HEDGING SECTORAL RISK ACROSS EUROPEAN EQUITY MARKETS: AN EMPIRICAL ANALYSIS OF ALTERNATIVE HEDGING STRATEGIES

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We first construct indices for shares in five European sectors (Banking, Chemicals, Insurance, Oil and Retail) and estimate the fair prices that a (currently unavailable) futures contract on each one of these indices would have had if it existed. We then show that hedging the sectoral exposure of a diversified portfolio of pan-European shares in the same sector with those futures contracts provides a superior risk-cover than an alternative hedging strategy using futures contracts based on either a cocktail of Domestic Stock Market Indices or a Pan-European Stock Market Index. We conclude that the introduction of futures contracts on pan-European sectoral indices should increase the efficiency of both the cash and futures European equity markets.

I. INTRODUCTION

Consider the case of an investor holding a diversified portfolio of European shares in the same sector or industry[1]. In this article we examine the performance of three alternative hedging strategies the investor could use to temporarily hedge his sectoral exposure[2], including the use of futures contracts on five European Sectoral Indices which we construct. Whether holding a diversified portfolio of European shares in the same sector is an optimal investment decision is not the issue we address. We take the investment decision as given and ask ourselves whether hedging the exposure can be achieved cheaply and efficiently.

As of early 1996 there were no sectoral futures or options instruments trading on European derivative markets that would have allowed our investor to hedge the risk of his sectoral portfolio[3]. Two possible substitute, both likely to be inferior to a (currently unavailable) sectoral hedging instrument, could have been used instead. One was to hedge the sectoral portfolio with a cocktail of futures contracts on individual Domestic Stock Market Indices. The other was to hedge it with futures contracts on a single European Stock Market

[1] Several investment banks and brokerage houses publish regular recommendations on pan-European sectoral investment, an indication that there must be a significant interest (and activity) in this type of investment strategy.

[2] In addition to a sectoral exposure, our investor is also exposed to currency risk which is not hedged. As we explain in the next section, the analysis we carry out is based on local currency data that has been converted into US Dollars.

[3] We are not aware of any concrete plans to introduce these types of instruments in the near future. There may be, however, financial institutions that offer tailor-made, over-the-counter, sectoral derivative instruments on European equities.

Index. Unfortunately, futures contracts on Domestic Stock Market Indices and a European Stock Market Index have not been available long enough to allow us the test these alternative hedging strategies with observable futures prices over a sufficiently long period of time.

To overcome this problem, we first constructed a number of futures indices using the *estimated futures daily fair prices* (that is, the arbitrage-free prices) of:

(1) Eleven Domestic Stock Market Indices (Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom);

(2) One Composite European Stock Market Index; and

(3) Five pan-European Sectoral Indices (Insurance, Banking, Chemicals, Retail and Oil).

We then formed pan-European sectoral portfolios according to a set of criteria presented in the next section. Finally, we tested the following three alternative hedging strategies in order to determine the one that provided the best cover for the pan-European sectoral portfolios.

(1) **Strategy I** calls for a hedge based on *futures contracts on the European Sectoral Indices.*

(2) **Strategy II** utilizes *a cocktail of futures contracts on individual Domestic Stock Market Indices.*

(3) **Strategy III** uses *futures contracts on a single Composite European Stock Market Index.*

In the next section we describe the sample properties and the characteristics of the various indices we constructed to test the hedging performance of the above three strategies. We assumed that the reference currency adopted by our investor is the US Dollar and converted all values and returns into that currency at the prevailing daily rate of exchange. In section III we present the methodology we used to estimate futures prices and calculate hedge ratios. The results of our empirical tests are reported in Section IV. Not surprisingly, we found that a hedging strategy using futures contracts on European Sectoral Indices (Strategy I) provided a superior risk-cover than the two alternative strategies. In the last section we conclude with a call for further research on whether European Sectoral Indices could be designed and launched profitably in one of the several derivatives markets currently in operations in Europe. Their availability should increase the efficiency of both the cash and futures equity markets in Europe.

II. SAMPLE PROPERTIES

1. Source of data and return measurement

The data used in this study were extracted from Datastream International files. It begins on the first trading day of June 1989 (06/01/89) and ends on the last trading day of May 1995 (05/31/95). Daily stock returns were calculated over this 6-year period as percentages of daily price changes after adjusting all prices for splits and stock dividends and converting local values into US Dollars. Other data extracted from the Datastream International files are the interest rates and dividend yields needed to estimate the fair prices of futures contracts as explained below. The proxy chosen for the rate of interest is the 3-month Eurodollar mid-rate.

2. Composition of the pan-European sectoral portfolios

The pan-European Banking, Chemicals, Insurance and Retail portfolios we wish to hedge consist of the 20 largest European companies in their respective sector[4], as measured by their market capitalization, with no more than 20 percent of the market value of a portfolio allocated to the same country[5]. The European Oil portfolio, however, consists of only 10 companies because there were fewer Oil companies in the sample. Exhibit 1 provides the names and the countries of origin of the companies that make up the five pan-European sectoral portfolios. They are listed in decreasing order of market capitalization as of December 1994. Note that most of the largest companies are in the oil and chemicals sectors with the exception of Allianz, the German Insurance company, whose market capitalization was close to $40 billion at the end of December 1994.

3. Composition and price behavior of the five pan-European Sectoral Indices

The European Banking, Chemicals, Insurance and Retail Indices, as well as the futures contracts based of those indices and used to hedge the sectoral portfolios, consist of the 10 largest European companies in the sector, as measured by their market capitalization, with no more than 20 percent of the market value of a portfolio allocated to the same country, while

[4] The Datastream International files indicate the sector in which securities belong.

[5] This selection criterion identified companies based in eleven different European countries. The (Western) European countries *without* a company in our sample are Austria, Finland, Ireland, Luxembourg and Portugal.

the European Oil Index consists of only 5 companies because, as pointed out earlier, there were fewer Oil companies in sample. The companies that make up the indices are identified in Exhibit 1 by an asterisk. The market value of the sectoral indices as a percentage of the sectoral portfolios vary from a low of 66 percent and 67 percent for the Retail and the Banking sectors, respectively, to a high of 76 percent for the Insurance Sector as indicated at the bottom of Exhibit 1.

The average daily return and daily volatility (the standard deviation of daily returns) of the five sectoral indices over the sample period (1586 daily observations) and their correlation matrix are reported in Exhibit 2. The average returns of the Chemicals and Retail sectors and all the correlation coefficients are significantly different from zero at the 1-percent level. The average returns of the other 3 sectors are significant at the 5-percent level. The Retail Index had the largest average daily returns of 0.072 percent with a daily volatility of 1.02 percent while the Oil Sector had the lowest average daily returns of .050 percent with a daily volatility of 1.04 percent. The correlation coefficients that make up the correlation matrix indicate that the five sectoral indices were highly positively correlated during the sample period. The average value of the correlation coefficients is 0.78. The highest correlation (0.89) was between the Banking and the Insurance Indices, two sectors that belong to the same broader financial-services industry, while the oil sector had the lowest average correlations with the other four sectors (0.69).

4. Characteristics of the eleven Domestic Stock Market Indices and the Composite European Stock Market Index

The Domestic Stock Market Indices and the Composite European Stock Market Index are drawn from the Datastream International data bank. They are comprehensive, market-value weighted indices constructed by Datastream. Their average daily return and volatility (the standard deviation of returns) as well as their correlation matrix over the sample period (1586 daily observations) are reported in Exhibit 3. Daily mean returns ranged from a low of 0.0082 percent for Italy (with a volatility of 1.46 percent) to a high of 0.0615 percent for Switzerland (with a volatility of 1.09 percent). This performance compares to a daily average return of 0.0339 percent achieved by the European Index over the same period with a volatility of 0.85 percent. Note that all average market returns, except those of the Dutch and Swiss markets, are not significantly different from zero. The relatively higher return delivered by the Dutch and Swiss Market Indices is partly explained by the weakening of the US Dollar relative to the Dutch Guilder and Swiss Franc over the sample period.

The structure of correlations between the European Indices is significantly positive with the highest correlations, averaging 0.77, between the German, Dutch and Swiss Indices reflecting in part the strong linkages that exist between their currencies and their similar behavior relative to the US Dollar. The lowest correlation coefficient of 0.37 is between the Norwegian and the Italian Indices[6]. This is not surprising given the significant differences that exist between the economies of these two countries and the behavior of their respective currency against the US Dollar[7].

III. METHODOLOGY

1. Estimation of the fair prices of futures contracts and the construction of futures indices

We have already pointed out in the introduction that there are no Futures Indices on sectors (either domestic or European) currently traded on the European futures markets. And even though spot and futures domestic stock market indices do exist, they have not been trading long enough to provide us with sufficient data to allow us to carry out our empirical tests. Exhibit 4 indicates the date on which domestic-market spot indices began to be available on Datastream International and the date on which their corresponding futures indices were introduced. Note that seven out of the eleven countries in our sample introduced Futures Indices in their markets in the early nineties. The earliest available data is from the UK for which Datastream reports the FT100 since January 1, 1977. The corresponding Futures Index was first introduced in January 1984. The most recent addition is Italy whose MIB spot index is available on Datastream since July 1993 and its corresponding Futures Index first introduced in November 1994.

To overcome these constraints we constructed historical futures indices based on their estimated daily fair prices. These are the futures prices that would have prevailed in an arbitrage-free market. They are estimated as follows[8]:

Futures Price = [Spot Price] × [Exponential (r - d)(T - t)]

where: t = the time at which the daily spot price is observed
T = the time at which the futures contract matures

[6] See Drummen and Zimmermann (1992) for an examination of the structure of European stock returns.
[7] Oil plays a major role in the Norwegian economy whereas the Italian economy is much more diversified. There is little significantly less trade between the two countries than between each country and the rest of Europe..
[8] See, for example, Ederington (1979), Figlewski (1985) and Sutcliffe (1993).

r = the riskless rate of interest at time t with a (T - t) maturity
d = the dividend yield at time t for the period (T - t)

2. Estimation of the hedge ratio and construction of a hedged position

The hedge ratio employed to construct a hedged position is the estimated slope of the linear regression of the sectoral portfolio's daily returns ($\mathbf{R_{Pt}}$) against those of the futures position adopted to hedge the sectoral portfolio ($\mathbf{R_{Ft}}$). We have:

$$\mathbf{R_{Pt}} = \alpha + \beta \cdot \mathbf{R_{Ft}} + \varepsilon_t \qquad (1)$$

where: $\mathbf{R_{Pt}}$ = the historical daily returns on the sectoral portfolio
$\mathbf{R_{Ft}}$ = the historical daily returns on the Futures Index used to hedge the sectoral portfolio
α = the estimated regression intercept (alpha)
β = the estimated regression slope which is the estimated hedge ratio (beta)
ε_t = the daily error terms

The historical hedge ratios (betas) are estimated over the three-month estimation period immediately preceding the 3-month test-period over which a hedging strategy will be implemented[9]. The initial 3-month estimation period begins on the first trading day of June 1989 and ends on the last trading day of August 1989. It is followed by the initial testing period which begins on the first trading day of September 1989 and ends on the last trading day of November 1989. The final 3-month estimation period begins on the first trading day of December 1994 and ends on the last trading day of February 1995. It is followed by the last 3-month testing period which begins on the first trading day of March 1995 and ends on the last trading period of May 1995. From the 6 years of available data we get a total of 23 estimation periods and 23 testing periods of 3-month length each[10].

The characteristics of the average estimated parameters of the 23 regressions are summarized in Exhibit 5 for each one of the five sectors. Notice that the regression intercepts (α coefficients) are not statistically different from zero and that the estimated hedge ratios (β coefficients) are not statistically different from one. In the next section we compare the hedging performance of two types of hedge ratios: The betas estimated with the regressions we have just described and a hedge ratio arbitrarily set to one (this is the value the hedge ratio

[9] There is an average of 63 daily return observations over a 3-month estimation period.
[10] The 6 years of data can be divided into 24 nonoverlapping subperiods of 3 months each but since we lose one estimation and one testing subperiod the total number is reduced to 23 estimation and testing periods.

would have if the hedge were perfect). The advantage of taking a hedge ratio equal to one is obvious. It saves the investor the time (and the cost) of estimating hedge ratios with historical regressions.

As mentioned earlier, the *first* hedge ratio is estimated with the 3 months of daily returns immediately preceding September 1st, 1989. The hedged positions are rolled over daily during the 3-month test period corresponding to the original maturity of the futures contracts used to carry out the hedge. Once a hedging strategy is initiated it is maintained up to the date on which the futures contracts mature and for which there is no *basis* risk.

The number N of futures contracts that should be sold daily to hedge the sectoral portfolios is calculated as follows:

$$\mathbf{N = Hedge\ Ratio \times \frac{Dollar\ Value\ of\ Portfolio}{(Underlying\ Index) \times (\$10)}} \tag{2}$$

where the *initial* dollar value of the sectoral portfolio we wish to hedge on June 1st, 1989 is equal to $10 million and the *initial* dollar value of the index underlying the futures contract on that same date is equal to $100,000, the product of an index set at 10,000 on June 1st, 1989 with each index point worth $10. To illustrate, on September 1st, 1989 the market value of the insurance portfolio was up to $11,892,576 from its initial value of $10 million three months earlier. On that date the Insurance Index had reached a value of 12,066.78 The number (N) of futures contracts on the Insurance Index that had to be sold on September 1st, 1989, given that the estimated hedge ratio was in this case equal to 0.9568, was equal to:

$$\mathbf{N = 0.9568 \times \frac{\$11{,}892{,}576}{(12{,}066.78) \times (\$10)} = 94.44} \tag{3}$$

This means that the number of three-month contracts sold on the 1st of September 1989 to hedge the Insurance Portfolio were equal to 94[11].

3. Construction of the Spot and Futures Sectoral Indices

We constructed two sets of Spot and Futures Sectoral Indices: One set with equal weights and the other with market-value weights. We assumed, however, that our investor wishing to hedge his sectoral position is holding an equally-weighted sectoral portfolio. In the

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[11] Fractional number of contracts are rounded to the nearest integer number.

next section we compare the hedging performance of the two weighting schemes and show that they do not differ significantly from one another.

4. Subperiod analysis

We divided the 6-year testing period into two nonoverlapping subperiods of 6 months as well as six nonoverlapping subperiods of one year to test whether our results are sensitive to the length and/or the choice of the testing period. In the next section we show that the results drawn from the subperiod analysis are consistent with those obtained over the full 6-year period.

IV. EMPIRICAL EVALUATION OF ALTERNATIVE HEDGING STRATEGIES

1. Alternative hedging strategies and their sensitivity to different testing methodologies

In this section we present the results of the tests we carried out to evaluate the relative performance of the three hedging strategies suggested earlier. Recall that Strategy I utilizes Futures contracts on sectoral indices, Strategy II calls for the use of a cocktail of futures contracts on the individual Domestic Stock Market Indices and Strategy III employs Futures contracts on a single Composite European Stock Market Index.

We also tested the sensitivity of our empirical results to the methodology employed to carry out the tests. As pointed out earlier, the empirical results were fairly robust. They were not significantly sensitive to:

(1) the weighting scheme used to construct the sectoral indices (equally-weighted versus value-weighted indices);
(2) the procedure employed to estimate the hedge ratio (estimated regression slope or hedge ratio equal to one); or
(3) the choice and the length of the test period.

We report below the complete results of our empirical work for the case of the Insurance Portfolio with only a summary of the results for the other four sectors[12]. We proceeded as follows. We first examined the hedging performance of Strategy I (Sectoral Indices) using a market-value weighted Insurance Index and showed that it was similar to that obtained with an equally-weighted Insurance Index (section 2). We then tested the hedging

[12] The complete set of results for the other four sectors is available on request from the authors. They do not differ from those obtained with the Insurance sector.

performance of Strategy I using the two alternative hedge ratios. The first is the estimated regression beta and the other a hedge ratio equal to one. The empirical analysis indicates that, at least over our sample period, the quality of the hedging performance using a hedge ratio equal to one is not significantly different from that using an estimated hedge ratio obtained with a regression analysis (section 3). Since the empirical evidence presented in the next three sections indicates that the hedging performance of Strategy I is insensitive to the weighting scheme of the index (section 2), the choice of the hedge ratio (section 3), and the length of the test period (section 4) we decided to compare, in section 5, the hedging performance of the three hedging strategies over the entire sample period using the simplest and most convenient combination of indices and hedge ratios, namely, equally-weighted indices and hedge ratios equal to one.

Note that since Strategy I and Strategy III are based on a single Futures Index (Futures contract on the appropriate Sectoral Index in the first case and the Composite European Stock Market Index in the second), the determination of the hedge ratio and the corresponding number contracts are given directly by equations (1) and (2) presented in the previous section. The estimation of the hedge ratio for Strategy II, however, requires an explanation because this hedging method is based on a combination of Domestic Stock Market Futures Indices rather than a single index.

In the case of Strategy II the hedge ratio is estimated according to the following three-step procedure. First, the hedge ratio of each one of the individual domestic security that make up a sectoral portfolio we wish to hedge is estimated separately against its corresponding Domestic Stock Market Futures Index. Second, the subset of individual securities that belong to the same country are grouped together and their hedge ratio is calculated as the equally-weighted average of the subset of individual hedge ratios. Finally, the total hedged position of the sectoral portfolio is obtained by hedging each subset of country securities against its respective Domestic Stock Market Futures Index.

2. Equally-weighted versus value-weighted Sectoral Indices

Does it make a significant difference if the Sectoral Futures Indices used to hedge our (equally-weighted) sectoral portfolios are equally-weighted or market-value weighted?. The empirical evidence indicates that there is no significant difference between the two weighting schemes employed to construct the Sectoral Futures Indices. This is shown in the data reported in Exhibit 6 in the case of the Insurance sector (similar results were obtained with the other four sectors).

The hedged position consists of an initial long position in the European Insurance portfolio worth US $11,892,576[13] (the spot position) combined with a short, or sell, position in the Futures contracts on the European Insurance Index with an equal value[14] (the futures position). The hedge ratio used to determine the number of Futures contracts required to cover the position is the estimated historical regression beta (see equations (1) and (2) above). Two cases are examined, one with an equally-weighted Insurance Index and the other with a market-value weighted Insurance Index. Exhibit 6 provides the average daily changes in the Dollar values of the spot, futures, and hedged positions as well as the corresponding average daily percentage changes for each one of the two weighting schemes.

The average daily changes in the value of the hedged position is $178 in the case of the equally-weighted index and $792 in the case of the value-weighted index. But given the magnitude of their respective standard deviations neither one of these two average values is significantly different from zero, or significantly different from the other[15]. Note, however, that the average values of both the Spot and Futures positions are significantly different from zero under both types of weighting schemes. Furthermore, the standard deviation or volatility of the hedged position is significantly smaller than that of either the Spot or the Futures Position a (about 35 to 40 percent smaller). In other words, the so-called "hedged position" is indeed hedged while both the Spot and Futures positions have non-zero mean values and relatively larger volatilities.

3. Estimated historical hedge ratios versus hedge ratios equal to one

To find out whether the historical regression estimates of the hedge ratio provide a superior hedging performance to a hedge ratio arbitrarily set to one, we compared the performance of the hedging strategy we have just described (estimated β coefficient) with the same hedging strategy but with a hedge ratio equal to one (β=1). The results are reported in Exhibit 7 for the cases of the equally-weighted as well as the value-weighted Insurance Index (similar results were obtained with the other four sectors).

When the hedge ratio is equal to one the average daily changes in the value of the hedge position is $213 in the case of the equally-weighted index and $949 in the case of the value-weighted index. These figures are neither significantly different from one another nor significantly different from those reported in the case of a hedged position based on an

[13] This is the market value of the Insurance Portfolio 3 months after its initial construction value of $10 million.

[14] Note that the value of the Futures position is always a multiple of $10, the minimum value of one index point.

[15] We performed a t-test for the difference between two means which is not reported on Exhibit 6.

estimated hedge ratio via regression analysis[16]. Given these results we decided to conduct the rest of the study with equally-weighted sectoral indices and hedge ratios equal to one. Note that this approach is simpler and significantly cheaper to implement than one based on value-weighted sectoral indices and estimated hedge ratios through linear regressions.

4. Sensitivity to the choice and length of the test period

In Exhibit 8 we report data on subperiod analyses. We first split the entire 6-year sample period into two nonoverlapping 3-year subperiods. The data showed no significant difference in the behavior of the hedged positions over the two subperiods. During the first subperiod the average daily changes in the value of the hedged position was $719. During the second it was $998. A t-test indicated that there is no statistical difference between these two mean values at the 5 percent level.

We then split the entire test period into six nonoverlapping 1-year subperiods. Here we examined the hedging performance of the six subperiods by regressing the daily returns of the spot position against those of the futures position and compared the results of the six regressions. As shown at the bottom of Exhibit 8, there are no differences between the estimated parameters of the six regressions (Lindahl (1989)). Their slopes are not significantly different from one, their intercepts not significantly different from zero and their R-squared vary from 90 percent in the last subperiod to 94 percent in the second[17]. We concluded that hedging the Insurance portfolio with futures on the Insurance Index is not sensitive to the length or choice of subperiods, at least over our 6-year sample period from June 1989 to May 1995 (identical conclusions were reached in the case of the other four sectors).

5. Hedging the European Insurance sector: Performance of alternative hedging strategies

In the preceding sections we examined the hedging performance of Strategy I, the strategy that calls for a hedge based on futures contracts on the appropriate sectoral index. We now turn to the comparison between the hedging performance of Strategy I and those of Strategy II (cocktail of futures contracts on the individual Domestic Stock Market Indices) and Strategy III (Futures contracts on a single Composite European Stock Index).

Exhibit 9 provides a graphical representation of the value of the spot (unhedged) Insurance Portfolio and the hedged Insurance Portfolio with the three alternative hedging

[16] We performed t-tests for the difference between two means which are not reported on Exhibit 6.

[17] The same results were obtained with a value-weighted Index and estimated regression betas.

strategies over the 6-year sample period. The horizontal axis indicates time. It begins with the first trading day of June 1989 and ends with the last trading day of May 1995[18]. The vertical axis shows the dollar value of the position over time. The upper graph (drawn with a thicker line) is the spot Insurance Portfolio while the lower three graphs represent the hedged Insurance Portfolio using each one of the three different hedging strategies.

Not surprisingly, Strategy I, which calls for the use of futures contracts on the Insurance Index, provided the best hedging performance[19] with no significant difference between the other two strategies. This is confirmed by examining the behavior of the daily changes in the values of the spot, future, and hedged positions reported in Exhibit 10.

The average daily changes in the value of the covered position in the case of the Insurance portfolio hedged with Futures contracts on the Insurance Index ($213 for Strategy I) is significantly smaller (at a 10 percent confidence level) than either the case of a portfolio hedged with a cocktail of Futures contracts on Domestic Market Indices ($1,371 for Strategy II) or a portfolio hedged with Futures contracts on a European Stock Index ($1,959 for Strategy III). Furthermore, the standard deviation or volatility of the daily changes in the value of the hedged position with Strategy I ($53,156) is significantly smaller (at a 10 percent confidence level) than that of Strategy II ($58,913) which is in turn significantly smaller than that of Strategy III ($94,813)[20].

Finally note that Strategy I, in addition to being superior to the other two, is also comparatively cheaper to implement than Strategy II (the cocktail strategy, which is the second best performer) because it calls for the use of a futures contracts on a single Sectoral Index instead of up to eleven different Domestic Stock Market Indices.

6. Hedging the European Banking, Chemicals, Oil, and Retail portfolios: Empirical evidence

The empirical results for the Banking, Chemicals, Oil, and Retail portfolios are only reported in graphical form and shown in Exhibits 11, 12, 13, and 14, respectively. As in the

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[18] Note that hedging begins three months later because in some of our tests the first three months of data were used to estimate the hedge ratio.

[19] Recall that the tests are based on equally-weighted indices and hedge ratios equal to one.

[20] We performed an F-test for the difference between two variances. With 1,493 observations the upper and lower critical values of F are 1.087 and 0.920, respectively, at a 5 percent level of significance. Since the computed F ratios shown below are outside the region of acceptance of the null hypothesis of equal variances, this hypothesis can be rejected. We have:

$$\frac{\text{Variance Strategy I}}{\text{Variance Strategy II}} = \frac{(\$53{,}158)^2}{(\$58{,}913)^2} = 0.81 \quad \text{and} \quad \frac{\text{Variance Strategy I}}{\text{Variance Strategy III}} = \frac{(\$53{,}158)^2}{(\$94{,}812)^2} = 0.31$$

case of the Insurance Portfolio, Strategy I, which calls for the use of a European Sectoral Index, provides the best hedging performance. Further, as in the case of the Insurance sector, the empirical results were found to be robust. They were not significantly sensitive to the Sectoral Index's weighing scheme, to whether the hedge ratio was estimated via regression or equal to one or to the length of the test period over which the empirical work was carried out[21].

V. CONCLUSION

In early 1996, investors holding pan-European sectoral portfolios and wanting to temporarily hedge their sectoral exposure could not have done it with tradable futures contracts or options on pan-European or Domestic Sectoral Indices because these hedging instruments did not trade in organized derivative markets at that time[22]. Two alternative strategies that could have been used as substitutes to the unavailable sectoral derivative instruments are hedging with either a cocktail of Domestic Futures Market Indices or a European Futures Market Index.

We have shown in this paper that if pan-European Futures contracts on Sectoral Indices existed for the Insurance, Banking, Chemicals, Oil, and Retail sectors during the 6-year period from June 1989 to May 1995 they would have provided a superior hedging performance than the two alternatives cited above. To test the superiority of the yet unavailable pan-European Futures on Sectoral Indices we constructed a time series of sectoral indices and estimated the price of Futures contracts on these indices assuming fair pricing in a market in which arbitrage would not be profitable.

We conclude this paper with a call for further research on whether European Sectoral Indices could be designed and launched profitably in one of the several derivatives markets currently in operations in Europe. Their availability should increase the efficiency of both the cash and futures European equity markets.

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[21] The empirical results for the four sectors other than Insurance were not reported in this paper for the sake of brevity but are available from the authors on request.

[22] As we already pointed out in the first footnote, we can not rule out the existence of non-tradable, over-the-counter derivative instruments offered by financial institutions to hedge domestic or European sectoral risk.

BIBLIOGRAPHY

Drummen, M., and Zimmerman, H. (1992): "The Structure of European Stock Return," *Financial Analysts Journal*, July-August:15-25.

Ederington, L. H. (1979): "The Hedging Performance of the New Futures Markets," *Journal of Finance,* 34:157-170.

Figlewski, S. (1985): "Hedging with Stock Index Futures: Theory and Application in a New Market," *Journal of Futures Markets*, 5:183-199.

Lindahl, M. (1989): "Measuring Hedging Effectiveness with R^2: A Note," *Journal of Futures Markets,* 9:469-475.

Sutcliffe, Ch. M. S.(1993): *Stock Index Futures* : Chapman & Hall.

EXHIBIT 1

FIRMS IN THE FIVE EUROPEAN SECTORAL PORTFOLIOS RANKED BY DECREASING MARKET VALUE (in US Million) AND COUNTRY OF ORIGIN ON DECEMBER 30, 1994 (FIRMS USED TO CONSTRUCT THE SECTORAL INDICES ARE INDICATED BY AN ASTERISK)

BANKING SECTOR		CHEMICALS SECTOR		INSURANCE SECTOR		OIL SECTOR		RETAIL SECTOR	
*Deutsche Bank (GE)	22,884	*Roche (SW)	45,250	*Allianz (GE)	39,737	*Royal Dutch (NL)	65,414	*Marks & Spencer (UK)	18,005
*HSBC Holding (UK)	22,813	*Glaxo (UK)	42,786	*Generali (IT)	18,831	*British Petroleum (UK)	39,655	*Carrefour (FR)	13,144
*Union Bank (UK)	21,699	*Sandoz (SW)	24,148	*Munchen Rugd. Regd. (GE)	16,410	Shell (UK)	39,601	*Sainsburry (UK)	12,726
*Barclays (UK)	17,617	Ciba-Geigy (SW)	18,759	*Prudential (UK)	10,142	*Elf Aquitaine (FR)	19,494	Tesco (UK)	9,509
*Credit Suisse (SW)	16,915	*Bayer (GE)	15,944	*Swiss Re (SW)	10,069	Total (FR)	13,689	G UStores (UK)	9,411
National Westminster (UK)	15,216	*Astra (SD)	15,463	*Aegon (NL)	8,953	*Norsk Hydro (NW)	9,605	*Pinault Printemps (FR)	4,717
Lloyds Bank (UK)	12,914	*Hoechst (GE)	12,693	*Axa (FR)	8,685	*Repsol (SP)	9,439	*Ahold (NL)	4,301
*Dresdner Bank (GE)	12,875	Smithkline Beecham (UK)	12,574	*UAP (FR)	7,760	Petrofina (BE)	7,001	Promodes (FR)	3,988
*ABN Amro (NL)	11,705	BASF	12,474	*Zurich (SW)	6,682	Petroleos (SP)	2,438	*Karstadt (GE)	3,684
*Societe Generale (FR)	9,941	*Air Liquide (FR)	10,406	*Commercial Union (UK)	6,185	Saga (NW)	1,429	*Kaufhof (GE)	2,659
Commerzbank (GE)	8,484	*ICI (UK)	8,880	Allianz Lebens (GE)	5,673			Asko (GE)	2,474
Swiss Bank Corp (SW)	8,471	*Akzo (NL)	8,489	Alleanza (IT)	5,454			*Hennes & Mauritz (SW)	2,421
*Paribas (FR)	6,972	BOC Group (UK)	6,124	AGF (FR)	4,361			*Danisco (DK)	2,398
*Banco Bilbao Vizcaya (SP)	6,667	Sanofi (FR)	5,058	Winterthur (SW)	4,341			*Delhaize (BE)	2,338
Banco Santander (SP)	6,298	Schering (GE)	4,770	Sun Alliance Group(UK)	4,326			Castorama (FR)	2,317
Bayerische Vbk (GE)	5,046	*Solvay (BE)	4,568	Lloyds Abbey Life (UK)	4,324			GIB (BE)	1,571
Banco Popular (SP)	4,296	Roussel-Uclaf (FR)	4,237	Fortis Amev (NL)	3,906			Ava (GE)	1,199
Banesto (SP)	4,220	Montedison (IT)	3,807	Fortis AG (BE)	3,449			Merkur (SW)	1,128
Generale de Banque (BE)	4,096	Novo Nordisk (DK)	3,404	Ras (IT)	2,856			Colruyt (BE)	1,067
Mediobanca (IT)	3,456	DSM (NL)	3,101	Finaxa (FR)	2,497			Rinascente (IT)	898
Total Market Value Portfolio	222,585	Total Market Value Portfolio	262,935	Total Market Value Portfolio	174,641	Total Market Value Portfolio	207,765	Total Market Value Portfolio	99,955
Total Market Value Index / Total Market Value Portfolio	= 67%	Total Market Value Index / Total Market Value Portfolio	= 72%	Total Market Value Index / Total Market Value Portfolio	= 76%	Total Market Value Index / Total Market Value Portfolio	= 69%	Total Market Value Index / Total Market Value Portfolio	= 66%

BE = Belgium; DK = Denmark; FR = France; GE = Germany; IT = Italy; NL = Netherlands; NW = Norway; SD = Sweden; SP = Spain; SW = Switzerland

EXHIBIT 2

MEANS AND STANDARD DEVIATIONS OF DAILY RETURNS AND CORRELATION MATRIX FOR THE FIVE SECTORAL INDICES FROM JUNE 1, 1989 TO MAY 30, 1995.

• MEANS AND STANDARD DEVIATIONS OF DAILY RETURNS

SECTOR	Mean Return	t-Statistics	Minimum	Maximum	Std Deviation
INSURANCE	0.0605×10^{-2}	2.21*	-9.30×10^{-2}	8.56×10^{-2}	1.09×10^{-2}
BANKING	0.0535×10^{-2}	1.92*	-10.09×10^{-2}	9.89×10^{-2}	1.11×10^{-2}
CHEMICALS	0.0664×10^{-2}	2.57**	-7.98×10^{-2}	7.71×10^{-2}	1.03×10^{-2}
OIL	0.0503×10^{-2}	1.93*	-7.01×10^{-2}	4.74×10^{-2}	1.04×10^{-2}
RETAIL	0.0720×10^{-2}	2.81**	-9.25×10^{-2}	7.12×10^{-2}	1.02×10^{-2}

Mean return are significantly different from zero at the 1% level (**) and 5% level (*)

• CORRELATION MATRIX*

SECTOR	INSURANCE	BANKING	CHEMICALS	OIL	RETAIL
INSURANCE	1.00	0.89	0.85	0.69	0.84
BANKING	0.89	1.00	0.86	0.70	0.83
CHEMICALS	0.85	0.86	1.00	0.68	0.84
OIL	0.69	0.70	0.68	1.00	0.69
RETAIL	0.84	0.83	0.84	0.69	1.00

*All coefficients are significantly different from zero at the 1% level.

EXHIBIT 3

MEANS AND STANDARD DEVIATIONS OF DAILY RETURNS AND CORRELATION MATRIX FOR THE ELEVEN DOMESTIC STOCK MARKET INDICES AND THE EUROPEAN COMPOSITE STOCK INDEX FROM JUNE 1, 1989 TO MAY 30,1995.

	Mean Return	t-Statistics	Maximum	Minimum	Standard Deviation
Europe	0.0339×10^{-2}	1.58	5.7796×10^{-2}	-7.5905×10^{-2}	0.8530×10^{-2}
Belgium	0.0299×10^{-2}	1.20	8.2949×10^{-2}	-7.9324×10^{-2}	0.9915×10^{-2}
Denmark	0.0377×10^{-2}	1.37	7.8323×10^{-2}	-8.3662×10^{-2}	1.0929×10^{-2}
France	0.0318×10^{-2}	1.12	9.0119×10^{-2}	-9.5998×10^{-2}	1.1311×10^{-2}
Germany	0.0474×10^{-2}	1.54	8.3860×10^{-2}	-11.7757×10^{-2}	1.2230×10^{-2}
Italy	0.0082×10^{-2}	0.22	7.6071×10^{-2}	-9.6968×10^{-2}	1.4603×10^{-2}
Netherlands	0.0504×10^{-2}	2.28*	5.1184×10^{-2}	-6.3356×10^{-2}	0.8815×10^{-2}
Norway	0.0354×10^{-2}	0.98	10.4765×10^{-2}	-11.9365×10^{-2}	1.4338×10^{-2}
Spain	0.0097×10^{-2}	0.32	9.4179×10^{-2}	-9.3553×10^{-2}	1.1977×10^{-2}
Sweden	0.0283×10^{-2}	0.83	9.3874×10^{-2}	-8.6974×10^{-2}	1.3538×10^{-2}
Switzerland	0.0615×10^{-2}	2.24*	6.5210×10^{-2}	-7.8763×10^{-2}	1.0934×10^{-2}
United Kingdom	0.0035×10^{-2}	0.14	5.9101×10^{-2}	-5.0583×10^{-2}	0.9989×10^{-2}

* Significantly different from zero at the 1% level.

	Europe	Belgium	Denmark	France	Germany	Italy	Netherlands	Norway	Spain	Sweden	Switzerl.	UK
Europe	1.00	0.65	0.56	0.77	0.74	0.53	0.70	0.54	0.65	0.59	0.69	0.77
Belgium	0.65	1.00	0.67	0.69	0.71	0.48	0.74	0.53	0.62	0.54	0.69	0.54
Denmark	0.56	0.67	1.00	0.57	0.66	0.46	0.66	0.51	0.56	0.50	0.62	0.47
France	0.77	0.69	0.57	1.00	0.74	0.49	0.76	0.54	0.68	0.57	0.70	0.65
Germany	0.74	0.71	0.66	0.74	1.00	0.50	0.78	0.59	0.65	0.58	0.77	0.57
Italy	0.53	0.48	0.46	0.49	0.50	1.00	0.50	0.37	0.51	0.47	0.46	0.41
Netherlands	0.70	0.74	0.68	0.76	0.78	0.50	1.00	0.61	0.65	0.57	0.77	0.68
Norway	0.54	0.53	0.51	0.54	0.59	0.37	0.61	1.00	0.48	0.56	0.57	0.48
Spain	0.65	0.62	0.56	0.68	0.65	0.51	0.65	0.48	1.00	0.55	0.62	0.56
Sweden	0.59	0.54	0.50	0.57	0.58	0.47	0.57	0.56	0.55	1.00	0.55	0.50
Switzerland	0.69	0.69	0.62	0.70	0.77	0.46	0.77	0.57	0.62	0.55	1.00	0.58
U.K.	0.77	0.54	0.47	0.65	0.57	0.41	0.68	0.48	0.56	0.50	0.58	1.00

All correlation coefficients are significantly different from zero at the 1% level.

EXHIBIT 4

DATES OF INTRODUCTION OF SPOT AND FUTURES MARKET INDICES IN THE SAMPLE OF COUNTRIES

COUNTRY	SPOT INDEX CODE	NUMBER OF STOCKS	AVAILABILITY ON DATASTREAM	FUTURES FISRT INTRODUCED IN	COMPOSITION OF INDEX
Belgium	BEL	20	Since March 1, 1991	October 29,1993	Market-value weighted
Denmark	KFX	20	Since December 4,1989	December 7, 1989	Market-value weighted
France	CAC	40	Since July 9, 1988	November 1988	Market-value weighted
Germany	DAX	30	Since August 5, 1989	October 23, 1990	Market-value weighted
Italy	MIB	30	Since July 16, 1993	November 28, 1994	Market-value weighted
Netherlands	EOE	25	Since January 1, 1983	May 18, 1987	Market-value weighted
Norway	OSE	25	Since 03/01/1983	September 4, 1992	Market-value weighted
Spain	IBEX	35	Since August 5, 1991	January 14, 1992	Market-value weighted
Sweden	OMX	30	Since May 10, 1991	March 1990	Market-value weighted
Switzerland	SMI	17	Since January 1, 1988	November 9, 1990	Market-value weighted
United Kingdom	FTSE	100	Since January 1, 1977	January 3, 1984	Market-value weighted

EXHIBIT 5

ESTIMATED SECTORAL REGRESSION RESULTS FOR THE HEDGE RATIO: AVERAGE OF 23 REGRESSIONS

SECTOR		INSURANCE	BANKING	CHEMICALS	OIL	RETAIL
Alpha (α)	**Mean**	**0.0068×10^{-2}**	**0.0069×10^{-2}**	**0.0060×10^{-2}**	**-0.0015×10^{-2}**	**-0.0017×10^{-2}**
	Standard Deviation	0.0203×10^{-2}	0.0350×10^{-2}	0.0323×10^{-2}	0.0373×10^{-2}	0.0345×10^{-2}
	Maximum	0.0702×10^{-2}	0.0687×10^{-2}	0.0625×10^{-2}	0.0827×10^{-2}	0.0594×10^{-2}
	Minimum	-0.0238×10^{-2}	-0.0684×10^{-2}	-0.0593×10^{-2}	-0.0779×10^{-2}	-0.0058×10^{-2}
t-Student (α)	**Mean**	**0.19**	**0.17**	**0.17**	**-0.04**	**0.01**
	Standard Deviation	0.57	0.98	0.89	0.89	0.91
	Maximum	2.04	2.40	1.79	1.79	1.86
	Minimum	-0.59	-1.88	-1.55	-2.15	-1.44
Beta (β)	**Mean**	**1.0106**	**0.9886**	**1.0096**	**1.0038**	**1.0209**
	Standard Deviation	0.0444	0.0507	0.0401	0.0596	0.0410
	Maximum	1.0932	1.06291	1.0737	1.1472	1.1008
	Minimum	0.9248	0.8541	0.9077	0.8913	0.9368
t-Student (β)	**Mean**	**27.96**	**30.08**	**28.48**	**23.08**	**23.77**
	Standard Deviation	6.92	9.97	8.35	5.63	8.09
	Maximum	54.46	60.60	59.56	44.69	57.75
	Minimum	19.56	15.98	17.11	16.17	16.83
R-Squared	**Mean**	**91.75%**	**92.05%**	**91.60%**	**86.40%**	**88.46%**
	Standard Deviation	2.60%	3.80%	3.67%	3.57%	3.94%
	Maximum	97.92%	98.31%	98.26%	96.94%	98.15%
	Minimum	85.66%	80.46%	82.07%	80.58%	81.81%

EXHIBIT 6

HEDGING PERFORMANCE OF THE EUROPEAN INSURANCE FUTURES INDEX
Equally-Weighted Index versus Market-Value Weighted Index
and hedge ratios equal to the estimated regression betas

Equally-Weighted Index (Hedge ratio = Estimated Regression Beta)

	Spot (unhedged) Position		Futures Position	Hedged Position	
	Daily change in value	Daily % change	Daily change in value	Daily change in value	Daily % change
Mean	$6,937**	0.0521%	-$5,811**	$178*	0.0025%
Standard Deviation	$154,228	1.0298%	$129,389	$54,093	0.4640%
Maximum	$1,029,953	8.2564%	$1,168,730	$210,774	1.8490%
Minimum	-$1,120,009	-8.4716%	-$1,048,489	-$234,475	-2.1053%

(**) Significantly different from zero at the 10% level.
(*) Not significantly different from zero at the 10% level.

Market -Value Weighted Index (Hedge Ratio = Estimated Regression Beta)

	Spot (unhedged) Position		Futures Position	Hedged Position	
	Daily change in value	Daily % change	Daily change in value	Daily change in value	Daily % change
Mean	$6,937**	0.0521%	-$5,197*	$792*	0.0076%
Standard Deviation	$154,228	1.0298%	$145,787	$60,346	0.5033%
Maximum	$1,029,953	8.2564%	$1,448,582	$328,574	2.7805%
Minimum	-$1,120,009	-8.4716%	-$1,209,207	-$287,537	-2.5517%

(**) Significantly different from zero at the 10% level.
(*) Not significantly different from zero at the 10% level.

EXHIBIT 7

HEDGING PERFORMANCE OF THE EUROPEAN INSURANCE FUTURES INDEX
Equally-Weighted Index versus Market-Value Weighted Index
and hedge ratios equal to one

Hedge Ratio = 1 (Equally-Weighted Index)

	Spot (unhedged) Position		Futures Position	Hedged Position	
	Daily change in value	Daily % change	Daily change in value	Daily change in value	Daily % change
Mean	$6,937**	0.0521%	-$5,776**	$213*	0.0028%
Standard Deviation	$154,228	1.0298%	$127,863	$53,158	0.4520%
Maximum	$1,029,953	8.2564%	$1,080,761	$205,642	1.7914%
Minimum	-$1,120,009	-8.4716%	-$971,232	-$226,827	-1.9529%

(**) Significantly different from zero at the 10% level.
(*) Not significantly different from zero at the 10% level.

Hedge Ratio = 1 (Market Value-Weighted Index)

	Spot (unhedged) Position		Futures Position	Hedged Position	
	Daily change in value	Daily % change	Daily change in value	Daily change in value	Daily % change
Mean	$6,937**	0.0521%	-$5,040*	$949*	0.0087%
Standard Deviation	$154,228	1.0298%	$140,211	$57,927	0.4757%
Maximum	$1,029,953	8.2564%	$1,257,260	$227,158	1.8700%
Minimum	-$1,120,009	-8.4716%	-$1,031,383	-$261,704	-2.3152%

(**) Significantly different from zero at the 10% level.
(*) Not significantly different from zero at the 10% level.

EXHIBIT 8
SUBPERIOD HEDGING PERFORMANCE OF THE EUROPEAN INSURANCE FUTURES INDEX
Equally-Weighted Index and Hedge Ratio Equal to One

September 1989 to August 1992

	Spot (unhedged) Position		Futures Position	Hedged Position	
	Daily change in value	Daily % change	Daily change in value	Daily change in value	Daily % change
Mean	$6,203*	0.0569%	-$4,872*	-$719*	-0.0055%
Standard Deviation	$151,405	1.1315%	$148,922	$42,010	0.3626%
Maximum	$1,029,953	8.2564%	$1,168,730	$149,890	1.3411%
Minimum	-$1,120,009	-8.4716%	-$1,048,489	-$203,179	-1.7814%

(**) Significantly different from zero at the 10% level.
(*) Not significantly different from zero at the 10% level.

September 1992 to May 1995

	Spot (unhedged) Position		Futures Position	Hedged Position	
	Daily change in value	Daily % change	Daily change in value	Daily change in value	Daily % change
Mean	$7,667*	0.0474%	-$6,669**	$998*	0.0099%
Standard Deviation	$157,175	0.9183%	$108,615	$63,155	0.5404%
Maximum	$493,015	3.1253%	$578,317	$210,774	1.8490%
Minimum	-$1,120,009	-8.4716%	-$1,048,489	-$234,475	-2.1053%

(**) Significantly different from zero at the 10% level.
(*) Not significantly different from zero at the 10% level.

Six nonoverlapping subperiods of one year

Subperiod	Sept. 89 - Aug. 90	Sept. 90 - Aug. 91	Sept. 91 - Aug. 92	Sept. 92 - Aug. 93	Sept. 93 - Aug. 94	Sept. 94 - May 95
Alpha	1.1409×10^{-4}	-1.0653×10^{-4}	0.4375×10^{-4}	0.8098×10^{-4}	0.1746×10^{-4}	2.9668×10^{-4}
t-alpha	0.55	-0.51	0.26	0.44	0.11	1.72
Beta	1.0140	1.0439	1.0589	0.9888	0.9925	0.9855
t-beta	50.28	65.89	64.13	55.52	51.48	48.91
R-squared	90.57%	94.28%	93.98%	92.13%	90.97%	90.22%

EXHIBIT 9
VALUE OF SPOT AND HEDGED EUROPEAN INSURANCE PORTFOLIOS

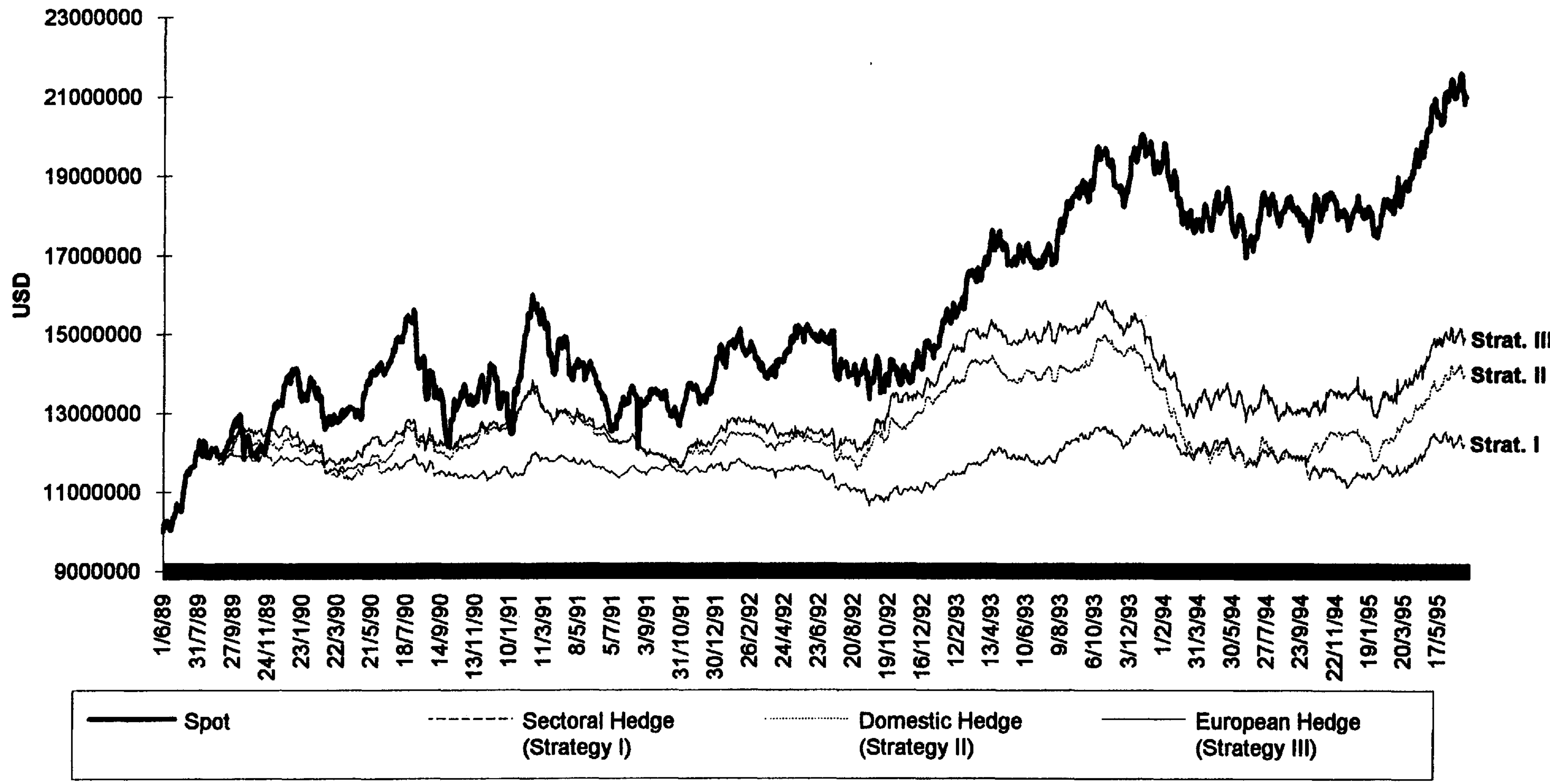

EXHIBIT 10
CHANGES IN THE VALUE OF THE SPOT(UNHEDGED) AND HEDGED EUROPEAN INSURANCE PORTFOLIO
(Equally-weighted Index and a Hedge Ratio Equal to One)

STRATEGY I : FUTURES CONTRACTS ON THE INSURANCE INDEX

	Spot (unhedged) Position		Futures Position	Hedged Position	
	Daily change in value	Daily % change	Daily change in value	Daily change in value	Daily % change
Mean	$6,937**	0.0521%	-$5,776**	$213*	0.0028%
Standard Deviation	$154,228	1.0298%	$127,863	$53,158	0.4520%
Maximum	$1,029,953	8.2564%	$1,080,761	$205,642	1.7914%
Minimum	-$1,120,009	-8.4716%	-$971,232	-$226,827	-1.9529%

STRATEGY II : COCKTAIL OF FUTURES CONTRACTS ON DOMESTIC STOCK MARKET INDICES

	Spot (unhedged) Position		Futures Position	Hedged Position	
	Daily change in value	Daily % change	Daily change in value	Daily change in value	Daily % change
Mean	$6,937**	0.0521%	-$3,919*	$1,371*	0.0117%
Standard Deviation	$154,228	1.0298%	$118,014	$58,913	0.4670%
Maximum	$1,029,953	8.2564%	$1,016,998	$246,008	1.8690%
Minimum	-$1,120,009	-8.4716%	-$853,210	-$255,291	-1.8330%

STRATEGY III : FUTURES CONTRACTS ON THE COMPOSITE EUROPEAN STOCK INDEX

	Spot (unhedged) Position		Futures Position	Hedged Position	
	Daily change in value	Daily % change	Daily change in value	Daily change in value	Daily % change
Mean	$6,937**	0.0521%	-$4,030*	$1,958*	0.0172%
Standard Deviation	$154,228	1.0298%	$111,541	$94,812	0.7127%
Maximum	$1,029,953	8.2564%	$930,658	$625,210	4.7170%
Minimum	-$1,120,009	-8.4716%	-$730,281	-$431,783	-3.1010%

(**) Significantly different from zero at the 10% level.
(*) Not significantly different from zero at the 10% level.

EXHIBIT 11
VALUE OF SPOT AND HEDGED EUROPEAN BANKING PORTFOLIOS

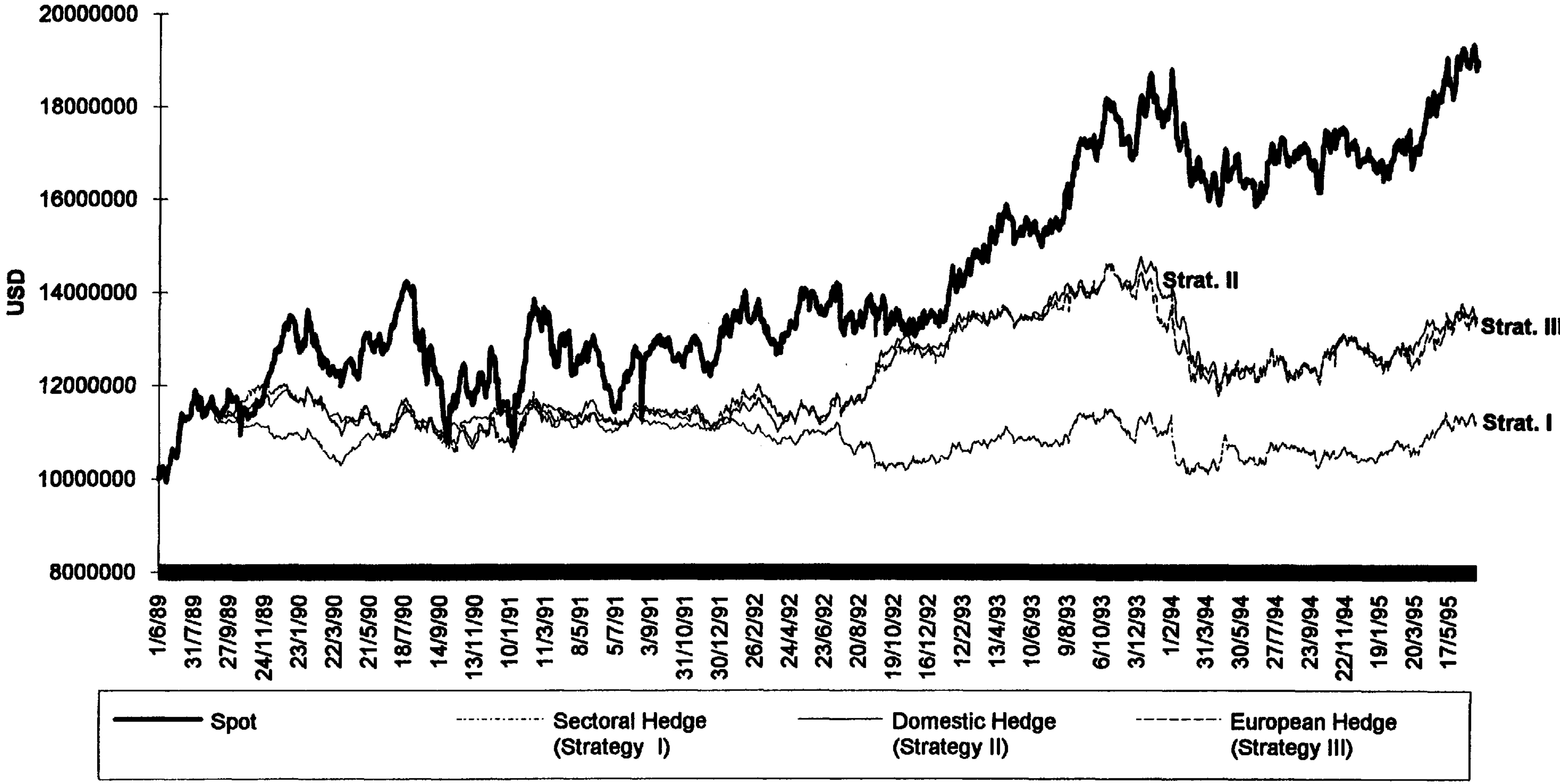

EXHIBIT 12
VALUE OF SPOT AND HEDGED EUROPEAN CHEMICALS PORTFOLIOS

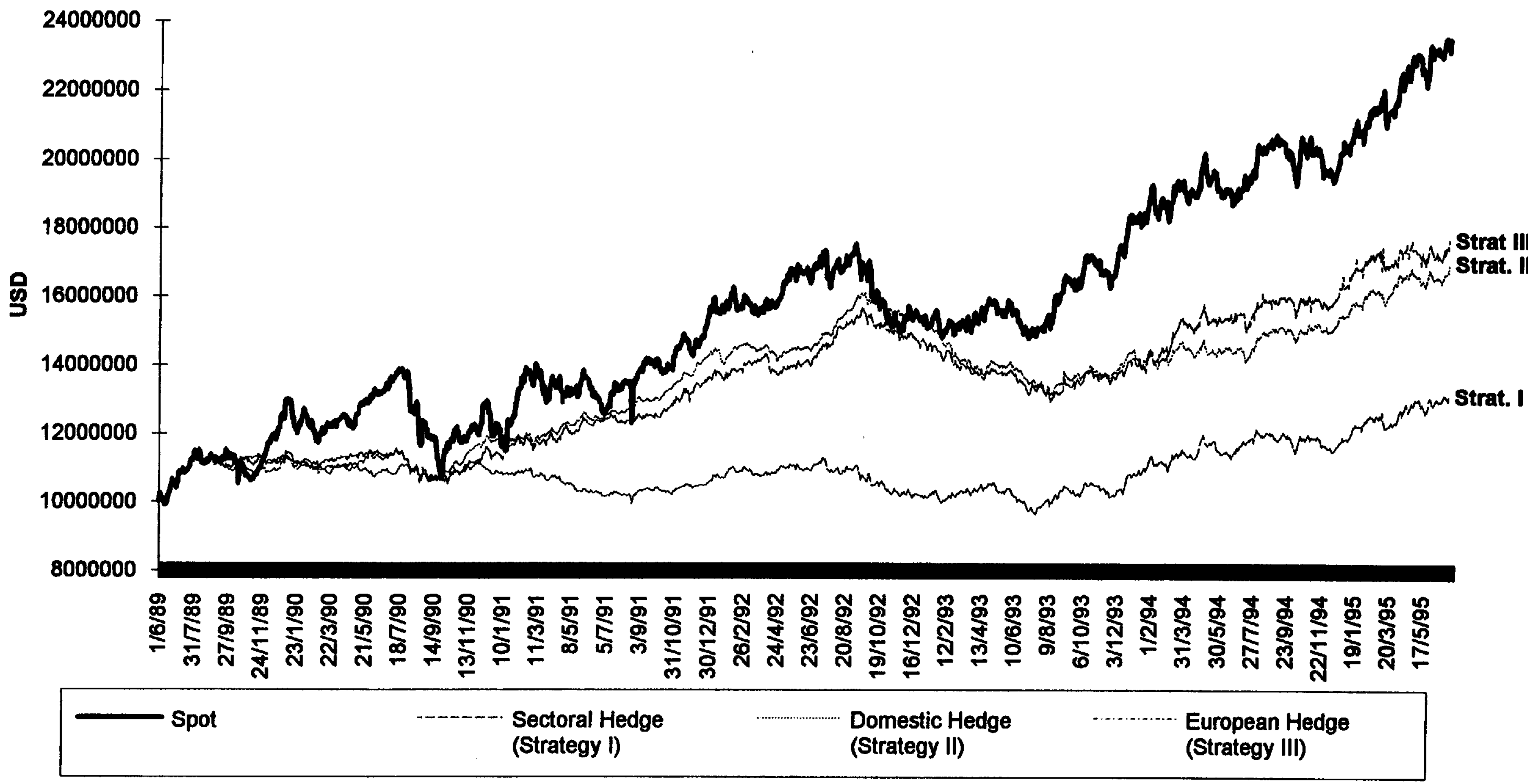

EXHIBIT 13
VALUE OF SPOT AND HEDGED EUROPEAN OIL PORTFOLIOS

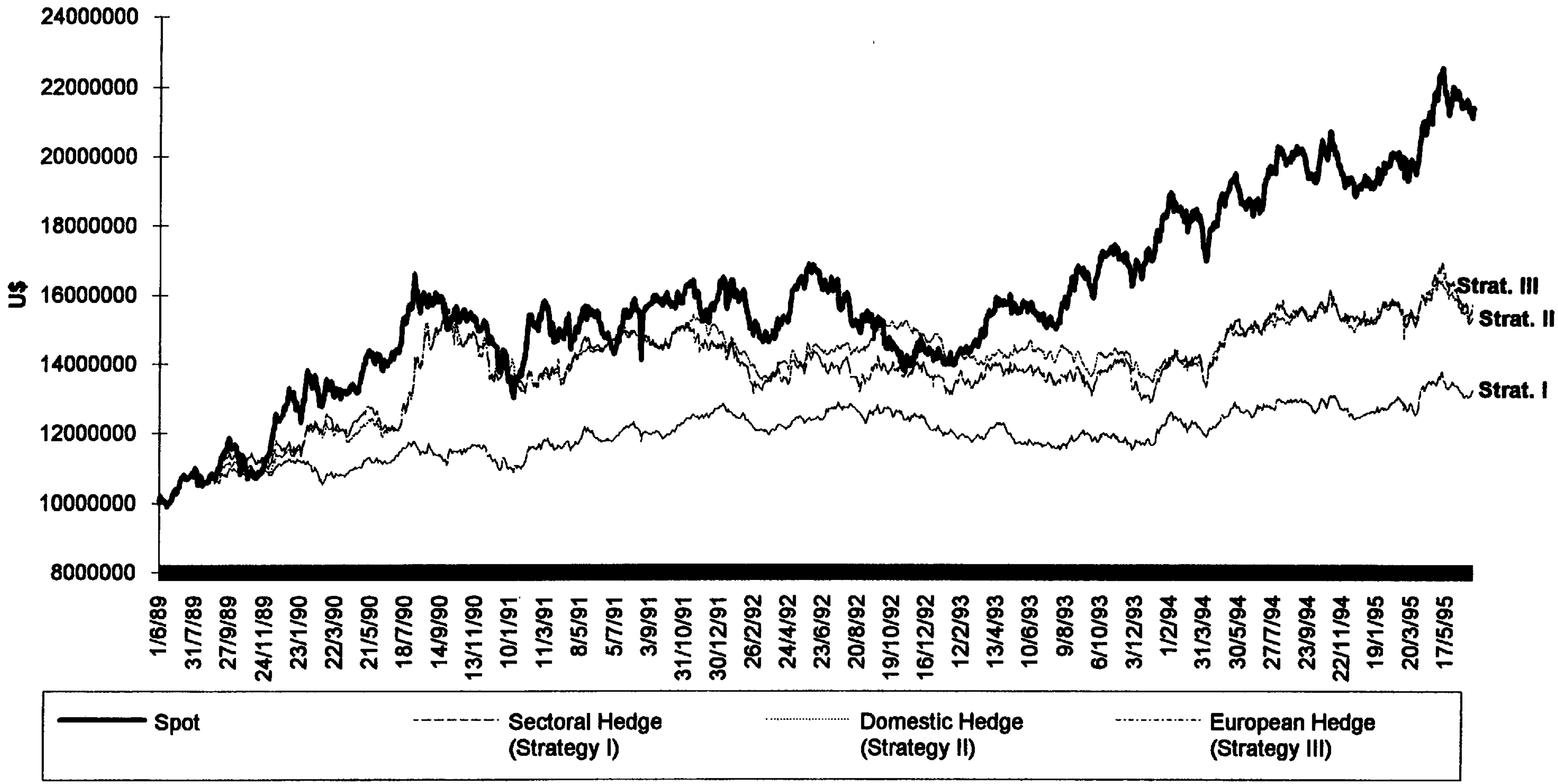

EXHIBIT 14
VALUE OF SPOT AND HEDGED EUROPEAN RETAIL PORTFOLIOS