The Impact of the Lengths of Estimation Periods and Hedging Horizons on the Effectiveness of a Hedge: Evidence from Foreign Currency Futures

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INTRODUCTION

Johnson (1960), Stein (1961), and more recently, Ederington (1979), McEnally and Rice (1979), Franckle (1980), and Hill and Schneeweis (1982) apply the principles of portfolio theory to show that the optimal or minimum-risk hedge ratio of a futures contract is given by the ratio of the covariance between the changes in the spot and futures prices and the variance of the changes in the futures prices. The hedger's objective is to minimize the variance of price changes:

$$\text{Min Var}(\Delta H_t) = \text{Var}(\Delta S_t) + N_f^2\text{Var}(\Delta F_t) + 2N_f\,\text{Cov}(\Delta S_t, \Delta F_t) \quad (1)$$

s.t.

$$\Delta H_t = E(\Delta S_t) + N_f E(\Delta F_t)$$

where: ΔS_t, ΔF_t = price changes during period t of the spot currency and the futures contract, respectively; and ΔH_t = target change in value (or target profit from the hedged portfolio) during period t of a portfolio composed of one unit of the spot currency and N_f units of the futures contract.

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The minimum-risk hedge ratio is determined by setting the derivative of the hedged portfolio variance with respect to N_f equal to zero and solving for N_f^*:

$$N_f^* = -\frac{\text{Cov}(\Delta S_t, \Delta F_t)}{\text{Var}(\Delta F_t)} \tag{2}$$

The optimal or minimum-risk hedge ratio is equivalent to the negative of the slope coefficient of a regression of spot price changes on futures price changes. That is, N_f^* can be estimated by running an OLS regression with ΔS as the dependent variable and ΔF as the independent variable:

$$\Delta S_t = a + b\Delta F_t + \varepsilon_t \tag{3}$$

where $b = N_f^*$ = beta or optimal hedge ratio.

The above regression gives the optimal or correct hedge ratio for a particular dataset. The effectiveness of the minimum-variance hedge can be determined by examining the percentage of risk reduced by the hedge. The measure of hedging effectiveness is defined as the ratio of the variance of the unhedged position, Var(U), minus the variance of the hedged position, Var(H), over the variance of the unhedged position:

$$E_f = \frac{\text{Var}(U) - \text{Var}(H)}{\text{Var}(U)} = 1 - \frac{\text{Var}(H)}{\text{Var}(U)}, \tag{4}$$

where E_f denotes the measure of hedging effectiveness. Ederington (1979) shows also that E_f is equal to R^2, the coefficient of determination of the OLS regression of eq. (3). That is,

$$E_f = R^2 = \frac{N_f^2 \text{ Var}(\Delta F_t)}{\text{Var}(\Delta S_t)} \tag{5}$$

Given that R^2 is the square of the correlation coefficient, the higher the correlation between spot and futures price changes, the more effective the futures contract is as a hedging instrument, provided the R^2 is correctly interpreted as suggested by Lindahl (1989).

Minimum-risk hedge ratios and measures of hedging effectiveness are estimated for GNMA futures by Ederington (1979), Hill, Liro, and Schneeweis (1983), and Hill and Schneeweis (1984); for foreign currency futures by Hill and Schneeweis (1981, 1984), Grammatikos and Saunders (1983), and Grammatikos (1986); for CD futures by Overdahl and Starleaf (1986); for T-bill futures, by Ederington (1979), Franckle (1980), and Howard and D'Antonio (1984); and for stock market index futures by Figlewski (1984, 1985) and Junkus and Lee (1985).

The major conclusions of these studies are: (1) futures contracts perform well as hedging vehicles, (2) optimal hedge ratios are less than one, and (3) hedge ratios and measures of hedging effectiveness change with the length of the hedging horizon. Grammatikos and Saunders (1983) criticize previous studies of hedging performance of futures markets that use regression analysis. They examine the question of hedge ratio stability (which is an implicit assumption of the OLS regression) for five major foreign currency futures and find that hedge ratios are unstable over time. Instability of hedge ratios and measures of hedging effectiveness is reported also by Malliaris and Urrutia (1991).[1]

This article further explores the consequences of changes in the hedge ratio and measure of hedging effectiveness. The analysis concentrates on determining the impact on the effectiveness of the hedge by the length of the estimation period (i.e., the number of observations in the sample used in estimating betas and R^2's by running OLS regressions) and the length of the hedging horizon (i.e., the length of the period the hedge is in effect). The data cover the period from March 4, 1980 to December 27, 1988, and correspond to spot exchange rates and nearby settlement futures prices for five foreign currencies: British pound, Japanese yen, Canadian dollar, German mark, and Swiss franc.

MOTIVATION OF THE RESEARCH

The motivation of this study is two-fold. First, the effect of changes in the length of the estimation period on the effectiveness of the hedge is examined. It is postulated that if hedge ratios are constant over time, then a longer estimation period should give a better estimate of the futures beta and improve the effectiveness of the hedge. If, on the other hand, hedge ratios are changing over time, then using data from long ago may lead to a poorer estimate of the futures beta and worsen the effectiveness of the hedge. In other words, if betas are unstable, the use of shorter estimation periods is advisable because they should give better hedges. Shorter estimation periods also save time and money because smaller data samples are easier to collect and analyze.

Second, the length of the hedging horizon is examined to see if it impacts on the effectiveness of the hedge. It is postulated that, if shorter hedges are more effective than longer ones, then hedgers are better off hedging their cash position for shorter periods of time, recomputing their hedge ratios, and rolling the hedges over rather than keeping the hedge for longer periods of time. If the opposite is true, then longer hedging horizons are advisable.

There are no theoretical guidelines in addressing both problems, that is, the impact of the length of the estimation period and the length of the hedging horizon on the effectiveness of a hedge. The modern portfolio theory approach to futures hedging derives the optimal hedge as the beta of a specific regression but offers no clues as to the length of the estimation period nor the appropriate length of the hedging horizon. Obviously, foreign exchange hedgers consider both issues of great practical significance.

The hedging issues addressed in this study are irrelevant for foreign currencies if one considers forward contracts instead of futures contracts. For example, if a firm has a 30-day yen liability, it can buy Yen forward and it is perfectly hedged. The emphasis here is on the futures markets because, in many cases of both real and theoretical interest, use of futures is unavoidable.

[1]The notion of hedge ratio instability is not given a rigorous definition in the futures literature. It is used to indicate that the hedge ratio does not remain constant over time. Malliaris and Urrutia (1991) confirm earlier results by other authors that hedge ratios for several foreign currencies change over time and go further to investigate the time series characteristics of these changing hedge ratios. For a rigorous mathematical definition of the notion of instability as used in economic analysis see Brock and Malliaris (1989).

DATA

The data correspond to weekly spot exchange rates and settlement futures prices for the nearby contract (0–3 months) for five foreign currencies traded in the International Monetary Market of the Chicago Mercantile Exchange: British pound, German mark, Canadian dollar, Japanese yen, and Swiss franc. Spot exchange rates, and nearby settlement futures contract prices are from the Center for Futures Markets of Columbia University and from the *Wall Street Journal* for the time period March 4, 1980 to December 27, 1988. Weekly Monday settlement prices are used to minimize the possible influence of the release of U.S. Treasury bills auction results. Usually, the U.S. Treasury releases the results of its weekly short-term T-bill auction after currency futures markets close on Monday. Therefore, Monday foreign currency settlement prices are not affected by short-term interest rates determined in this auction.[2]

METHODOLOGICAL REMARKS

Ederington's technique of estimating optimal minimum risk hedge ratios using ordinary least squares (OLS) regression yields unbiased estimates only when the data satisfy (among other standard assumptions) the assumptions of homoscedasticity (constant variance) and no-autocorrelation (uncorrelated error terms). Franckle (1980) and Hill and Schneeweis (1982) point out that time series data on spot and futures rates for foreign currencies show significant serial correlation. Autocorrelation of residuals yields unbiased but inefficient estimates of hedge ratios (the regression coefficients are no longer minimum variance). The true standard errors are underestimated and, therefore, the significance tests using t and F distributions are no longer strictly applicable. In addition, the presence of autocorrelation causes overestimation of the R^2 statistic. Other authors, such as Herbst, Kare, and Caples (1989) report heteroscedasticity problems in time series data of foreign currency futures. If the assumption of equal error variances is violated, the estimates obtained by OLS procedures are no longer minimum variance (even though they are still unbiased and consistent).

Preliminary regressions performed on the data reveal the presence of heteroscedasticity and autocorrelation. The first problem is corrected by taking the natural logarithm of the data. The problem of autocorrelation among residuals is corrected using an autoregression (AR) model. The SAS procedure AUTOREG is used.[3]

EX POST HEDGING RESULTS

Hedge ratios and measures of hedging effectiveness are estimated by running OLS regressions of the form of eq. (3) for two different lengths of the estimation periods

[2]The selection of a specific day of the week is not of great significance.

[3]Herbst, Kare, and Caples (1989) show that their Box–Jenkins ARIMA procedure is superior to an autoregression in correcting for autocorrelation in the residuals. They also indicate that their ARIMA procedure yields optimal hedge ratios that are lower than those obtained by using OLS regressions. These authors also point out that the autoregressive models proved to offer no improvement because the error terms showed infinite memory. In this study, with different data sets, two lags are sufficient to adjust for most of the presence of autocorrelation. In addition, the major concern is not the absolute magnitude of the hedge ratio but the relative impact of changes in the lengths of the estimation period and the hedging horizon on the effectiveness of the hedge. With this objective in mind, the use of the procedure AUTOREG for correcting for autocorrelation in the regression residuals allows meaningful comparisons among hedge ratios and measures of hedging effectiveness computed from different estimation periods and for different hedging horizons.

and two different lengths of the hedging horizons. The lengths of the hedging horizons are one week (weekly hedge) and four weeks (monthly hedge). For both the weekly and monthly hedging horizon the lengths of the estimation periods are 26 and 104 weeks (half a year and two years).[4] To generate a distribution of betas and

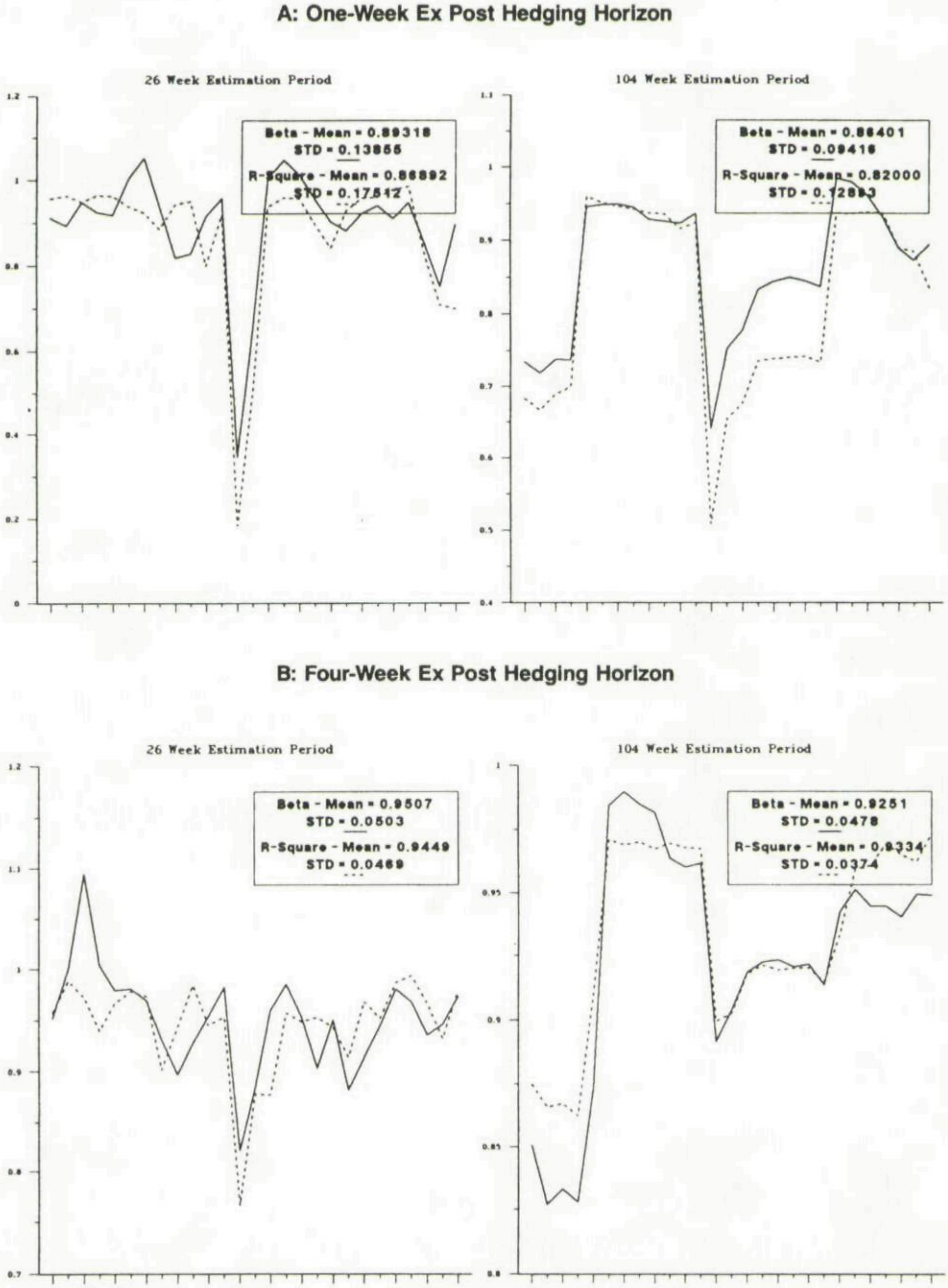

Figure 1

Hedge Ratios and Measures of Hedging Effectiveness for British Pound.

[4]Two additional intermediate estimation periods of 52 and 78 weeks were considered but are not included here due to space constraints.

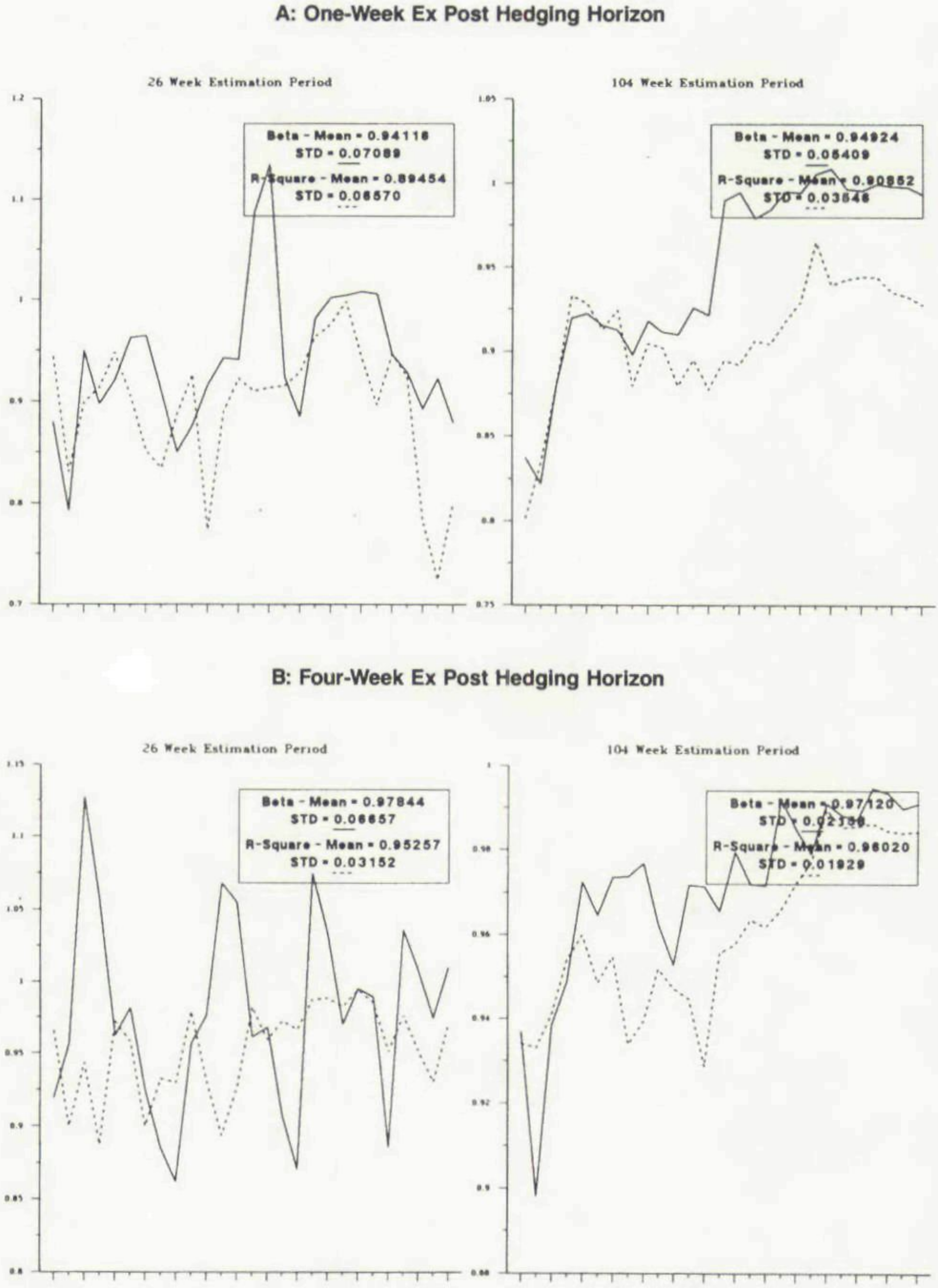

Figure 2

Hedge Ratios and Measures of Hedging Effectiveness for German Mark.

R^2's, an overlapping or moving window procedure is used, consisting of deleting the first 12 weeks (a quarter), and adding a new quarter's data, keeping the length of the estimation period constant.

The moving hedge ratios and measures of hedging effectiveness are shown graphically in Figures 1–5 for weekly and monthly hedging horizons. The data in the figures confirm findings reported by authors such as Grammatikos and Saun-

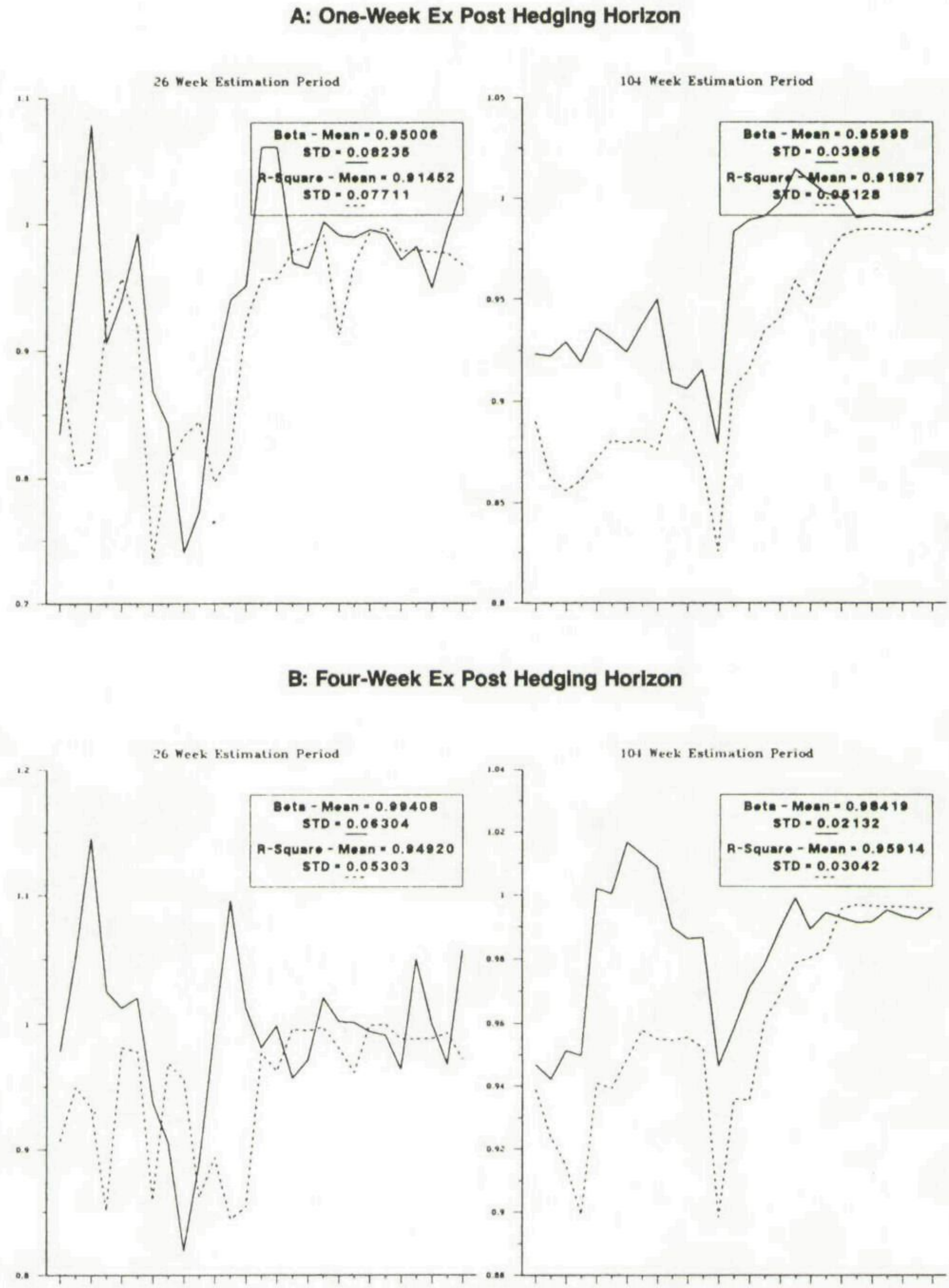

Figure 3

Hedge Ratios and Measures of Hedging Effectiveness for Japanese Yen.

ders (1983) and Malliaris and Urrutia (1991) about the instability of betas and R^2's over time. The mean betas and R^2's and their corresponding standard deviations are shown also in the figures. The average hedge ratios are less than one but they are not significantly different from one in a statistical sense. These findings agree with Grammatikos (1986) but not with Hill and Schneeweis (1982) who find betas to be significantly less than one. The average R^2's are large, indicating that foreign

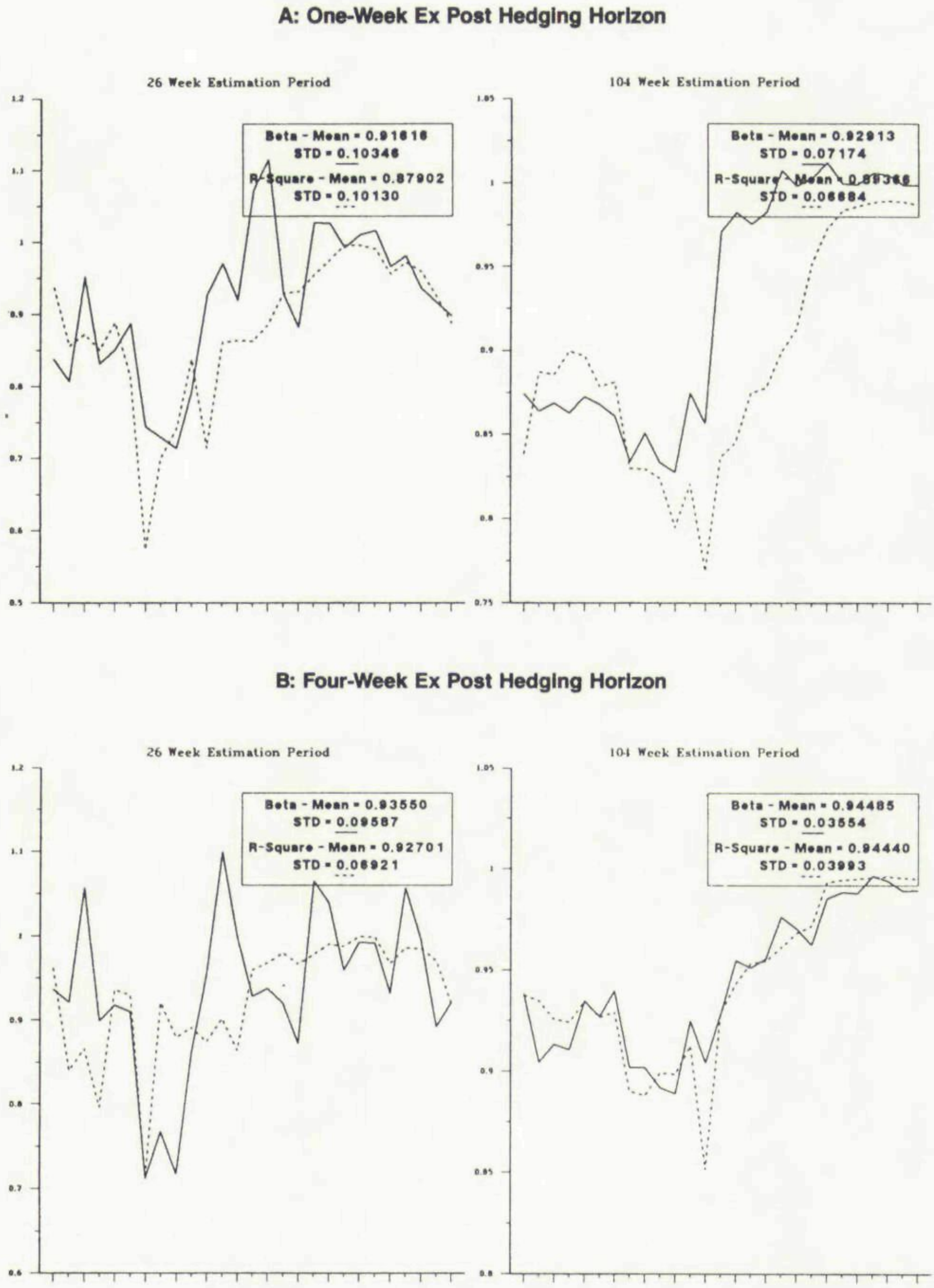

Figure 4
Hedge Ratios and Measures of Hedging Effectiveness for Swiss Franc.

currency futures are good hedging instruments. Also, the results confirm findings by Dale (1981) who reports that foreign currency futures, as hedging instruments, are as effective as the more traditional agricultural commodities futures.

The results for weekly hedging horizons in Figures 1–5 show, on average, the R^2's for the Japanese yen, German mark, and Swiss franc tend to slightly increase with the length of the estimation period. The opposite is observed for the British pound and the Canadian dollar. A similar pattern is observed for the monthly hedging

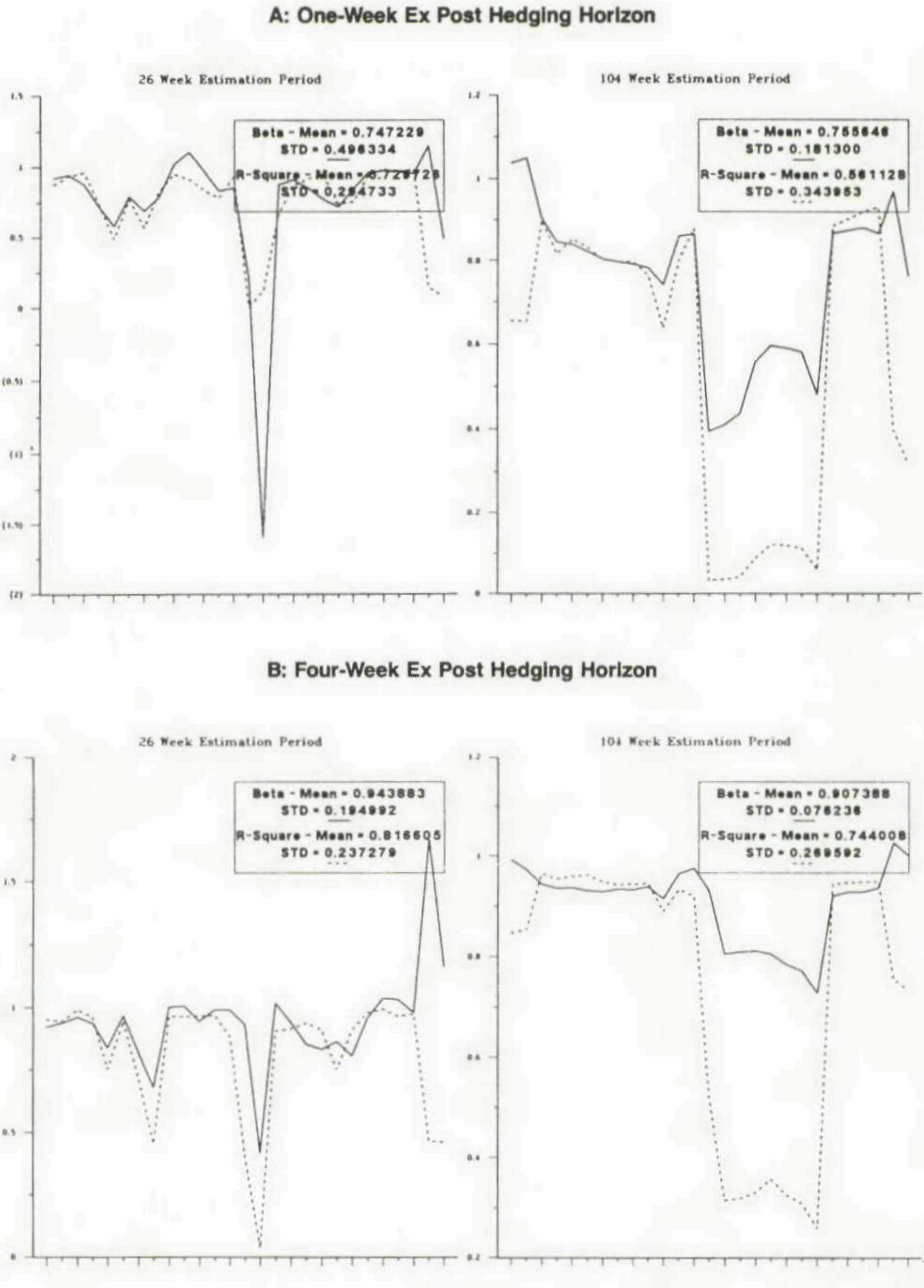

Figure 5
Hedge Ratios and Measures of Hedging Effectiveness for Canadian Dollar.

horizons. The betas for the weekly and monthly hedging horizons follow similar patterns to R^2 because of their relationship in eq. (5). From Figures 1–5, one can conclude that, for *ex post* hedges, the length of the estimation period does not appear to have an important impact in betas and R^2's. In effect, the *t*-statistics of the difference of mean R^2's presented in Table I indicate that for *ex post* hedging, except for the Canadian dollar (weekly hedge), the length of the estimation period does not have a statistically significant impact in the effectiveness of weekly or

Table I
t-STATISTICS FOR THE DIFFERENCE OF MEAN R^2's FOR *EX POST* HEDGES OBTAINED FROM 26-WEEK AND 104-WEEK ESTIMATION PERIODS

H_0: $R^2_{104\ weeks} - R^2_{26\ weeks}$		H_A: $R^2_{104\ weeks} > R^2_{26\ weeks}$
Futures Contract	**Weekly Hedging Horizon**	**Monthly Hedging Horizon**
British pound	1.19	1.01
German mark	0.99	1.09
Japanese yen	0.26	0.86
Swiss franc	0.65	1.15
Canadian dollar	1.97	1.07

Note: The null hypothesis, H_0, cannot be rejected except for the Canadian dollar (Weekly Hedging Horizon) at the 5% confidence level.

monthly hedges. Thus, the effectiveness of the *ex post* hedge seems not to be affected by the length of the estimation period. These results provide some empirical evidence in support of the hypothesis that hedge ratios are unstable over time (if hedge ratios are stable over time, longer estimation periods would yield consistently higher R^2's).

Figures 1–5 also suggest that, for *ex post* hedges, the R^2's are larger for monthly hedges than for weekly hedges. Table II shows the t-statistics for the difference of mean R^2's for *ex post* monthly and weekly hedges. The hypothesis that the effectiveness of *ex post* hedging improves with the length of the hedging horizon is confirmed for all currencies, except for the Canadian dollar (26-week estimation period). These results agree with those reported by other authors. Hill and Schneeweis (1982), in studying several foreign currency futures, covering the time period March, 1974 through December, 1978, find that the effectiveness of the hedge improves with the length of the hedging horizon. Ederington (1979) also finds that for GNMA, T-bills, wheat, and corn futures, the hedging effectiveness increases with the length of the hedging horizon. Since this research covers a more recent period, the findings about *ex post* hedges can be considered an update of previous studies and a confirmation of their major conclusion, namely that the measure of hedging effectiveness improves with the length of the hedging horizon.

To summarize, for *ex post* hedging, the evidence presented in Figures 1–5 and Tables I and II indicates that the length of the hedging horizon is a critical invest-

Table II
t-STATISTICS FOR THE DIFFERENCE OF MEAN R^2's FOR *EX POST* MONTHLY AND WEEKLY HEDGES

H_0: $R^2_{monthly\ hedge} - R^2_{weekly\ hedge}$		H_A: $R^2_{monthly\ hedge} > R^2_{weekly\ hedge}$
Futures Contract	**26-Week Estimation Period**	**104-Week Estimation Period**
British pound	2.22	4.47
German mark	4.21	7.01
Japanese yen	1.96	3.57
Swiss franc	2.07	3.45
Canadian dollar	1.22	2.21

Note: The null hypothesis, H_0, is rejected in favor of the alternative, H_A, for all currencies except for the Canadian dollar (26-week estimation period) at the 5% confidence level.

ment decision, while the length of the estimation period is a statistical issue of less importance.

EX ANTE HEDGING RESULTS

Past data is used now to generate hedge ratios by running the standard OLS regression, and then these betas are used to hedge a cash position on an *ex ante* basis. The purpose of these tests is to provide new empirical evidence about the hypothesis of the instability of hedge ratios over time and the impact of the length of the hedging horizon on the effectiveness of the hedge. Furthermore, the *ex post* hedging effectiveness measured in statistical terms by the magnitude of R^2 is contrasted with the economic consequence of a hedge which is evaluated in terms of returns.

The argument is as follows: In a regression-based strategy, hedgers must estimate the optimal hedge ratio using past data and then employ the estimated ratio to form the hedge. If the true hedge ratio is constant over time, then use of the longest possible estimation period should provide the best estimate of the hedge ratio and the most effective hedge. If, on the contrary, betas change over time, then using data from long ago may lead to a poor estimate of the futures beta and worsen the hedge. In this case, it would be better to use a shorter estimation period. Therefore, the hedging effectiveness of betas computed over various lengths of estimation periods is compared by computing the returns of a long hedge.

The following long hedging strategy is employed.[5] The hedge consists of buying futures contracts and closing out the position by selling the futures contracts when the spot market transaction occurs. Risk is reduced to the extent that the gain from the futures position offsets the loss in the spot position. In a perfect hedge, the gain (loss) in the futures position, completely offsets the loss (gain) in the spot. That is, in a perfect hedge, the return from a hedging strategy is on average equal to zero. Therefore, the more effective the hedge is, the closer to zero the return is on the hedged portfolio. Denote by R_H the return on the hedged portfolio; R_H is computed as follows:

$$R_H = [(F_{t+i} - F_t)H_R - (S_{t+i} - S_t)] \times 100 \tag{6}$$

where

F_{t+i}, F_t = futures contract prices at time t and $t + i$ for $i = 1,4$ (weekly and monthly hedging horizons); and S_{t+i}, S_t = spot foreign currency rates at time t and $t + i$ for $i = 1,4$.

The hedge ratios are estimated by running regressions of the form of eq. (3). The lengths of the hedging horizons are one week and four weeks. As in the *ex post* case, an overlapping or moving window procedure is used to generate a distribution of betas.

The distribution of returns on the hedged position obtained from the hedge ratios generated by means of the moving window procedure are shown in Figures 6–10 for weekly and monthly hedging horizons. In general, the mean returns for weekly and monthly hedges, with the exception of the British pound, decrease slightly when the length of the estimation period is increased from 26 weeks to 104 weeks. The figures show that the length of the estimation period does not seem to have an important impact in the effectiveness of the hedge. In effect, the t-statistics reported in Table III indicate that, for the *ex ante* hedges, the length of the estimation period does not have a statistically significant impact in the effectiveness of

[5]The numerical results would be analogous if a short hedge is used instead of a long one.

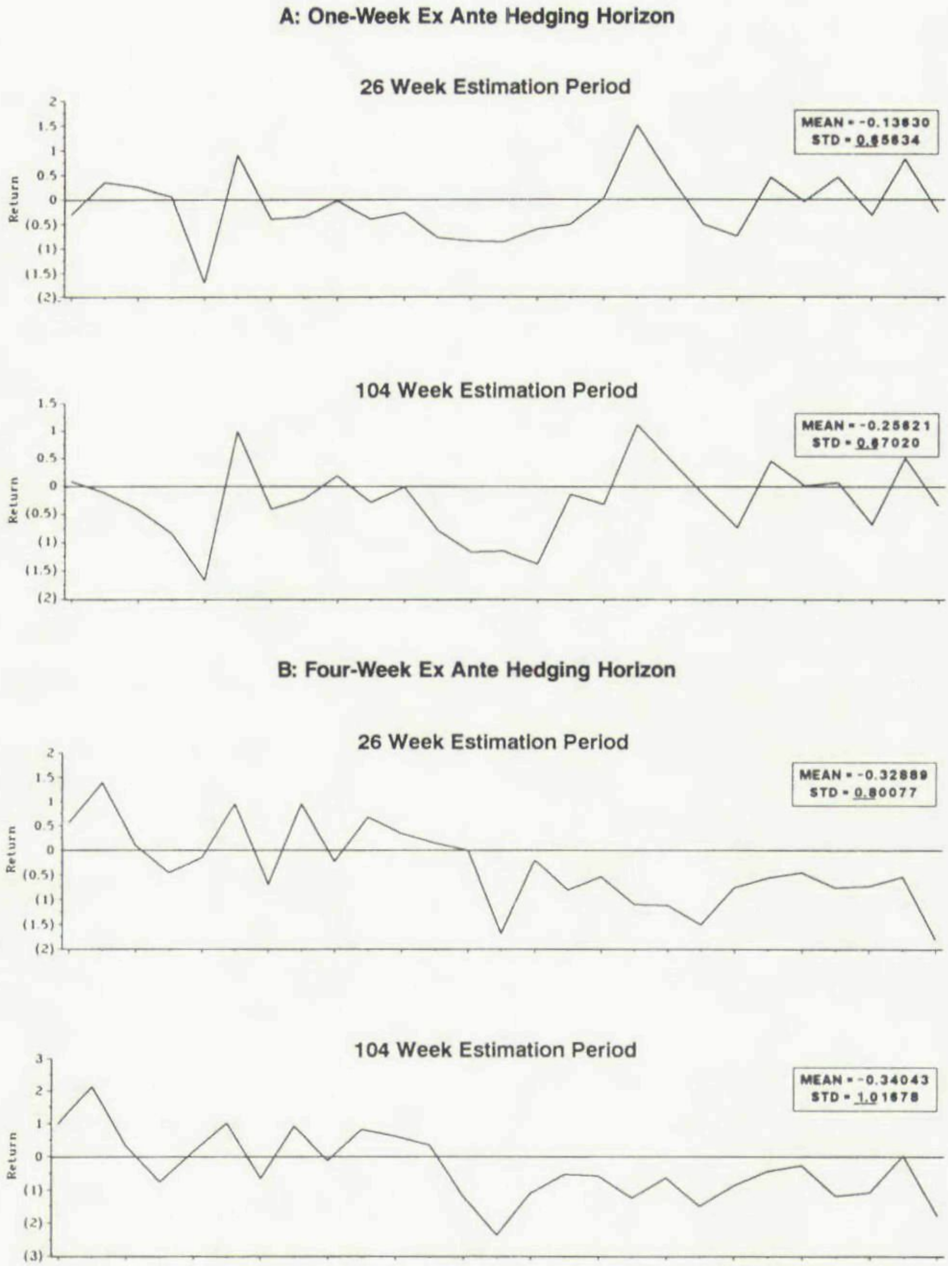

Figure 6
Return Graph of British Pound.

weekly or monthly hedges. This is essentially the same conclusion reached for the *ex post* analysis presented in the previous section. Recall the hypothesis that if hedge ratios are constant over time, one should expect longer estimation periods to provide more effective hedges than shorter ones. Therefore, the results for the *ex ante* hedges provide some empirical evidence in favor of the hypothesis that mean hedge ratios are unstable over time.

The comparison of the hedging effectiveness of the *ex ante* weekly and monthly hedges shows that the hedged portfolio mean returns for the four-week holding

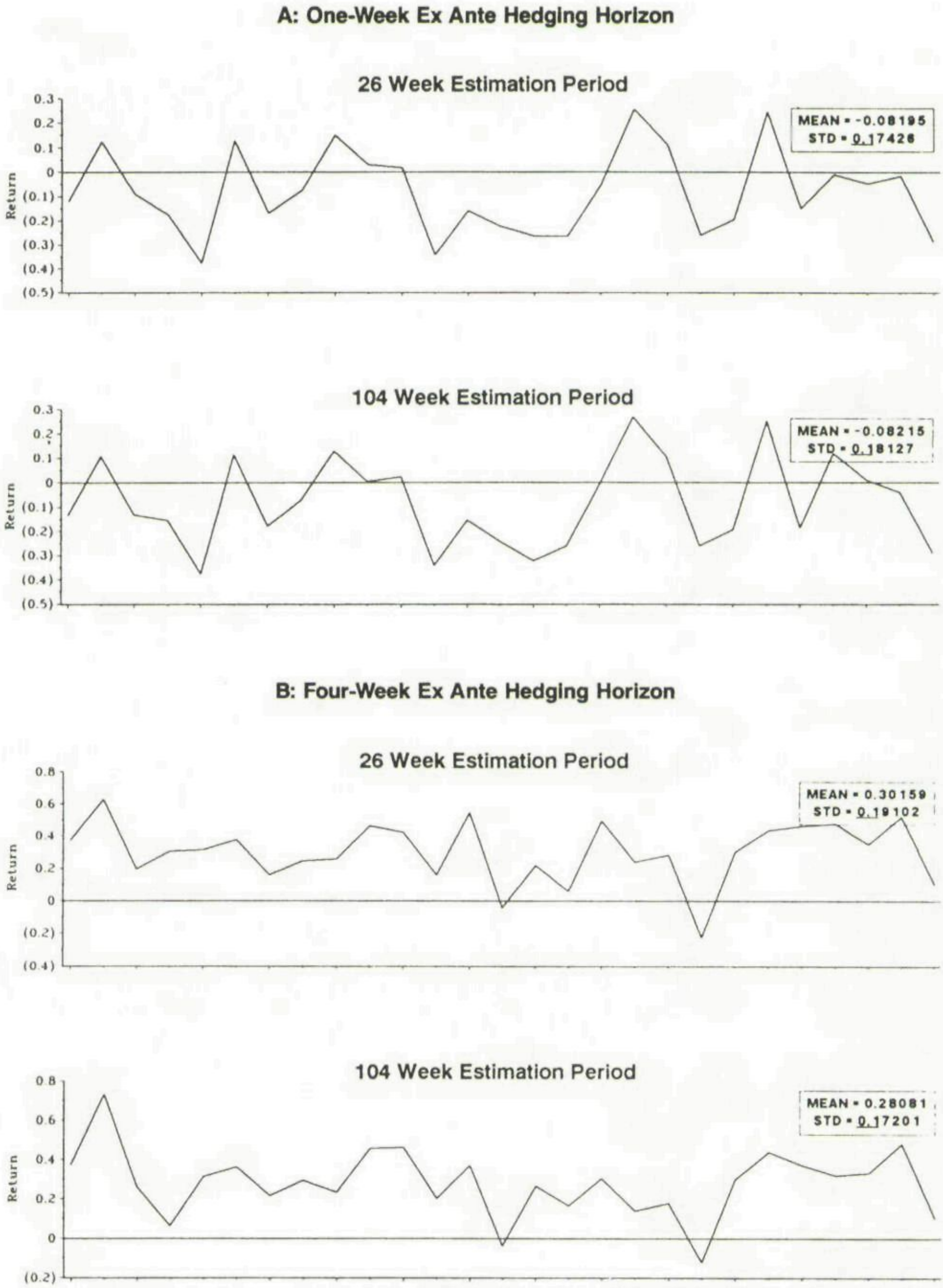

Figure 7
Return Graph of German Mark.

horizon are larger than those of the one-week holding period. In fact, the mean returns for the monthly holding period are two (for the British pound) to six (for the Canadian dollar) times the mean returns of the weekly holding period. That is, the effectiveness of the *ex ante* hedges appears to improve when the length of the hedging horizon is shortened from four weeks to one week. Recall that a perfect hedge is defined as one yielding a return of zero. Table IV reports the *t*-statistics for the difference of mean returns for the hedged portfolios for *ex ante* weekly and monthly

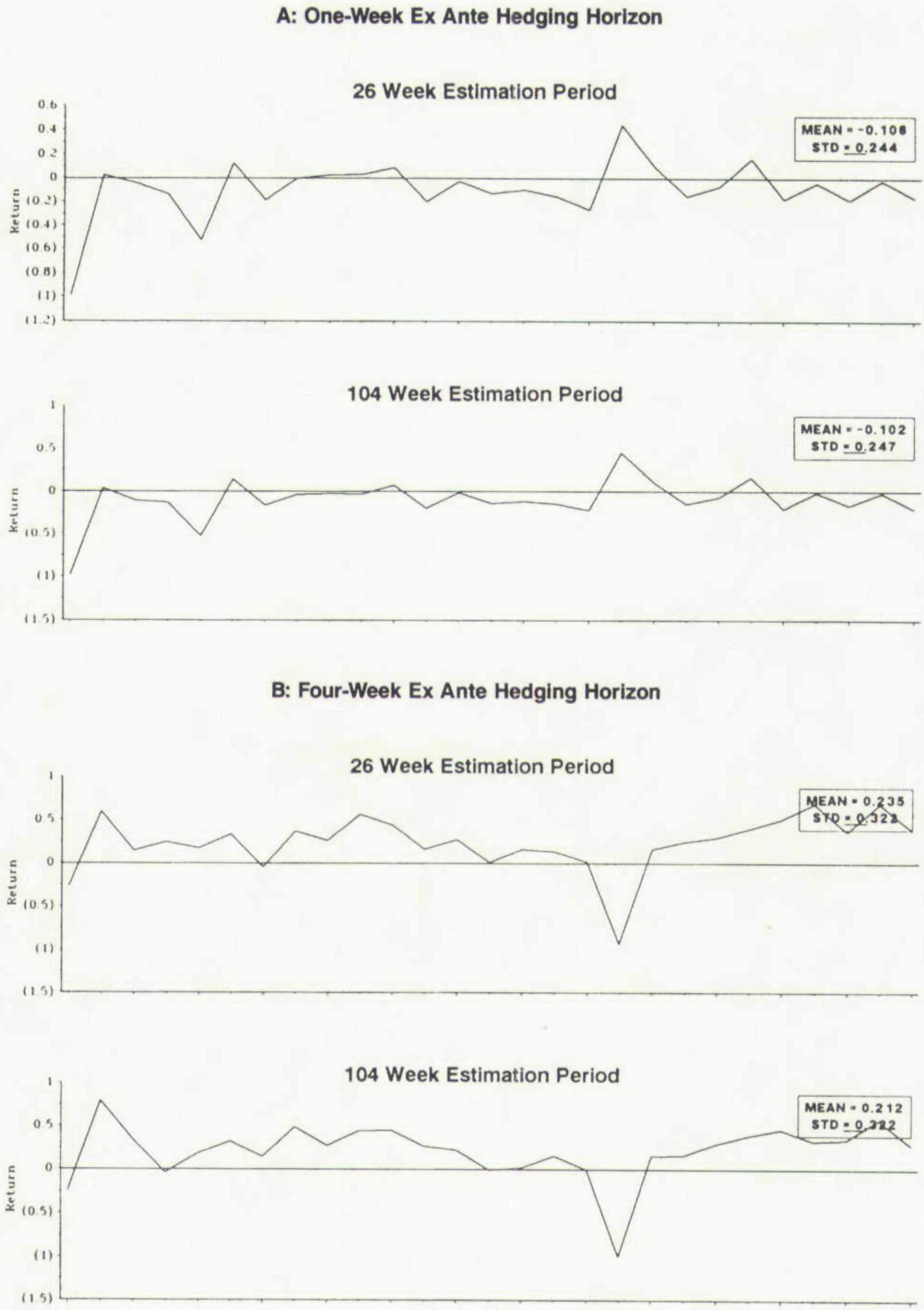

Figure 8
Return Graph of Japanese Yen.

hedges. The hypothesis that, the effectiveness of an *ex ante* hedge is higher for shorter (weekly) hedges than for longer (monthly) hedges is confirmed for all currencies, except the British pound. These results are the opposite of those obtained in section 5 and those reported by other authors for the *ex post* hedges. Observe the results in Table II that suggest that the effectiveness of the hedge improves with the length of the hedging horizon.

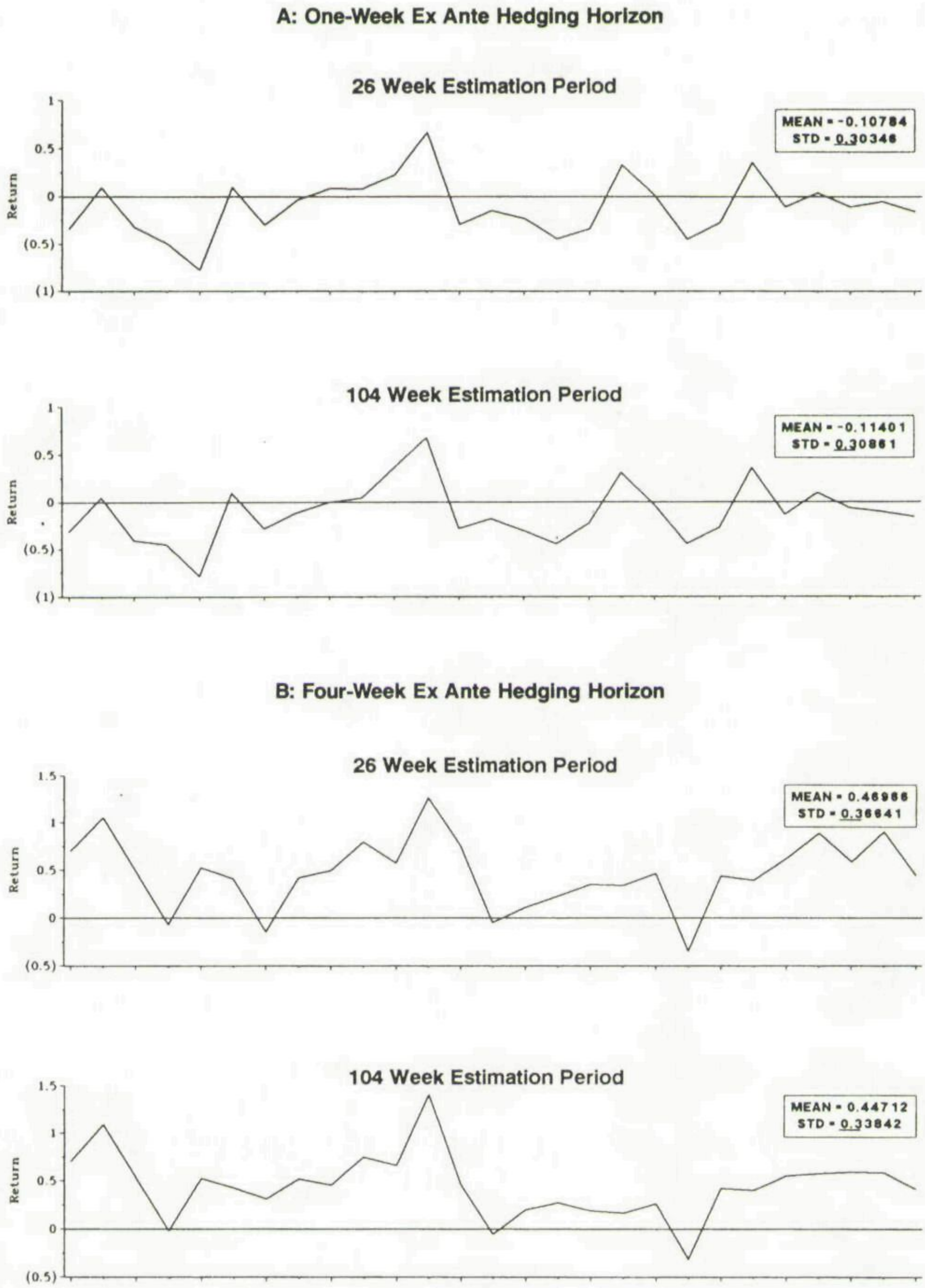

Figure 9
Return Graph of Swiss Franc.

Upon reflection, it is not hard to offer an explanation of these seemingly contradictory results. Observe that the *ex post* methodology judges the effectiveness of the hedge by the R^2 while the *ex ante* methodology uses portfolio returns. Financial theory suggests that arbitrage forces changes in spot currency and changes in nearby futures currency prices to be correlated. Therefore, as the sample size increases, a larger portion of the variability in the spot price changes is explained by the futures

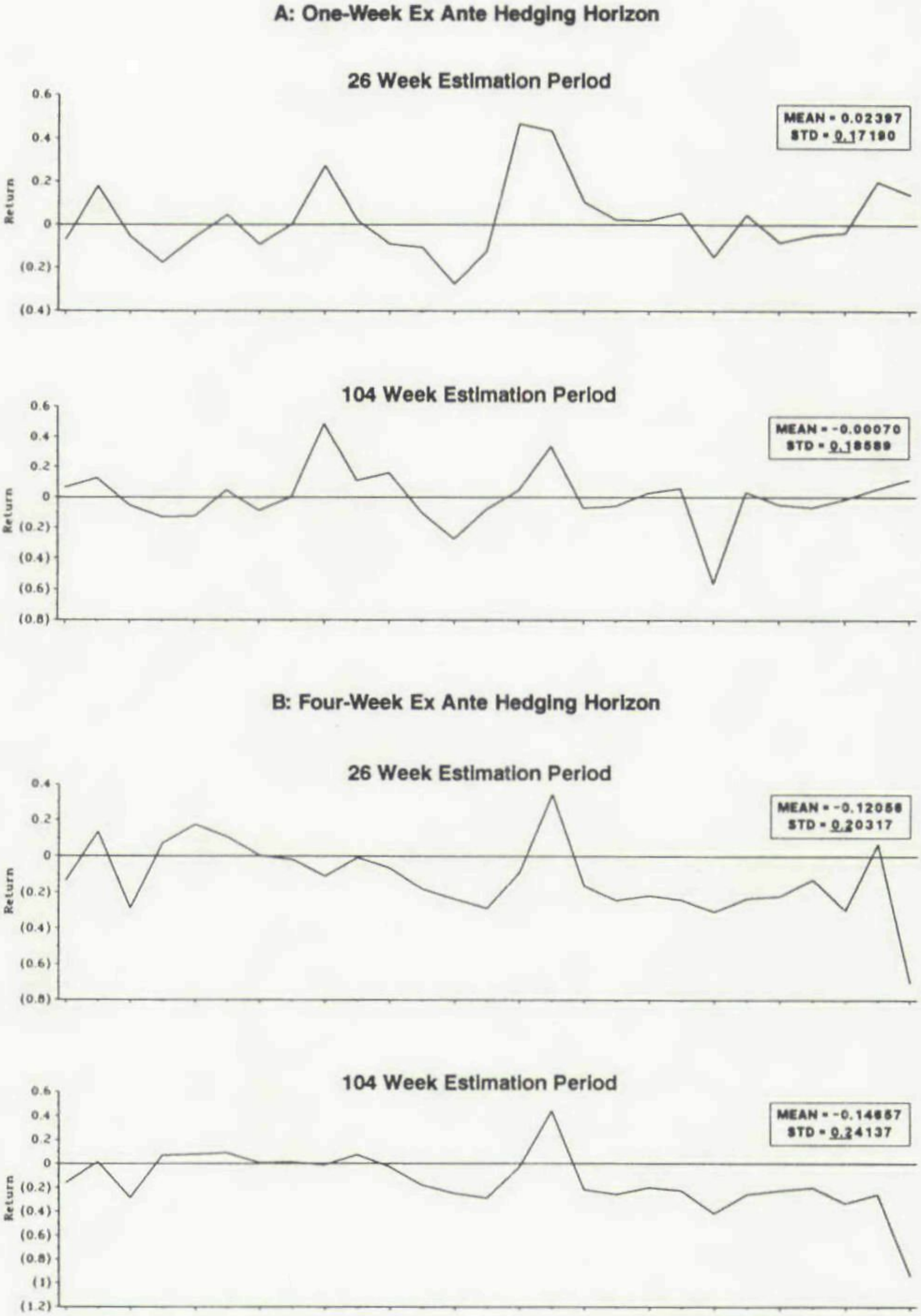

Figure 10
Return Graph of Canadian Dollar.

price changes. In other words, the economic relationship between ΔS_t and ΔF_t and the statistical methodology of OLS can explain the *ex post* results which plainly demonstrate a good fit which becomes better as the sample size increases. However, a good fit does not result necessarily in good forecasting. The *ex ante* methodology

Table III
t-STATISTICS FOR THE DIFFERENCE OF MEAN HEDGED PORTFOLIO RETURNS ($\bar{R}$) FOR *EX ANTE* HEDGES OBTAINED FROM 26-WEEK AND 104-WEEK ESTIMATION PERIODS

H_0: $\bar{R}_{104\ weeks} - \bar{R}_{26\ weeks}$		H_A: $\bar{R}_{104\ weeks} < \bar{R}_{26\ weeks}$
Futures Contract	**Weekly Hedging Horizon**	**Monthly Hedging Horizon**
British pound	0.40	0.23
German mark	0.004	0.43
Japanese yen	0.08	0.27
Swiss franc	0.08	0.24
Canadian dollar	0.44	0.40

Note: The null hypothesis, H_0, cannot be rejected for all currencies, at 5% confidence level.

Table IV
t-STATISTICS FOR THE DIFFERENCE OF MEAN HEDGED PORTFOLIO RETURNS ($\bar{R}$) FOR *EX ANTE* MONTHLY AND WEEKLY HEDGES

H_0: $\bar{R}_{monthly\ hedge} - \bar{R}_{weekly\ hedge}$		H_A: $\bar{R}_{monthly\ hedge} > \bar{R}_{weekly\ hedge}$
Futures Contract	**26-Week Estimation Period**	**104-Week Estimation Period**
British pound	0.95	0.36
German mark	7.71	7.55
Japanese yen	4.24	4.02
Swiss franc	6.31	6.37
Canadian dollar	2.66	2.37

Note: The null hypothesis, H_0, is rejected in favor of the alternative, H_A, for all currencies except the British pound, at the 5% confidence level.

judges the effectiveness of the hedge by returns. The shorter the hedging horizons, the smaller the probability of large deviations from zero and, therefore, the better the hedge. Note that *ex ante* hedges are judged best when the hedger's expected return is zero. Obviously, the *ex ante* methodology appears more relevant in economic applications, with an emphasis on returns rather than good fitting based on past data.

It is important to note that the effectiveness of the *ex ante* and the *ex post* methodologies are not comparable. Grant and Eaker (1989) propose a variance reduction measure to compare complex hedging strategies. This study is not interested in a direct comparison of *ex post* and *ex ante* hedging. The purpose of this study is to illustrate that using R^2, as proposed by the portfolio approach to hedging as an indicator of hedging effectiveness, is not always accurate. R^2 becomes an accurate indicator of hedging effectiveness if the hedge ratios are reasonably stable over time. Otherwise, with variable hedge ratios shorter hedging horizons are more desirable because they reduce the financial exposure to economic uncertainty and keep expected hedged portfolio returns close to zero.

In summary, the evidence presented in Figures 6–10 and the statistical testing exhibited in Tables III and IV confirm once again that the length of the estimation period remains a less critical decision, even if judged on an *ex ante* basis. Also, it is confirmed that the hedging horizon continues to be the most important decision.

However, contrary to *ex post* hedging, which supports a longer hedging horizon, the *ex ante* hedging analysis supports a shorter hedging horizon.

SUMMARY AND CONCLUSIONS

This article presents empirical evidence of the effect of the lengths of estimation periods and the hedging horizons on the hedging effectiveness for five foreign currency futures contracts: British pound, Japanese yen, Canadian dollar, German mark, and Swiss franc. The data is weekly spot exchange rates and futures prices for the time period March 4, 1980 to December 27, 1988. By means of a moving window procedure, OLS regression betas and R^2's are generated for estimation periods of two lengths, 26 and 104 weeks, and for two hedging horizons, one week and four weeks. The effectiveness of the five foreign currency futures contracts as hedging devices is evaluated: first, in an *ex post* basis, by using the betas and the coefficients of determination of the OLS regressions; second, in an *ex ante* basis, by computing the returns of hedged portfolios of futures and cash positions constructed with hedge ratios estimated by OLS regressions.

The following conclusions confirm and update results previously reported by other authors:

1. *Ex post* hedge ratios are less than one and show instability over time. However, it is found that, on the average, betas are not significantly different from one, which contradicts results previously reported by some researchers.
2. Measures of hedging effectiveness are large, indicating that foreign currency futures contracts are good hedging devices.
3. For *ex post* hedges, it is found that longer hedges (one-month hedging horizons) are more effective than shorter hedges (one-week hedging horizons).

   The following results are new and original findings:

4. The length of the estimation period, used for computing the betas and R^2's by means of OLS regressions, does not appear to have an impact on the effectiveness of the hedge both on an *ex post* hedging (evaluated in terms of R^2) and on an *ex ante* hedging (evaluated in terms of returns). This result provides some empirical evidence in favor of the hypothesis that hedge ratios are unstable over time.
5. For *ex ante* hedges, it is found that shorter hedges (weekly hedging horizons) are more effective than longer hedges (monthly hedging horizons). This finding is the opposite of the one obtained for the *ex post* hedges, but not necessarily contradictory, since the *ex post* and *ex ante* methodologies utilize different criteria.

The last two results raise two important questions: First, does a similar behavior occur in other futures markets? Second, do these results depend on the sampling period, 1980–1988, or are they more general? Obviously, there is room for further research on this topic.

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