Market Overreaction and Under-reaction for Currency Futures Prices

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Abstract

Research has documented overreaction and under-reaction in many markets including the stock market and the foreign currency spot market. This paper addresses market over- and under-reaction for foreign currency futures contracts. Our data set consists of daily observations of futures prices, spot exchange rates, and Eurocurrency LIBOR for the British Pound, Japanese Yen and Swiss Franc from January 2, 1991 to December 31, 2006. Using a 5-year moving window method and the foreign currency futures pricing model of Amin and Jarrow (1991), we find repeated evidence of cointegration among the futures price, the spot exchange rate, and interest rates over ten different estimation periods. An error-correction model is then used to develop a series of predicted futures price changes. We assess whether the market overreacted or under-reacted to new information by comparing the actual futures price change to the change predicted by the error correction model.

For each event (extreme, one-day price change), Lexis-Nexis is accessed to determine if news services offered an explanation. An informed event (winner or loser) refers to an extreme currency futures price change that corresponds with an explanation in Lexis/Nexis. The informed winner and informed loser samples are each broken down according to whether the announcement is economic or political in nature. Uninformed winners and uninformed losers are extreme, one-day futures price changes that do not correspond to Lexis/Nexis news announcements.

Our results suggest the type of underlying announcement is useful in pinpointing when the market over- and under-reacts to new information pertaining to foreign currency futures prices. Specifically, for winners it appears the market overreacts to political news and news that is not widely publicized (uninformed events). For losers there is evidence suggesting the market under-reacts to political announcements and there is some evidence of overreaction for the sample of uninformed losers. Overall, there are two major findings. First, it appears the market is too optimistic when favorable and unfavorable political news is released pertaining to the British Pound, Japanese Yen and Swiss Franc. Second, it appears the market overreacts to new information when that information is not widely publicized.

Introduction and Literature Review

This paper addresses the behavior of currency futures prices upon the release of new information. We examine extreme, one-day changes in futures prices where a loser is defined as an extreme, one-day decline in the futures price and a winner is defined as an extreme, one-day increase in the futures price. The underlying information at the time of each extreme price change (event) is gathered from Lexis/Nexis and the type of information is categorized. An informed event is an extreme price change that corresponds to a release of news while an uninformed event does not correspond to publicly released information. The sample of informed events is categorized further into two groups. The first group pertains to the release of economic news and the second group pertains to the release of political news.

Our results suggest controlling for the type of underlying announcement is useful in pinpointing currency futures market over-and under-reaction. The full sample of winners and the full sample of losers are not associated with over- or under-reaction. However, for winners the political sub-sample and uninformed sub-sample are each associated with overreaction. There is also some evidence that economic announcements are associated with under-reaction. For losers, the political sub-sample is associated with under-reaction and there is some evidence of overreaction for the uninformed sub-sample.

In their influential paper, DeBondt and Thaler (1985) were the first to formally study overreaction in the stock market. Using a three year period, DeBondt and Thaler formed ten portfolios of stocks based on performance. During the subsequent three year period the lowest decile of stocks out-performs the highest decile of stocks by 24.6% (statistically significant). Many studies follow such as Atkins and Dyl (1990) and Bremer and Sweeney (1991) where evidence suggests the stock market overreacts to news at the time it is released and subsequently corrects itself over the next few trading days.

Larson and Madura (2003) examine stock price overreaction for winners and losers while controlling for the underlying information releases. They control for the information that was released at the time of the extreme price changes. Informed events (losers and winners) are associated with underlying information releases while uninformed events are not. Their results suggest controlling for the underlying information is useful when attempting to pinpoint when the market over- and under-reacts. Specifically, their uninformed winners are associated with an overreaction phenomenon, but their informed winners are not. This suggests the market overreacts to information when trading of private information, but efficiently reacts to public information. This may be related to investor self-attribution bias as discussed by Daniel, Hirshleifer, and Subrahmanyam (1998); they postulate that market participants are more prone to overreact when trading on non-publicized information.

Using an event-study method Larson and Madura (2001) also examine overreaction and under-reaction for spot currency exchange rates. For emerging currencies these authors find evidence suggesting the market overreacts, but for industrial currencies these authors find evidence suggesting the market under-reacts. These authors also control for the underlying information releases and find evidence that the degree of overreaction is conditioned upon the underlying information released.

In this paper, we examine the response of currency futures prices to underlying information releases using the theory of cointegrated processes. We also control for the underlying information releases to help pinpoint when the market is prone to over- and under-react.

Hypotheses

It seems reasonable to assume the currency futures market will under-react to information causing extreme, one-day price adjustments for currency futures prices. Larson and Madura (2001) examine spot exchange rates and their results suggest the market under-reacts to news about industrial currency. Since spot and futures prices almost always move in phase we expect to find under-reaction for the currency futures prices in our sample. Our first hypothesis is formally stated below:

Hypothesis 1: Extreme, one-day price changes in currency futures prices will be followed by price changes in the same direction.

Extreme futures price changes are expected to be associated with the release of public information. In light of findings in the literature, it seems reasonable to presuppose the market will respond differently to different types of information. Larson and Madura (2001) find evidence pursuant to industrial spot exchange rates that suggests the market is more likely to overreact when extreme currency price changes are not associated with underlying information releases. In their theoretical paper, Daniel, Hirshleifer, and Subrahmanyam (1998) suggest market participants overreact more when trading on private information. These authors suggest market participants possess self attribution bias, which suggests they are over confident when they hold information that has not been delegated to the general public. For this reason we believe our samples of uninformed winners and uninformed losers will be associated with overreaction. Our second hypothesis is formally stated below:

Hypothesis 2: Extreme, one-day price changes in foreign currency futures prices will be associated with reversals (overreaction) when no news corresponds to the price change.

A cross-sectional analysis is conducted and the main purpose is to examine whether the market reacts differently to different types of announcements while controlling for other factors. The other factors are the initial degree of mispricing on day 0 and the degree of mispricing (leakage) on day -1. We offer two hypotheses based on the existing literature with regard to these two factors.

First, Brown and Harlow (1988); and Akhigbe, Gosnell and Harikumar (1998) find evidence that larger abnormal returns on day zero are associated with a higher degree of overreaction. These authors reason that larger events are associated with larger degrees of uncertainty and therefore larger degrees of overreaction. Hypothesis three is stated formally below:

Hypothesis 3: Larger price movements on the event day will be associated with larger degrees of overreaction.

Second, Daniel, Hirshleifer, and Subrahmanyam (1998) postulate that stock prices will overreact to private information signals. They reason that investors overweigh private signals and therefore overreact. They attribute this to investor self-attribution bias, or overconfidence. If their theory is correct, higher degrees of pre-event leakage will be associated with a higher degree of overreaction. Hypothesis four is stated formally below:

Hypothesis 4: Larger price movements on day -1 will be associated with higher degrees of overreaction.

Model Development

In their seminal paper, Engle and Granger (1987) introduced the theory of cointegrated processes as a means of testing long-run theories among non-stationary variables. Because many financial time series contain stochastic trends, much attention in the financial literature has been devoted to the possibility of two or more assets being cointegrated, that is, sharing a common stochastic trend. Examples of cointegration among equities can be found in Bossaerts (1988), Cerchi and Havenner (1998), and Kasa (1992). Cointegration has also frequently been found among foreign exchange rates and Baillie and Bollerslev (1989) find that seven currencies are cointegrated.

Cointegration has been found in many commodity markets. For example, Bachmeier and Griffin (2006) use a cointegration method to evaluate the integration between and within the markets for coal, natural gas and crude oil. They find that the markets for crude oil are highly integrated and can be viewed as a single global market. In contrast, while the US coal industry is cointegrated across regions, it shows less integration than the oil industry as indicated by the slow speeds of adjustment in the error correction representation. Finally, the market for natural gas is only weakly related to the other two sources of energy. Based on their analysis, the authors conclude that a single energy complex does not exist. Warrel (2006) uses the Engle-Granger two stage cointegration method to analyze international integration in the coal industry. She finds cointegration and interprets this as evidence of a global coal market. She concludes that market concentration concerns for mergers in the coal industry may be exaggerated because the relevant reference region is the entire global market.

In the case of futures markets, traders agree to receive or deliver a given spot market commodity at a certain time in the future for a price that is determined today. In such circumstances, it is not surprising that a long-run relationship between futures prices and spot prices may prevail. Cointegration in futures markets does not necessarily occur in every instance, but, under many circumstances, cointegration between spot and futures prices would be expected on theoretical grounds and has been documented empirically.

The theoretical arguments for cointegration between spot and futures prices are typically based on market efficiency, price convergence, and/or the stationarity of the cost of carry. Hakkio and Rush (1989) and Shen and Wang (1990) demonstrate that cointegration between spot and futures prices is a necessary condition for market efficiency if there is no risk premium. Chowdhury (1991) and Lai and Lai (1991) argue that price convergence at maturity will lead to cointegration between the spot and futures prices. Lien and Luo (1993) discuss the relationship between cointegration and the cost of carry and argue that a stationary cost of carry should exist for short maturity contracts, particularly if interest rates are low. For longer maturity contracts, cointegration may still apply if the cost of carry is near zero due to a trade-off between the convenience yield and storage costs.

Empirically, Chowdhury (1991) finds evidence of cointegration between certain spot and futures prices in metal markets. Wahab and Lashgari (1993) and Ghosh (1993) find cointegration between the S&P 500 spot index and futures contracts. Quan (1992) and Seretis and Banack (1990) discover cointegration in crude oil markets. In currency markets, Baillie and Bollerslev (1989), Hakkio and Rush (1989), Kroner and Sultan (1993), Ghosh (1993), and Lien and Luo (1993) find cointegration between foreign exchange futures and spot markets.

More recently, error-correction methods have been used to investigate market integration and to forecast commodity prices, particularly in the energy complex. In the electricity and natural gas futures markets, Emery and Liu (2002) find that the mean reversion in their trading rule simulation is both statistically and economically significant. Girma and Paulson (1999) find that risk arbitrage opportunities exist in the crack spread (crude oil, heating oil and unleaded gasoline) complex for the period 1983 to 1994.

Lanza et al. (2005) build an error-correction model for the dynamics of ten grades of crude oil and fourteen different refinery products. They compare the out-of-sample forecasting performance of the error-correction models with a naïve autoregressive model which lacks the cointegration constraints. They find that imposing the cointegrating constraint marginally improves some of their forecasts. Ewing et al. (2006) apply a variant of an error-correction model, the momentum-threshold autoregression (M-TAR), to the gasoline, heating oil and crude oil markets. Their model is better able to accommodate asymmetric responses to shocks in these markets. They emphasize that modeling the interactions between the spot and futures markets is important for proper hedging and forecasting.

In the foreign currency markets, Sequeira, et al (1999) find cointegrating relationships between the Australian dollar spot and futures prices, and U.S. and Australian risk-free rates of interest. These cointegrating relationships suggest an error-correction representation for the cost-of-carry model which, with zero restrictions, yields the error-correction formulation for the unbiased expectations hypothesis. The authors find the cost-of-carry model to be empirically superior to the unbiased expectations hypothesis for the four sample sets considered.

In this effort, we make use of the foreign currency futures pricing model derived by Amin and Jarrow (1991) within the framework of Heath, et al (1992) as indicated in equation (1). $F_{t,T}^{d/f}$ is the futures exchange rate between a domestic currency, d, and a foreign currency, f, at time t for a futures contract with maturity T, $S_t^{d/f}$ is the spot exchange rate between domestic currency d and foreign currency f at time t, e is Euler's number, $i_{t,T}^{d}$ and $i_{t,T}^{f}$ are the domestic and foreign T-period interest rates at time t, respectively, and $\theta_{t,T}^{d/f}$ is an adjustment term for the marked-to-market feature of a futures market contract.

$$F_{t,T}^{d/f} = S_t^{d/f} e^{\left(i_{t,T}^{d} - i_{t,T}^{f}\right)T} e^{\theta_{t,T}^{d/f}} \tag{1}$$

Assuming T =1 and applying the properties of the natural logarithm to both sides of equation (1) results in equation (2). $f_{t,T}^{d/f}$ and $s_t^{d/f}$ are the natural logarithms of $F_{t,T}^{d/f}$ and $S_t^{d/f}$, respectively.

$$f_{t,T}^{d/f} = s_t^{d/f} + i_{t,T}^{d} - i_{t,T}^{f} + \theta_{t,T}^{d/f} \tag{2}$$

The marked-to-market adjustment term is not directly observable, but it is reasonable to assume that this term is covariance stationary and can treated as an intercept term in an empirical model. Accordingly, the model we test for cointegration is presented in equation (3) where the estimated coefficients for β_1 and β_2 are predicted to be positive and the estimated coefficient for β_3 is predicted to be negative.

$$f_{t,T}^{d/f} = \beta_0 + \beta_1 s_t^{d/f} + \beta_2 i_{t,T}^{d} + \beta_3 i_{t,T}^{f} + \varepsilon_t \tag{3}$$

If cointegration between the data series in (3) is present, then there exists an error-correction model that predicts changes in $f_{t,T}^{d/f}$ based on past changes in $s_t^{d/f}$, $i_{t,T}^d$, and $i_{t,T}^f$, and deviations in any existing cointegrating relationships.

Data

We make use of daily closing prices for the British pound (BP), Japanese yen (JY), and Swiss franc (SF) futures contracts that trade via open outcry on the Chicago Mercantile Exchange. We assume continuous contract pricing, so the futures price used is that for the nearby futures contract. We also make use of daily BP, JY, and SF spot exchange rates, expressed as American quotes to match the pricing convention of the futures contracts. Finally, we make use of daily observations of the 3-month BP, JY, SF, and U.S. dollar ($) LIBOR rates for interest rate data.

The data set begins in 1991 and runs through year-end 2005. Following Norbin, et al (1997), we employ a 5-year rolling window methodology. The rolling regressions help to validate the stability of the relationship and allow us to evaluate whether the forecasting ability is robust to varying time periods. Our analysis makes use of ten in-sample 5-year estimation periods from January 2, 1991 to December 31, 2004. The error-correction model for each of these ten 5-year estimation periods is then used to predict changes in the currency futures exchange rate in the following 1-year out-of-sample time period. Table 1 illustrates the ten in-sample estimation periods as well as the ten out-of-sample testing periods.

-INSERT TABLE 1 HERE-

Unit Root Tests

The first condition for a set of series to be cointegrated is that each series must be integrated of the same order. The augmented Dickey-Fuller (ADF) [see Dickey and Fuller (1979)] and Phillips-Perron (PP) [see Phillips and Perron (1988)] unit root tests can be used to test the values of all the specified data series for nonstationarity. The starting point for a unit root in time series x_t is to first consider a first-order autoregressive process [AR(1)] such as that in equation (4).

$$x_t = \mu + \rho x_{t-1} + \varepsilon_t \tag{4}$$

μ and ρ are parameters and the error term, ε_t, is assumed to be white noise. Tests are carried out by estimating equation (5) where x_{t-1} is subtracted from both sides of equation (4) where $\alpha = \rho - 1$.

$$\Delta x_t = \mu + \alpha x_{t-1} + \varepsilon_t \quad (5)$$

The null hypothesis of a non-stationary series [an I(1) series or series with a unit root] can be evaluated by testing whether the value of the estimated coefficient for α, $\hat{\alpha}$, is zero. Because a α greater than zero implies an explosive series that makes little economic sense, the hypothesis is tested against the one-sided alternative that $\hat{\alpha}$ is less than zero.

The simple unit root test described above is valid only if the series is an AR(1) process. If the series is correlated at higher order lags, the assumption of white noise disturbances is violated. The ADF and PP tests use different methods to control for higher-order serial correlation in the series. The ADF approach controls for higher-order correlation by adding lagged difference terms of the dependent variable, Δx_t, to the right-hand side of the regression, resulting in equation (6). [1]

$$\Delta x_t = \mu + \alpha x_{t-1} + \sum_{i=1}^{L} \beta_i \Delta x_{t-i} + \varepsilon_t$$

(6)

The lag length, L, is chosen to render the error term ε_t white noise.[2] If the ADF t-statistic for $\hat{\alpha}$ is negative and significant, the null hypothesis of a unit root is rejected and the series cannot be considered non-stationary. If the null hypothesis is not rejected, then there is no evidence that the series is stationary and the series is assumed to be non-stationary.

The PP test makes use of a non-parametric method of controlling for higher-order serial correlation. The test regression for the PP test is the AR(1) process presented in equation (6) above. The PP test makes a correction to the test statistic of the α coefficient to account for serial correlation in ε_t. The correction is non-parametric because the procedure makes use of an estimate of the spectrum of ε_t that is robust to hetereoskedasticity and autocorrelation of unknown form. The asymptotic distribution of the PP t-statistic is the same as the ADF t-statistic and test results are interpreted in the same manner.

The Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test (1992) differs from the ADF and PP tests in that the series x_t is assumed to be stationary under the null hypothesis. The KPSS test statistic makes use of the residuals from the OLS

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[1] There are actually three possible variations of the ADF and PP unit root tests: (1) estimation with a constant and a trend term, (2) estimation with a constant [see equation (8)], and (3) estimation with neither a constant nor trend term. We have included a constant term, μ, in our analysis because the mean change in some of the data series was statistically different from zero and all data series exhibited some skewness. We did not include a deterministic trend term because economic theory predicts none will exist in the data series we use for this paper.

[2] We choose a lag length that minimizes the Schwarz Information Criterion for the optimal lag, L, in our ADF tests.

regression of x_t on the exogenous variables. The (Lagrange multiplier) KPSS test statistic is based on a cumulative residual function and an estimate of the residual spectrum at frequency zero. Critical values are based upon the asymptotic results presented in KPSS.[3]

Table 2A presents the results of the unit root tests for the natural logarithm of the British pound futures exchange rate, $f^{\$/BP}$, the natural logarithm of the British pound spot exchange rate, $s^{\$/BP}$, the 3-month U.S. dollar LIBOR, $i^{\$}$, and the 3-month British pound LIBOR, i^{BP}. For the ADF and PP tests, the null hypothesis that the series is non-stationary is rejected in only two of the ten 5-year time periods tested for $f^{\$/BP}$, $s^{\$/BP}$, and i^{BP}. The null hypothesis of non-stationarity is rejected in only one of the ten 5-year time periods tested for $i^{\$}$. For the KPSS tests, the null hypothesis that the series is stationary is rejected for all four series in all of the ten 5-year time periods at the 1 percent confidence level.

Table 2B presents the results of the unit root tests for the natural logarithm of the Japanese yen futures exchange rate, $f^{\$/JY}$, the natural logarithm of the Japanese yen spot exchange rate, $s^{\$/JY}$, the 3-month U.S. dollar LIBOR, $i^{\$}$, and the 3-month Japanese yen LIBOR, i^{JY}. For the ADF and PP tests, the null hypothesis that the series is non-stationary is not rejected in any of the ten 5-year time periods tested for $f^{\$/JY}$ and $s^{\$/JY}$ and is rejected in only one of the ten 5-year time periods tested for $i^{\$}$. The null hypothesis of non-stationarity is rejected by both the ADF and PP tests in three of the ten 5-year time periods tested for i^{JY}. For the KPSS tests, the null hypothesis that the series is stationary is rejected for all four series in all of the ten 5-year time periods at the 1 percent confidence level.

Table 2C presents the results of the unit root tests for the natural logarithm of the Swiss franc futures exchange rate, $f^{\$/SF}$, the natural logarithm of the Swiss franc spot exchange rate, $s^{\$/SF}$, the 3-month U.S. dollar LIBOR, $i^{\$}$, and the 3-month Swiss Franc LIBOR, i^{SF}. For the ADF and PP tests, the null hypothesis that the series is non-stationary is not rejected in any of the ten 5-year time periods tested for $f^{\$/JY}$ and $s^{\$/JY}$ and is rejected in only one of the ten 5-year time periods tested for $i^{\$}$ and i^{SF}. For the KPSS tests, the null hypothesis that the series is stationary is rejected for all four series in all of the ten 5-year time periods at the 1 percent confidence level.

The results presented in Tables 2A, 2B, and 2C strongly suggest that all the individual data series used in our model are non-stationary and possess a unit root. The KPSS null hypothesis of stationarity is rejected for all series in all ten 5-year time periods tested at the 1 percent confidence level.

-INSERT TABLES 2A, 2B, AND 2C HERE-

[3] The AR spectral density estimator at frequency zero for the PP and KPSS tests is determined using the Bartlett kernel sum of covariances. The bandwidth parameter for the kernel-based estimators is determined using the Newey-West (1994) procedure.

Cointegration Tests

Cointegration results when a linear combination of a set of non-stationary series is stationary. Johansen's (1991, 1995) method for determining whether non-stationary series are cointegrated tests the restrictions imposed by cointegration on the unrestricted vector autoregression (VAR) involving the series. Equation (7) represents a VAR of order ρ.

$$X_t = \sum_{i=1}^{\rho} A_i X_{t-i} + BY_t + E_t \tag{7}$$

X_t is a vector of non-stationary, I(1) variables, Y_t is a vector of deterministic variables, and E_t is a vector of innovations. Equation (8) represents another way to write the VAR where $\Pi = \sum_{i=1}^{\rho} A_i - I$ and $\Gamma_i = -\sum_{j=i+1}^{\rho} A_j$.

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{\rho-1} \Gamma_i \Delta X_{t-i} + BY_t + E_t \tag{8}$$

Assuming r represents the number of cointegration relations or rank, if Π has reduced rank r < k, then there exist k × r matrices κ and ω each with rank r such that $\Pi = \kappa\omega'$ and $\omega' X_t$ is stationary. Each column of ω is the cointegrating vector and the elements of κ are known as the adjustment parameters in a vector error correction model.

Johansen's method is to estimate the Π matrix in an unrestricted form, then use a trace test to test whether the restrictions implied by the reduced rank of Π can be rejected. The trace test is a likelihood ratio test statistic that is based on eigenvalues. To determine the number of cointegrating relations, r, the test proceeds sequentially from r = 0 to r = k -1 until it fails to reject. In words, the null hypothesis of no cointegration is tested against the alternative hypothesis of full rank. If that is rejected, the null hypothesis of one cointegrating relation is tested against the alternative hypothesis of full rank. The process would be repeated until the null hypothesis of some number of cointegrating relations, r ≤ k -1, cannot be rejected. Critical values for the trace statistic can be found in Osterwald-Lenum (1992). The exact form of the Johansen cointegration test depends on the assumption one makes concerning the possible deterministic components of the system. From Equation (5), the cointegrating relation should contain a constant to account for the marked-to-market adjustment. Also, to allow for short run trends in the level of the variables (particularly the interest rates), we specify the error-correction component to have an intercept (α_0) in Equation (9).

Tables 3A, 3B, and 3C present the Johansen cointegration test results for the BP. JY, and SF futures exchange rate, respectively, based on the relationship suggested in equation (3). The Johansen cointegration test results indicate that a cointegrating relationship exists in each of the ten 5-year estimation periods for all three currencies. We rely on the trace test and its 5 percent critical value to identify the number of cointegrating relations.[4] The number of statistically significant cointegrating equations ranges from one to three depending on the time period tested. These test results strongly support the predictions of our model that cointegration should exist between a foreign currency futures exchange rate, the corresponding spot exchange rate, and short-term interest rates in the two countries of exchange.

-INSERT TABLES 3A, 3B, AND 3C HERE-

[4] The trace test and the maximum eigenvalue test identify the same number of cointegrating vectors in seven of the ten sub-periods. Lutkepohl, et al (2001) compare the power of the trace and maximum eigenvalue tests. They find that, in general, the two tests show similar power, although in some cases the trace test has greater power. Overall, they recommend the trace test be used. Because of this, we report both the trace test and the maximum eigenvalue test and when the two tests disagree we use the number of cointegrating vectors indicated by the trace test.

Error Correction Models

A (vector) error correction model is a restricted VAR designed for use with nonstationary series that are known to be cointegrated. An error correction model has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustments. The error correction model used in this paper is presented in equation (9) where n is the number of cointegrating equations. The Δ notation refers to the change in the level of the variable.[5]

$$\Delta f_{t,T}^{d/f} = \alpha_0 + \sum_{j=1}^{n}\beta_j CE_j + \sum_{i=1}^{2}\chi_i \Delta f_{t-i,T}^{d/f} + \sum_{i=1}^{2}\delta_i \Delta s_{t-i}^{d/f} + \sum_{i=1}^{2}\varphi_i \Delta i_{t-i,T}^{d} + \sum_{i=1}^{2}\gamma_i \Delta i_{t-i,T}^{f} + \eta_t \tag{9}$$

The form of the cointegrating equation, CE_j, is presented in equation (10) where the subscript j corresponds to the number of the cointegrating vector and j varies from 1 to 3 across the sub-time periods.

$$CE_j = \Theta_{0j} + \Theta_{1j} f_{t-1,T}^{d/f} + \Theta_{2j} s_{t-1,T}^{d/f} + \Theta_{3j} i_{t-1,T}^{d} + \Theta_{4j} i_{t-1,T}^{f} \tag{10}$$

The first cointegrating vector is normalized with $\Theta_{11} = 1$. The second cointegrating vector (when present) is normalized with $\Theta_{22} = 1$. Finally, the third cointegrating vector (when present) is normalized with $\Theta_{33} = 1$. The actual number of cointegrating vectors, n = 1, 2, or 3, corresponds to the Johannsen cointegration test results presented in Tables 3A. 3B, and 3C.

The error correction model in equation (9) is estimated using five years of daily data and then used to forecast $\Delta f_{t,T}^{d/f}$ in the following one-year out-of-sample testing period. Equation (11) then defines a pricing error, x_t, as the difference between the actual change, $\Delta f_{t,T}^{d/f}$, and the expected change predicted by the model, $E\left(\Delta f_{t,T}^{d/f}\right)$, presented in equation (9).

$$x_t = \Delta f_{t,T}^{d/f} - E\left(\Delta f_{t,T}^{d/f}\right) \tag{11}$$

A positive x_t suggests the foreign currency futures exchange rate is higher than what is warranted given the predictions of the model. Conversely, a negative x_t suggests the foreign currency futures exchange rate is lower than what is warranted given the predictions of the model.

To control for volatility differences over the different estimation periods, we standardize x_t based on Brown and Warner's (1980) mean-adjusted returns model as shown in equation (12) where $AERC_t$ is the abnormal exchange rate change.

[5] While we only forecast the change in the foreign currency futures exchange rate, to avoid exogeneity issues we estimate the cointegrating error-correction system using the Johansen full-information maximum-likelihood estimation. In addition, we restrict ourselves to one-day-ahead forecasts and, therefore, the forecasts only rely on predetermined variables.

$$\text{AERC}_t = \frac{x_t}{\sigma\left(\Delta f_t^{d/f}\right)} \quad (12)$$

To identify the extreme one-day price changes, we sort from highest to lowest the entire distribution (combining all ten estimation periods) of the abnormal exchange rate changes for each currency. We then choose the highest 5 percent as "winners" and the lowest 5 percent as "losers." The result is 244 observations of extreme one-day price changes for each currency; 122 of these observations are defined as winners and 122 of these observations are defined as losers. In total for all three currencies, there are 732 observations with 366 winners and 366 losers.

The statistical significance of the pricing error is determined using the statistic in equation (13) where n is the sample size, AERC_{it} is the standardized mispricing for event i on day t, σ_{AERC} is the standard deviation of the abnormalexchange rate changes for the 5 year pre-event period.

$$Z = \frac{1}{\sqrt{n}}\left(\frac{\sum \text{AERC}_{it}}{\sigma_{\text{AERC}}}\right) \quad (13)$$

The statistical significance of the average pricing error will be calculated for day -3, day -2, day -1, day 0, day 1, day 2, and day 3. The statistical significance of the cumulative average pricing error will also be calculated for days -1 to -3, days -1 to -2, days 1 to 2, and days 1 to 3. The statistical significance will be reported for the full sample of winners followed by results for sub-samples pertaining to economic announcements, political announcements and uninformed announcements. This will be repeated for losers.

Two cross-sectional regression equations are used to assess whether the market's degree of mispricing is related to the type of information (economic, political, and uninformed) while controlling for other factors. The other factors are the initial price change (standardized mispricing on day 0) and the degree of leakage (standardized mispricing on day -1). The regression model in equation (14) is run separately for winners and losers where $\text{AERC}_{i,1\rightarrow 3}$ is the cumulative standardized mispricing for days 1 to 3 for event i, IPC_i is the initial mispricing ($\text{AERC}_{i,0}$) on day zero for event i, LEAK_i is the mispricing ($\text{AERC}_{i,-1}$) on day -1 for event i, PN_i is a dummy variable equal to 1 (0 otherwise) if event i corresponds to a news announcement that is political in nature, UN_i = a dummy variable equal to 1 (0 otherwise) if event i does not correspond to a news announcement, and ε_i is the error term.

$$\text{AERC}_{i,1\rightarrow 3} = \beta_0 + \beta_1 \text{IPC}_i + \beta_2 \text{LEAK}_i + \beta_3 \text{PN}_i + \beta_4 \text{UN}_i + \varepsilon_i \quad (14)$$

Results

-INSERT TABLE 4 HERE-

Results for the degree of mispricing are disclosed in Table 4. The first column breaks down the sample of losers and the sample of winners into sub-samples based on the type of information associated with the extreme futures price changes. The second column shows the sample size. The next eleven columns disclose the results of assessing the statistical significance of the mispricing during the three day period surrounding day zero, which is the day of the extreme, one-day price change. Bold-type indicates statistical significance.

For winners (top half of Table 4), there is substantial evidence of pre-event mispricing especially on day -2. All of the signs on the statistically significant degrees of mispricing are positive except for the sign pertaining to the uninformed sample on day -1. This suggests winners are associated with a substantial degree of leakage before the event day (day 0).

We can assess the degree of over- or under-reaction by examining the signs on the degree of mispricing for the post event period (day 1, day 2, day 3, days 1 and 2, and days 1-3). For the full sample of winners the results do not suggest market participants under-reacted (or over-reacted) to new favorable information pertaining to currency future prices. When examining the full sample of winners there is no evidence supporting hypothesis one, which suggests the market will under-reaction the new information. When examining the sample of events corresponding to economic announcements only, there is some evidence of hypothesis one; for day two the sign on the degree of mispricing is positive and statistically significant suggesting the market under-reacted on the event day.

When examining the degree of mispricing during the post event period for political announcements all of the signs on the degree of mispricing are negative and statistically significant. This suggests the market overreacted on the day favorable political information was released. When examining the degree of mispricing during the post event period for uninformed winners all of the signs are negative and statistically significant except for day 3. This provides evidence that market participants over-reacted to information that was not publicly released; this finding supports hypothesis two.

For losers (bottom half of Table 4), there is substantial evidence of pre-event mispricing especially on day -2. All of the signs on the statistically significant degrees of mispricing are positive. This suggests that unfavorable information releases, like favorable information releases, were preceded by substantial increases in foreign currency futures prices.

For the sample of all losers and the sample of losers pertaining to economic announcements the results do not suggest market participants under-reacted (or overreacted) to new unfavorable information pertaining to currency future prices. None of the post-event degrees of mispricing are statistically significant. For the sample of losers pertaining to political announcements all of the post-event signs are negative and statistically significant except for day 1. This suggests the market under-reacted when unfavorable news pertaining to currency futures prices was released. This finding supports hypothesis one that extreme price changes will be followed by price changes in the same direction (under-reaction).

For the sample of uninformed losers there is some evidence the market overreacted at the time unfavorable news was released. For day 3, the sign on the standardized mispricing is positive and statistically significant. This supports hypothesis two.

For winners and losers our data supports hypothesis two that extreme changes in foreign currency prices will be associated with reversals when no news corresponds to the price change (uninformed events). The evidence for winners is stronger than the evidence for losers. This finding is in agreement with Larson and Madura's (2001) study examining currency spot rates.

For winners and losers pertaining to political announcements the evidence suggests the market is overly optimistic when pricing new political information that is either favorable or unfavorable. That is, for each sample, the degree of mispricing during the post-event period is negative and statistically significant except for on day one for losers. This suggests that during our sample period market participants were optimistic about foreign currency, or pessimistic about the U.S. dollar.

Overall, it appears that controlling for the type of announcement at the time of extreme price changes is advantageous when trying to pinpoint when the market for foreign currency futures contracts over- and under-reacts to new information.

-INSERT TABLE 5 HERE-

Results for the least squares estimates are disclosed in Table 5. Results for winners appear in the top half of the table and results for losers appear in the bottom half of the table. The main purpose of this analysis is to determine whether political and uninformed events are associated different degrees of mispricing while controlling for other factors. The other factors are the initial price change and degree of leakage.

The coefficients on IPC and Leak are not statistically significant for both winners and losers. Therefore, this data does not support hypotheses three and four that higher initial price changes and higher degrees of leakage will each be associated with higher degrees of overreaction.

For winners the coefficients on PN (political news) and UN (uninformed) are each negative and statistically significant. This confirms the results in table four that political events and uninformed events are associated with overreaction while economic events are not even when controlling for other factors.

For losers the coefficient on PN is negative and the t-statistic is -1.62. Therefore, this result does not confirm the results found in Table 5. It seems important to note that the F-statistic is not significant.

Conclusion

This paper addresses market overreaction and under-reaction for foreign currency futures contracts. Using a 5-year moving window method and the foreign currency futures pricing model of Amin and Jarrow (1991), we find repeated evidence of cointegration among the futures price, the spot exchange rate, and interest rates over ten different estimation periods. An error-correction model is then used to develop a series of predicted futures price changes. We assess whether the market overreacted or under-reacted to new information by comparing the actual futures price change to the change predicted by the error correction model.

Our results suggest the type of underlying announcement is relevant in pinpointing when the market over- and under-reacts to new information pertaining to foreign currency futures prices. Specifically, it appears the market overreacts to non-publicized news and is too optimistic when political news is released about foreign currency.

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TABLE 1

IN-SAMPLE ESTIMATION PERIODS AND OUT-OF-SAMPLE TESTING PERIODS (DAILY DATA)

In-Sample Estimation Period	Out-of-Sample Testing Period
1991-1995	1996
1992-1996	1997
1993-1997	1998
1994-1998	1999
1995-1999	2000
1996-2000	2001
1997-2001	2002
1998-2002	2003
1999-2003	2004
2000-2004	2005

Notes: Our analysis makes use of a 5-year moving window methodology which results in ten in-sample 5-year estimation periods from January 2, 1990 to December 31, 2004. The error correction model for each of these ten 5-year estimation periods is then used to predict changes in the foreign currency futures exchange rate in the following 1-year out-of-sample time period.

TABLE 2A
UNIT ROOT TESTS

British pound (BP): Natural logarithm of futures exchange rate ($f^{\$/BP}$), natural logarithm of spot exchange rate ($s^{\$/BP}$), and 3-month LIBOR ($i^{BP}$).

Time period	Test	$f^{\$/BP}$	$s^{\$/BP}$	$i^{\$}$	i^{BP}		Time period	Test	$f^{\$/BP}$	$s^{\$/BP}$	$i^{\$}$	i^{BP}
1991 to	ADF statistic	-2.27	-2.15	-2.37	-3.07**		1996 to	ADF statistic	-1.80	-1.69	-0.70	-0.76
1995	PP statistic	-2.26	-2.20	-2.30	-3.09**		2000	PP statistic	-1.82	-1.76	-0.82	-0.90
	KPSS statistic	2.02***	-2.12***	1.05***	3.19***			KPSS statistic	1.04***	1.06***	1.58***	0.83***
1992 to	ADF statistic	-2.34	-2.28	-0.45	-2.81*		1997 to	ADF statistic	-1.58	-1.55	2.86	1.01
1996	PP statistic	-2.39	-2.37	-0.45	-2.79*		2001	PP statistic	-1.55	-1.55	2.61	0.69
	KPSS statistic	0.90***	0.99***	3.11***	1.72***			KPSS statistic	3.65***	3.66***	1.03***	2.67***
1993 to	ADF statistic	-2.36	-2.43	-1.40	-0.60		1998 to	ADF statistic	-1.60	-1.52	1.09	-0.99
1997	PP statistic	-2.39	-2.35	-1.38	-0.71		2002	PP statistic	-1.56	-1.51	0.88	-1.01
	KPSS statistic	2.62***	2.57***	2.77***	1.60***			KPSS statistic	3.13***	3.09***	2.91***	3.47***
1994 to	ADF statistic	-2.79*	-2.54	-4.02***	-1.54		1999 to	ADF statistic	-0.75	-0.65	0.32	-1.08
1998	PP statistic	-2.72*	-2.51	-3.95***	-1.55		2003	PP statistic	-0.78	-0.71	0.20	-1.10
	KPSS statistic	2.74***	2.78***	0.82***	2.43***			KPSS statistic	1.04***	1.05***	3.90***	3.76***
1995 to	ADF statistic	-3.05**	-2.84*	-2.26	-0.90		2000 to	ADF statistic	0.02	0.07	-1.95	-1.63
1999	PP statistic	-2.89**	-2.80*	-2.27	-1.04		2004	PP statistic	0.02	0.04	-1.80	-1.54
	KPSS statistic	2.08***	2.07***	1.33***	0.57**			KPSS statistic	3.33***	3.38***	3.64***	2.83***

For the ADF and PP tests, the null hypothesis is that the series is non-stationary and has a unit root. Rejecting the null hypothesis suggests the series may be stationary. The test statistics presented above are compared to the critical values determined by the methodology provided in MacKinnon (1991, 1996). The ***, **, and * notation indicates that the computed test statistic exceeds the 1%, 5%, and 10% MacKinnon critical values, respectively.

For the KPSS test, the null hypothesis is that the series is stationary. Rejecting the null hypothesis suggests the series is non-stationary. The test statistics presented above are compared to the critical values determined by the methodology provided in KPSS. The ***, **, and * notation indicates that the computed test statistic exceeds the 1%, 5%, and 10% KPSS critical values, respectively.

TABLE 2B
UNIT ROOT TESTS

Japanese yen (JY): Natural logarithm of futures exchange rate ($f^{\$/JY}$), natural logarithm of spot exchange rate ($s^{\$/JY}$), and 3-month LIBOR ($i^{JY}$).

Time period	Test	$f^{\$/JY}$	$s^{\$/JY}$	$i^{\$}$	i^{JY}		Time period	Test	$f^{\$/JY}$	$s^{\$/JY}$	$i^{\$}$	i^{JY}
1991 to	ADF statistic	-1.25	-1.25	-2.37	-1.99		1996 to	ADF statistic	-1.97	-1.90	-0.70	-1.68
1995	PP statistic	-1.20	-1.23	-2.30	-1.98		2000	PP statistic	-2.00	-1.96	-0.82	-1.76
	KPSS statistic	3.90***	3.88***	1.05***	3.83***			KPSS statistic	0.95***	0.94***	1.58***	2.26***
1992 to	ADF statistic	-1.44	-1.36	-0.45	-2.46		1997 to	ADF statistic	-1.65	-1.57	2.86	-1.19
1996	PP statistic	-1.41	-1.36	-0.45	-2.47		2001	PP statistic	-1.68	-1.67	2.61	-1.29
	KPSS statistic	2.26***	2.16***	3.11***	3.98***			KPSS statistic	1.11***	0.94***	1.03***	2.52***
1993 to	ADF statistic	-1.11	-0.90	-1.40	-2.65*		1998 to	ADF statistic	-1.87	-1.83	1.09	-2.11
1997	PP statistic	-1.11	-0.92	-1.38	-2.59*		2002	PP statistic	-1.89	-1.89	0.88	-2.12
	KPSS statistic	1.21***	1.26***	2.77***	3.78***			KPSS statistic	0.80***	0.79***	2.91***	2.29***
1994 to	ADF statistic	-1.16	-1.08	-4.02***	-1.25		1999 to	ADF statistic	-1.65	-1.53	0.32	-2.65*
1998	PP statistic	-1.18	-1.13	-3.95***	-1.25		2003	PP statistic	-1.59	-1.54	0.20	-2.71*
	KPSS statistic	3.12***	3.15***	0.82***	2.95***			KPSS statistic	1.32***	1.22***	3.90***	1.41***
1995 to	ADF statistic	-1.29	-1.24	-2.26	-4.65***		2000 to	ADF statistic	-1.74	-1.66	-1.95	-2.50
1999	PP statistic	-1.31	-1.29	-2.27	-4.66***		2004	PP statistic	-1.75	-1.68	-1.80	-2.77*
	KPSS statistic	2.55***	2.56***	1.33***	2.00***			KPSS statistic	1.00***	1.03***	3.64***	1.71***

For the ADF and PP tests, the null hypothesis is that the series is non-stationary and has a unit root. Rejecting the null hypothesis suggests the series may be stationary. The test statistics presented above are compared to the critical values determined by the methodology provided in MacKinnon (1991, 1996). The ***, **, and * notation indicates that the computed test statistic exceeds the 1%, 5%, and 10% MacKinnon critical values, respectively.

For the KPSS test, the null hypothesis is that the series is stationary. Rejecting the null hypothesis suggests the series is non-stationary. The test statistics presented above are compared to the critical values determined by the methodology provided in KPSS. The ***, **, and * notation indicates that the computed test statistic exceeds the 1%, 5%, and 10% KPSS critical values, respectively.

TABLE 2C
UNIT ROOT TESTS

Swiss franc (SF): Natural logarithm of futures exchange rate ($f^{\$/SF}$), natural logarithm of spot exchange rate ($s^{\$/SF}$), and 3-month LIBOR ($i^{SF}$).

Time period	Test	$f^{\$/SF}$	$s^{\$/SF}$	$i^{\$}$	i^{SF}		Time period	Test	$f^{\$/SF}$	$s^{\$/SF}$	$i^{\$}$	i^{SF}
1991 to	ADF statistic	-1.14	-1.13	-2.37	-0.04		1996 to	ADF statistic	-1.97	-1.93	-0.70	-0.92
1995	PP statistic	-1.15	-1.17	-2.30	-0.11		2000	PP statistic	-1.97	-1.94	-0.82	-0.74
	KPSS statistic	2.24***	2.15***	1.05***	3.93***			KPSS statistic	3.45***	3.45***	1.58***	1.23***
1992 to	ADF statistic	-1.50	-1.48	-0.45	-1.37		1997 to	ADF statistic	-1.97	-1.95	2.86	-1.23
1996	PP statistic	-1.48	-1.50	-0.45	-1.32		2001	PP statistic	-1.96	-1.96	2.61	-1.13
	KPSS statistic	2.92***	2.83***	3.11***	3.68***			KPSS statistic	3.50***	3.46***	1.03***	2.64***
1993 to	ADF statistic	-1.42	-1.32	-1.40	-1.76		1998 to	ADF statistic	-1.36	-1.28	1.09	-0.55
1997	PP statistic	-1.41	-1.32	-1.38	-1.78		2002	PP statistic	-1.34	-1.29	0.88	-0.50
	KPSS statistic	1.19***	1.15***	2.77***	4.00***			KPSS statistic	1.86***	1.78***	2.91***	0.95***
1994 to	ADF statistic	-1.66	-1.57	-4.02***	-1.30		1999 to	ADF statistic	-0.57	-0.41	0.32	-0.13
1998	PP statistic	-1.66	-1.57	-3.95***	-1.23		2003	PP statistic	-0.56	-0.45	0.20	-0.14
	KPSS statistic	1.61***	1.67***	0.82***	3.54***			KPSS statistic	1.86***	1.92***	3.90***	2.09***
1995 to	ADF statistic	-0.83	-0.74	-2.26	-3.18**		2000 to	ADF statistic	0.30	0.16	-1.95	-0.31
1999	PP statistic	-0.79	-0.73	-2.27	-3.20**		2004	PP statistic	0.21	0.24	-1.80	-0.35
	KPSS statistic	3.64***	3.64***	1.33***	2.79***			KPSS statistic	4.17***	4.19***	3.64***	3.96***

For the ADF and PP tests, the null hypothesis is that the series is non-stationary and has a unit root. Rejecting the null hypothesis suggests the series may be stationary. The test statistics presented above are compared to the critical values determined by the methodology provided in MacKinnon (1991, 1996). The ***, **, and * notation indicates that the computed test statistic exceeds the 1%, 5%, and 10% MacKinnon critical values, respectively.

For the KPSS test, the null hypothesis is that the series is stationary. Rejecting the null hypothesis suggests the series is non-stationary. The test statistics presented above are compared to the critical values determined by the methodology provided in KPSS. The ***, **, and * notation indicates that the computed test statistic exceeds the 1%, 5%, and 10% KPSS critical values, respectivel

TABLE 3A
JOHANSEN COINTEGRATION TESTS

Model tested: $f_{t,T}^{\$/BP} = \beta_0 + \beta_1 s_t^{\$/BP} + \beta_2 i_{t,T}^{\$} + \beta_3 i_{t,T}^{BP} + \varepsilon_t$

$f^{\$/BP}$: natural logarithm of the British pound futures exchange rate
$s^{\$/BP}$: natural logarithm of the British pound spot exchange rate
$i^{\$}$: 3-month U.S. dollar LIBOR
i^{BP} : 3-month British pound LIBOR

Time Period	Hypothesized Number of Cointegrating Equations	Trace Statistic	Maximum Eigenvalue
1991:1995	None#	155.8391***	107.5094***
	At most 1#	48.32975***	32.01809**
	At most 2#	16.31166**	12.31970*
1992:1996	None#	147.3683***	110.1644***
	At most 1#	37.20393***	22.24626**
	At most 2	14.95767*	9.445965
1993:1997	None#	199.3153***	148.3889***
	At most 1#	50.92639***	30.20233***
	At most 2#	20.72406***	13.19417*
1994:1998	None#	199.6570***	160.8819***
	At most 1#	38.77508***	20.69756*
	At most 2#	18.07752***	12.55773*
1995:1999	None#	194.4808***	160.3745***
	At most 1#	34.10633**	16.68731
	At most 2#	17.41902**	12.44782*
1996:2000	None#	173.9251***	148.6349***
	At most 1	25.29023	18.14302
	At most 2	7.147205	6.285826
1997:2001	None#	156.0471***	130.7472***
	At most 1	25.29992	22.93486**
	At most 2	2.365060	14.26460
1998:2002	None#	131.3976***	111.7929***
	At most 1	19.60466	13.86286
	At most 2	5.741797	4.756499
1999:2003	None#	139.0680***	101.5679***
	At most 1#	37.50009***	20.33025*
	At most 2#	17.16984**	13.63741*
2000:2004	None#	119.3520***	86.57530***
	At most 1#	32.77674***	23.96734**
	At most 2	8.809401	4.936438

Critical values-***: 1% critical value, **: 5% critical value, and *: 10% critical value.
#-Denotes rejection of the specified number of cointegrating equations based on the Trace Statistic and the 5% critical value.

TABLE 3B
JOHANSEN COINTEGRATION TESTS

Model tested: $f_{t,T}^{\$/JY} = \beta_0 + \beta_1 s_t^{\$/JY} + \beta_2 i_{t,T}^{\$} + \beta_3 i_{t,T}^{JY} + \varepsilon_t$

$f^{\$/JY}$: natural logarithm of the Japanese yen futures exchange rate
$s^{\$/JY}$: natural logarithm of the Japanese yen spot exchange rate
$i^{\$}$: 3-month U.S. dollar LIBOR
i^{JY} : 3-month Japanese yen LIBOR

Time Period	Hypothesized Number of Cointegrating Equations	Trace Statistic	Maximum Eigenvalue
1991:1995	None#	120.7875***	95.95135***
	At most 1	24.83610	18.36487
	At most 2	6.471234	4.760644
1992:1996	None#	95.31798***	74.46698***
	At most 1	20.85100	13.23150
	At most 2	7.619492	5.962066
1993:1997	None#	192.6628***	69.00176***
	At most 1#	33.66101**	22.08676**
	At most 2	11.57424	10.69534
1994:1998	None#	123.7465***	71.55111***
	At most 1#	52.19541***	32.43043***
	At most 2#	19.76498**	15.26249**
1995:1999	None#	106.2120***	68.71545***
	At most 1#	37.49651***	27.47767***
	At most 2	10.01883	8.553852
1996:2000	None#	101.6084***	72.12414***
	At most 1#	29.48427**	18.05784
	At most 2	11.42643	6.100098
1997:2001	None#	94.68450***	71.06068***
	At most 1	23.62383	16.05930
	At most 2	7.564523	6.211102
1998:2002	None#	92.37597***	72.98022***
	At most 1	19.39575	11.04332
	At most 2	8.352426	7.608645
1999:2003	None#	105.1550***	73.93260***
	At most 1#	31.22242**	25.43922**
	At most 2	5.783191	5.778460
2000:2004	None#	115.5561***	80.40590***
	At most 1#	35.15021**	25.45933**
	At most 2	9.690881	7.997569

Critical values-***: 1% critical value, **: 5% critical value, and *: 10% critical value.
#-Denotes rejection of the specified number of cointegrating equations based on the Trace Statistic and the 5% critical value.

TABLE 3C
JOHANSEN COINTEGRATION TESTS

Model tested: $f_{t,T}^{\$/SF} = \beta_0 + \beta_1 s_t^{\$/SF} + \beta_2 i_{t,T}^{\$} + \beta_3 i_{t,T}^{SF} + \varepsilon_t$
$f^{\$/SF}$: natural logarithm of the Swiss franc futures exchange rate
$s^{\$/SF}$: natural logarithm of the Swiss franc spot exchange rate
$i^{\$}$: 3-month U.S. dollar LIBOR
i^{SF} : 3-month Swiss franc LIBOR

Time Period	Hypothesized Number of Cointegrating Equations	Trace Statistic	Maximum Eigenvalue
1991:1995	None#	169.0874***	122.6355***
	At most 1#	46.45190***	25.42806**
	At most 2#	21.02384***	21.01347***
1992:1996	None#	143.6003***	106.0993***
	At most 1#	37.50103***	31.31825***
	At most 2	6.182774	5.638299
1993:1997	None#	113.1702***	94.46614***
	At most 1	18.70405	14.47646
	At most 2	4.227585	2.809962
1994:1998	None#	122.0693***	80.58732***
	At most 1#	41.48201***	31.03614***
	At most 2	10.44587	5.934620
1995:1999	None#	108.2958***	78.63199***
	At most 1	29.66360*	18.88704
	At most 2	10.77656	8.694473
1996:2000	None#	92.63495***	74.93700***
	At most 1	17.69795	11.22387
	At most 2	6.474078	4.941799
1997:2001	None#	129.8456***	86.78024***
	At most 1#	43.06536***	32.57428***
	At most 2	10.49108	10.15684
1998:2002	None#	139.2848***	92.57209***
	At most 1#	46.71272***	35.11575***
	At most 2	11.59697	7.330835
1999:2003	None#	157.6061***	104.2987***
	At most 1#	53.30738***	34.73883***
	At most 2#	18.56856**	14.93331**
2000:2004	None#	171.0083***	121.6054***
	At most 1#	49.40288***	28.99331***
	At most 2#	20.40957***	19.18107***

Critical values-***: 1% critical value, **: 5% critical value, and *: 10% critical value.
#-Denotes rejection of the specified number of cointegrating equations based on the Trace Statistic and the 5% critical value

TABLE 4

Results for the Statistical Significance of the Standardized Mispricing (AERC)

Winners: Pound, Swiss franc, and yen

	N	t=-3 to t=-1	t=-2 to t=-1	t=-3	t=-2	t=-1	t=0	t=1	t=2	t=3	t=1 to 2	t=1 to 3
All	366	0.00196	**0.00201****	-0.00005	**0.00156*****	0.00045	**0.01507*****	-0.00019	0.00044	-0.00003	0.00025	0.00022
		1.34	2.14	-0.25	3.44	0.83	35.58	-0.29	0.85	-0.14	0.28	0.41
EN	265	0.00124	0.00145	-0.00020	**0.00074***	0.00071	**0.01529*****	0.00030	**0.00095****	0.00029	0.00125	0.00153
		0.84	1.58	-0.63	1.76	1.40	36.01	0.66	2.09	0.57	1.37	1.11
PN	36	**0.00252***	**0.00297*****	-0.00044	**0.00151*****	**0.00146*****	**0.01484*****	**-0.00124*****	**-0.0008****	**-0.00120*****	**-0.00205*****	**-0.00326*****
		1.91	3.56	-1.38	3.42	3.70	33.54	-2.62	-2.24	-2.68	-2.43	-2.51
U	65	**0.00456*****	**0.00377*****	**0.00078***	**0.00494*****	**-0.00116*****	**0.01428*****	**-0.00161*****	**-0.00092*****	-0.00069	**-0.00252*****	**-0.00321*****
		3.04	3.61	1.90	10.34	-3.12	34.94	-2.90	-2.49	-1.60	-2.70	-2.33

Losers: Pound, Swiss franc, and yen

	N	t=-3 to t=-1	t=-2 to t=-1	t=-3	t=-2	t=-1	t=0	t=1	t=2	t=3	t=1 to 2	t=1 to 3
All	366	**0.00225***	**0.00168***	0.00057	**0.00107*****	0.00061	**-0.01372*****	0.00022	0.00006	0.00043	0.00028	0.00071
		1.67	1.92	1.16	2.50	1.35	-32.66	0.54	0.19	0.85	0.52	0.52
EN	264	.00123	0.00105	0.00018	**0.00112*****	-0.00007	**-0.01386*****	0.00026	0.00009	0.00040	0.00035	0.00075
		0.84	1.19	0.13	2.67	-0.29	-32.71	0.63	0.14	0.93	0.39	0.57
PN	23	**0.00453*****	**0.00327*****	**0.00126*****	**0.00138*****	**0.00190*****	**-0.01353*****	-0.00025	**-0.00157*****	**-0.00176*****	**-0.00182***	**-0.00358*****
		3.85	3.98	3.58	2.72	5.25	-33.37	-0.38	-3.21	-4.58	-1.79	-2.72
U	79	**0.00500*****	**0.00333*****	**0.00167*****	**0.00081***	**0.00251*****	**-0.01328*****	0.00024	0.00041	**0.00118****	0.00065	0.00184
		3.82	3.79	3.90	1.90	5.68	-32.25	0.48	1.33	2.13	0.91	1.31

Bold type indicates statistical significance at the 0.01 (***), 0.05 (**), or 0.10 (*) level

Variable Key:
t = day (t=0 is day of announcement),
EN = Economic announcement on t=0,
PN = Political announcement on t=0,
U = Uninformed (no news) announcement on t=0

TABLE 5
Least Squares Estimates
Model Tested:

$$AERC_{i,1\rightarrow 3} = \beta_0 + \beta_1 IPC_i + \beta_2 LEAK_i + \beta_3 PN_i + \beta_4 UN_i + \varepsilon_i$$

Winners	β_0	IPC_i	$Leak_i$	PN_i	UN_i	Adj. R^2	F-Stat.
Coefficient t-statistic	-0.02 -0.06	0.11 0.81	-0.08 -0.91	**-0.64*** -1.75	**-0.65**** -2.29	0.01	2.14*
Losers							
Coefficient t-statistic	-0.02 -0.05	-0.07 -0.40	-0.02 -0.21	-0.61 -1.62	0.15 0.66	0.00	0.90

Bold type indicates statistical significance at the 0.01 (***), 0.05 (**), or 0.10 (*) level

Variable Key:
$AERC_{i,1\rightarrow 3}$ = cumulative standardized mispricing on days 1 to 3,
IPC_i= initial mispricing ($AERC_{i,0}$) on day 0,
$Leak_i$ = mispricing on day -1 ($AERC_{i,-1}$)
PN_i = event i is associated with a political announcement,
UN_i = event i is not associated with an announcement (uninformed)