}}}{[E_t S_{t+n}/\Omega_t]} = [S_{t+n}]$, where $R_{P_{t,n}}$ is the risk premium. See Levich (1989), p.47. Frankel and Froot (1988) note other studies regressing against forward discounts. There are many interpretations of negative estimates of the coefficient in equation (7), one of which is that forward markets are inefficient. This paper does not make an attempt to determine market efficiency or inefficiency. Rather, the point of the above discussion was merely to suggest that using forward rates as measures of expectations may be inappropriate. Dominguez (1986) notes that since exchange market efficiency does not preclude the existence of a risk premium, tests which reject the joint hypothesis of risk neutrality and rationality do not provide clear evidence of efficiency. These results may simply reflect the time varying risk premium.

14 Frankel and Froot (1987), data notes.
As noted by Dominguez (1986), the "methodology and respondent sample" used to obtain these forecasts "inspire unusual confidence". Respondents are professional economists and forecasters with major international institutions who have access to minute-by-minute information on all relevant factors. In addition, the business careers of these forecasters are dependent on the accuracy of the predictions. Criticisms that the survey responses may not be truthful or that they do not represent the marginal investor seem less problematic. Regardless of the objections raised for using survey data, at the very least, these data provide insightful information concerning investors' expectations.15

IV a. Temporary Components

A common test of the random walk hypothesis focuses on testing for unit roots in an autoregressive process. Using weekly DM/$ and V/$ spot rates from January 1984 through August 1989, I found $3 in the regression

\[
S_t = \alpha + \beta S_{t-1} + \nu_t,
\]

where \( S_t \) is the log of the spot rate and \( \nu_t \) is a random error term. insignificantly different from unity. The inability to reject the unit root hypothesis in Table II seems to suggest that weekly movements in spot rates are well captured by random walks. We saw in Section II, however, that if exchange rates are composed of both a transitory and a random walk component, as in equation (5.b), we should expect to observe unit roots.

In general Cochrane (1988) showed that a first difference stationary series with a unit root can be interpreted as a series composed of a random walk and a

\[15\] Investigations by Engel and Frankel (1984), Pearce and Roley (1985) and others suggest that MMS survey data for the M1 have desirable properties such as unbiasedness and efficiency.
transitory component. Thus, if exchange rates are modeled as a combination of a transitory and a random walk component, as in equation (5.b), the inability to reject the unit root hypothesis in equation (8) cannot be interpreted as supporting a random walk hypothesis. In such a series, unit root tests can only provide information as to whether the series contains a random walk or is composed of a random walk plus a transitory component.

Since error terms of a random walk process (i.e., $s_t = s_{t-1} + v_t$) are assumed to be serially uncorrelated, a more direct test of the random walk hypothesis involves estimating $a$ in the following regression:

\begin{equation}
\begin{align*}
(9.a) \quad v_t &= av_{t-1} + \delta_t \\
(9.b) \quad (s_t - s_{t-1}) &= a(s_{t-1} - s_{t-2}) + \delta_t,
\end{align*}
\end{equation}

where $s_t$ is the log of the spot rate, $\delta_t$ is a random error term, and $a=0$ if exchange rates follow a random walk only.

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16 Estimating coefficients individually using OLS may not be accurate. Because exchange rates are measured relative to the U.S. dollar, triple arbitrage opportunities may cause cross-correlation in the error terms of the regression. Zellner's (1962) "seemingly unrelated regression" technique will improve the precision of the estimates.
Table III shows Seemingly Unrelated estimates of $a$ for the DM/$ and ¥/$ spot rates.

### Table III

$$(s_t - s_{t-1}) = \alpha + a(s_{t-1} - s_{t-2}) + \delta_t$$

Seemingly Unrelated Regression Results.

<table>
<thead>
<tr>
<th></th>
<th>Obs.</th>
<th>$a$</th>
<th>SE</th>
<th>$t: \beta = 0$</th>
<th>DW</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM/$</td>
<td>286</td>
<td>.009</td>
<td>.046</td>
<td>.204</td>
<td>1.928</td>
</tr>
<tr>
<td>¥/$</td>
<td>286</td>
<td>.081</td>
<td>.047</td>
<td>1.71*</td>
<td>2.038</td>
</tr>
</tbody>
</table>

* $H_0$: Random Walk, $a=0$.
** Each currency given an intercept term which is not reported here.
* Significant at the 5% (one-tailed) level.

These results suggest, particularly for the ¥/$ spot rate, that exchange rates contain more than a pure random walk component. We can, at 5% significance, reject the null that the ¥/$ spot rate follows a random walk only. Evidence for the DM/$ is not as convincing. Implied in Table III is that the ¥/$ spot rate contains a larger temporary component, whereas the DM/$ spot rate seems to be explained more by a permanent component, with the temporary portion having little influence, if any at all.

It may be evident by now that equation (9.b) is a special case of equation (6.a),

$$(s_t + k - s_t) = \beta_k(s_t - s_{t-k}) + \gamma_t$$

the $k$ difference autocorrelation, with $a = \beta_k$ and $k=1$.

Thus, testing the hypothesis that random walks have uncorrelated error terms is qualitatively equivalent to testing for the existence of a mean-reverting, transitory component at the one week horizon. Results in Table III indicate that, at the one week interval, the ¥/$ spot rate contains a temporary component which has not begun to revert to a mean. Though we cannot reject the hypothesis that error terms for the DM/$ spot rate are uncorrelated, we cannot conclude from this that
the DM/$ spot rate does not contain a transitory component. Based on equations (6.a) and (9.b) all we can say is that the transitory component of the DM/$ spot rate does not seem to be detectable at the one week horizon. If a temporary component exists, it may be detectable over longer intervals.

Table IV
Seemingly Unrelated Regression Estimates of Equation (6.a)

\[(s_{t+k} - s_t) = \alpha + \beta_k(s_{t+k} - s_{t-k}) + \gamma_t\]

<table>
<thead>
<tr>
<th>(k) (Wks)</th>
<th>Obs</th>
<th>(\beta_k)</th>
<th>SE</th>
<th>DW</th>
<th>(\beta_k)</th>
<th>SE</th>
<th>DW</th>
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<tr>
<td>1</td>
<td>286</td>
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<td>0.047*</td>
<td>2.038</td>
<td>0.009</td>
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<td>1.928</td>
</tr>
<tr>
<td>8</td>
<td>271</td>
<td>0.089</td>
<td>0.047*</td>
<td>1.177</td>
<td>0.005</td>
<td>0.046</td>
<td>0.211</td>
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<tr>
<td>16</td>
<td>256</td>
<td>0.172</td>
<td>0.052**</td>
<td>0.087</td>
<td>0.109</td>
<td>0.048*</td>
<td>0.114</td>
</tr>
<tr>
<td>20</td>
<td>248</td>
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<td>0.053*</td>
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<tr>
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<td>-0.015</td>
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<td>0.048**</td>
<td>0.029</td>
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<td>0.028</td>
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<td>0.029</td>
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<td>0.045**</td>
<td>0.026</td>
<td>-0.314</td>
<td>0.047**</td>
<td>0.024</td>
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<tr>
<td>46</td>
<td>196</td>
<td>-0.516</td>
<td>0.044**</td>
<td>0.022</td>
<td>-0.364</td>
<td>0.047**</td>
<td>0.018</td>
</tr>
</tbody>
</table>

* Each currency given an intercept term which is not reported.
* Significant at the 5% (one-tailed) level.
** Significant at the 1% (one-tailed) level.

Table IV shows estimates of \(\beta_k\) in the regression \((s_{t+k} - s_t) = \beta_k(s_{t+k} - s_{t-k}) + \gamma_t\), for \(k=\{1, 8, 16, 20, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46\}\), for both the Y/$ and DM/$ spot rates. The estimates are plotted in Figure II. The results show negative autocorrelations in long-horizon differences of spot rates. These data indicate that
both the Y/$ and DM/$ spot rates begin to exhibit mean reverting behavior around the 30 week interval.

As hypothesized, the negative autocorrelations continue to decrease as the time horizon is lengthened. After 46 weeks, the transitory component of the Y/$ and DM/$ spot rates accounts for approximately 50% and 36% of the variation in exchange rates, respectively. These estimates support the above evidence from Table III which suggests that the DM/$ spot rate contains a smaller transitory component than the Y/$ rate at the one week horizon; or similarly, the mean reversion of the DM/$ spot rate is smaller than that of the Y/$ spot rate at a given time. After 40 weeks, for example, the transitory component accounts for 30% of
the variation in the ¥/$ exchange rate, while for the DM/$ rate, the transitory component explains 20% of the variation.\textsuperscript{17}

As the coefficients continue to decline over longer horizons, the standard errors become relatively small, and t-values increase. T-values near the early stages of mean reversion ($k=26-34$), on the other hand, are quite small. Interpretation of the regression coefficients for these shorter horizons is statistically problematic. However, as Huizinga (1987) notes:

> While the magnitude of these deviations from random-walk behavior is obviously large in an economic sense, it is not significant in a statistical sense. Someone with strong \textit{a priori} information that real exchange rates are random walks need not be persuaded otherwise by the data. Nonetheless, those who look to the data to obtain a reasonable "best guess" are unlikely to select a random-walk specification to describe long-run behavior of real exchange rates (p.186).

\textbf{IV. b. Sources of Temporary Components}

The assertion that foreign exchange rates may contain a transitory component can be motivated intuitively by considering, for example, monetary policies of the Federal Reserve. In October of 1979 the Fed reaffirmed its commitment to a stable monetary policy. Subsequent perception of the Fed's credibility could have led market participants to expect the Fed to correct any deviations of the money supply from its expected growth target. For instance, if the money supply announcement were greater than the expected level, the anticipation of future tightening would cause an increase in the current interest rate, and these higher interest rates would lead to an increase in the demand for dollar denominated assets, thus causing an appreciation of the dollar. Similarly, if the commitment of other public and private actions designed to prevent extreme

\textsuperscript{17} See Appendix A for OLS estimates.
volatility of currencies were also perceived as credible, market participants would expect a certain level of stability in the long run. This intuitive outline rooted in monetarist theories is by no means exhaustive; nevertheless, given investors’ expectation of these various intervention policies, it would not be surprising to discover temporary movements in exchange rates.

Interpreting the predictability of long-horizon movements in asset prices caused by a transitory component is subject to two competing economic explanations. Implied temporary swings away from fundamental values can be interpreted as supporting an inefficient market hypothesis (or as a rejection of the equilibrium asset pricing models). On the other hand, the presence of such behavior could also result from time-varying risk factors, in which case the swings constitute variations in equilibrium expected values.\textsuperscript{18}

Another possible suggestion can be found in the stock market literature. Recently, De Long, Shleifer, Summers, and Waldman (1990) showed that the existence of transitory components in stock prices can be explained if market participants are either sophisticated investors (i.e., those who use fundamental analysis) or noise traders. DSSW argued that with the unpredictable nature of noise traders’ misconceptions of fundamental values, noise traders may be compensated for bearing the additional risk which they themselves create; thus, in arbitraging to exploit noise traders’ opinions, sophisticated investors must bear the additional risk that misconceptions will become even more extreme. If noise traders’ misconceptions are serially correlated, sophisticated investors will not be willing to bet as heavily against noise traders. If we assume that some market participants are passive (not responding to noise or betting against noise

\textsuperscript{18} Fama and French (1988) provide an intuitive explanation of how these opposite positions can imply similar predictability in stock prices. A formal discussion can be found in Summers and Poterba (1988).
trades), the temporary nature of the noise traders’ errors can cause asset prices to deviate temporarily from fundamental values.

Yet another cause of temporary fluctuations in exchange rates may be found by considering coordinated exchange rate policies between countries. The extreme volatility of exchange rates, since floating regimes were implemented in 1973, led monetary authorities to coordinate attempts to stabilize currencies. Unlike the stock market, exchange rate markets can be influenced directly by coordinated policy intervention.

Concerned with increasing U.S. external trade deficits and the ballooning dollar during the mid 1980’s, finance ministers of the G5 agreed during their famous Plaza meeting in February 1985 to pursue direct intervention in order to drive the dollar lower. Other well publicized accords aimed at stabilizing exchange rates include the Baker-Miyazawa Pact of 1986 and the Louvre Accord in February 1987. The purpose of these meetings, ostensibly, was to obtain commitments to coordinate intervention policies in order to stabilize exchange rates. Commitments alone, however, do not stabilize exchange markets.

If a shock causes the demand for dollars to fall, we could observe an appreciation of the \( Y \) and the DM, as investors shift their demand from dollar denominated assets into \( Y \) and DM denominated assets. The commitment of intervention by central monetary organizations to support the dollar from any additional depreciation could result in the dollar taking only a temporary swing. Similarly, an increase in demand for dollars, followed by intervention to bring the dollar back down, would also result in only a temporary fluctuation. The existence of temporary movements, then, depends to a certain degree on the extent and effectiveness of intervention.

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19 Whether or not the subsequent depreciation of the dollar would have occurred regardless of the G5 intervention is questionable. The G5 includes the United States, Germany (then West Germany), France, Japan and Britain.
As the evidence in Table III and IV suggests, the ¥/$ spot rate seems to contain a larger temporary component than the DM/$. This empirical observation can be supported by considering the institutional structure which anchors the DM – the European Monetary System. One of the main goals of the EMS is to limit exchange rate volatility between member countries, with the German DM serving as the anchor currency. Prior to the Basle-Nyborg meetings in September 1987, intervention was obligatory when an EMS member currency reached the 2.25% margin around the EMS valuated exchange rate. Unlike this “red-light” intervention, West Germany agreed, after September 1987, to finance “orange-light” interventions before a currency reached its ceiling or floor rate; that is, Germany was readily willing to intervene in matters concerning EMS members.20

If the ¥ and DM appreciate as investors shift their demand from dollar denominated assets to DM and ¥ denominated assets, the ¥/$ and DM/$ spot rates will fall. To maintain stability of the dollar, intervention from the Bank of Japan would support the dollar and drive the ¥/$ spot rate back to a more appropriate level. Before West Germany can intervene to strengthen the dollar, however, its important position in the EMS warrants priority attention. The appreciation of the DM against the French franc, for example, could cause the Bundesbank to intervene by purchasing French francs in order to bring the DM/Ffr rate within the prescribed EMS margin. As a result, Germany’s DM holdings would fall while its Ffr reserves would rise. This movement in the domestic DM supply could cause interest rates in Germany to rise.21 These higher interest rates

20 “A long Road to Reform,” The Economist, March 26, 1988, p.86.
21 Another possibility is that Germany could sell DM, in which case the domestic money supply would increase, and its interest rates fall. However, it was well known in the 1980’s that the Bundesbank was reluctant to gamble because of its inflationary anxiety. This anxiety caused the Bundesbank to be reluctant to sell DM. See “Francy Speaking,” The Economist, January 10, 1987, p.66.
would then lead to increased demand for DM denominated assets, thus keeping the DM strong.

A possible implication, then, is that because of Germany's priority position within the EMS, the Bundesbank may be slower to react directly in the DM/$ market. This seems to suggest that a positive shock to the DM caused by investors shifting their demand from dollars to DMs will only be augmented by Germany's efforts to maintain EMS parities. The delayed intervention to maintain dollar stability may result in temporary shocks to the DM/$ exchange rate which take longer to return to fundamental levels.22

Directly obtaining empirical evidence which supports this hypothesis is quite difficult. Central monetary authorities are hesitant to provide details concerning the number and size of direct interventions. News from the financial grapevine, however, may provide some insight. As the dollar kept depreciating in 1987, stories spread that the Secretary of Treasury, James Baker 3d, continued to urge Japan and West Germany to stimulate their domestic demand. At the April 1987 meeting in Washington of the G7 finance ministers, Kiichi Miyazawa, Japan's Minister of Finance, presented stimulative fiscal measures for Japan. West Germany's finance minister, Gerhard Stoltenberg, did not.23 Later in 1987, Baker was reported to have criticized the Germans for not lowering their interest rates.

When the dollar recovered in 1989 and seemed to be appreciating too quickly, the Germans did not freely intervene to put depreciating pressures on the dollar. A Wall Street Journal article quotes an economist from Salomon as saying, "Whenever the market has put the most pressure on the Bundesbank to

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22 That is to say, $\beta_k$ in equation (6.b) – the proportion of the variation of the $k$-period difference in exchange rates which is explained by the mean reversion of the decaying transitory component – will be smaller for the DM/$ spot rate than the ¥/$ spot rate, as was reported in Table IV.

23 "On the Skids," The Economist, April 18, 1989, p.76.
tighten, it has resisted."24 The Germans were reluctant to raise domestic interest rates to help depreciate the dollar.

Intervention by the Japanese, on the other hand, seems to have been more direct and aggressive. During 1987, though central banks from various nations intervened in exchange markets to assist in pegging-up the depreciating dollar, "The Japanese [were] clearly at the forefront of the currency battle . . . Japan seemed to be the only country making a genuine effort."25 These comments from the financial press are intended to serve only as a brief glance into the complexities involved in exchange rate policy coordination. They merely provide insights into one possible suggestion as to how a delayed response from central monetary authorities could lead to a slower correction of temporary swings in exchange rates.

V. a. Exchange Rate Expectations

Given that transitory components cause exchange rates to exhibit mean reverting behavior, how are expectations of future spot rates influenced by this temporary swing? Specifically, are expectations consistent with the behavior implied in the long horizon movement of exchange rates? If investors expect exchange rates to revert to a mean, it seems intuitive that a past appreciation of a currency leads investors to expect a future depreciation, and *vice versa.*26 This final section of the paper examines some of the different specifications of expectations. These mechanisms are intended to provide only a picture of possible specifications most likely to be used in forming expectations.

26 The key assumption is that they expect no changes in fundamentals.
Using forecasts from the *Financial Report, Amex Bank Review*, and MMS for various horizons, Frankel and Froot (1987, 1988) examine different specifications for how expectations are formed. The general framework begins with the assumption that the expected future spot rate is a weighted average of the contemporaneous spot rate, $s_t$, and other factors, $x_t$:

\[(10) \ s^e_{t+n} = (1-\beta)s_t + \beta x_t,\]

where $s_t$ is the log of the spot rate and $s^e_{t+n}$ is the log of the expected future spot rate for $t+n$ at $t$.

Examining the weight investors (survey respondents) place on the other factors allows us to distinguish how expectations are formed. The null that expectations are random walks, or static, is $\beta=0$. The task is then to examine different candidates for the other factors, $x_t$.

**V. b. Extrapolative Expectations**

Suppose, for simplicity, that expectations are formed as a distributive lag, with investors assigning a weight of $\omega$ to the lagged spot rate and a weight of $(1-\omega)$ to the current spot rate:

\[(11) \ s^e_{t+1} = (1-\omega)s_t + \omega s_{t-1}\]

where $s_t$ is the log of the spot rate and $s^e_{t+1}$ is the expected future spot rate for $t+1$ at time $t$.

If we subtract the current spot rate from both sides, we get the expected depreciation (appreciation) of the spot rate as proportional to the current change in the spot rate:
Frankel and Froot term this model “extrapolative expectations”. If investors extrapolate the most recent trend (i.e., \( \omega<0 \)), then they exhibit “bandwagon expectations”. If, for example, a currency has recently appreciated, investors would expect the appreciation to continue and they would increase their demand for the currency; similarly, if a depreciation of the currency has recently occurred, future depreciation would be expected. This type of extrapolation of recent trends seems to be consistent with the chartists perspective (investors who project trends from charts).

Then, if chartists were to dominate foreign exchange markets, the bandwagon effects would make the markets somewhat de-stabilizing. Frankel and Froot (1990) note that during the 1980’s a move was made away from fundamental analysis to more technical or chartists methods by many of the leading institutions involved in exchange rate trading. Balancing this destabilizing influence, however, is the transitory component in exchange rates. If investors are aware of the mean reverting behavior of exchange rates, then their chartists tendencies may be suspended.

Table V reports SUR estimates of the coefficient in equation (12.b), the extrapolative expectations equation. These results seem to contradict Frankel and Froot’s (1988) finding that short term expectations exhibit bandwagon tendencies. Their estimates from using the MMS one week and one month forecasts indicate that given a 10% appreciation, the spot rate is expected to appreciate an additional 1.35% and .54% over the next one week and one month, respectively.
Table V depicts a different scenario. One week expectations for both the Y/$ and DM/$ spot rates are “stabilizing” and are significant at the 5% and 7.5% levels, respectively; since the spot rates are in logarithmic form, a 10% appreciation of the DM/$ spot rate over the past week leads to an expected depreciation of .81% for the following week. Similarly, a 10% appreciation in the Y/$ spot rate will lead to an expected depreciation of .69% in the next seven days.\(^{27}\) In contrast to the one

\(^{27}\) Since exchange rates seem to exhibit mean reversion around 30 weeks, it may seem odd that expectations for one week are not extrapolative. One interpretation of the bandwagon tendency reported by Frankel and Froot is that investors anticipate mean reversion sometime in the far future. It can be interpreted that, as long as \(\omega < 1\), the extrapolative model of expectations is not de-stabilizing. The fact that the absolute value of the coefficient is less

Table V

Extrapolative Expectations Model
Independent Variables: \(s_t-s_{t-1}\)
SUR regressions of: \(s_{t+1} = \alpha - \omega(s_t - s_{t-1})\)

<table>
<thead>
<tr>
<th>Spot Rate</th>
<th>Forecast</th>
<th>Dates</th>
<th>(\omega)</th>
<th>(t: \omega=0)</th>
<th>DW</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM/$</td>
<td>One Week</td>
<td>11/7/84-2/8/89</td>
<td>.081 (.049)</td>
<td>1.626*</td>
<td>1.511</td>
</tr>
<tr>
<td></td>
<td>One Month</td>
<td>11/7/84-2/8/89</td>
<td>.017 (.054)</td>
<td>.324</td>
<td>1.340</td>
</tr>
<tr>
<td>Y/$</td>
<td>One Week</td>
<td>11/7/84-2/8/89</td>
<td>.069 (.038)</td>
<td>1.803**</td>
<td>1.870</td>
</tr>
<tr>
<td></td>
<td>One Month</td>
<td>11/7/84-2/8/89</td>
<td>.066 (.058)</td>
<td>1.131</td>
<td>1.313</td>
</tr>
</tbody>
</table>

* \(H_0\): Random Walk or Static Expectations, \(\omega=0\). \(H_1\): Non-Bandwagon, \(\omega>0\).
** Standard errors are reported in parentheses. Each currency given an intercept term which is not reported.
* Significant at approximately the 7.5% (one-tailed) level.
** Significant at the 5% (one-tailed) level.
week expectations, results of extrapolative expectations for the one month horizon do not provide conclusive evidence. The estimates are not at all significant. The extrapolative expectations model does not seem to adequately portray expectations for longer horizons.28

The discrepancy in estimates for the one week extrapolative model can be explained if we consider the two different sample periods. Expectations data used by Frankel and Froot (1988) covered the dollar's alleged "bubble" path between June 1984 and February 1986.29 In 1984, the dollar began its steady and consistent appreciation; the mood of the market may have been similar to Schiller's "fads" model. At any moment during this period, the chartists' techniques or technical analysis would have predicted continued appreciation. Seeing the rest of the market profit from speculating on the dollar's appreciation would have lured many to join the "bandwagon".30 The dollar reached its peak in February of 1985 and began its steady fall; this subsequent period of depreciation could have provided another foundation for speculative, bandwagon expectations. It seems, then, that the bandwagon tendencies observed by Frankel and Froot (1988) can be explained, to a certain extent, by the speculative character of their sample period.

The expectations data used in this paper extend well beyond the volatile mid 1980's and into the era of international exchange rate coordination. As the dollar continued its depreciation, finance ministers from the leading industrialized countries began discussing ways to curb excessive volatility within exchange markets. As discussed earlier, two important meetings in November 1986 and
February 1987 arguably seemed to signal the end of excessive volatility such as the alleged "bubble" path of the mid 1980's. In November 1986, Treasury Secretary Baker met with Japan's Finance Minister, Miyazawa; they agreed that the dollar had fallen enough and that future concerns should focus on stability. This position was reiterated during the Louvre Accord in February 1987. Agreeing that the dollar had fallen to a more fundamental level, the finance ministers of the G7 publicly committed themselves to helping stabilize exchange markets.

Understandably, if investors believed these commitments to be credible, speculating on another swing of the dollar similar to that of the mid 1980's would not have been perceived as profitable. Swings in exchange rates would be short lived. In such a market, participants would be unlikely to bet that trends would continue without intervention from monetary authorities. The profitable strategy, then, would seem to be the one which speculates against recent trends. Thus, the credibility of the various monetary authorities to maintain a stable dollar may have influenced the way in which short term expectations were formed.

To test the hypothesis that coefficients for the extrapolative expectations

<table>
<thead>
<tr>
<th>Extrapolative Expectations</th>
<th>$F_{DMwk}$</th>
<th>$F_{¥wk}$</th>
<th>$F_{DMmth}$</th>
<th>$F_{¥mth}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.00*</td>
<td>5.78*</td>
<td>8.69**</td>
<td>8.04**</td>
</tr>
</tbody>
</table>

* Significant at the 5% level.
** Significant at the 1% level.

specification did not remain constant throughout the two sample periods, a Chow test was performed by dividing the data set into two sub-periods: the approximate
period covered by the Frankel and Froot data set (1984 through 1986), and the period between 1987 through 1989. Results in Table VI indicate that coefficients for extrapolative expectations were not constant through the two sub-periods.

V. c. Regressive Expectations

We have seen evidence which suggests that mean reversion in nominal exchange rates occur at relatively long horizons. Naturally, the next step is to examine how expectations are formed relative to long horizon movements in spot rates. Again, the specification for such an expectations model can be in Frankel and Froot's (1988) study. Using the longer horizon forecasts provided by Amex Bank Review and the Financial Report, Frankel and Froot (1988) found that expectations for these horizons exhibited a regressive tendency. That is to say, over time investors expected exchange rates to move towards a long-run equilibrium level, $s^*$. Frankel and Froot (1988) assumed that expected spot rates were a weighted average of the current spot rate and a long-run equilibrium rate (defined in terms of fundamental notions such as PPP):

\begin{equation}
se_{t+1} = (1-\theta)s_t + \theta s^* \tag{13}
\end{equation}

where $s^*_t$ is a long-run equilibrium exchange rate.$^{31}$

Re-arranging, we get the following in terms of expected depreciation:

\begin{equation}
(s_{e,t+1} - s_t) = -\theta(s_t - s^*_t) \tag{14}
\end{equation}

---

$^{31}$ $s^*_t = s_0 + \log \left( \frac{P}{P^*} \right)$, where $s_0$ is the log of the average nominal value of the foreign exchange currency in terms of dollars, 1973 - 1979, and $P$ is the domestic ratio of the current CPI to the average CPI for 1973-1979 and $P^*$ is the foreign ratio of the current ratio of the current CPI to the average CPI for 1973-1979.
If $\theta > 0$, the spot rate is expected to move towards $s^*$. If $\theta < 0$ the expected spot rate moves away from the long-run equilibrium. Frankel and Froot's results shed more light on exchange rate behavior. Their specification, however, for the equilibrium rate seems inappropriate. Their long run equilibrium is calculated using PPP for 1973 through 1979. To use this value as a proxy for the long run equilibrium rate during the 1980's is questionable. Presumably, the early period of floating exchange rate regimes was affected by factors driving PPP, such as the selection of appropriate price indices, etc., which were completely different in the 1980's. There is no reason to believe that factors such as relative prices between countries remained constant over the two time periods.

Since we are interested in how expectations are formed in light of mean reversion, a simple but effective model would be to test if investors expect exchange rates to return to their mean. Given the large number of observations (288 weeks), the sample mean should be a good proxy for the true mean (the possibility that the true mean may not have been constant throughout the sample period is addressed below). Suppose then, that expected future spot rates are a function of the contemporaneous spot rate and the mean spot rate. If we replace $s^*$ in equation (14) with the sample mean, $s_m$, then $\theta$ measure the speed at which the spot rate is expected to move towards the mean (This specification will be termed Mean Regressing Expectations.) If $\theta > 0$ the spot rate is expected to move towards the mean. Verifying this hypothesis would be consistent with mean reversion; namely, if exchange rates are currently above the long run average, then investor's who expect mean reversion would anticipate future exchange rates to fall towards the mean. Table VII reports estimates of $\theta$.

Expectations for longer horizons should be better explained by specifications which take into consideration current spot rate movements relative to a “long run equilibrium”. Results in Table VII seem to support this notion.
Table VII
Mean Regressive Expectations
Independent Variables: $s_{t-1}-s_m$
SUR regressions of: $s_{t+1} = \alpha - \theta (s_t - s_m)$

<table>
<thead>
<tr>
<th>Spot Rate</th>
<th>Forecast</th>
<th>Dates</th>
<th>$\theta$</th>
<th>$t: \theta=0$</th>
<th>DW</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM/$</td>
<td>One Week</td>
<td>11/7/84-8/2/89</td>
<td>.0067</td>
<td>1.570*</td>
<td>1.450</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(.0043)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DM/$</td>
<td>One Month</td>
<td>11/7/84-8/2/89</td>
<td>.0278</td>
<td>5.277**</td>
<td>1.526</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(.0052)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>¥/$</td>
<td>One Week</td>
<td>11/7/84-8/2/89</td>
<td>.0036</td>
<td>1.315</td>
<td>1.744</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(.0027)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>¥/$</td>
<td>One Month</td>
<td>11/7/84-8/2/89</td>
<td>.0175</td>
<td>3.688**</td>
<td>1.324</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(.0047)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $H_0$: Random Walk or Static Expectations, $\theta=0$. $H_1$: Mean Regressive, $\theta>0$.
* Standard errors are reported in parentheses. Each currency is given an intercept term which is not reported.
* Significant at the 5% (one-tailed) level.
** Significant at the 1% (one-tailed) level.

Not only are the coefficients for the one month forecasts larger than the coefficients for the one week forecasts, but they are more significant. As we can see from Table VII, exchange rates are expected to move toward their sample mean. If the current DM/$ spot rate is 10% above its mean, forecasters expect it to fall .28% towards the sample mean over the next month.

Of course, using the mean for the entire sample in the independent variable may not be appropriate, since it is possible that the true mean varies over time. In our data sample, two distinct periods become obvious: the large swing in the dollar between 1984 and 1986, and the subsequent rather stable period between 1987 and 1989. Though the true mean and its innovations cannot be observed, if a change in
the mean actually occurred, these two periods may provide some insight. I
estimated the Mean Regressing Expectations for these two periods using their
respective sample means. Table VIII reports the Chow test results.

Table VIII

<table>
<thead>
<tr>
<th>Chow F Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>F_{DMwk}</td>
</tr>
<tr>
<td>5.02*</td>
</tr>
</tbody>
</table>

* Significant at the 5% level.
** Significant at the 1% level.

These critical F values allow us to reject the null that coefficients on the Mean
Regressing Expectations model remained constant throughout the two different
periods.

VI. Conclusions

Using a similar technique that Fama and French (1988) applied to stock
prices, this paper focused on the long run predictability of nominal exchange
rates. Both the theoretical and empirical results suggest that accepted tests of
random walks cannot be simply accepted. Rather, spot rates seem to be positively
 correlated over short horizons (up to around thirty weeks) and negatively
 correlated over long intervals. This behavior is consistent with the statistical
 hypothesis that exchange rates contain a slowly decaying stationary component.
The negative autocorrelations over long intervals are caused by the mean
reversion of this temporary component.
In addition, the results in Section V (based on data for 1984 through 1989) indicate that standard methods of specifying expectations produce estimates which are consistent with the mean reversion in exchange rates; a past appreciation leads to an expected depreciation, and *vice versa*. As with many empirical studies, however, this paper raises additional questions. Particularly, the consistency of expectations with mean reversion of exchange rates contradicts Frankel and Froot's (1988) finding (based on data for 1984 through 1886) that one week and one month expectations are formed extrapolatively based on recent trends.

The hypothesis which naturally stems from such a contradiction is that we have no reason to believe expectations remained constant throughout the different sample periods. Specifically, the shift to international exchange rate coordination in 1986-1987 seems to provide an extremely plausible juncture at which expectations may have been altered. Within such a context, it should not be surprising that Frankel and Froot (1988) observed "bandwagon" tendencies; their sample period coincided with the ballooning roller coaster ride of the dollar during the mid 1980’s. The data used in this paper extend well beyond this volatile period into the relatively stable years of international exchange rate coordination. Such a policy shift in 1986-1987 could arguably have had an affect on the way in which expectations were formed. Simple Chow tests support the hypothesis that regression coefficients of expectations models did not remain constant throughout the two sample periods, 1984-1986 and 1987-1989.

To the outsider, the foreign exchange market is imagined as a face-paced, high-tech, high-power playground where the wealth of men in red suspenders are made (and lost) based on the latest piece of information flashing across electronic boards. Predicting long run movements in such a market may seem like an impossible task. The fact that major international financial institutions are
willing to support their exchange rate traders with millions of dollars in such an unpredictable environment may shock the un-initiated. However, results in this paper suggest that long horizon movements in exchange rates may be less risky than what are implied by extrapolating short run trends; and in addition to statistical tests on actual spot rate fluctuations, forecasts by leading institutional participants seem to support this notion of predictability in the long run.
APPENDIX A

Results in Table IV were estimated using Seemingly Unrelated Regressions. Using monthly stock returns, Fama and French (1988) estimate the same equations, but with OLS. Huizinga (1987) used OLS on monthly real exchange rates. This appendix reports estimates of the $k$-difference autocorrelations using OLS. In order to avoid the biases in OLS estimates, Fama and French (1988) constructed simulations to estimate bias adjustments. They report that when stock prices have stationary components which produce negative autocorrelations, the simulations generate estimates which are similar to OLS estimates. OLS seems to have little bias.

**OLS Estimates of Equation (6.a)**

$$(s_{t+k} - s_t) = \alpha + \beta_k (s_{t-k} - s_{t-k}) + \gamma_t$$

| $k$ (Wks) | YEN/$ | | | |
|---|---|---|---|
| 1 | 286 | .067 | .059 | 2.010 |
| 8 | 272 | .152 | .061** | .190 |
| 16 | 256 | .220 | .064** | .091 |
| 20 | 248 | .201 | .066** | .075 |
| 26 | 236 | .213 | .065** | .056 |
| 28 | 232 | .209 | .065** | .054 |
| 30 | 228 | .172 | .065** | .047 |
| 32 | 224 | .115 | .065* | .046 |
| 34 | 220 | .056 | .064 | .038 |
| 36 | 216 | -.007 | .064 | .032 |
| 38 | 212 | -.086 | .063 | .029 |
| 40 | 208 | -.167 | .062** | .033 |
| 42 | 204 | -.245 | .062** | .031 |
| 44 | 200 | -.319 | .061** | .028 |
| 46 | 196 | -.370 | .060** | .023 |

| $k$ (Wks) | DM/$ | | | |
|---|---|---|---|
| 1 | 245 | .045 | .452 | 1.999 |
| 8 | 238 | .128 | .060* | .242 |
| 16 | 229 | .294 | .059** | .143 |
| 20 | 224 | .291 | .059** | .118 |
| 26 | 216 | .286 | .058** | .080 |
| 28 | 212 | .266 | .058** | .080 |
| 30 | 208 | .231 | .057** | .073 |
| 32 | 204 | .188 | .057** | .069 |
| 34 | 200 | .157 | .057** | .057 |
| 36 | 196 | .128 | .058* | .048 |
| 38 | 192 | .088 | .059 | .044 |
| 40 | 188 | .043 | .060 | .037 |
| 42 | 184 | -.015 | .062 | .038 |
| 44 | 180 | -.073 | .063 | .029 |
| 46 | 176 | -.120 | .065* | .023 |

* Each currency given an intercept term which is not reported.
* Significant at the 5% (one-tailed) level.
** Significant at the 1% (one-tailed) level.
Qualitatively, the above results are similar to those in Table IV. The Y/$ spot rate seems to contain a larger temporary component. The autocorrelations for the Y/$ become negative around the 36 week horizon, whereas the DM/$ begins to revert to the mean around the 42 week interval (Using SUR, the coefficients became negative at the 30 week horizon.) This suggests that the Y/$ reverts to the mean earlier than the DM/$. At the 42 week horizon, for example, mean reversion in the Y/$ transitory component accounts for approximately 24% of the variation in the spot rate; the transitory component for the DM/$ accounts for much less at .15% of the variation in the spot rate.
REFERENCES


