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EXCHANGE RATE WITH DEUTSCHE MARK FUTURES

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Francesco S. Braga, Larry J. Martin
and
Karl D. Meilke

UNIVERSITY of GUELPH

Department of Agricultural Economics and Business

University of Guelph
Guelph, Ontario
Canada
N1G 2W1

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Francesco S. Braga is a Ph.D. candidate, Larry J. Martin is a Professor and Chairman, Karl D. Meilke is a Professor, Dep. of Agricultural Economics and Business, University of Guelph.

Cross hedging the Italian lira/US dollar exchange rate with Deutsche mark futures

The recent volatility of the US dollar/Italian lira exchange rate introduces a substantial exchange rate risk for traders and investors with a portfolio including the two currencies. As will be explained later, due to foreign exchange controls in Italy, this risk can be managed using a rather limited set of traditional instruments. From this situation emerges the importance of investigating new exchange rate hedging strategies. Therefore, the objective of this paper is to assess the empirical performance of a strategy using the Deutsche mark (dm) futures to cross hedge the US$/Italian lira exchange rate [1].

That a currency cross hedge can be considered when "there are no futures or forward markets in a currency" (Eaker and Grant, p. 85) is quite common in the literature. Implicit in this statement is the assumption that the results of a currency futures (or forward) cross hedge are inferior to that of a direct hedge. However, this assumption may not be true in the case of the US$/Italian lira exchange rate, as is argued in the next section. In order to substantiate this claim, two broad questions are considered. First, is the dm futures cross hedge an effective hedging strategy? Second, how does it compare with the traditional US$/Italian lira forward market hedge?

The first question is investigated by adopting Johnson's (1960) portfolio model for three different hedge lengths, 1, 2 and 4 weeks, and using stochastic dominance (SD) rules to rank the results of the 4 week futures and forward hedges.

The empirical results show that for a long US dollar hedge the dm futures strategies are, on average, much cheaper than the traditional forward market one, and that at least one cross hedge strategy is always in the optimal set.

This paper is organized in four sections. Section one discusses several aspects of the problem under investigation. Section two presents the data and the methodology used in the analysis. Section three reports the empirical findings. Section four concludes the study.

The problem

The Italian lira foreign exchange market is hampered by strict foreign exchange controls. Although, following an European Community ruling, a partial deregulation is taking place, no Italian lira futures contract is currently traded, and only since 1986 have some banks been allowed to sell call and put currency options in the Italian market. However, Italian traders cannot write these options and this casts some doubt on the competitiveness of the price of these instruments. The inter bank forward market appears to be the only simple solution to hedging the US$/lira exchange rate.

Why, then, investigate a dm futures cross hedge strategy? First, there is evidence in the literature, for example in Thomas (1985, 1986), that profits would have been made in recent years in the currencies futures market by following a random walk based trading strategy; that is by selling the currency futures trading at a premium over the current spot rate, cross the US$, and buying these at a discount under the US$. Recently, compared to the US, Italy has been a high interest rate country and the forward exchange rate market discounted the value of the Italian lira accordingly. Other European countries, in particular Germany, are low interest rate countries in comparison with the US and their currencies are normally priced at a premium to the US$ in the forward exchange market. The lira is however tied to the dm by the solidarity mechanism within the European Monetary System (EMS) that calls for the central banks of the member states to intervene collectively to manage the cross spot exchange rates within previously agreed upon upper and lower limits of divergence from a fixed central rate. Therefore, it may be advantageous to cross hedge a long lira (short US$) position by selling the low interest rate currency futures, specifically the dm, and a short lira (long US$) position by buying lire on the forward market [2]. Note that, according to the empirical evidence presented by Giavazzi and Giovannini (1986) the EMS intervention mechanism is quite effective in reducing the intra EMS exchange rate volatility following an external disturbance[3].

Second, a currency futures (cross) hedging strategy is normally more flexible than a forward market one. The average cost of a futures cross hedge or a forward hedge is not the only variable to be considered when choosing the hedging instrument, and a trader should be concerned with the actual transaction costs, market liquidity and the flexibility of the hedging strategy. According to Fieleke "the futures market probably has no cost advantage over the forward market, at least in executing large transactions; but it no doubt accomodates smaller transactors, including speculators, whom the banks would turn away" (Fieleke, p. 628). Smaller traders should also benefit from the standardization of the futures contract, its higher liquidity and flexibility. For example, a bank could accommodate a change in a finalized forward transaction, if the need arises for the hedger to close the transaction before the agreed upon date, but this would normally imply a higher cost than that of lifting a futures hedge.

Methodology and Data

Assume that a US investor has a long position in Italian lire, for example an announced dividend payment from an Italian corporation, to be converted to US$. Three strategies are considered in this paper. First, the investor can simply wait for the actual payment and then buy US$ at the spot rate. Second he can buy the US$ equivalent of the lire payment by selling lire with a forward contract. Third he can cross hedge by selling dm futures.

Each strategy differs in its payoff, which is non-random only for the forward market hedge. If the first option is selected, the cost in US$ of a fluctuation of the US$/Italian lira exchange rate is given by equation (1):

$$(1) \quad \tilde{Rs} = y \, [\, \tilde{ERs}_2 - ERs_1 \,] \, ,$$

where $\tilde{}$ indicates a random variable, $\tilde{Rs}$ is the profit (loss) in

US\$, y is the amount, in lire, of the cash position (y>0 if long, y<0 if short), and ERs_i is the spot US\$/Italian lira exchange rate at the time of the dividend announcement (i=1) or at the time of the actual purchase of US\$ (i=2).

In the case of a forward market hedge the investor is not exposed to any exchange rate fluctuation. The cost of this strategy is known and it is given by equation (2):

$$(2) \quad Rfwd = y\ SR_1 \ ,$$

where Rfwd is the cost of the forward contract in US\$, SR_1 is the appropriate swap rate on day 1, for a period up to the actual dividend payment, on day 2. As previously mentioned, $SR_1<0$ during the entire period of this analysis.

When the cross hedge strategy is selected, the net cost of the strategy is given by equation (3):

$$(3) \quad \tilde{Rf} = y\ [\ \tilde{ERs}_2 - ERs_1\ ] + y_{dm}\ [\ \tilde{ERf}_2 - ERf_1\ ] \ ,$$

where $\tilde{Rf}$ is the profit (loss) in US\$, y_{dm} is the short ($y_{dm}<0$) or long ($y_{dm}>0$) dm futures position, and ERf_i is the dm futures price in US\$ when the hedge is placed (i=1) or lifted (i=2). For simplicity it is assumed that the timing of the futures hedge matches that of the cash position.

The payoff of each strategy as a percent of the initial US\$ position is given in equations (1'), (2') and (3'), obtained from equations (1), (2), and (3) by multiplying the lira spot position by ERs_1/ERs_1, and the dm futures position by ERf_1/ERf_1.

$$(1')\quad \tilde{R}s\% = V_s \tilde{r}_s ,$$

$$(2')\quad Rfwd\% = V_s r_{sr} ,$$

$$(3')\quad \tilde{R}f\% = V_s \tilde{r}_s + V_f \tilde{r}_f ,$$

where V_i is the US$ value at time 1 of the spot (i=s) or futures (i=f) position, r_i is the percentage change in the US$/Italian lira spot exchange rate (i=s) or in the US$ price of the dm futures (i=f), or the percentage cost of the appropriate US$/Italian lira swap rate (i=sr).

Equations (1'), (2') and (3') are used in this paper.

The first question to be answered is whether the dm futures contract is a good cross hedge instrument for the lira/US$ exchange rate: this is done in the context of Ederington's (1979) version of Johnson's (1960) portfolio model. Many studies have applied this model to the analysis of exchange rate hedges so that a brief review will suffice (Grammatikos and Saunders, 1983, Marmer, 1986).

The agent's problem is to maximize its expexted utility:

$$(4)\quad \max_{V_f}\ E(U) = E(\tilde{R}f\%) - 1/2\ \emptyset\ Var\ (\tilde{R}f\%) ,$$

where $\tilde{R}f\%$ is given in eq. (3'), and $\emptyset$ is the coefficient of risk aversion. Var $(\tilde{R}f\%)$ is given in equation (5):

$$(5)\quad Var\ (\tilde{R}f\%) = V_s^2\, \sigma_{00} + 2\ V_s\ V_f\, \sigma_{01} + V_f^2\, \sigma_{11} ,$$

where $\sigma_{00} = Var\ (\tilde{r}_s)$, $\sigma_{01} = Cov\ (\tilde{r}_s, \tilde{r}_f)$, $\sigma_{11} = Var\ (\tilde{r}_f)$.

It can be seen that the optimal futures position is given by equation (6):

$$(6) \quad V_f = + \tilde{r}_f / [\, \emptyset\, \sigma_{11} \,] - V_s\, \sigma_{01} / \sigma_{11} .$$

If the futures market is unbiased, or the agent is extremely risk averse, the futures position is given as a proportion of the cash position by equation (7):

$$(7) \quad V_f/V_s = -\sigma_{01} / \sigma_{11} ,$$

that is, the negative of the slope coefficient of the regression of the percentage changes in the US$/lira spot exchange rate over the percentage changes in the dm futures exchange rate. The coefficient of determination of the regression is a measure of the ex-post hedge effectiveness.

The three hedge durations of one, two and four weeks are considered for a continously hedged position: every first, second and fourth Thursday the hedge is lifted and a new one is immediately placed. Whenever a contract expires, any position still open for the 2 and 4 week hedges is rolled over (at the settlement prices) to the next contract. Two hedging strategies are considered for each hedge length (a) a naive one, with opposite positions in lire and dm futures of equal value in US $, and (b) one based on Johnson's optimal hedge ratio. Each strategy is in turn run with two sets of futures data: one relative to the nearby contract, the other to the contract next to expiration[4].

Two sets of optimal hedge ratios are estimated, long term OHR and short term OHR that are used in the trading simulations.

The stability of the long term optimal hedge ratio is tested using sets of binary variables for the pre and post-March 1985 subperiods of increasing and decreasing values of the US$, and for each single year as suggested by Martin and Garcia (1981).

In order to effectively compare the out-of-sample trading results of the different strategies, the short term optimal hedge ratios are estimated over one year samples and are naively updated every eight weeks. The most recent OHR value is then used in the trading simulation.

The forward market hedge and the futures market cross hedge results are compared only for the four week time period. Stochastic dominance rules are used to compare the out-of-sample trading results of the futures cross hedge strategies, obtained from equation (3') where $V_f = \hat{\beta} V_s$ and $\hat{\beta}$ is the most recent OHR, with the percentage cost at the beginning of the same four week period of a traditional forward market hedge, obtained from equation (2'). The SD rules are "universally valid for all investors in certain well-defined risk preference classes.." (Levy and Lerman, p. 32). Contrary to the mean-variance (MV) portfolio approach that requires either the assumption of risk aversion and normality of the distribution of the returns or that of a quadratic utility function the assumptions for the use of the SD rules are less stringent; no information on the form of the distribution is necessary, and very little information on the investor's preferences is required. Note that since the comparison of the different trading strategies is based on out-of-sample trading results, there is no implicit assumption of normality of the distributions of the hedge returns, as would be the case with the in-sample returns. Two caveats are, however, appropriate. First, there is evidence in the literature that SD rules are quite inefficient in the selection of the optimal set, unless borrowing and lending at a riskless rate of return is allowed, which is not assumed in this analysis. Second, if the assumptions of normality of the distribution of the returns is valid the mean-variance optimal set coincides with that obtained using the second degree SD rule. A short outline of the SD algorithms used in this paper can be found in the Appendix.

The study covers the period from January 7, 1982 to September 25, 1986. The 10 a.m. Thursday spot and one month forward Italian lira/US$ mid-point rate for the New York market, as reported by the Federal Reserve Bank of New York, were purchased from an I.P. Sharp Associates Ltd. data base; the settlement prices of the dm futures were collected from the International Monetary Market yearbooks. The last available market day data were used when any of the Thursday data was not available. The one month forward discount was proportionally reduced to the value appropriate for the hedge length, in general 28 days. This may introduce a minor bias in the data, to the extent that the "odd" length forward rates are in general more expensive than the standard one month rates (Riehl and Rodriguez, 1983). A better matching of the timing of the data would have been desirable: however, particularly for the longer hedges, the few hours of difference should not affect the results in a significant way.

As previously discussed, forward and futures markets seem to be competitive in terms of transaction costs, which may justify the exclusion from the calculations of any proxy for this variable. This is clearly a simplyfying assumption and again a trader should carefully consider his own transaction costs before choosing a specific hedging strategy.

Results

The estimated long term optimal hedge ratios for the different futures strategies are reported in table 1. The two equations reported for the two week hedges refer to a sample beginning on January 14, 1982, or January 21, 1982; similarly, the four equations for the 4 week hedges refer respectively to a sample beginning on January 7, 14, 21 or 28; the different number of observations utilized in the regression is due to the different sample sizes. This procedure was selected due to the residual volatility within the EMS, which is quite high in the weeks immediately preceding and following a central rate realignment, such that the different grouping of the weekly observations may affect the estimation of the short term OHR and the out-of-sample hedging results[5]. However, as is clear from table 1, this distinction is not very important in the case of the long term OHRs. The value of the estimated OHR is always lower than, and in general also statistically different from, one. As could be expected given the operation of the EMS the OHR value tends to increase with increases in the hedge length.

Six of the equations reported in table 1 (equations 1, 2, 3, 4, 11 and 12 numbered from left to right, top to bottom) were estimated with corrections for first-order autocorrelation. This procedure was necessary even though the regressions were estimated using percentage changes and not absolute exchange rate values. In all six cases the estimated coefficient of autocorrelation was negative and smaller than 0.3 in absolute value. Although the autocorrelation tends to disappear in the case of the longer hedges, as expected given the evidence of the efficient working of the EMS, it still represents a potentiallly negative factor for cross hedgers. These findings may also suggest that selective speculative trading of the short term US$/Italian lira forward rate and the dm futures spread with equal US$ positions may result in profits, at least for traders with limited transaction costs[6].

The post-March 1985 dummy, corresponding to the period of decreasing value of the US dollar, is statistically different from zero only in the case of the one week hedge length, using the mid-distant futures contract. Similar results were obtained by testing the stability of the OHR estimates using yearly dummy variables. Hovever, the value of the OHR estimated for 1986 is statistically higher than the OHR estimated for 1983 and 1984 in the case of the one week hedge length, and for some of the two and four week hedges [7]. These results seem to confirm the stability of the value of the long term OHRs for the given hedge lengths.

The evidence presented in this paper differs from Eaker and Grant's (EA) recently published results. However, this is not surprising, given the fact that EA estimated the OHR using endof-the-month data on a different sample period. Moreover, EA's sample includes both pre and post-EMS data; the OHR estimated using the first half of the sample, including both pre and post EMS data, is compared with that estimated for the second one. The difference of the two OHRs in EA's work is therefore quite understandable. Finally, EA seem to ignore the findings of Giavazzi and Giovannini: "From June 1973 to March 1979 asymmetric movements of the mark and other currencies relative to the dollar are quite large. ... the start of the EMS represents an important break in the data. After March 1979 a change in the effective dollar rate is associated with smaller fluctuations of bilateral rates with the mark." (Giavazzi and Giovannini, p. 459).

The average OHRs estimated for the different hedge lengths utilized for the trading simulations are reported in table 2, together with the corresponding ranges and standard deviations, and the out-of-sample hedge effectiveness for the entire trading simulation, defined as the percentage reduction in the variance of the exchange rate changes obtained from the dm futures cross hedging strategies.

Although some differences are apparent among the results obtained from the different samples, some general comments are possible. First, the average value of the OHR for a given hedge length does not change substantially when using the nearby or the mid-distant contract, but, as expected, it is generally lower for the shorter hedge lengths. The average of the OHRs is in any case close to the corresponding values in table 1. Second, the hedge effectiveness of the strategies that adopt the estimated

OHRs is higher than that of the naive ones and this holds in particular for the shorter hedge lengths. Third, the nearby contract is a superior cross hedge instrument than the mid-distant contract, regardless of the strategy used, but the difference seems small. Also, the longer the hedge length, the higher the hedge effectiveness.

All these results are quite straightforward and seem to be consistent with a higher lira/dm futures spread volatility in the very short term; as the spread tends to widen the EMS solidarity mechanism is called into play, which also explains the higher HE obtainable with the longer hedge lengths.

The hedger shouldn't, however, bet too blindly on EMS stability; five currency realignments took place during the 57 month period covered by the sample, with a marked increase in the relative instability of the forward lira-dm futures spread in correspondence with four of these events. The effects of this increased instability may be appreciated by comparing the results in table 2 with those reported in table 3, that were obtained from a reduced sample, in which four groups of four weekly observations each corresponding to an EMS realignment were dropped [8].

Not surprisingly, all hedging strategies perform better with this smaller sample. The range of the estimated OHRs is substantially reduced, and the hedge effectiveness is much higher for both the OHR and the naive trading strategies. These results are interesting from the hedger's perspective at least to the extent that the EMS realignments can be predicted. This may be possible, by closely monitoring the intra-EMS cross rates in relation to the agreed limits of fluctuations, but it clearly exposes the hedger to a certain degree of surprise. The presence, even in this reduced sample, of first-order negative autocorrelation of the residuals particularily in the case of the shorter hedges seems to confirm the potential risks for the hedger and the possible speculative opportunities when a quick and large change of the US$/Italian lira forward - dm futures spread is observed[9].

The final point to be addressed is the comparison of the out-of-sample trading results of the futures cross hedges with the initial cost of the forward hedge. As can be seen from the average cost figures reported in table 4, the different specifications of the sample, that is the four week observations beginning in week i, i+1, i+2, and i+3, do affect the average cost of all strategies, particularly the futures ones. However, it is clear that the average out of sample cost of all cross hedge strategies for a short US$ position was substantially lower than that of a traditional forward market hedge (the geometric average results are similar to the values reported in this table). This result is interesting because the figures shown in table 4 refer to the entire sample, and they include any negative effect of the five EMS realignments that took place during the time frame of the study.

The set of efficient strategies was selected for the given SD rule by dropping all strategies that were dominated by any other strategy in any of the four different sample simulations. The test was conducted on the entire sample as well as separately for the "up" and "down" US$ periods. The results are reported in table 5.

First no strategy can be eliminated by first degree SD (FSD), whereas third degree SD (TSD) does not further restrict the second degre SD (SSD) efficient set. As expected on the basis of traditional currency hedging theory, and consistent with Thomas' arguments, the forward market hedge is the only efficient strategy to hedge a short lira position and the result holds regardless of the period considered. Interestingly, however, in the case of a short US$ position the forward market hedge does not dominate all other cross hedge strategies; the optimal hedge with the nearby contract and the forward hedge are always in the efficient set. The naive hedge with the nearby contract was also an efficient strategy during the first part of the sample (the "up" US$ period) whereas the optimal hedge with the mid-distant contract is efficient for the second part of the sample. The efficient set does not change when the MV approach is used.

Summary and Conclusion

The Italian lira-US$ exchange rate risk can be cross hedged with reasonably good results with the dm futures contract traded on the floor of the IMM. The out-of-sample trading results show that from January 1983 to September 1986 the average cost of all dm futures cross hedge strategies for a short US$ position is much lower than that obtainable with a traditional forward contract. This lower cost is however associated with a much higher variability of the results. In general, the out of sample hedge effectiveness of the futures strategies increased with the length of the hedge, when using the nearby contract instead of the mid-distant one, and the OHR strategies instead of naive hedges.

First degree stochastic dominance is inconclusive in order to select the efficient set of hedging strategies, whereas third degree stochastic dominance does not reduce the second degree stochastic dominance efficient set any further. As expected, the forward hedge dominated all the futures markets cross hedge strategies for a short lira (i.e. long US$) position, such as that of an Italian exporter selling goods priced in US$, or an American importer pricing goods in lire. However, in the case of a short US$ position, the OHR with the nearby contract strategy and the forward hedge were always in the efficient set. The naive hedge with the nearby contract and the optimal hedge with the mid-distant contract were also efficient strategies during the first part of the sample (the up US$ period) and the second part of the sample (the down US$ period), respectively.

The final selection between the forward or the futures cross hedge is clearly left to the individual trader who is the best judge of the trade-off between lower average cost with higher risk, and higher cost with zero risk.

Transaction costs were ignored in this study for both the forward and the futures markets; those costs may be currency specific, and for the major currencies they tend to be similar for the forward and futures markets, at least for large transactions. The futures market may, however, offer some advantages to smaller hedgers and this may be particularly true for the lira forward market that, given its smaller dimensions, may involve higher transaction costs than the dm futures.

The capital controls still in effect in Italy may indirectly offer some arbitrage opportunities to the international trader and penalize Italian operators who cannot legally access the off-shore financial services, at least at a reasonable cost. Ironically, in the context of the problem described in this paper, these currency controls seem to penalize primarily the Italian exporters.

APPENDIX

What follows is only a short outline of the SD rules: interested readers should refer for example to Kroll and Levy (1980). The notation used is that of Levy and Lerman (1985) and Levy and Kroll (1979) for the quantile approach.

Let u', u'' and u''' be the first, second and third derivative of the investor utility function, respectively; let U_1 be the class of all non decreasing utility functions, U_2 the set of all non decreasing concave utility functions, and U_3 the set of all non decreasing concave utility functions with convex marginal utility; let also F and G be the cumulative probability distributions of two strategies with the p^{th} order quantiles $Q_F(p)$ and $Q_G(p)$.

In the case of an utility maximizer with utility function belonging to U_1, option F is said to dominate option G by First Degree Stochastic Dominance (FSD) if, and only if, $Q_F(p) >= Q_G(p)$ for all p and with a strict inequality for at least one p.

If the further restriction of decreasing marginal utility is imposed on the utility function, as is the case for all utility functions in U_2, the Second Degree Stochastic Dominance (SSD) can be used. Option F is therefore said to dominate option G by SSD (F D2 G) if, and only if,

$$\int_0^p Q_F(t)dt >= \int_0^p Q_G(t)dt$$

for all p and with a strict inequality for at least one p.

Third Degree Stochastic Dominance (TSD) can be used when also the assumption of a positive third derivative of the utility function is added, as is the case of the utility functions in U_3.

Option F is said to dominate option G by TSD if, and only if,

$$\int_0^p \int_0^t Q_F(z)dzdt >= \int_0^p \int_0^t Q_G(z)dzdt,$$

for all p and with a strict inequality for at least one p, and in addition,

$$\int_0^1 Q_F(t)dt >= \int_0^1 Q_G(t)dt.$$

Note that FSD is consistent with any type of risk preferences, SSD implies a risk averse behaviour, and that the TSD assumptions of $u'>0$, $u''<0$, $u'''>0$, are only a necessary, but not sufficient condition for decreasing absolute risk aversion.

The algorithm used in the calculations is that presented by Levy and Kroll (1979) for discrete distributions: let $[x_{i,j}]$ be a matrix of the j (j=1,2,...,m) rates of return obtained from the ith strategy (i=1,2,...,n), rearranged in increasing order, so that $x_{i,1} <= x_{i,2} <= \ldots <= x_{i,m}$. Each of the m rates of return has the same probability of occurrence.

Let $[x'_{i,j}]$ be a matrix such that $x'_{i,j} = \Sigma_{t=1}^{j} x_{i,t}$, and $[x''_{i,j}]$ be a matrix such that $x''_{i,j} = \Sigma_{t=1}^{j-1} x'_{i,t} + x'_{i,j}/2$.

The three SD rules can then be formulated as:

FSD: X_1 D1 X_2 if $x_{1,j} >= x_{2,j}$ for all j, with at least one strict equality;

SSD: X_1 D2 X_2 if $x'_{1,j} >= x'_{2,j}$ for all j, with at least one strict equality;

TSD: X_1 D3 X_2 if $x''_{1,j} >= x''_{2,j}$ for all j, with at least one strict equality, and $x'_{1,m} >= x'_{2,m}$.

FOOTNOTES

1- The paper considers only the US$/lira exchange rate risk. The results are therefore general in scope and the hedge ratios may not be optimal for the solution of the specific portfolio problem of an individual investor or entrepreneur importing or exporting goods or services.

2- A multiple currency futures cross hedge could also be considered. However, the fact that the British pound is not a member of the EMS and the low liquidity of the French franc futures contracts -and the fact that France is a high interest rate country relative to Germany- suggest restricting the cross hedge analysis to the dm futures. Futures' lumpiness may further limit the practical importance of a multiple currency cross hedge, in particular for small positions.

3- In the past the revisions on the EMS central parity rates often coincided with a major change in the value of the US$ relative to European currencies.

4- Some studies consider also a distant futures contract, six to nine months prior to expiration. This is not repeated here due to concerns over potential liquidity problems in the case of a countinously hedged short term position.

5- The two different results listed for the two week hedges refer to continously hedged positions beginning on a odd or an even week. Similarly, in the case of the 4 week hedges the results of the hedge beginning in week i, i+1, i+2 and i+3 are reported. Some differences emerge among these alternative measurements: in most of the cases they may be due to the "abnormal spread changes" observed in particular moments of strain within the EMS, such as the week from July 19 to July 26, 1985, when the lira lost approximately 3.5% and the dm rose about 0.5% with respect to the US $. An EMS realignment took place on July 21. Since the spread changes tend to be negatively autocorrelated, and to smoothly even out, they may affect the result of the different simulations in a different fashion.

6- This problem is currently under investigation.

7- The results are available upon request.

8- The following periods were dropped: May 22, 1982 to June 17, 1982 (realignment on June 6); March 10, 1983 to March 31, 1983 (realignment on March 21); all of July 1985 (realignment on July 27); April 10, 1986 to May 1, 1986 (realignment on April 4).

9- Note that this differs from Thomas' (1986) trading rule to be short the dm futures (selling at a premium) and long the lira forward (selling at a discount) in that here the arbitrageur would choose to be long or short the lira forward/dm futures spread on the basis of the observed changes in the value of the spread itself, not its absolute value.

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Table 1 : Stability of the long term optimal hedge ratio .

		Using nearby contract (0 to 3 months to expiration)			Using mid-distant contract (3 to 6 months to expiration)		
	Number of obs.	Estimated coefficient		Dummy (from March 21,1985)	Estimated coefficient		Dummy (from March 21,1985)
One Week Hedge[a]							
	246	0.768 **		0.108 ** [*]	0.762 **		0.116 ** [*]
		(0.039)		(0.054)	(0.040)		(0.055)
				[0.036]			[0.037]
Two Week Hedges[b]							
I	123	0.830 **		0.062 *	0.820 **		0.079 *
		(0.052)		(0.074)	(0.054)		(0.078)
				[0.053]			[0.055]
II	122	0.801 **		0.072 **	0.799 **		0.075 **
		(0.041)		(0.059)	(0.042)		(0.060)
				[0.042]			[0.043]
Four Week Hedges							
I	61	0.870 *		0.018	0.866 *		0.021
		(0.058)		(0.083)	(0.063)		(0.087)
				[0.059]			[0.063]
II	61	0.860 *		0.060	0.858 *		0.059
		(0.061)		(0.091)	(0.061)		(0.092)
				[0.067]			[0.068]
III	61	0.865		-0.183 *	0.848		-0.178 **
		(0.073)		(0.134)	(0.074)		(0.139)
				[0.114]			[0.119]
IV	60	0.805 **		-0.055 **	0.799 **		-0.050 **
		(0.052)		(0.086)	(0.051)		(0.090)
				[0.069]			[0.072]

*,** indicate that the estimated coefficient,including the value of the dummy if appropriate, is statistically different from one at the 5% and 1% probability level, respectively.

[*] indicates that the dummy is statistically different from zero at the 5% probability level.

(a) Standard error between brackets. In the case of the dummy the first s.e. refers to the dummy itself, the second, within the squared brackets, to the sum of the coefficient and the dummy.

(b) The Roman numerals indicate the different samples as described in text.

Table 2: Optimal hedge ratio and out of sample hedge effectiveness of the different strategies: full sample.

		Optimal hedge ratio: Nearby	Optimal hedge ratio: Mid-distant	Naive hedge: Nearby	Naive hedge: Mid-distant
One Week Hedge[a]					
	OHR aver.	0.78	0.78		
	OHR s.err.	0.084	0.091		
	OHR range	0.64 to 0.95	0.62 to 0.95		
	HE	0.79	0.77	0.75	0.74
Two Week Hedges[b]					
I	OHR aver.	0.84	0.83		
	OHR s.err.	0.099	0.102		
	OHR range	0.58 to 1.02	0.56 to 1.03		
	HE	0.81	0.81	0.80	0.79
II	OHR aver.	0.84	0.83		
	OHR s.err.	0.047	0.052		
	OHR range	0.77 to 0.92	0.76 to 0.93		
	HE	0.90	0.89	0.86	0.86
Four Week Hedges					
I	OHR aver.	0.85	0.84		
	OHR s.err.	0.084	0.086		
	OHR range	0.66 to 1.00	0.64 to 0.98		
	HE	0.89	0.89	0.88	0.88
II	OHR aver	0.87	0.87		
	OHR s.err.	0.083	0.085		
	OHR range	0.61 to 1.01	0.61 to 1.10		
	HE	0.90	0.90	0.89	0.89
III	OHR aver.	0.83	0.81		
	OHR s.err.	0.146	0.134		
	OHR range	0.52 to 1.16	0.48 to 1.10		
	HE	0.77	0.76	0.77	0.76
IV	OHR aver.	0.80	0.80		
	OHR s.err.	0.087	0.091		
	OHR range	0.67 to 1.01	0.66 to 1.07		
	HE	0.88	0.87	0.84	0.83

Hedging strategy and futures contract used.

(a) OHR aver. and OHR s.err. are the average and the standard error of the estimated optimal hedge ratios, respectively. HE is the corresponding out of sample hedge effectiveness.

(b) The Roman numerals indicate the different samples defined in text.

Table 3: Optimal hedge ratio (OHR) and out of sample hedge effectiveness (HE) of the different strategies: reduced sample.

		Hedging strategy and futures contract used			
		Optimal hedge ratio		Naive hedge	
		Nearby	Mid-distant	Nearby	Mid-distant
One Week Hedge[a]					
	OHR aver.	0.82	0.82		
	OHR s.err.	0.069	0.073		
	OHR range	0.72 to 0.94	0.71 to 0.95		
	HE	0.86	0.86	0.83	0.83
Two Week Hedges[b]					
I	OHR aver.	0.86	0.86		
	OHR s.err.	0.080	0.081		
	OHR range	0.71 to 1.02	0.72 to 1.02		
	HE	0.91	0.90	0.90	0.90
II	OHR aver.	0.86	0.85		
	OHR s.err.	0.059	0.065		
	OHR range	0.77 to 0.95	0.76 to 0.95		
	HE	0.92	0.92	0.89	0.89
Four Week Hedges					
I	OHR aver.	0.85	0.85		
	OHR s.err.	0.086	0.088		
	OHR range	0.71 to 1.02	0.72 to 1.03		
	HE	0.93	0.92	0.92	0.92
II	OHR aver	0.90	0.90		
	OHR s.err.	0.072	0.078		
	OHR range	0.78 to 1.00	0.77 to 1.00		
	HE	0.94	0.93	0.93	0.93
III	OHR aver.	0.87	0.87		
	OHR s.err.	0.083	0.075		
	OHR range	0.70 to 1.03	0.70 to 1.03		
	HE	0.92	0.92	0.91	0.91
IV	OHR aver.	0.83	0.83		
	OHR s.err.	0.088	0.087		
	OHR range	0.70 to 1.06	0.72 to 1.06		
	HE	0.91	0.91	0.89	0.89

(a) OHR aver. and OHR s.err. are the average and the standard error of the estimated optimal hedge ratios, respectively. HE is the corresponding out of sample hedge effectiveness.

(b) The Roman numerals indicate the different samples defined in text.

Table 4: Average percentage cost of a 4 week hedge for a short US$ position, full sample.

		Optimal Hedges		Naive Hedges		Forward
	Period	Nearby	Mid Distant	Nearby	Mid Distant	Contract
I[a]	1[b]	0.07	0.09	0.07	0.07	0.51
	2	0.15	0.18	-0.10	0.26	0.52
	3	-0.03	-0.04	0.29	0.27	0.51
II	1	0.12	0.13	0.09	0.09	0.53
	2	0.15	0.18	-0.06	-0.05	0.56
	3	0.08	0.05	0.30	0.28	0.50
III	1	0.03	0.05	0.10	0.10	0.49
	2	0.20	0.24	-0.01	-0.00	0.49
	3	-0.19	-0.22	0.26	0.23	0.49
IV	1	-0.01	-0.00	0.07	0.07	0.49
	2	0.26	0.28	0.02	0.02	0.50
	3	-0.39	-0.39	0.15	0.14	0.47

(a) The Roman numerals indicate the different samples defined in text.

(b) Period 1: January 1983 to September 1986; Period 2: January 1983 to March 1985; Period 3: March 1985 to September 1986.

Table 5: Stochastic dominance results, 4 week hedge.

Sample period	Position hedged	Stochastic dominance degree used	Optimal strategy set [a]
Entire Sample			
	Long lira	first	no ranking is possible
		second [b]	optimal hedge with nearby contract and forward market hedge
	Short lira	first	no ranking is possible
		second	forward market hedge
January 1983 to March 1985			
	Long lira	first	no ranking is possible
		second [b]	optimal hedge with nearby contract, naive hedge with nearby contract and forward market hedge
	Short lira	first	no ranking is possible
		second [c]	forward market hedge
March 1985 to September 1986			
	Long lira	first	no ranking is possible
		second [b]	optimal hedge with nearby contract optimal hedge with mid distant contract and forward market hedge
	Short lira	first	no ranking is possible
		second	forward market hedge

(a) Defined as the strategy that is never dominated by any other hedging strategy under the given stochastic dominance criterium.
(b) Third degree stochastic dominance did not reduce the optimal set.
(c) The unhedged position was never dominated by any of the hedging strategies.