The Futures Premium Puzzle: A Reconsideration

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Abstract

This paper contributes to the literature on the futures premium puzzle in three ways. First, it describes a theoretical model of futures pricing and derives the conditions under which the futures premium puzzle shows up. Further, this model serves to explain, why the futures premium puzzle disappears, when the futures market has a 'news advantage' of only a few days. Second, we use three-month US$/DM, US$/Franc, and US$/Pound futures rates to test the Expectations Hypothesis empirically. Finally, by applying a non-linear least squares estimator, we gain new information about the stochastic structure of the futures premium and shed light on the underlying reason of the futures premium puzzle.

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1 Introduction

The 'Expectations Hypothesis' that forward exchange rates are unbiased predictors of future spot exchange rates is the subject of a large theoretical and empirical literature. It is a central part of the claim that foreign exchange markets are informationally efficient (Fama, 1970). In view of the non-stationarity of exchange rates, empirical tests of this hypothesis are typically based on regressing the change in the exchange rate on the forward premium. The 'Expectations Hypothesis' predicts that the coefficient on the forward premium in such regressions is unity. However, empirical studies show that, for a large number of different exchange rates, time periods, and forecast horizons, that coefficient is negative.[1] Froot (1990) reports that the average estimate in over 75 published articles is (-0.88). This result, which was first reported by Cumby and Obstfeld (1984) and Fama (1984), has been dubbed the forward premium puzzle. Taken at face value, it suggests that market participants do not even get the direction of exchange-rate changes right.

The literature has so far failed to produce a consensus on the reasons for these findings. Two kinds of explanations have been offered; both build on the idea that the empirical tests suffer from an omitted variable bias. The first is that the forward premium contains a time-varying risk premium which is negatively correlated with the expected change in the exchange rate (e.g. Fama (1984), Hodrick and Srivastava (1984), and Hsieh (1984)). Adler and Dumas (1983), Engel and Rodrigues (1989), Frankel (1982) and Lewis (1995) model this risk premium based on a partial-equilibrium, capital-asset-pricing model (CAPM). Hodrick and Srivastava (1986) and Engel (1992) model the risk premium using a general-equilibrium pricing condition. The general conclusion is that, unless risk aversion is extremely high, neither the static CAPM nor the general-equilibrium relationship can explain the empirical variability of the forward premium bias solely by a risk premium.

The second explanation argues that the forward premium contains a systematic forecast error, which could be due to inefficient information processing by financial market participants (e.g. Mark and Wu, 1998), peso problems (Krasker (1980), Rogoff (1985)), Evans and Lewis (1995)), or learning.

Lewis (1995) points out that these potential explanations are not mutually exclusive. Evans and Lewis (1995) apply a switching model and show that the regression

[1] compare e.g. Froot (1990), Bekaert and Hodrick (1993), Mark, Wu and Hai (1993), Engel (1996), and Mark and Wu (1998).

coefficient contains a significant forecast error due to expected shifts in exchange rate regimes, but that this "peso problem" cannot fully explain the forward premium bias. Froot and Frankel (1989), Frankel and Chinn (1993), and Cavaglia et al. (1994) use survey data on exchange rate expectations to decompose the forward premium bias into a forecast error component and a risk premium component. While Froot and Frankel conclude, that almost the entire bias is attributable to systematic expectation errors, Frankel and Chinn (1993) and Cavaglia et al. (1994) find some evidence for both, time-varying risk premia and systematic forecast errors. However, the use of survey data is often criticized in the literature, since the data is likely to be biased by a measurement error.[2] Kandon and Smith (2003) use different forecast models and also conclude that the rejection of the Expectations Hypothesis can be attributed to both, forward exchange market inefficiency and a time-varying risk premium.

Pope and Peel (1991) and McCallum (1994) add another aspect to the puzzle. Using quarterly and monthly data, respectively, they first confirm the result of a negative regression coefficient of the change in the exchange rate on the forward premium. Next, they show that, in a regression of the change in the exchange rate between t and $t-2$ on the difference between the forward rate in $t-1$ and the spot rate in $t-2$, the regression coefficient is close to one. Thus, if the forward market has a "news advantage" in the sense that the forward rate is priced later than the spot rate used as the basis for the predicted change, the forward premium puzzle seems to disappear.

In this paper, we reconsider the forward premium puzzle by using futures exchange rates instead of forward exchange rates. Futures rates are quoted on a daily basis, so that, for a contract expiring at time t, multiple futures rates with different times to expiration can be observed. The use of futures rate data allows for a more flexible and detailed analysis of the forward/futures premium puzzle than the use of forward rate data.

This paper contributes to the existing literature in three ways. First, it describes a theoretical model of futures pricing. This model is used to derive the conditions

[2]Froot and Frankel (1988, 1989) note that one usually calculates the median survey response as if there exists a single expectation that is homogeneously held by investors. But the fact that different survey respondents report different answers, suggest that they are measured with errors, if there is only a single true expectation. The other source of measurement error is that the expected futures spot rate may not be recorded by the survey at precisely the same moment as the contemporaneous spot rate is recorded.

under which the futures premium puzzle shows up. Similar to the related literature on the forward premium puzzle, we propose two potential explanations of the futures premium puzzle, a time-varying risk premium that is negatively correlated with the expected change of exchange rates and/or systematic forecast errors. Additionally, the model discusses the influence of the 'news advantage' of futures rates on the estimation results. We show that with an increase in the news advantage of futures rates, the variance of the exchange rate innovation gains weight and dominates the estimation results, which finally drives the estimated slope coefficient towards unity.

Second, we use three-month US$/DM, US$/French Franc, and US$/Yen futures rates with forecast horizons of up to three months to test the Expectations Hypothesis empirically. Similar to previous results, we confirm a negative slope coefficient when regressing the futures premium on the actual change of exchange rates. In contrast, we show that the Expectations Hypothesis cannot be rejected, when futures rates have a news advantage of only four days, which stresses the dominance of the variance of the exchange rates in the regressions.

Third, after running the estimations for various forecast horizons and news advantages of futures rates, we use our estimation results to apply a nonlinear least squares estimator for the identification of the unknown model parameters. The estimation results serve to identify the stochastic structure of the futures premium and to shed light on the underlying reasons for the futures premium puzzle.

The paper proceeds as follows. Section 2 presents a model of the Expectations Hypothesis of exchange rate futures. Section 3 describes the data, and Section 4 presents the estimation results. In Section 5, we identify the unknown model parameters. Section 6 concludes.

2 A Model of the Futures Premium

Let s_t denotes the log of the spot exchange rate at time t. Arbitrage requires that the expectation of the spot exchange rate formed at time $t-i+1$, differs from the expectation formed the day before only by a one-period forecast correction term, α_{t-i+1}:

$$E_{t-i}(s_t) = E_{t-i+1}(s_t) - \alpha_{t-i+1}, \tag{1}$$

where $E_{t-i}(.)$ is the conditional expectation given all information available to the market participants at time $t-i$. Equation (1) implies that the actual spot exchange rate is equal to the expected spot exchange rate plus the forecast error α_t:

$$E_{t-1}(s_t) = E_t(s_t) - \alpha_t = s_t - \alpha_t. \tag{2}$$

Let $\xi_t = E_{t-1}(s_t) - s_{t-1}$ denote the expected change and $\epsilon_t = \xi_t + \alpha_t$ the actual change in the exchange rate. After subtracting the past spot exchange rate s_{t-1} from both sides of equation (2), we obtain that the spot exchange rate process is described as follows:

$$s_t - s_{t-1} = \xi_t + \alpha_t = \epsilon_t. \tag{3}$$

Iterative substitution of equation (3) yields:

$$s_t = s_{t-i} + \sum_{j=0}^{i-1} \epsilon_{t-j}, \tag{4}$$

Let f_{t-i}^t be the log of the futures exchange rate priced at time $t-i$ with maturity at time t. According to the Expectations Hypothesis, the futures rate f_{t-1}^t is equal to the conditional expectation of the log of the spot exchange rate at time t, $E_{t-1}s_t$, plus a one-period risk premium μ_{t-1}:

$$f_{t-1}^t = E_{t-1}(s_t) + \mu_{t-1}. \tag{5}$$

Similar to Hodrick and Sivastava (1987), we assume that futures rates for the same maturity date priced at two consecutive dates are linked through the following equation:

$$f_{t-i-1}^t = E_{t-i-1}f_{t-i}^t + \mu_{t-i-1} \tag{6}$$

This reflects the possibility of arbitrage between futures contracts over time.

We define ν_{t-i} to be the one-period forecast error of the risk premium at time $t-i$ and $\hat{\mu}_{t-i}$ to be the the expected risk premium conditional on the information available at time $t-i-1$, and it holds:

$$\hat{\mu}_{t-i} = E_{t-i-1}(\mu_{t-i}) = \mu_{t-i} - \nu_{t-i}. \tag{7}$$

Combining equations (5), (6), and (7), the futures rate at time $t-1$ is now equal to the futures rate at time $t-2$ minus the one-period risk premium μ_{t-2} plus two forecast errors, one for the spot rate, α_{t-1}, and one for the risk premium contained in the futures rate f_{t-1}^t:

$$f_{t-1}^t = f_{t-2}^t - \mu_{t-2} + \alpha_{t-1} + \nu_{t-1}. \tag{8}$$

Iterative substitution of equation (8) yields:

$$f_{t-1}^{t} = f_{t-i}^{t} + \sum_{j=1}^{i-1} \alpha_{t-j} - \sum_{j=1}^{i-1} \hat{\mu}_{t-j-1} + \nu_{t-1} - \nu_{t-i}. \tag{9}$$

Taking equations (2),(5) and (9), we can derive the following relationship between the futures rate f_{t-i}^{t} and the corresponding spot exchange rate s_t:

$$s_t = f_{t-i}^{t} + \sum_{j=0}^{i-1} \alpha_{t-j} - \sum_{j=0}^{i-1} \hat{\mu}_{t-j-1} - \nu_{t-i}. \tag{10}$$

Thus, the futures rate f_{t-i}^{t} differs from the actual spot rate at maturity by the sum of one-period forecast errors of the actual exchange rate, the sum of expected one-period risk-premia between $t-i$ and t, and a one-period forecast error of the risk premium. From equations (4) and (10) it follows[3]:

$$f_{t-i}^{t-1} = f_{t-i}^{t} - \xi_t - \hat{\mu}_{t-1}, \tag{11}$$

$$f_{t-i}^{t} = f_{t-i+1}^{t+1} - \alpha_{t-i+1} - \hat{\mu}_t + \hat{\mu}_{t-i} - \xi_{t+1} + \nu_{t-i} - \nu_{t-i+1}. \tag{12}$$

Thus, equation (12) is the forward rate equivalent process of futures rates. Combining equation (3) with equation (10) yields the following expression for the futures premium:

$$f_{t-i}^{t} - s_{t-i} = \sum_{j=0}^{i-1} \hat{\mu}_{t-j-1} + \sum_{j=0}^{i-1} \xi_{t-j} + \nu_{t-i}. \tag{13}$$

Let λ and γ denote the covariances between the risk premium at time $t-i-1$ and the expected change of the exchange rate and the forecast error of the spot rate at time $t-i$, respectively, $Cov(\xi_{t-i}, \hat{\mu}_{t-i-1}) = \lambda$, $Cov(\alpha_{t-i}, \hat{\mu}_{t-i-1}) = \gamma$. Under the efficient market hypothesis, forecast errors are uncorrelated with past information, and γ is zero. We further assume that the forecast error of the risk premium, ν_{t-i}, is in dependent and uncorrelated with all other terms.

In general terms, we can write the conventional regression equation to test the Expectations Hypothesis as follows:

$$s_t - s_{t-i-k} = \phi + \beta_{(i,k)}(f_{t-i}^{t} - s_{t-i-k}) + \eta_{t-i}, \tag{14}$$

where i denotes the time to maturity of the futures rates.

[3]A detailed derivation of equations (11) and (12) is provided in the Appendix.

The slope coefficient of regression equation (14) can be written as follows:

$$\begin{aligned} \beta_{(i,k)} &= \frac{Cov(s_t - s_{t-i-k}, f^t_{t-i} - s_{t-i-k})}{Var(f^t_{t-i} - s_{t-i-k})} \\ &= \frac{Cov(\sum_{j=0}^{i+k-1} \xi_{t-j} + \sum_{j=0}^{i+k-1} \alpha_{t-j}, \sum_{j=i}^{i+k-1} \alpha_{t-j} + \sum_{j=0}^{j-1} \hat{\mu}_{t-j-1} + \sum_{j=0}^{i+k-1} \xi_{t-j} + \nu_{t-i})}{Var(\sum_{j=i}^{i+k-1} \alpha_{t-j} + \sum_{j=0}^{j-1} \hat{\mu}_{t-j-1} + \sum_{j=0}^{i+k-1} \xi_{t-j} + \nu_{t-i})} \end{aligned} \tag{15}$$

For $k = 0$ and i constant, equation (14) corresponds to the 'Fama regression', in which the futures premium $f^t_{t-i} - s_{t-i}$ is regressed on the corresponding change of exchange rates $s_t - s_{t-i}$. The slope coefficient simplifies to:

$$\beta_{(i,0)} = \frac{i\lambda + i\sigma^2_\xi + i\gamma}{i\sigma^2_{\hat{\mu}} + i\sigma^2_\xi + \sigma^2_\nu + 2i\lambda} \tag{16}$$

$$\begin{aligned} &= \frac{\lambda + \sigma^2_\xi + \gamma}{\sigma^2_{\hat{\mu}} + \sigma^2_\xi + \frac{1}{i}\sigma^2_\nu + 2\lambda} \\ &= 1 - \frac{\sigma^2_{\hat{\mu}} + \frac{1}{i}\sigma^2_\nu + \lambda - \gamma}{\sigma^2_{\hat{\mu}} + \sigma^2_\xi + \frac{1}{i}\sigma^2_\nu + 2\lambda} \end{aligned} \tag{17}$$

Like Frankel and Froot (1986), we can write the slope coefficient $\beta_{(i,0)}$ as equal 1 minus a term arising from a time-varying (expected) risk premium ($\sigma^2_{\hat{\mu}} + \frac{1}{i}\sigma^2_\nu + \lambda \neq 0$), minus another term arising from failure of efficient information processing ($\gamma \neq 0$). According to equation (17), a necessary condition for $\beta_{(i,0)}$ to become negative is that $(\lambda + \gamma)$ is negative and larger in absolute values than the variance of the expected change of exchange rate, σ^2_ξ.

Assuming efficiency, $\gamma = 0$, a negative slope coefficient requires that $\sigma^2_\xi < |\lambda| < \sigma^2_{\hat{\mu}} + \frac{1}{i}\sigma^2_\nu$. Thus, the variance of the expected risk premium must be larger than the variance of the expected change in the exchange rate, and the exchange rate must be negatively correlated with the expected risk premium.[4]

Further, equation (17) shows that only the variance of the forecast error of the risk premium depends on the time to maturity i. Thus, if $\sigma^2_\nu = 0$, the slope coefficient $\beta_{(i,0)}$ is independent of the forecast horizon of the futures rates.

For $k > 0$, equation (14) describes a generalized version of the 'McCallum-Pope-Peel regression'. In this case, one investigates, whether the futures rate at time $t-i$ is able to predict the change of exchange rates between the maturity date t and a date that lies k days to the past of the pricing date of that futures rate, $t-i-k$. Accordingly, the futures market knows already a fraction of the true innovation of the exchange rate that it seeks to predict, namely the change between $t-i-k$ and

[4]Although Fama (1984) finds such a covariation puzzling and potentially inconsistent with economic theory, Hodrick and Srivastava (1986) demonstrate that it is intuitively plausible and consistent with the prediction of the Lucas (1982) model.

$t-i$. Thus, we interpret the lag length k as the 'news advantage' of the futures rate relative to the spot rate s_{t-i-k}. The slope coefficient of equation (14) is given by:

$$\begin{aligned}\beta_{(i,k>0)} &= \frac{i\lambda + i\sigma_\xi^2 + i\gamma + k\sigma_\epsilon^2}{k\sigma_\epsilon^2 + i\sigma_{\hat{\mu}}^2 + \sigma_\nu^2 + i\sigma_\xi^2 + 2i\lambda} \\ &= \frac{\lambda + \sigma_\xi^2 + \gamma + \frac{k}{i}\sigma_\epsilon^2}{\frac{k}{i}\sigma_\epsilon^2 + \sigma_{\hat{\mu}}^2 + \frac{1}{i}\sigma_\nu^2 + \sigma_\xi^2 + 2\lambda} \\ &= \frac{\beta_{(i,0)} + \frac{k\sigma_\epsilon^2}{V_{i,0}}}{1 + \frac{k\sigma_\epsilon^2}{V_{i,0}}},\end{aligned} \tag{18}$$

where $V_{i,0}$ denotes the variance of the futures premium at time $t-i$ with $k=0$, $Var(f_{t-i}^t - s_{t-i})$. If $\sigma_\nu^2 = 0$, we have that $\beta_{(i,k>0)} = \beta_{(j,k>0)}$ for a given value of k. $\beta_{(i,k>0)}$ differs from $\beta_{(i,0)}$ in that the variance term $k\sigma_\epsilon^2$ appears additionally in the nominator and denominator. If k grows large, the slope coefficient converges to unity irrespective of the value of $\beta_{i,0}$. The reason for this is that the right hand side and the left hand side variables contain the same stochastic noise term, $s_{t-i} - s_{t-i-k} = \sum_{j=0}^{k} \epsilon_{t-i-j}$. The implication is that estimates of $\beta_{i,k>0}$ tell us nothing about the validity of the Efficient Market Hypothesis beyond what we can infer from estimates of $\beta_{i,0}$. Note that the speed of convergence of $\beta_{i,k>0}$ to one depends on the size of the variance σ_ϵ^2.

To analyze the effect of the news advantage on the slope coefficient more formally, we derive the first and second order derivative of $\beta_{(i,k>0)}$ with respect to k:

$$\frac{\partial \beta_{(i,k>0)}}{\partial k} = \frac{\frac{\sigma_\epsilon^2}{V_{i,0}}}{[Var(f_{t-1} - s_{t-i-k})]^2}(1 - \beta_{(i,0)}) > 0 \tag{19}$$

$$\frac{\partial^2 \beta_{(i,k>0)}}{(\partial k)^2} = -\frac{2\frac{\sigma_\epsilon^4}{V_{i,0}}}{[Var(f_{t-1} - s_{t-i-k})]^3}(1 - \beta_{(i,0)}) < 0 \tag{20}$$

If $\beta_{i,0} < 1$, the first order derivative of $\beta_{(i,k>0)}$ with respect to the news advantage k is positive and the second order derivative is negative. Thus, $\beta_{(i,k>0)}$ increases at a decreasing rate as k increases. The relationship between β_k and k is non-linear. Measuring time to maturity i and the news advantage k in working days, Pope and Peel (1991) use $i = k = 65$ and McCallum $i = k = 21$. Below, we use daily quoted futures rates, and we are therefore able to vary the news advantage k of futures markets independently of the time to maturity, i.

With $i + k > 0$ and $k < 0$, the slope coefficient in equation (14) is:

$$\beta_{(i,k<0)} = \frac{(i+k)\lambda + (i+k)\sigma_\xi^2 + (i+k)\gamma}{-k\sigma_\alpha^2 + i\sigma_{\hat{\mu}}^2 + \sigma_\nu^2 + (i+k)\sigma_\xi^2 + 2k\gamma + 2(i+k)\lambda}$$

$$
\begin{aligned}
&= 1 + \frac{k\sigma_\epsilon^2 - k\sigma_\xi^2 - (i+k)\lambda + (i-k)\gamma - i\sigma_{\hat{\mu}}^2 - \sigma_\nu^2}{-k\sigma_\epsilon^2 + i\sigma_{\hat{\mu}}^2 + \sigma_\nu^2 + (i+2k)\sigma_\xi^2 + 2k\gamma + 2(i+k)\lambda} \qquad (21)\\
&= \frac{\beta_{(i,0)}V_{i,0}}{V_{i,0} - k(\sigma_\alpha^2 - \sigma_\xi^2 - 2(\gamma+\lambda))} + \frac{\beta_{(i,0)}V_{i,0}}{\frac{iV_{i,0}}{k} - i(\sigma_\alpha^2 - \sigma_\xi^2 - 2(\gamma+\lambda))}.
\end{aligned}
$$

When k gets very large and negative, the slope coefficient converges to $\beta_{(i,k\to-\infty)} = \frac{\lambda+\sigma_\xi^2+\gamma}{2\lambda+\sigma_\xi^2-\sigma_\alpha^2+2\gamma}$.

3 Data

The majority of earlier studies analyzing the expectations hypothesis use forward exchange rates instead of futures exchange rates. Both, forward and futures contracts, are traded on a daily basis. The difference between forward and futures contracts is that the latter are traded on secondary markets. Accordingly, for every contract expiring at time t, multiple futures rates with different times to expiration can be observed.

Our estimations are based on daily closing spot and 3-month futures exchange rate data for three currencies, i.e. US\$/DM, US\$/Franc, and US\$/Yen. The futures contracts have four delivery dates during a year, namely the third Wednesday of May, June, March, and December. We regard futures rates f_{t-i}^t with a time to delivery of up to three months, thus, the forecast horizon of the futures rates range between one and 65 working days, thus, $i = 1, \ldots, 65$.

Our data set covers US\$/DM futures rates that are priced between 6 September 1990 and 17 December 2001. Thus, we observe 44 different US\$/DM futures contracts, which settle between March 1991 and December 2001. The data set contains 32 different US\$/Franc futures contracts with delivery between March 1994 and December 2001, and the futures rates are priced between 2 September 1993 and 17 December 2001. Our data set includes 52 US\$/Yen futures contracts, which settle between March 1991 and December 2003, and the futures rates are priced between 6 September 1990 and 15 December 2003.

Figures 1, 3, and 5 contrast the change in the spot rate and the futures premium over time for futures rates with a forecast horizon of one month, $i = 21$. Figures 2, 4, and 6 show the relationship between $s_t - s_{t-42}$ and $f_{t-21}^t - s_{t-42}$, to illustrate the data Pope and Peel (1991) use for their estimations, $i = k = 21$. The figures indicate that the futures premium, $f_{t-21}^t - s_{t-21}$, is much more volatile than the corresponding

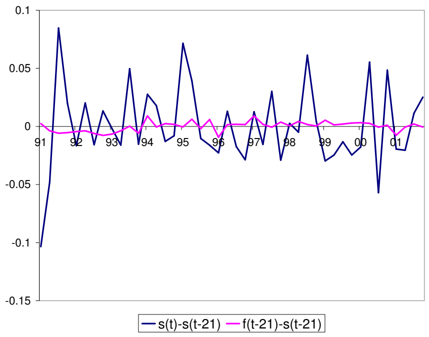

Figure 1: US$/DM Futures

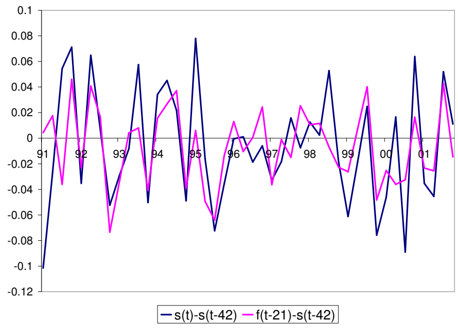

Figure 2: US$/DM Futures

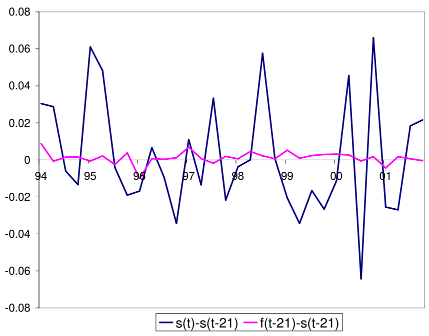

Figure 3: US$/Franc Futures

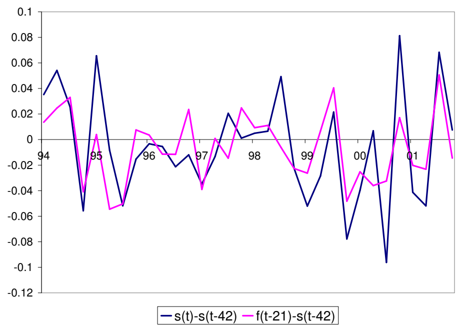

Figure 4: US$/Franc Futures

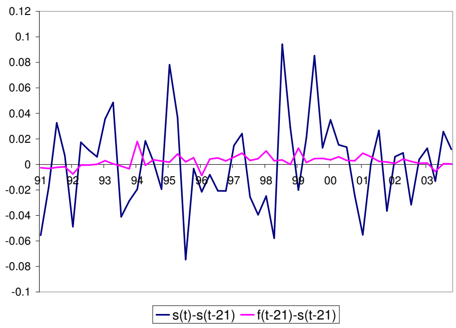

Figure 5: US$/Yen Futures

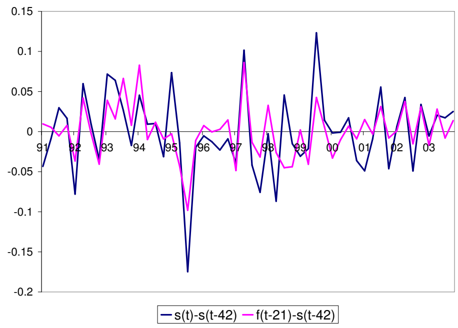

Figure 6: US$/Yen Futures

change in spot exchange rates, $s_{t-21}-s_t$, and seems to have little or even no predictive power. In contracts, Figures 2, 4, and 6 show that the time series of $f^t_{t-21} - s_{t-42}$ lies close to the corresponding spot exchange rates $s_t - s_{t-42}$ suggesting that futures rates with a time to maturity of one month are good predictors of exchange rate changes two month prior the maturity date.

4 Estimation Results

Similar to the result of Hai, Mark, and Wu (1997), Dickey-Fuller tests show that the futures premium and the change of exchange rates satisfy the stationarity condition, so that the estimation of equation (14) is feasible.

We run regression (14) for all combinations of k and i, with $k \in -20, \ldots, 65$ and $i \in 1, \ldots, 65$. Thus, with N different futures contracts, every regression is based on N observations, and we receive in total 5590 different slope estimates, from which we calculate the mean across the time to maturity i for all elements of k, i.e. $\bar{\beta}_k$. We call this a cross-sectional estimation.

In addition, we pool all futures rates across their time to maturity and apply a panel estimation approach as proposed by Dunis and Keller (1995) and Bernoth and von Hagen (2004). The panel estimator takes the time to maturity $i \in 1, \ldots, N$ as the cross-sectional and the settlement date of the futures contract, $t \in 1, \ldots, T$, as the time-series dimension, so that we have in total NT observations for each estimate $\hat{\beta}_k$.

A necessary condition for this approach to be feasible is the poolability of futures rates with different forecast horizons, i.e., $\beta_{(i,k)} = \beta_{(j,k)} = \hat{\beta}_k$ for $i \neq j$. For $k \geq 0$, the poolability test is the same as to test the hypothesis that $\sigma^2_\nu = 0$, since this is the only term that depends on the time to maturity i (compare equations (17) and (18)). As proposed by Baltagi (1995), we use a Chow test to verify poolability. The test results are listed in the first columns of Tables (2) to (4) in the Appendix and confirm poolability for all three currencies and $k = -20, \ldots, 65$. We estimate the panel with an OLS estimator with panel-corrected standard errors as proposed by Beck and Katz (1992), which corrects for heteroscedasticity across panels and time, cross-sectional correlation and if necessary for serial correlation.[5]

[5]Tables (2) to (4) in the Appendix show different test results to determine the panel error structure of our data set.

Figures 7 to 12 show the average slope coefficients of our cross-sectional estimations, $\bar{\beta}_k$ and of the panel estimations, $\hat{\beta}_k$.[6] In contrast to the Expectations Hypothesis, our estimation results show negative coefficients when regressing the futures premium on the corresponding spot exchange rate change, $\hat{\beta}_0 < 0$, $\bar{\beta}_0 < 0$.

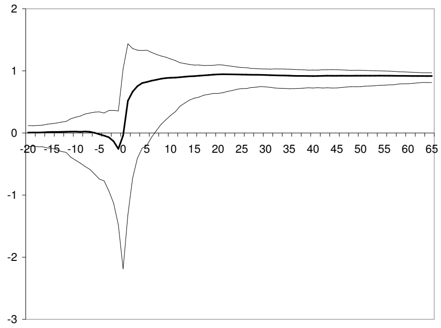

Figure 7: US$/DM Futures, Cross-Sectional Estimations

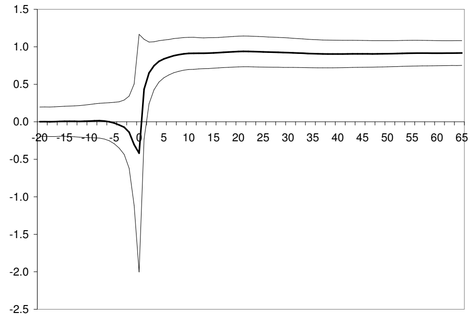

Figure 8: US$/DM Futures, Panel Estimations

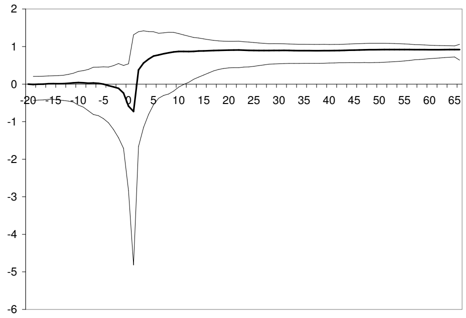

Figure 9: US$/Franc Futures, Cross-Sectional Estimations

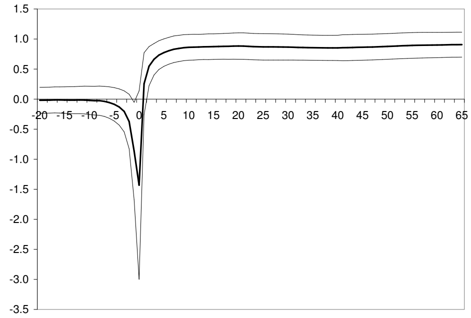

Figure 10: US$/Franc Futures, Panel Estimations

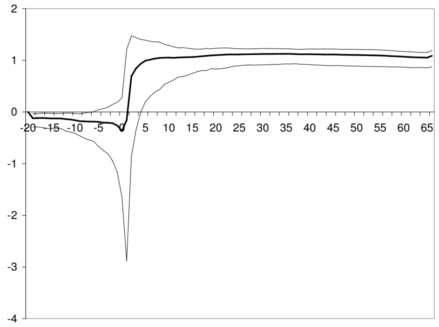

Figure 11: US$/Yen Futures, Cross-Sectional Estimations

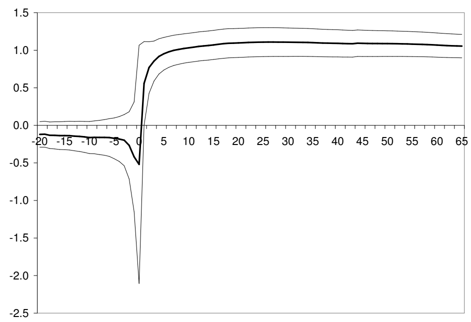

Figure 12: US$/Yen Futures, Panel Estimations

As predicted by our model, the estimation results report further that the slope

[6] Detailed estimation results of the panel estimation approach are listed in Tables 5 to 7 in the Appendix. Note, that the listed nominal p-values are not exact, since they are correlated between each other.

coefficient gradually increases when the news advantage ($k > 0$) of futures rates increases. With a news advantage of only a few days, i.e. two days according to the panel estimations and seven days according to the cross-sectional estimations, the slope coefficients turn to significantly positive values. The slope coefficients rise and converge to values ranging between 0.92 for US$/Franc rates and 1.09 for US$/Yen rates. According to the panel estimation results, we cannot reject the Expectations Hypothesis, $H_0 : \beta_k = 1$, for $k > 3$. Referring to equation (18), this rapid convergence stresses the dominance of the variance of the exchange innovation in the estimation regression.

Furthermore, the R^2 rises substantially with an increase in the news advantage. With no news advantage, futures rates explain at most one percent of the variation of future spot exchange rates. In contrast, for $k = 65$, futures markets explain around 60 percent of the development of changes in spot exchange rates.

As far as we know, there is no published work, in which regression (14) is run for $k < 0$. For $k < 0$, the slope coefficient is insignificant in all regressions and near zero, which means that futures rates at time $t - i$ have no power to predict the change of spot exchange rates between t and $t - i - k$.

To summarize, our estimation results confirm the result of negative slope coefficients described by e.g. Fama (1984), Bekaert and Hodrick (1993) and Engel (1994), when regressing the futures premium on the corresponding change of spot exchange rates. Additionally, we show that futures rates are good in predicting the change of spot exchange rates, when they have a news advantage of only a few days.

5 Identification of the Model Parameters

An identification of the source of the futures premium bias on the basis of the 'Fama regression', $k = 0$, is impossible. Previous studies imposed additional assumptions to gain some information on the futures premium bias. For example, Fama (1984) assumes efficiency, $\gamma = 0$, and concludes that the negative estimates of $\beta_{i,0}$ imply that the forward risk premium must be highly volatile, and probably more volatile than the expected rate of change of the exchange rate itself, $\sigma^2_{\hat{\mu}} > \sigma^2_{\xi}$. But he is not able to estimate the size of the variance terms $\sigma^2_{\hat{\mu}}$, σ^2_{ξ} nor the covariance term λ individually.

If one does not assume efficiency of markets, $\gamma \neq 0$, the identification of the model parameters is even more difficult. Dominguez (1986), Froot and Frankel

(1989), Froot and Chinn (1993), and Cavaglia et al. (1994) propose to use survey data to approximate the market participants' expectation about future changes in exchange rates in order to learn more about the source of the futures premium bias. But, regarding our data set of daily quoted futures rates with different forecast horizons, the use of survey data is not possible, since they are not recorded on a daily basis and evaluated only for specific forecast periods.[7]

As shown in equation (18), the relative weight of each unknown parameter, λ, γ, $\sigma^2_{\hat{\mu}}$, and σ^2_{ξ} on the right hand side does not change with a variation in the parameters i and k, if $k > 0$. Only the influence of the innovation of spot exchange rates relative to the other parameters depends on the size of k. Thus, the estimation results of the 'McCallum-Pope-Peel regression' for various i and k do not help to identify the model parameters, and to answer the question, what is the reason for the futures premium puzzle, inefficiency and/or time-varying risk premia.

Equation (21) suggests that for negative values of k, the weight of each unknown parameter on the right hand side depends differently on a given parameter combination of i and k. Thus, by comparing different slope coefficients $\beta_{i,k<0}$ for different pairs of i and k, we are able to identify the unknown parameters.

We propose to use a nonlinear least squares estimator to estimate the model parameters. Given equation (21), we regard $\beta_{i,k<0}$ as the dependent variable, λ, γ, $\sigma^2_{\hat{\mu}}$, σ^2_{ξ}, and σ^2_{ν} as the parameters to be estimated, and the different combinations of i and k with which the model parameters are multiplied in equation (21), are the independent variables. For $i \in \{1, \ldots, 65\}$, $k \in \{0, \ldots, -20\}$ and $i + k > 0$, our estimations are based on 1155 observations for each exchange rate.

The restrictions we impose on our parameters are that σ^2_{ξ} has to be smaller than σ^2_{ϵ} (compare equ. (3)), and that the variance terms $\sigma^2_{\hat{\mu}}$ and σ^2_{ν} have to be positive. The estimated variances of the daily change of exchange rates is $4.54e^{-5}$ for US\$/DM exchange rates, $4.26e^{-5}$ for US\$/Franc, and $5.05e^{-5}$ for US\$/Yen. Froot and Frankel (1989) and Cavaglia et al. (1994) show on the basis of survey data that the variance of the risk premium is close to the magnitude of the variance of the expected change of exchange rates. Accordingly, we restrict $\sigma^2_{\hat{\mu}} < 1.00e^{-3}$ in the numerical estimation. This restriction is not binding in the subsequent results.

The estimation results are presented in Table 1. In the first regression, we

[7]For example, Money Market Services (MMS) publishes its survey results only once a week for forecast periods of one and three months and the Economist's Financial Report reports its survey results for three, six, and twelve months forecasts only in six-week intervals.

Table 1: Estimated Model Parameters (x 10^5)

	σ_ξ^2	λ	σ_μ^2	γ	σ_ν^2	N	RSS
			US$/DM				
(1)	1.86	-1.98	1.99	-0.09	8.46	1155	164.73
	(0.02)	(-4.70)	(0.02)	(0.00)	(1.02)		
(2)	1.92	-0.99	0.22	-0.95		1155	177.30
	(0.00)	(0.00)	(0.00)	(0.00)			
(3)	1.91	-1.94	1.87		7.59	1155	164.64
	(5.01)	(-5.15)	(6.84)		(1.62)		
(4)	1.50	-1.51	1.69			1155	177.30
	(0.03)	(-0.03)	(0.03)				
(5)	2.30E-09		2.29E-06	-2.33E-02	2.30	1155	166.93
	(0.00)		(0.00)	(0.00)	(1.08)		
(6)	1.66		9.28E-07	-1.72		1155	178.04
	(0.00)		(0.00)	(0.00)			
			US$/French Franc				
(1)	1.82	-2.34	2.77	-0.43	7.26	1155	469.57
	(0.03)	(-6.41)	(0.05)	(0.01)	(1.61)		
(2)	1.80	-1.74	1.76	-0.12		1155	524.91
	(0.00)	(-0.00)	(0.00)	(0.00)			
(3)	2.18	-2.24	2.27		3.55	1155	464.72
	(8.94)	(-9.48)	(12.61)		(2.35)		
(4)	2.26	-2.26	2.20			1155	573.86
	(71.64)	(-78.25)	(590.90)				
(5)	2.30E-09		2.91E-09	-0.06	1.81	1155	469.38
	(0.00)		(0.00)	(0.00)	(1.81)		
(6)	0.08		1.63E-07	-0.14		1155	524.91
	(0.00)		(0.00)	(0.00)			
			US$/Yen				
(1)	2.02	-2.13	1.95	-0.08	26.50	1155	174.97
	(0.01)	(-0.36)	(0.01)	(0.00)	(1.87)		
(2)	1.15E-06	-5.44	67.50	-9.96		1155	192.83
	(0.00)	(0.00)	(0.00)	(0.00)			
(3)	2.24	-2.42	2.33		25.20	1155	174.97
	(0.61)	(-0.66)	(0.67)		(3.70)		
(4)	6.89E-04	-8.21	46.30			1155	192.89
	(0.00)	(0.00)	(0.00)				
(5)	3.21E-09		2.34E-09	0.27	19.90	1155	178.03
	(0.00)		(0.00)	(0.00)	(1.91)		
(6)	1.69E-05		32.60	-8.91		1155	192.88
	(0.00)		(0.00)	(0.00)			

Notes: t-values shown in parenthesis, N denotes the number of observations, and RSS is the residual sum of squares. In regression (2), (4), and (6) we assumes sn2=0, in regression (3) and (4) we assume informational efficiency (g=0), in regression (5) and (6) we take λ=0.

include all five unknown parameters, and in regression (2) we assume σ_ν^2 to be zero. In regression (3) and (4), we assume informational efficiency by setting γ equal zero. In regression (5) and (6) we assume that the risk premium is uncorrelated with the expected change of exchange rates by excluding λ from our regression.

For all three currencies, the residual sum of squares (RSS) is the smaller in regression (3), where we impose the restriction $\gamma = 0$, than in the unconstrained regression (1). This suggests that the likelihood surface is very flat in the relevant region and the estimator had difficulties to converge when all parameters are estimated freely. Imposing $\lambda = 0$ and estimating γ freely, in contrast, leads to a higher RSS compared to the unconstrained regression. For the US$/DM and the US$/Yen exchange rates, Chi-Square tests comparing regressions (1) and (5) are , respectively. Both are significant at the one-percent level. For the US$/French Franc rate, restricting $\lambda = 0$ and estimating γ freely leads to practically the same RSS, but the RSS of regression (3) is considerably lower. Thus, the data clearly point to regression (3) as the preferred one. As a result, we do not reject the efficiency hypothesis, $\gamma = 0$.

In all regressions, the covariance terms λ and γ show negative values, which suggests that the risk premium as well the forecast error of exchange rates are negatively correlated with the expected change of exchange rates. For the US$/DM and US$/Franc futures rates, the estimation results of regression (1) and (2) suggest that γ is much smaller in absolute values than λ. This observation confirms our previous conclusion that for these two currencies informational inefficiency plays a minor role in explaining the futures premium bias, and that the futures premium puzzle is mainly driven by time-varying risk premia that are negatively correlated with the expected change of exchange rates. But since the estimated coefficients in these regressions are insignificant, this interpretation has to be taken with caution.

For all three currencies a t-test cannot reject the hypothesis $H_0 : \sigma_\xi^2 = \sigma_{\hat{\mu}}^2$. Accordingly, our estimations confirm neither the result of e.g. Fama (1984), who states that the risk premium is more volatile than the expected change of exchange rates, nor the finding of Froot and Frankel (1989) and Cavaglia et al. (1994), who claim that the opposite holds.

6 Conclusion

This paper contributes to the literature on the futures premium puzzle in three ways. First, we describe a theoretical model of futures pricing and derive the conditions under which the futures premium puzzle shows up. Similar to the literature on the forward premium puzzle, we show that two factors might cause the futures premium puzzle, time varying risk premia that are negatively correlated with the expected change of exchange rates and market inefficiency. Further, our model serves to explain the Pope-Peel-McCallum puzzle. Pope and Peel (1991) and McCallum (1994) show that the forward premium puzzle disappears when forward rates have a news advantage of one period. We find that this result is explained by the fact that with an increase in the news advantage of futures rates the variance of the actual change of exchange rates gains weight and outweights the variation in the futures premium bias.

Second, we use three-month US$/DM, US$/French Franc, and US$/Yen futures rates with a forecast horizon between one day and three months to test the Expectations Hypothesis empirically. We confirm a negative slope coefficient when regressing the futures premium on the actual change of exchange rates. Further, we show that the slope coefficient increases and turns to a significant and positive value, when futures rates have a news advantage of only a few days, thus, much faster than described by Pope and Peel (1991) and McCallum (1994). However, this result has no bearings on the analysis of market efficiency. Additionally we find that futures rates have no predictive power, when they are priced earlier than the spot rate, which formes the basis of the predicted change.

Third, on basis of our estimation results, we identify the unknown model parameters, i.e. the variances of the futures risk premium, the forecast error of the risk premium, the expected change the exchange rates, the covariance between the risk premium and the expected change in exchange rates, and finally the covariance between the forecast error of exchange rates and the risk premium. Our estimation results for the US$/Yen futures rates do not yield conclusive results. For US$/DM and US$/French Franc currency futures, we show that a time varying risk premium, which is negatively correlated with the expected change in exchange rates, can explain the futures premium bias.

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A Appendix

Derivation of equation (11):
From equation (10) it follows:

$$s_t = f_{t-i}^t + \sum_{j=0}^{i-1} \alpha_{t-j} - \sum_{j=0}^{i-1} \hat{\mu}_{t-j-1} - \nu_{t-i}$$

and

$$s_{t-1} = f_{t-i}^{t-1} + \sum_{j=1}^{i-1} \alpha_{t-j} - \sum_{j=1}^{i-1} \hat{\mu}_{t-j-1} - \nu_{t-i}$$

After subtracting both sides of the latter two equations from each other, it follows:

$$\begin{aligned} s_t - s_{t-1} &= f_{t-i}^t - f_{t-i}^{t-1} + \sum_{j=0}^{i-1} \alpha_{t-j} - \sum_{j=1}^{i-1} \alpha_{t-j} - \sum_{j=0}^{i-1} \hat{\mu}_{t-j-1} + \sum_{j=1}^{i-1} \hat{\mu}_{t-j-1} \\ &= f_{t-i}^t - f_{t-i}^{t-1} + \alpha_t - \mu_{t-1}. \end{aligned}$$

From equation (3) it holds that $s_t - s_{t-1} = \xi_t + \alpha_t$, which implies:

$$f_{t-i}^{t-1} = f_{t-i}^t - \xi_t - \hat{\mu}_{t-1}.$$

Derivation of equation (12):

From equation (10) it follows:

$$s_t = f_{t-i}^t + \sum_{j=0}^{i-1} \alpha_{t-j} - \sum_{j=0}^{i-1} \hat{\mu}_{t-j-1} - \nu_{t-i}$$

and

$$s_{t+1} = f_{t-i+1}^{t+1} + \sum_{j=0}^{i-1} \alpha_{t+1-j} - \sum_{j=0}^{i-1} \hat{\mu}_{t-j} - \nu_{t+1-i}$$

After subtracting both sides of the latter two equations from each other, it follows:

$$\begin{aligned} s_{t+1} - s_t &= f_{t-i+1}^{t+1} - f_{t-i}^t + \sum_{j=0}^{i-1} \alpha_{t+1-j} - \sum_{j=0}^{i-1} \alpha_{t-j} - \sum_{j=0}^{i-1} \hat{\mu}_{t-j} + \sum_{j=0}^{i-1} \hat{\mu}_{t-j-1} - \nu_{t+1-i} + \nu_{t-i} \\ &= f_{t-i+1}^{t+1} - f_{t-i}^t + \alpha_{t+1} - \alpha_{t-i+1} - \hat{\mu}_t + \hat{\mu}_{t-i} - \nu_{t+1-i} + \nu_{t-i} \end{aligned}$$

From equation (3) it holds that $s_t - s_{t-1} = \xi_t + \alpha_t$, which implies:

$$f_{t-i}^t = f_{t-i+1}^{t+1} - \alpha_{t-i+1} - \hat{\mu}_t + \hat{\mu}_{t-i} - \xi_{t+1} + \nu_{t-i} - \nu_{t-i+1}.$$

k	Poolability H_0: $\beta_{3,(i,k)}=\beta_{3,k}$	Indiv. Effects H_0: $\alpha_i = \alpha$	Heterosk. across i H_0: $\sigma_{ii} = \sigma$	Contemp. Correl. H_0: $\sigma_{ij} = 0$	Serial Correl. H_0: $\rho = 0$
-20	1.00	1.00	0.00	0.00	0.00
-19	1.00	1.00	0.00	0.00	0.00
-18	1.00	1.00	0.00	0.00	0.00
-17	1.00	1.00	0.00	0.00	0.00
-16	1.00	1.00	0.00	0.00	0.00
-15	1.00	1.00	0.00	0.00	0.00
-14	1.00	1.00	0.00	0.00	0.00
-13	1.00	1.00	0.00	0.00	0.00
-12	1.00	1.00	0.00	0.00	0.00
-11	0.99	1.00	0.00	0.00	0.00
-10	0.94	1.00	0.00	0.00	0.00
-9	0.76	1.00	0.00	0.00	0.00
-8	0.62	1.00	0.00	0.00	0.00
-7	0.47	1.00	0.00	0.00	0.00
-6	0.36	1.00	0.00	0.00	0.01
-5	0.45	1.00	0.00	0.00	0.00
-4	0.60	1.00	0.00	0.00	0.01
-3	0.68	1.00	0.00	0.00	0.01
-2	0.91	1.00	0.00	0.00	0.01
-1	1.00	1.00	0.00	0.00	0.01
0	0.99	1.00	0.00	0.00	0.01
1	0.17	1.00	0.00	0.00	0.01
2	0.11	1.00	0.00	0.00	0.01
3	0.07	1.00	0.00	0.00	0.01
4	0.03	1.00	0.00	0.00	0.01
5	0.03	1.00	0.00	0.00	0.01
6	0.02	1.00	0.00	0.00	0.01
7	0.05	1.00	0.00	0.00	0.01
8	0.13	1.00	0.00	0.00	0.01
9	0.32	1.00	0.00	0.00	0.01
10	0.67	1.00	0.00	0.00	0.01
11	0.87	1.00	0.00	0.00	0.01
12	0.98	1.00	0.00	0.00	0.01
13	1.00	1.00	0.00	0.00	0.01
14	1.00	1.00	0.00	0.00	0.01
15	1.00	1.00	0.00	0.00	0.01
16	1.00	1.00	0.00	0.00	0.01
17	1.00	1.00	0.00	0.00	0.01
18	1.00	1.00	0.00	0.00	0.01
19	1.00	1.00	0.00	0.00	0.01
20	1.00	1.00	0.00	0.00	0.02
21	1.00	1.00	0.00	0.00	0.02
22	1.00	1.00	0.00	0.00	0.02
23	1.00	1.00	0.00	0.00	0.02
24	1.00	1.00	0.00	0.00	0.02
25	1.00	1.00	0.00	0.00	0.03
26	1.00	1.00	0.00	0.00	0.03
27	1.00	1.00	0.00	0.00	0.04
28	1.00	1.00	0.00	0.00	0.04
29	1.00	1.00	0.00	0.00	0.05
30	1.00	1.00	0.00	0.00	0.06
31	1.00	1.00	0.00	0.00	0.08
32	1.00	1.00	0.00	0.00	0.09
33	1.00	1.00	0.00	0.00	0.12
34	1.00	1.00	0.00	0.00	0.15
35	1.00	1.00	0.00	0.00	0.18
36	1.00	1.00	0.00	0.00	0.22
37	1.00	1.00	0.00	0.00	0.27
38	1.00	1.00	0.00	0.00	0.32
39	1.00	1.00	0.00	0.00	0.37
40	1.00	1.00	0.00	0.00	0.44
41	1.00	1.00	0.00	0.00	0.49
42	1.00	1.00	0.00	0.00	0.55
43	1.00	1.00	0.00	0.00	0.60
44	1.00	1.00	0.00	0.00	0.66
45	1.00	1.00	0.00	0.00	0.74
46	1.00	1.00	0.00	0.00	0.80
47	1.00	1.00	0.00	0.00	0.87
48	1.00	1.00	0.00	0.00	0.93
49	1.00	1.00	0.00	0.00	0.99
50	1.00	1.00	0.00	0.00	0.94
51	1.00	1.00	0.00	0.00	0.89
52	1.00	1.00	0.00	0.00	0.84
53	1.00	1.00	0.00	0.00	0.80
54	1.00	1.00	0.00	0.00	0.75
55	1.00	1.00	0.00	0.00	0.70
56	1.00	1.00	0.00	0.00	0.66
57	1.00	1.00	0.00	0.00	0.60
58	1.00	1.00	0.00	0.00	0.53
59	1.00	1.00	0.00	0.00	0.47
60	1.00	1.00	0.00	0.00	0.41
61	1.00	1.00	0.00	0.00	0.36
62	1.00	1.00	0.00	0.00	0.32
63	1.00	1.00	0.00	0.00	0.28
64	1.00	1.00	0.00	0.00	0.25
65	1.00	1.00	0.00	0.00	0.24

Figures in p-Values

Table 2: Panel Test Results for US$/DM Exchange Rate Futures

k	Poolability H_0: $\beta_{3,(i,k)}=\beta_{3,k}$	Indiv. Effects H_0: $\alpha_i = \alpha$	Heterosk. across i H_0: $\sigma_{ii} = \sigma$	Contemp. Correl. H_0: $\sigma_{ij} = 0$	Serial Correl. H_0: $\rho = 0$
-20	0.99	1.00	0.00	0.00	0.00
-19	1.00	1.00	0.00	0.00	0.00
-18	1.00	1.00	0.00	0.00	0.00
-17	1.00	1.00	0.00	0.00	0.00
-16	1.00	0.99	0.00	0.00	0.00
-15	1.00	0.99	0.00	0.00	0.00
-14	1.00	0.99	0.00	0.00	0.00
-13	1.00	0.98	0.00	0.00	0.00
-12	1.00	0.98	0.00	0.00	0.00
-11	0.99	0.97	0.00	0.00	0.00
-10	0.96	0.97	0.00	0.00	0.00
-9	0.87	0.97	0.00	0.00	0.00
-8	0.81	0.96	0.00	0.00	0.00
-7	0.71	0.95	0.00	0.00	0.00
-6	0.69	0.94	0.00	0.00	0.00
-5	0.80	0.94	0.00	0.00	0.00
-4	0.79	0.95	0.00	0.00	0.00
-3	0.86	0.96	0.00	0.00	0.00
-2	0.93	0.97	0.00	0.00	0.00
-1	0.52	0.99	0.00	0.00	0.00
0	0.01	1.00	0.00	0.00	0.00
1	0.08	0.96	0.00	0.00	0.00
2	0.05	0.93	0.00	0.00	0.00
3	0.05	0.93	0.00	0.00	0.00
4	0.04	0.93	0.00	0.00	0.00
5	0.04	0.93	0.00	0.00	0.00
6	0.02	0.93	0.00	0.00	0.00
7	0.02	0.94	0.00	0.00	0.00
8	0.02	0.94	0.00	0.00	0.00
9	0.05	0.94	0.00	0.00	0.00
10	0.15	0.95	0.00	0.00	0.00
11	0.25	0.95	0.00	0.00	0.00
12	0.51	0.96	0.00	0.00	0.00
13	0.72	0.96	0.00	0.00	0.00
14	0.85	0.96	0.00	0.00	0.00
15	0.94	0.97	0.00	0.00	0.00
16	0.97	0.97	0.00	0.00	0.00
17	0.98	0.97	0.00	0.00	0.00
18	0.98	0.97	0.00	0.00	0.00
19	0.98	0.97	0.00	0.00	0.00
20	0.97	0.98	0.00	0.00	0.00
21	0.95	0.98	0.00	0.00	0.00
22	0.93	0.98	0.00	0.00	0.00
23	0.92	0.99	0.00	0.00	0.00
24	0.95	0.99	0.00	0.00	0.00
25	0.97	0.99	0.00	0.00	0.00
26	0.99	0.99	0.00	0.00	0.00
27	0.99	0.99	0.00	0.00	0.00
28	0.99	0.99	0.00	0.00	0.00
29	0.99	0.99	0.00	0.00	0.00
30	0.99	0.99	0.00	0.00	0.00
31	0.99	0.99	0.00	0.00	0.00
32	0.99	0.99	0.00	0.00	0.00
33	0.98	0.99	0.00	0.00	0.00
34	0.98	0.99	0.00	0.00	0.00
35	0.98	0.99	0.00	0.00	0.01
36	0.96	0.99	0.00	0.00	0.01
37	0.95	0.99	0.00	0.00	0.01
38	0.95	0.99	0.00	0.00	0.02
39	0.95	0.99	0.00	0.00	0.03
40	0.96	0.99	0.00	0.00	0.04
41	0.96	0.99	0.00	0.00	0.05
42	0.96	0.99	0.00	0.00	0.07
43	0.96	0.99	0.00	0.00	0.08
44	0.93	0.99	0.00	0.00	0.09
45	0.91	0.98	0.00	0.00	0.12
46	0.87	0.98	0.00	0.00	0.14
47	0.84	0.98	0.00	0.00	0.16
48	0.80	0.98	0.00	0.00	0.18
49	0.78	0.97	0.00	0.00	0.20
50	0.77	0.96	0.00	0.00	0.21
51	0.77	0.96	0.00	0.00	0.22
52	0.78	0.95	0.00	0.00	0.23
53	0.82	0.94	0.00	0.00	0.25
54	0.85	0.94	0.00	0.00	0.27
55	0.89	0.93	0.00	0.00	0.29
56	0.92	0.92	0.00	0.00	0.30
57	0.95	0.91	0.00	0.00	0.32
58	0.97	0.91	0.00	0.00	0.37
59	0.99	0.90	0.00	0.00	0.40
60	1.00	0.90	0.00	0.00	0.44
61	1.00	0.89	0.00	0.00	0.47
62	1.00	0.88	0.00	0.00	0.48
63	1.00	0.88	0.00	0.00	0.51
64	1.00	0.88	0.00	0.00	0.56
65	1.00	0.88	0.00	0.00	0.60

Figures in p-Values

Table 3: Panel Test Results for US$/Franc Exchange Rate Futures

k	Poolability H_0: $\beta_{(i,k)}=\beta_k$	Indiv. Effects H_0: $\alpha_i = \alpha$	Heterosk. across i H_0: $\sigma_{ii} = \sigma$	Contemp. Correl. H_0: $\sigma_{ij} = 0$	Serial Correl. H_0: $\rho = 0$
-20	1.00	1.00	0.00	0.00	0.08
-19	1.00	1.00	0.00	0.00	0.05
-18	1.00	1.00	0.00	0.00	0.03
-17	1.00	1.00	0.00	0.00	0.03
-16	1.00	1.00	0.00	0.00	0.02
-15	1.00	1.00	0.00	0.00	0.01
-14	1.00	1.00	0.00	0.00	0.01
-13	1.00	1.00	0.00	0.00	0.01
-12	1.00	1.00	0.00	0.00	0.00
-11	1.00	1.00	0.00	0.00	0.00
-10	1.00	1.00	0.00	0.00	0.00
-9	1.00	1.00	0.00	0.00	0.00
-8	1.00	1.00	0.00	0.00	0.00
-7	1.00	1.00	0.00	0.00	0.00
-6	1.00	1.00	0.00	0.00	0.00
-5	1.00	1.00	0.00	0.00	0.00
-4	1.00	1.00	0.00	0.00	0.00
-3	1.00	1.00	0.00	0.00	0.00
-2	1.00	1.00	0.00	0.00	0.00
-1	1.00	1.00	0.00	0.00	0.00
0	1.00	1.00	0.00	0.00	0.00
1	0.87	1.00	0.00	0.00	0.14
2	0.78	1.00	0.00	0.00	0.28
3	0.86	1.00	0.00	0.00	0.37
4	0.95	1.00	0.00	0.00	0.44
5	0.98	1.00	0.00	0.00	0.49
6	0.98	1.00	0.00	0.00	0.51
7	0.99	1.00	0.00	0.00	0.53
8	1.00	1.00	0.00	0.00	0.53
9	1.00	1.00	0.00	0.00	0.54
10	1.00	1.00	0.00	0.00	0.53
11	1.00	1.00	0.00	0.00	0.53
12	1.00	1.00	0.00	0.00	0.52
13	1.00	1.00	0.00	0.00	0.51
14	1.00	1.00	0.00	0.00	0.50
15	1.00	1.00	0.00	0.00	0.49
16	1.00	1.00	0.00	0.00	0.47
17	1.00	1.00	0.00	0.00	0.46
18	1.00	1.00	0.00	0.00	0.44
19	1.00	1.00	0.00	0.00	0.42
20	1.00	1.00	0.00	0.00	0.41
21	1.00	1.00	0.00	0.00	0.39
22	1.00	1.00	0.00	0.00	0.38
23	1.00	1.00	0.00	0.00	0.37
24	1.00	1.00	0.00	0.00	0.35
25	1.00	1.00	0.00	0.00	0.32
26	1.00	1.00	0.00	0.00	0.30
27	1.00	1.00	0.00	0.00	0.28
28	1.00	1.00	0.00	0.00	0.26
29	1.00	1.00	0.00	0.00	0.24
30	1.00	1.00	0.00	0.00	0.22
31	1.00	1.00	0.00	0.00	0.19
32	1.00	1.00	0.00	0.00	0.17
33	1.00	1.00	0.00	0.00	0.15
34	1.00	1.00	0.00	0.00	0.13
35	1.00	1.00	0.00	0.00	0.12
36	1.00	1.00	0.00	0.00	0.11
37	1.00	1.00	0.00	0.00	0.09
38	1.00	1.00	0.00	0.00	0.08
39	1.00	1.00	0.00	0.00	0.07
40	1.00	1.00	0.00	0.00	0.06
41	1.00	1.00	0.00	0.00	0.06
42	1.00	1.00	0.00	0.00	0.05
43	1.00	1.00	0.00	0.00	0.04
44	1.00	1.00	0.00	0.00	0.04
45	0.99	1.00	0.00	0.00	0.03
46	0.99	1.00	0.00	0.00	0.03
47	0.98	1.00	0.00	0.00	0.03
48	0.96	1.00	0.00	0.00	0.02
49	0.94	1.00	0.00	0.00	0.02
50	0.92	1.00	0.00	0.00	0.02
51	0.90	1.00	0.00	0.00	0.01
52	0.86	1.00	0.00	0.00	0.01
53	0.82	1.00	0.00	0.00	0.01
54	0.79	1.00	0.00	0.00	0.01
55	0.78	1.00	0.00	0.00	0.01
56	0.79	1.00	0.00	0.00	0.01
57	0.81	1.00	0.00	0.00	0.01
58	0.79	1.00	0.00	0.00	0.01
59	0.78	1.00	0.00	0.00	0.01
60	0.77	1.00	0.00	0.00	0.01
61	0.77	1.00	0.00	0.00	0.01
62	0.76	1.00	0.00	0.00	0.01
63	0.78	1.00	0.00	0.00	0.01
64	0.77	1.00	0.00	0.00	0.02
65	0.73	1.00	0.00	0.00	0.02

Figures in p-Values

Table 4: Panel Test Results for US$/Pound Exchange Rate Futures

	Independent Variables				Statistics		Coeff. test
k	α	p-value	$\beta_{3,k}$	p-value	R^2	NT	$\beta_{3,k}$=1
-20	0.00	0.53	0.00	0.99	0.00	1980	0.00
-19	0.00	0.51	0.00	0.98	0.00	2024	0.00
-18	0.00	0.50	0.00	1.00	0.00	2068	0.00
-17	0.00	0.48	0.00	0.99	0.00	2112	0.00
-16	0.00	0.47	0.00	0.96	0.00	2156	0.00
-15	0.00	0.45	0.01	0.95	0.00	2200	0.00
-14	0.00	0.43	0.01	0.95	0.00	2244	0.00
-13	0.00	0.41	0.01	0.95	0.00	2288	0.00
-12	0.00	0.39	0.00	0.96	0.00	2332	0.00
-11	0.00	0.38	0.01	0.95	0.00	2376	0.00
-10	0.00	0.37	0.01	0.94	0.00	2420	0.00
-9	0.00	0.36	0.01	0.91	0.00	2464	0.00
-8	0.00	0.35	0.01	0.90	0.00	2508	0.00
-7	0.00	0.34	0.01	0.93	0.00	2552	0.00
-6	0.00	0.34	0.00	1.00	0.00	2596	0.00
-5	0.00	0.33	-0.02	0.91	0.00	2640	0.00
-4	0.00	0.33	-0.04	0.78	0.00	2684	0.00
-3	0.00	0.32	-0.07	0.69	0.00	2728	0.00
-2	0.00	0.31	-0.14	0.56	0.00	2772	0.00
-1	0.00	0.31	-0.30	0.45	0.00	2816	0.00
0	0.00	0.30	-0.42	0.60	0.00	2860	0.07
1	0.00	0.32	0.43	0.19	0.01	2860	0.09
2	0.00	0.33	0.65	0.00	0.03	2860	0.09
3	0.00	0.33	0.75	0.00	0.05	2860	0.11
4	0.00	0.33	0.81	0.00	0.08	2860	0.08
5	0.00	0.33	0.84	0.00	0.10	2860	0.10
6	0.00	0.33	0.86	0.00	0.12	2860	0.24
7	0.00	0.33	0.88	0.00	0.14	2860	0.30
8	0.00	0.33	0.89	0.00	0.16	2860	0.34
9	0.00	0.34	0.91	0.00	0.18	2860	0.39
10	0.00	0.34	0.91	0.00	0.20	2860	0.41
11	0.00	0.33	0.91	0.00	0.22	2860	0.41
12	0.00	0.33	0.91	0.00	0.23	2860	0.40
13	0.00	0.33	0.91	0.00	0.25	2860	0.40
14	0.00	0.33	0.92	0.00	0.26	2860	0.41
15	0.00	0.33	0.92	0.00	0.27	2860	0.42
16	0.00	0.33	0.92	0.00	0.29	2860	0.44
17	0.00	0.33	0.93	0.00	0.30	2860	0.47
18	0.00	0.33	0.93	0.00	0.31	2860	0.49
19	0.00	0.33	0.93	0.00	0.32	2860	0.51
20	0.00	0.33	0.94	0.00	0.34	2860	0.54
21	0.00	0.33	0.94	0.00	0.35	2860	0.55
22	0.00	0.33	0.94	0.00	0.36	2860	0.55
23	0.00	0.33	0.94	0.00	0.37	2860	0.53
24	0.00	0.33	0.93	0.00	0.38	2860	0.52
25	0.00	0.33	0.93	0.00	0.38	2860	0.50
26	0.00	0.33	0.93	0.00	0.39	2860	0.48
27	0.00	0.33	0.93	0.00	0.40	2860	0.47
28	0.00	0.33	0.93	0.00	0.41	2860	0.46
29	0.00	0.33	0.92	0.00	0.42	2860	0.44
30	-0.01	0.33	0.92	0.00	0.43	2860	0.42
31	-0.01	0.36	0.92	0.00	0.44	2860	0.40
32	-0.01	0.35	0.92	0.00	0.44	2860	0.38
33	-0.01	0.36	0.91	0.00	0.45	2860	0.37
34	-0.01	0.35	0.91	0.00	0.46	2860	0.35
35	-0.01	0.35	0.91	0.00	0.46	2860	0.33
36	-0.01	0.35	0.91	0.00	0.47	2860	0.32
37	-0.01	0.35	0.90	0.00	0.47	2860	0.30
38	-0.01	0.34	0.90	0.00	0.47	2860	0.30
39	-0.01	0.34	0.90	0.00	0.48	2860	0.30
40	-0.01	0.34	0.90	0.00	0.49	2860	0.29
41	-0.01	0.34	0.90	0.00	0.50	2860	0.29
42	-0.01	0.34	0.90	0.00	0.51	2860	0.29
43	-0.01	0.34	0.91	0.00	0.51	2860	0.30
44	-0.01	0.34	0.91	0.00	0.52	2860	0.30
45	-0.01	0.34	0.91	0.00	0.53	2860	0.29
46	-0.01	0.34	0.91	0.00	0.53	2860	0.29
47	-0.01	0.33	0.91	0.00	0.54	2860	0.28
48	-0.01	0.33	0.91	0.00	0.54	2860	0.29
49	-0.01	0.33	0.91	0.00	0.55	2860	0.29
50	-0.01	0.33	0.91	0.00	0.55	2860	0.29
51	-0.01	0.33	0.91	0.00	0.56	2860	0.29
52	-0.01	0.33	0.91	0.00	0.56	2860	0.30
53	-0.01	0.33	0.91	0.00	0.57	2860	0.31
54	-0.01	0.32	0.91	0.00	0.58	2860	0.32
55	-0.01	0.33	0.91	0.00	0.58	2860	0.32
56	-0.01	0.33	0.92	0.00	0.58	2860	0.32
57	-0.01	0.33	0.92	0.00	0.59	2860	0.32
58	-0.01	0.33	0.92	0.00	0.59	2860	0.32
59	-0.01	0.32	0.92	0.00	0.60	2860	0.31
60	-0.01	0.33	0.91	0.00	0.60	2860	0.31
61	-0.01	0.32	0.91	0.00	0.60	2860	0.31
62	-0.01	0.33	0.92	0.00	0.61	2860	0.31
63	-0.01	0.32	0.92	0.00	0.61	2860	0.31
64	-0.01	0.32	0.92	0.00	0.61	2860	0.31
65	-0.01	0.32	0.92	0.00	0.62	2860	0.31

Table 5: Estimation Results for $\hat{\beta}_k$ for US\$/DM Futures, $i \in [1, \ldots, 65]$ and $k \in -20, \ldots, 65$

	Independent Variables				Statistics		Coeff. test
k	α	p-value	$\beta_{3,k}$	p-value	R^2	NT	$\beta_{3,k}=1$
-20	0.00	0.77	-0.02	0.86	0.00	1440	0.00
-19	0.00	0.74	-0.02	0.86	0.00	1472	0.00
-18	0.00	0.72	-0.02	0.88	0.00	1504	0.00
-17	0.00	0.69	-0.01	0.90	0.00	1536	0.00
-16	0.00	0.67	-0.01	0.90	0.00	1568	0.00
-15	0.00	0.65	-0.02	0.88	0.00	1600	0.00
-14	0.00	0.62	-0.02	0.88	0.00	1632	0.00
-13	0.00	0.60	-0.02	0.88	0.00	1664	0.00
-12	0.00	0.58	-0.02	0.90	0.00	1696	0.00
-11	0.00	0.56	-0.02	0.90	0.00	1728	0.00
-10	0.00	0.54	-0.02	0.86	0.00	1760	0.00
-9	0.00	0.53	-0.03	0.83	0.00	1792	0.00
-8	0.00	0.51	-0.03	0.83	0.00	1824	0.00
-7	0.00	0.50	-0.04	0.76	0.00	1856	0.00
-6	0.00	0.49	-0.06	0.66	0.00	1888	0.00
-5	0.00	0.48	-0.09	0.54	0.00	1920	0.00
-4	0.00	0.48	-0.13	0.38	0.00	1952	0.00
-3	0.00	0.48	-0.20	0.23	0.01	1984	0.00
-2	0.00	0.50	-0.37	0.10	0.01	2016	0.00
-1	0.00	0.58	-0.86	0.03	0.02	2048	0.00
0	0.00	0.67	-1.43	0.07	0.03	2080	0.00
1	0.00	0.40	0.26	0.32	0.00	2080	0.00
2	0.00	0.37	0.55	0.00	0.02	2080	0.01
3	0.00	0.35	0.66	0.00	0.04	2080	0.01
4	0.00	0.35	0.73	0.00	0.06	2080	0.03
5	0.00	0.35	0.77	0.00	0.09	2080	0.05
6	0.00	0.34	0.81	0.00	0.11	2080	0.08
7	0.00	0.34	0.83	0.00	0.13	2080	0.12
8	0.00	0.34	0.84	0.00	0.15	2080	0.15
9	0.00	0.34	0.86	0.00	0.16	2080	0.18
10	0.00	0.34	0.86	0.00	0.18	2080	0.20
11	0.00	0.34	0.86	0.00	0.20	2080	0.20
12	0.00	0.33	0.87	0.00	0.21	2080	0.21
13	0.00	0.33	0.87	0.00	0.22	2080	0.22
14	0.00	0.33	0.87	0.00	0.24	2080	0.23
15	0.00	0.33	0.87	0.00	0.25	2080	0.24
16	0.00	0.33	0.88	0.00	0.26	2080	0.24
17	0.00	0.33	0.88	0.00	0.28	2080	0.26
18	0.00	0.33	0.88	0.00	0.29	2080	0.27
19	0.00	0.33	0.88	0.00	0.30	2080	0.28
20	0.00	0.34	0.88	0.00	0.31	2080	0.29
21	0.00	0.34	0.88	0.00	0.32	2080	0.29
22	0.00	0.34	0.88	0.00	0.34	2080	0.27
23	0.00	0.34	0.87	0.00	0.33	2080	0.25
24	0.00	0.34	0.87	0.00	0.34	2080	0.24
25	0.00	0.34	0.87	0.00	0.35	2080	0.23
26	0.00	0.34	0.87	0.00	0.36	2080	0.23
27	0.00	0.34	0.87	0.00	0.37	2080	0.23
28	0.00	0.34	0.87	0.00	0.37	2080	0.22
29	0.00	0.34	0.87	0.00	0.38	2080	0.22
30	0.00	0.34	0.87	0.00	0.39	2080	0.21
31	0.00	0.35	0.86	0.00	0.40	2080	0.20
32	0.00	0.35	0.86	0.00	0.41	2080	0.19
33	0.00	0.35	0.86	0.00	0.41	2080	0.18
34	0.00	0.35	0.86	0.00	0.42	2080	0.17
35	0.00	0.35	0.86	0.00	0.42	2080	0.17
36	0.00	0.35	0.85	0.00	0.43	2080	0.16
37	0.00	0.35	0.85	0.00	0.44	2080	0.16
38	0.00	0.35	0.85	0.00	0.44	2080	0.16
39	0.00	0.35	0.85	0.00	0.45	2080	0.16
40	0.00	0.35	0.85	0.00	0.45	2080	0.16
41	-0.01	0.34	0.86	0.00	0.45	2080	0.18
42	-0.01	0.34	0.86	0.00	0.46	2080	0.19
43	-0.01	0.34	0.86	0.00	0.46	2080	0.19
44	-0.01	0.34	0.86	0.00	0.47	2080	0.20
45	-0.01	0.34	0.86	0.00	0.48	2080	0.21
46	-0.01	0.34	0.87	0.00	0.48	2080	0.21
47	-0.01	0.34	0.87	0.00	0.49	2080	0.22
48	-0.01	0.34	0.87	0.00	0.49	2080	0.23
49	-0.01	0.34	0.87	0.00	0.50	2080	0.24
50	-0.01	0.34	0.88	0.00	0.51	2080	0.25
51	-0.01	0.34	0.88	0.00	0.51	2080	0.26
52	-0.01	0.34	0.88	0.00	0.52	2080	0.28
53	-0.01	0.34	0.89	0.00	0.53	2080	0.29
54	-0.01	0.34	0.89	0.00	0.53	2080	0.31
55	-0.01	0.34	0.89	0.00	0.54	2080	0.32
56	-0.01	0.34	0.90	0.00	0.54	2080	0.33
57	-0.01	0.34	0.90	0.00	0.55	2080	0.34
58	-0.01	0.34	0.90	0.00	0.55	2080	0.34
59	-0.01	0.34	0.90	0.00	0.55	2080	0.34
60	-0.01	0.33	0.90	0.00	0.56	2080	0.34
61	-0.01	0.33	0.90	0.00	0.56	2080	0.35
62	-0.01	0.33	0.90	0.00	0.57	2080	0.36
63	-0.01	0.33	0.91	0.00	0.57	2080	0.36
64	-0.01	0.33	0.91	0.00	0.57	2080	0.36
65	-0.01	0.33	0.91	0.00	0.58	2080	0.37

Table 6: Estimation Results for $\hat{\beta}_k$ for US$/Franc Futures, $i \in [1,\dots,65]$ and $k \in -20,\dots,65$

	Independent Variables				Statistics		Coeff. test
k	α	p-value	$\beta_{3,k}$	p-value	R^2	NT	$\beta_{3,k}=1$
-20	0.00	0.77	-0.12	0.17	0.01	2340	0.00
-19	0.00	0.77	-0.12	0.18	0.01	2392	0.00
-18	0.00	0.76	-0.13	0.14	0.01	2444	0.00
-17	0.00	0.75	-0.13	0.14	0.01	2496	0.00
-16	0.00	0.74	-0.14	0.15	0.01	2548	0.00
-15	0.00	0.72	-0.14	0.15	0.01	2600	0.00
-14	0.00	0.71	-0.14	0.14	0.01	2652	0.00
-13	0.00	0.71	-0.14	0.14	0.01	2704	0.00
-12	0.00	0.69	-0.15	0.14	0.01	2756	0.00
-11	0.00	0.68	-0.15	0.13	0.01	2808	0.00
-10	0.00	0.68	-0.16	0.15	0.01	2860	0.00
-9	0.00	0.68	-0.16	0.16	0.01	2912	0.00
-8	0.00	0.67	-0.16	0.18	0.01	2964	0.00
-7	0.00	0.68	-0.16	0.20	0.01	3016	0.00
-6	0.00	0.66	-0.16	0.20	0.00	3068	0.00
-5	0.00	0.66	-0.17	0.20	0.00	3120	0.00
-4	0.00	0.66	-0.18	0.22	0.00	3172	0.00
-3	0.00	0.65	-0.20	0.25	0.00	3224	0.00
-2	0.00	0.61	-0.27	0.23	0.00	3276	0.00
-1	0.00	0.54	-0.42	0.25	0.01	3328	0.00
0	0.00	0.52	-0.52	0.51	0.00	3380	0.06
1	0.00	0.92	0.56	0.05	0.01	3380	0.11
2	0.00	0.81	0.77	0.00	0.04	3380	0.18
3	0.00	0.77	0.86	0.00	0.06	3380	0.28
4	0.00	0.74	0.92	0.00	0.08	3380	0.48
5	0.00	0.72	0.95	0.00	0.11	3380	0.67
6	0.00	0.70	0.98	0.00	0.13	3380	0.84
7	0.00	0.69	1.00	0.00	0.15	3380	0.99
8	0.00	0.68	1.01	0.00	0.17	3380	0.91
9	0.00	0.68	1.02	0.00	0.19	3380	0.81
10	0.00	0.67	1.03	0.00	0.21	3380	0.74
11	0.00	0.67	1.04	0.00	0.22	3380	0.67
12	0.00	0.66	1.05	0.00	0.24	3380	0.60
13	0.00	0.66	1.06	0.00	0.26	3380	0.56
14	0.00	0.65	1.06	0.00	0.28	3380	0.51
15	0.00	0.65	1.07	0.00	0.29	3380	0.46
16	0.00	0.64	1.08	0.00	0.31	3380	0.41
17	0.00	0.63	1.09	0.00	0.33	3380	0.37
18	0.00	0.63	1.09	0.00	0.34	3380	0.34
19	0.00	0.63	1.09	0.00	0.36	3380	0.33
20	0.00	0.62	1.10	0.00	0.37	3380	0.31
21	0.00	0.62	1.10	0.00	0.39	3380	0.30
22	0.00	0.62	1.10	0.00	0.40	3380	0.29
23	0.00	0.61	1.11	0.00	0.41	3380	0.28
24	0.00	0.61	1.11	0.00	0.43	3380	0.27
25	0.00	0.61	1.11	0.00	0.44	3380	0.26
26	0.00	0.61	1.11	0.00	0.45	3380	0.26
27	0.00	0.61	1.11	0.00	0.46	3380	0.26
28	0.00	0.61	1.11	0.00	0.47	3380	0.26
29	0.00	0.61	1.11	0.00	0.48	3380	0.26
30	0.00	0.60	1.11	0.00	0.49	3380	0.26
31	0.00	0.60	1.11	0.00	0.50	3380	0.26
32	0.00	0.60	1.11	0.00	0.51	3380	0.26
33	0.00	0.60	1.10	0.00	0.51	3380	0.26
34	0.00	0.60	1.10	0.00	0.52	3380	0.27
35	0.00	0.61	1.10	0.00	0.53	3380	0.27
36	0.00	0.61	1.10	0.00	0.53	3380	0.28
37	0.00	0.61	1.10	0.00	0.54	3380	0.29
38	0.00	0.61	1.09	0.00	0.55	3380	0.30
39	0.00	0.61	1.09	0.00	0.55	3380	0.31
40	0.00	0.61	1.09	0.00	0.56	3380	0.31
41	0.00	0.61	1.09	0.00	0.57	3380	0.32
42	0.00	0.61	1.09	0.00	0.57	3380	0.33
43	0.00	0.61	1.09	0.00	0.58	3380	0.33
44	0.00	0.59	1.09	0.00	0.59	3380	0.28
45	0.00	0.59	1.09	0.00	0.60	3380	0.29
46	0.00	0.59	1.09	0.00	0.60	3380	0.29
47	0.00	0.59	1.09	0.00	0.61	3380	0.29
48	0.00	0.59	1.09	0.00	0.61	3380	0.29
49	0.00	0.59	1.09	0.00	0.62	3380	0.29
50	0.00	0.59	1.09	0.00	0.62	3380	0.30
51	0.00	0.59	1.09	0.00	0.63	3380	0.30
52	0.00	0.59	1.09	0.00	0.63	3380	0.30
53	0.00	0.59	1.09	0.00	0.63	3380	0.30
54	0.00	0.59	1.08	0.00	0.64	3380	0.31
55	0.00	0.59	1.08	0.00	0.64	3380	0.32
56	0.00	0.59	1.08	0.00	0.65	3380	0.33
57	0.00	0.59	1.08	0.00	0.65	3380	0.34
58	0.00	0.60	1.08	0.00	0.65	3380	0.35
59	0.00	0.60	1.07	0.00	0.65	3380	0.37
60	0.00	0.60	1.07	0.00	0.66	3380	0.39
61	0.00	0.61	1.07	0.00	0.66	3380	0.41
62	0.00	0.61	1.06	0.00	0.66	3380	0.43
63	0.00	0.61	1.06	0.00	0.67	3380	0.45
64	0.00	0.61	1.06	0.00	0.67	3380	0.46
65	0.00	0.62	1.05	0.00	0.67	3380	0.48

Table 7: Estimation Results for $\hat{\beta}_k$ for US$/Yen Futures, $i \in [1, \ldots, 65]$ and $k \in -20, \ldots, 65$