Managing cash flow in sector portfolios: A hedging approach

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Practical applications

The hedging approach outlined in this paper can be used to deal with short-term cash flows in sector portfolios. There are two alternatives that a portfolio manager can use: (1) hedge with futures and/or (2) hedge with sector-based exchange-traded funds (ETFs). Neither of these approaches is a perfect solution but each has its own merits. The principal advantages of futures are their liquidity and the fact that they can be traded after hours through GLOBEX. Suppose, for example, that a portfolio manager wishes to use S&P 500 and Nasdaq-100 futures contracts. If there are net flows into the fund, the manager can go long the futures contracts, and gradually invest the actual underlying securities over the next day while simultaneously closing out the corresponding futures position. Conversely, if there are net outflows from the fund, the manager can short the futures instead of immediately liquidating some of his portfolio holdings. The beta for each hedge can be computed using a rolling regression of daily returns of the fund against the two contracts. If there are leverage constraints, the manager may instead run a constrained regression as discussed in the paper. Although using a futures hedge is not perfect, it still reduces daily tracking error for most sector portfolios versus holding cash.

Alternatively, a manager can use ETFs to adjust exposure, given some short-term fund flows. Suppose, for example, that one is managing a technology-related fund. Then, one may wish to use a combination of the technology ETFs to manage flows. That is, go long the ETF if there are net inflows, and short the ETF if there are net outflows. For the

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hedge, the manager can compute betas on a set of ETFs that he/she thinks most closely track the fund, or simply use a beta of 1 for convenience. The principal disadvantage of ETFs is that they trade only during regular hours, so, unlike futures, they cannot be traded after the market close. Another drawback is that some of the ETFs have large spreads. For this reason, ETFs may not work as well as futures to reduce daily tracking error stemming from large cash flows, even where the ETF's composition is similar to the fund. The author recommends using futures for daily hedges — where the hedge is closed out within the next day — and using ETFs for longer-term hedges. If the manager has the option of adjusting the exposure over a period of many days rather than just one day, he/she can invest in ETFs and slowly adjust the portfolio as needed. In that case, ETF spreads become less problematic.

Abstract

This paper looks at hedging from the perspective of a quantitative equity portfolio manager facing relatively large cash flows into or out of a fund which seeks to match the performance of a particular sector or industry. It examines two alternatives in managing market exposure for funds with relatively large cash flows: (1) using index futures and (2) using sector-based exchange-traded funds (ETFs). It is found that hedging with futures overnight is better than holding cash, and that dynamic hedging with several futures is better than hedging an equal amount of one futures contract. Hedging sector funds with ETFs overnight works well for the energy and utility sectors, but not as well as futures for most of the other sectors studied.

INTRODUCTION

Turnover presents a challenge for a quantitative equity portfolio manager seeking to track the performance of some benchmark. For the typical fund, daily flows are small relative to the fund's assets and, frequently, new contributions will offset fund redemptions. For such a fund, net inflows can be temporarily invested in a money market fund without adversely affecting tracking error. Conversely, small redemptions can be met out of the fund's cash buffer, in which case the manager does not have to liquidate any stocks.

However, for mutual funds with large net flows that occur near the end of the trading day, and are frequently much larger relative to assets, such flows will impose additional constraints on the fund manager. For these types of funds, portfolio managers do not have the option of holding cash without affecting tracking error, especially in an environment of low interest rates. If outflows are large, the manager cannot rely on just cash to meet redemptions and may be forced to liquidate some of the portfolio. This, of course, can be particularly problematic if there is low liquidity or if spreads are wider in some of the stocks. In such cases, the manager might be better off adjusting exposure in two ways: (1) by equitising cash with index futures and/or (2) purchasing an exchange-traded fund (ETF) that invests in the same sector(s) as the fund. The latter alternative has recently become a more feasible solution for many funds since the Securities and Exchange Commission (SEC) lifted some restrictions on ETF ownership.[1] Even with the wide availability of sector-specific ETFs, however, a manager might still use futures, as futures have three distinct advantages: futures are more liquid in normal trading hours, futures can be traded after hours and, finally, have the added tax benefit in that gains are treated partly as long-term gains (60 per cent) and partly as short-term gains (40 per cent).

This paper looks at each of these two alternatives as a way to hedge market exposure to a particular sector. Optimal hedge ratios are constructed based on four index contracts — the S&P 500, Nasdaq-100, S&P MidCap 400 and Russell 2000 index futures. It is shown that, even though hedging is not perfect for some sectors, both futures and ETFs reduce tracking error compared with an unhedged position.

The rest of the paper is organised as follows. The next two sections describe the data and methodology used to hedge sector returns with both futures and ETFs, the fourth section discusses the results of the analysis, the fifth section reviews the practical applications of this hedging approach and the final section concludes.

Hedging ratios are determined for 17 sector indexes shown in Table 1. Hedging ratios are computed using exchange-traded index futures contracts and sector ETFs.

Daily returns are computed for each sector benchmark and for each ETF from the market close to the market close of the following trading session, including dividends. Table 2 lists some return statistics for all the sector benchmarks. Returns for each of the index futures are based on the nearest-to-expiration futures contract.[2] In each case, the author uses an index of the nearest-to-expiration contract for each index, as this is the most liquid contract. Index data dates from 10th April, 1996 — the introduction of the Nasdaq-100 futures contract — to 31st December, 2003.

HEDGING METHODOLOGY

Hedge construction

The paper first looks at futures as a way of mimicking sector index returns. The four instuments that are used are the S&P 500, the S&P MidCap 400, the Nasdaq-100 and the Russell 2000 futures contract. Mutual

Table 1: Sector benchmarks

1	Banks	Philadelphia Stock Exchange Bank Index
2	Basic materials	S&P 500 Materials
3	Biotechnology	NASDAQ Biotechnology Index
4	Commodities	Goldman Sachs Commodity Index
5	Consumer discretionary	S&P 500 Consumer Discretionary
6	Consumer staples	S&P 500 Consumer Staples
7	Energy	DJ US Energy
8	Financial	S&P 500 Financial
9	Healthcare	S&P 500 Health Care
10	Industrial	S&P 500 Industrial
11	Insurance	NASDAQ Insurance Index
12	Internet	Inter@ctive Week Internet Index
13	Precious metals	Philadelphia Stock Exchange Gold & Silver Index
14	Real estate	DJ US Real Estate
15	Technology	DJ US Technology
16	Telecommunications	DJ US Telecomms
17	Utilities	DJ US Utilities

fund rules do not place any trading or holding restrictions on these contracts, so managers can freely use futures in doing this kind of hedge. One advantage of using index futures versus ETFs is that futures are often more liquid. Another advantage is that futures can be used in after-hours trading.[3] For example, if there is a large inflow or outflow from the fund near the end of the trading day, a manager can still reposition the portfolio by trading futures after the close of the equity market. The downside of these contracts, as Table 3 shows, is that none of these broad indexes will be perfectly correlated with the various sectors.

For example, it is almost impossible to do a cross-hedge for the precious metals using any of the futures owing to the low correlation of gold with the broad market indexes. For sectors such as finance, technology, and consumer discretionary, which comprise a large portion of the underlying indexes, however, the correlations are much higher, so the manager can at least do a partial hedge.

Consequently, the problem for the fund's manager is which futures contract, or combination of contracts, to use to mimic the return of a sector index as he/she manages cash flows. The minimum variance hedge ratio ($\beta^\star$) can be computed using a

Table 2: Return statistics for sector indexes, percentage points[a]

Sector index	*Mean*	*Standard deviation*	*Annualised volatility*	*Minimum*	*Maximum*
Banks	0.06	1.78	28.21	−7.53	9.18
Basic materials	0.03	1.45	22.91	−7.73	7.23
Biotechnology	0.08	2.45	38.70	−12.53	10.56
Commodities	0.03	1.27	20.16	−8.73	5.17
Consumer discretionary	0.05	1.44	22.79	−8.21	8.84
Consumer staples	0.03	1.14	18.09	−8.88	7.88
Energy	0.04	1.49	23.52	−6.78	8.24
Financial	0.06	1.64	25.96	−7.73	8.75
Healthcare	0.05	1.44	22.77	−8.77	7.96
Industrial	0.04	1.36	21.55	−7.04	7.47
Insurance	0.05	1.05	16.56	−4.38	5.51
Internet	0.08	2.94	46.56	−13.19	21.07
Precious metals	0.02	2.64	41.70	−12.8	21.07
Real estate	0.03	0.78	12.37	−5.07	4.82
Technology	0.07	2.45	38.74	−9.74	17.63
Telecommunications	0	1.68	26.62	−9.9	8.28
Utilities	0.01	1.16	18.31	−7.77	8.11

[a]Based on daily returns from 11th April, 1996 to 31st December, 2003.

least squares regression:

$$\beta\star = \frac{\mathrm{Cov}(R_{\mathrm{Sector}}, R_{\mathrm{Futures}})}{\mathrm{Var}(R_{\mathrm{Futures}})} \tag{1}$$

where R_{Sector} and R_{Futures} are the returns of the sector and the futures index, respectively.[4]

One first determines in-sample factor exposures over the entire period, employing three methodologies to construct an optimal hedge ratio.

First, one runs a regression that includes all four of the futures contracts:

$$r_{\mathrm{Sector},t} = \alpha + \beta_{\mathrm{SPX}} r_{\mathrm{SPX},t} + \beta_{\mathrm{NDX}} r_{\mathrm{NDX},t} + \beta_{\mathrm{MID}} r_{\mathrm{MID},t} + \beta_{\mathrm{RUS}} r_{\mathrm{RUS},t} + \varepsilon_t \tag{2}$$

There are no leverage restrictions. This will be referred to as the Unconstrained Model.

Table 3: Correlation between futures contracts and sectors[a]

Futures contract	*SPX*	*NDX*	*RUS*	*MID*
SPX	1			
NDX	0.81	1		
RUS	0.80	0.81	1	
MID	0.87	0.82	0.91	1
Sector benchmarks				
Banks	0.79	0.53	0.58	0.66
Basic materials	0.61	0.36	0.47	0.54
Biotechnology	0.63	0.67	0.71	0.71
Commodities	–0.01	0.01	0.03	0.04
Consumer discretionary	0.84	0.65	0.68	0.74
Consumer staples	0.59	0.26	0.33	0.41
Energy	0.47	0.24	0.37	0.47
Financial	0.83	0.56	0.62	0.71
Healthcare	0.67	0.39	0.44	0.52
Industrial	0.86	0.65	0.69	0.76
Insurance	0.64	0.48	0.62	0.64
Internet	0.74	0.91	0.76	0.75
Precious metals	0.01	–0.03	0.02	0.03
Real estate	0.50	0.36	0.53	0.55
Technology	0.79	0.95	0.78	0.79
Telecommunications	0.68	0.55	0.54	0.57
Utilities	0.44	0.22	0.34	0.42

[a]Futures contracts are SPX, NDX, RUS and MID for S&P 500, Nasdaq-100, Russell 2000 and S&P 400 Midcap respectively. Correlations are computed using daily returns for each sector index daily returns of each futures contract using the nearest-to-expiration futures contract price. Correlations are computed based on daily returns from 11th April, 1996 to 31st December, 2003.

Secondly, one runs a least squares regression that includes only a single contract

$$r_{\text{Sector},t} = \alpha + \beta r_{\text{Futures},t} + \varepsilon_t \tag{3}$$

where $r_{\text{Sector},t}$ is the return of a particular sector, and $r_{\text{Futures},t}$ is the return of a given futures, contract. Returns are calculated over a one-day horizon from close of trading to the close of the following trading session. There are no short-sale constraints on futures, and weights need not sum to 100 per cent.

The contracts used in this hedge are the S&P 500, the Nasdaq-100, the Russell or the S&P Midcap, depending on which of these contracts provides the best fit (as measured by R^2). Typically, the S&P 500 and Nasdaq-100 contracts are much more liquid than the MidCap and Russell contracts, so from a liquidity standpoint there is a clear benefit to using one (or both) of the more liquid contracts rather than all four contracts. This is referred to as the Single Contract Model. Such a model will be more applicable if the portfolio manager wishes to utilise only one of the two more liquid futures contracts.

Lastly, hedging ratios are calculated using all four futures contracts, with the restriction that there is no short selling and that the coefficients sum to 100 per cent (ie $\beta_j = 0$ and $\Sigma_{j=1}^{N}\beta_j = 1$). This model, which the author refers to as the Constrained Model, will be applicable in cases where the manager does not wish to short. This is essentially style analysis on each sector, using the futures contracts to represent the possible styles. One attempts to find the coefficients β_i that minimise tracking error. Thus,

$$\min_{\beta_i} \sigma_{xr}^2 = \min_{\beta_i} \left(\sum_{i=1}^{N+1} \beta_i^2 \sigma_i^2 + \sum_{i,j=1;i\neq j}^{N+1} 2\beta_i\beta_j \mathrm{Cov}(X_iX_j) \right) \tag{4}$$

and

$$s.t. \mu_{xr} = \sum_{i=1}^{N+1} \beta_i \mu_i = 0 \tag{5}$$

where there are N hedging instruments plus one extra asset class known as the 'sector' benchmark; β_i represents the weight of the portfolio given to hedging instrument i; the weight given to the sector index is constrained to be equal to -1; and where $\mathrm{Cov}(X_iX_j)$ is the covariance between hedging instruments i and j (sector benchmark included).[5] In computing ETF hedge ratios, one takes the four ETFs that are most correlated with the sector index and regresses these against the sector to find the 'optimal' hedge ratio.

A 30-day lookback period is used to create the dynamic hedge ratios. The reason for the 30-day lookback is to create a dynamic hedging strategy that continuously adjusts to shifts in the hedge ratio.[6] One can also consider other periods, such as 60-, 90- and 240-day periods to create the hedges.

Evaluating the effectiveness of the hedge

Given the hedge ratios from the various techniques described above — the

Unconstrained Model, Single Contract Model and Constrained Model — some metrics are needed to evaluate the effectiveness of the hedge.

The author examines the effectiveness of a minimum variance hedge ratio by applying the hedge ratios over the next business day and lifting the hedge at that day's close.

To evaluate the hedge, the mean absolute error (MAE) is used, which measures the absolute deviation of the hedged position from the index on any given day. Thus, for every day, is computed the absolute error is computed as:

$$AE = |R_{H,t} - R_{S,t}| \tag{6}$$

where $R_{H,t}$ represents the return of the hedged portfolio on day t based upon the estimated hedging parameters of the previous day, and $R_{S,t}$ represents the return of the sector index on day t. The MAE is the mean over all days.

Because there are days when there are extreme movements in a sector, one also looks at median absolute error and the worst day absolute error. One uses the absolute error, since the trader or portfolio manager is more concerned with having the cash mimic the sector than outperformance. Thus, any deviation from the sector index is considered 'bad' from a managing cash flow perspective.

The different hedge methodologies are compared against two alternatives: (1) not hedging and (2) a 'naïve' approach, where the manager simply uses one unit of a futures contract (similar to the Single Regression Model but with an implicit hedge ratio of one). For the first alternative, one assumes that when there are inflows the manager holds cash overnight and will wait for up to a day to add to his/her positions. Of course, when there are significant outflows, this 'do nothing' approach is not feasible, as the manager must sell some of his/her holdings to meet redemptions.

When there are large outflows from the fund, this is a more important reason for using futures to hedge rather than selling some of the holdings. The results of these hedging techniques are discussed in the next section of the paper.

EMPIRICAL RESULTS

Hedging with futures

Table 4 shows the in-sample results of the unconstrained regressions over the entire period. Technology, internet and industrial related sectors fit best with the four futures contracts, with sectors such as precious metals and commodities seemingly the least amenable to futures hedging.

In most cases, the S&P 500 futures contract explains most of the variation in sector returns. The table also shows the results of a single contract regression — for each sector the one contract with the most explanatory power was chosen. The table

Table 4: In-sample estimation of hedging parameters[a]

Sector	Unconstrained regression α	β_{SPX}	β_{NDX}	β_{RUS}	β_{MID}	$\bar{R}^2$	Best futures contract Contract	α	β	$\bar{R}^2$
Banks	0.00	1.40	−0.25	−0.09	0.17	0.66	SPX	0.00	1.08	0.62
	0.85	26.22	−9.51	−1.50	2.20			0.73	43.13	
Basic materials	0.00	0.87	−0.28	−0.04	0.31	0.44	SPX	0.00	0.68	0.38
	−0.15	15.98	−11.52	−0.62	3.78			−0.04	26.13	
Biotechnology	0.00	−0.16	0.23	0.48	0.62	0.54	MID	0.00	1.31	0.51
	0.31	−2.04	6.08	4.45	5.37			0.03	33.98	
Commodities	0.00	−0.20	0.00	−0.05	0.26	0.01	MID	0.00	0.04	0.00
	0.67	−3.83	0.06	−0.90	3.81			0.78	1.47	
Consumer discretionary	0.00	0.99	−0.09	0.06	0.03	0.72	SPX	0.00	0.93	0.71
	0.87	25.92	−3.90	1.41	0.56			0.83	53.79	
Consumer staples	0.00	1.06	−0.27	−0.09	−0.06	0.50	SPX	0.00	0.52	0.35
	1.07	24.31	−11.08	−1.58	−0.85			0.55	18.77	
Energy	0.00	0.57	−0.33	−0.15	0.68	0.33	SPX	0.00	0.54	0.22
	0.33	8.60	−11.22	−2.19	8.19			0.63	16.62	
Financial	0.00	1.31	−0.24	−0.09	0.20	0.73	SPX	0.00	1.05	0.69
	1.10	28.28	−10.48	−1.81	3.18			0.99	50.00	
Healthcare	0.00	1.18	−0.24	−0.10	0.03	0.52	SPX	0.00	0.74	0.45
	1.17	23.89	−9.60	−1.94	0.42			0.89	26.11	
Industrial	0.00	0.98	−0.12	0.03	0.09	0.76	SPX	0.00	0.90	0.75
	0.49	29.94	−7.13	0.98	1.87			0.48	58.44	
Insurance	0.00	0.38	−0.14	0.22	0.17	0.47	SPX	0.00	0.51	0.41
	1.44	9.62	−8.51	5.34	2.83			1.47	27.59	
Internet	0.00	−0.06	1.05	0.29	−0.17	0.83	NDX	0.00	1.08	0.83
	−0.06	−1.20	34.88	4.18	−1.87			−0.21	67.78	
Precious metals	0.00	−0.01	−0.16	0.08	0.24	0.01	SPX	0.00	0.02	0.00
	0.23	−0.10	−3.35	0.65	1.44			0.28	0.25	
Real estate	0.00	0.15	−0.13	0.18	0.21	0.35	MID	0.00	0.32	0.30
	0.66	5.43	−9.31	5.39	4.97			0.41	19.73	
Technology	0.00	0.06	0.90	0.09	−0.06	0.90	NDX	0.00	0.94	0.90
	−0.36	1.76	45.93	2.71	−1.32			−0.45	85.16	
Telecommunications	0.00	1.00	−0.01	0.13	−0.26	0.47	SPX	0.00	0.88	0.46
	−0.92	19.10	−0.25	2.21	−3.58			−1.12	32.38	
Utilities	0.00	0.47	−0.24	−0.06	0.38	0.28	SPX	0.00	0.39	0.19
	−0.25	10.03	−9.17	−1.21	5.82			−0.04	13.38	

[a]Estimated using daily return data from 11th April, 1996 to 31st December, 2003. Best futures contract was selected on the basis of in-sample R^2. t statistics are presented directly underneath the parameters estimates.

Table 5: Hedge parameters with leverage constraints[a]

Sector	β_{SPX}	β_{NDX}	β_{RUS}	β_{MID}	*MAE*	R^2
Banks	100	0	0	0	80	0.62
Basic materials	82.51	0	0	17.49	86	0.30
Biotechnology	0	29.13	41.99	28.88	122	0.53
Commodities	36.66	0	1.94	61.41	136	-0.96
Consumer discretionary	96.23	0	0.55	3.22	58	0.71
Consumer staples	100	0	0	0	78	0.05
Energy	55.24	0	0	44.76	103	0.10
Financial	100	0	0	0	66	0.69
Healthcare	100	0	0	0	80	0.39
Industrial	93.61	0	0	6.39	50	0.74
Insurance	53.37	0	17.07	29.56	72	0.14
Internet	0	100	0	0	91	0.83
Precious metals	41.60	0	4.45	53.95	221	-0.21
Real estate	43.61	0	14.32	42.07	81	-0.88
Technology	4.23	89.44	6.32	0	55	0.90
Telecommunications	98.55	0	1.45	0	90	0.45
Utilities	62.17	0	0	37.83	94	-0.23

[a]In-sample estimates using data over the entire period from 11th April, 1996, to 31st December, 2003, with the constraint that there is no shorting and that the weights sum to 1 ($\beta_{j\geq 0}$ and $\Sigma_{j=1}^{N}\beta_j = 1$).

can be interpreted as follows. For a sector portfolio manager indexed to the S&P 500 Financial Index, he/she should go long 1.31 dollars the S&P 500 future, short 0.24 dollars the Nasdaq-100 future, short 0.09 dollars the Russell futures and long 0.20 dollars the S&P Midcap futures for every dollar of sector cash flow he/she wishes to hedge. The other sectors can be interpreted similarly by reading the table of estimated coefficients. Explanatory power is not significantly affected by switching to only one contract so, given the liquidity advantages of both the S&P 500 and Nasdaq-100 futures, using only one futures contract may be just as good.

Table 5 shows the results of the Constrained Model with leverage restrictions, where hedging parameters are estimated over the entire sample period. For example, the table shows that the optimal weights in tracking the technology sector are 89.44 per cent Nasdaq-100, 4.23 per cent S&P 500 and 6.32 per cent Russell. It appears that, for most sectors, the S&P 500 comes in more strongly. Surprisingly, the MidCap and the Russell futures also account for much of the variation in this model. For example, the data suggest that an approximately equal split among Nasdaq, Russell and MidCap futures can be used to mimic the Nasdaq Biotech index. The table also shows the in-sample MAE for each sector. One can see it does worse than the unconstrained hedging methods. The R^2 is computed by dividing the variance of the errors from the model by the total variance of the sector. In some cases, the R^2 is negative owing to the optimal constrained model being so poor that the hedging actually increases rather than decreases the variance of the portfolio.

Table 6 compares the performance of the Unconstrained Model using all four contracts, to the performance of the Single Contract dynamic hedge using only 'the best' futures contract, but this time the hedge is evaluated out-of-sample. The best futures contract was chosen by picking the future that had the highest R^2 in-sample. For the most part, the results are similar. The Single Contract Model does better for many sectors, but this is in part due to the choosing of the best contract ex-post. In many cases, the difference is not large.

Since the differences between the Unconstrained Model using four contracts and the Single Contract Model are not that large, the author focuses on the latter mechanism, as it is easier to implement for portfolio managers. Table 7 shows the out-of-sample tracking error for three hedging strategies: (1) a dynamic hedge, where the parameters are adjusted daily based on a 30-day rolling regression; (2) a 'naïve' hedge where the portfolio manager simply purchases one unit of the futures (thus using a hedge ratio of 1); and (3) a no-hedge strategy whereby the manager stays invested in cash. The hedge is evaluated over a period of one day using one futures contract.[7] The author also includes the median AE since some large jumps in the sector returns might distort the overall picture.

The last two columns show that, with the exception of the precious metals, commodities, utilities, insurance and real estate sectors, which are very difficult to hedge using equity futures, even a naïve strategy reduces daily tracking error. For example, a naïve hedge strategy of buying one unit of the S&P futures contract reduces tracking error by 25 basis points (bps) for the healthcare sector versus an unhedged position, another 4 bps reduction is achieved by implementing a dynamic hedge. This represents a 30 per cent and 35 per cent reduction in median AE respectively. Thus, most of the gains come from a simple hedge, and it appears that dynamic hedging over such a short period

Table 6: Out-of-sample comparison of an unconstrained four contract hedge versus a single contract hedge[a]

	Unconstrained regression			*Single contract dynamic model*			
Sector	*Mean*	*Median*	*Worst*	*Contract*	*Mean*	*Median*	*Worst*
Banks	82	60	644	SPX	81	57	632
Basic materials	82	60	677	SPX	81	57	726
Biotechnology	128	96	1308	MID	125	94	884
Commodities	104	80	875	MID	98	76	933
Consumer discretionary	58	43	753	SPX	56	43	617
Consumer staples	60	44	644	SPX	63	47	722
Energy	96	72	1140	SPX	96	72	1076
Financial	67	50	537	SPX	67	49	529
Healthcare	76	56	538	SPX	74	54	573
Industrial	51	37	440	SPX	50	36	501
Insurance	58	42	475	SPX	58	41	468
Internet	93	72	858	NDX	90	67	763
Precious metals	213	167	1997	SPX	201	159	2134
Real estate	48	35	470	MID	46	34	519
Technology	57	42	448	NDX	55	41	471
Telecommunications	96	71	770	SPX	90	66	723
Utilities	72	47	641	SPX	72	50	644

Note: [a]Parameters for the dynamic hedge strategy are estimated using the futures contract shown for each sector over a 30–day period, and then applying the hedge until the close of the following trading session. The naïve strategy assumes that the manager purchases one unit of futures, and the cash/no hedge strategy shows the tracking error when no hedge is used. The mean absolute error is the difference of the hedged return less the actual return of the sector average over all days in the sample. Table shows mean, median and worst day tracking error in basis points. The mean is skewed by days when there were large jumps in the sector. The last two columns show the reduction in median error in basis points of (1) naïve hedge over cash and (2) dynamic over naïve hedge. Estimated using daily returns data from 11th April, 1996, to 31st December, 2003.

Table 7: Out-of-sample hedge using one futures contract[a] versus no hedge

		Dynamic hedge			Naïve hedge			Cash/no hedge			Reduction in median AE	
Sector	Contract	Mean	Median	Worst	Mean	Median	Worst	Mean	Median	Worst	Naïve/ cash	Dynamic/ naïve
Banks	SPX	81	57	632	80	57	649	133	102	918	45	1
Basic materials	SPX	81	57	726	87	62	724	107	81	773	19	5
Biotechnology	MID	125	94	884	129	95	1006	179	131	1253	36	1
Commodities	MID	98	76	933	138	107	1133	96	74	873	−33	31
Consumer discretionary	SPX	56	43	617	58	45	472	106	81	884	36	2
Consumer staples	SPX	63	47	722	78	55	921	84	65	888	10	8
Energy	SPX	96	72	1076	106	81	1134	113	89	824	9	8
Financial	SPX	67	49	529	66	48	534	123	95	875	46	−1
Healthcare	SPX	74	54	573	80	57	824	107	82	877	25	4
Industrial	SPX	50	36	501	51	38	549	101	78	747	41	1
Insurance	SPX	58	41	468	77	59	616	76	56	551	-2	17
Internet	NDX	90	67	763	92	68	816	221	173	2107	104	2
Precious metals	SPX	201	159	2134	223	178	2048	197	156	2107	−22	18
Real estate	MID	46	34	519	85	67	630	56	41	507	−26	33
Technology	NDX	55	41	471	56	41	563	183	143	1763	102	0
Telecommunications	SPX	90	66	723	91	68	740	124	96	990	28	2
Utilities	SPX	72	50	644	96	72	920	81	58	811	−14	22

Note: [a]See notes to Table 6.

of time produces only a marginal reduction in tracking error.

Overall, however, a dynamic hedge saves another 9 bps per day (average median AE across all sectors) than the simple or naïve hedge.

For the Constrained Model, the author computed the coefficients and resulting sample statistics from the in-sample estimation. Using these coefficients, he computed the MAE for each sector (see Table 5).

Technology, for example, experienced 55 bps daily MAE similar to the dynamic hedge, but most of the sectors experienced MAE greater than the dynamic hedge, suggesting that hedging is worse under these leverage constraints.

Hedging with ETFs

Owing to the exemptive relief obtained from the SEC, ETFs can now be held in large proportions in a managed portfolio. One would naturally think that the sector ETFs may offer a better hedging tool for cash flows than the exchange-traded futures contracts. Even ETFs based on the sector as the benchmark, however, like the Nasdaq Biotechnology Index and the Nasdaq Biotechnology Index Fund, can have relatively high absolute errors on any given day. The author ran the dynamic hedge using the four most correlated ETFs with each sector. The results are presented in Table 8.

Unfortunately, the results from ETF hedging are not as encouraging as one might expect. In 14 of the 17 sectors, dynamic ETF hedging actually does worse than using the Unconstrained Model with futures. In some cases, such as the internet and technology portfolios, it does as much as 65 and 68 bps worse on average per day.

In the utilities sectors, the use of the ETF does significantly reduce the daily median AE by as much as 40.

The results seem very counterintuitive. One would think that daily hedging using the ETFs would dramatically reduce the daily MAE. The author did not examine the sources of the large MAEs in detail, but he thinks that they could come from two sources. One source is the extent to which the ETF and the index are not similar (eg using the Technology Select Sector SPDR to hedge the Inter@ctive Week Internet Index). The second source could be the bid-ask spreads of the ETFs. Given that the spreads are wide, and are being used using closing prices, half the spread may be lost on average from daily hedging. The spreads for the ETFs are listed in the last column of Table 8.[8] The spread listed is for the first of the four ETFs used to hedge each sector. Spreads can be as high as 96 bps for telecommunications. Some of the ETFs that are not listed have even higher spreads. It also seems that sectors with lower volatility and an ETF that matches the sector more appropriately have lower MAEs. Also, where futures did a very poor job of matching, as evidenced by a low $\overline{R}^2$, such

Table 8: Out-of-sample comparison of ETF hedge versus Unconstrained Model[a]

	Unconstrained Model				*ETFs used*				
Sector	*Mean*	*Median*	*Worst*		*Mean*	*Median*	*Worst*	*Reduction in median AE*	*Spread*
Banks	53	43	442	XLF,IYF,IYG,XLI	31	23	176	19	43
Basic materials	70	54	515	XLB,IYM,XLI,IYJ	80	62	581	–7	29
Biotechnology	124	103	903	IBB,IYH,XLV,IYJ	151	117	1033	–14	36
Commodities	114	84	875	IYE,XLE,IDU,IBB	116	90	962	–5	50
Consumer discretionary	60	44	1074	IYC,XLY,XLI,IYJ	73	58	1077	–14	43
Consumer staples	53	38	1040	IYK,XLP,IYH,XLF	61	45	1052	–7	49
Energy	85	62	557	XLE,IYE,IYJ,XLI	89	64	546	–2	89
Financial	44	32	304	XLF,IYF,IYG,XLI	17	13	119	19	43
Healthcare	64	49	444	IYH,XLV,XLP,IBB	73	55	526	–6	40
Industrial	45	33	440	XLI,IYJ,XLF,IYF	61	44	392	–11	92
Insurance	46	38	307	XLF,IYF,IYG,XLI	49	38	241	–1	43
Internet	79	57	464	XLK,IYW,IGM,MTK	161	122	1137	–65	58
Precious metals	198	159	1170	IYE,XLE,XLB,XLU	207	180	1650	–21	50
Real estate	52	39	362	IYR,ICF,IYF,XLF	57	46	355	–7	38
Technology	53	40	336	XLK,IYW,IYJ,IYC	138	108	937	–68	58
Telecommunications	104	74	770	IYZ,XLK,XLF,XLI	101	75	956	–1	96
Utilities	84	58	641	IDU,XLU,IYF,XLF	24	18	161	40	65

Notes:
[a]Estimated using daily return data from 20th March, 2001 to 3rd March, 2004.

as energy and utilities, the ETF hedge was more effective (see Table 4). For instance, the utilities sector is managed to the Dow Jones US Utility Index and the corresponding ETF is the iShares Dow Jones US Utilities Sector Index fund. This ETF did substantially improve the hedging performance over the futures hedging.

Although the author is not entirely sure of the reasons for the large MAE using ETFs, it can be concluded that for the energy and utility sectors studied, fund managers can hedge more effectively using ETFs than using futures contracts. It should also be noted that the author is concerned with hedging over one business day. Presumably, over longer periods ETFs will hedge these sectors better because the bid-ask spread is spread over a longer investment horizon.

Finally, portfolio managers with large daily cash flows should consider changing their benchmarks to those represented by the ETFs, thus improving their tracking error when using ETFs for hedging purposes.

Further analysis

Because the hedging ratios were shown to vary through time, the author also evaluated the effectiveness of hedging using 60-day, 90-day and 270-day rolling windows. Out-of-sample results, however, were not greatly affected by the choice of the number of days over which the hedge parameters were estimated. Neither did it make a difference whether the nearest-to-expiration futures contract or the second-nearest expiring contract was used. Given the extra liquidity in the front contract, using the near-term contract is probably more sensible.

Lastly, the author investigated futures as a hedge of overnight exposure. Thus, rather than hedging from the close of the market to the *close* of the following day, the hedge was evaluated from the close to the *open* of the following session. The rationale for looking at this is that, often, a manager will have to trade a basket of securities near or after the market close, such as when there is a large inflow or outflow near the end of the day. A manager may trade futures after the market's close until the opening of the following trading day, when he/she can then purchase the underlying securities. To measure the effectiveness of such a hedging strategy, the author looked at the returns of each sector benchmark from the close of the market to the opening of the next trading session. The author found that, especially for sector indices, the variance of close-to-open prices is so small that it makes the futures hedging strategy less attractive. Lockwood and Linn[9] found that market volatility for the Dow Jones Industrial Average is significantly lower in overnight versus intra-day periods. There is also evidence that opening prices may be skewed by specialist actions, so using opening price data muddies the hedge. Thus, the author concluded that holding

Table 9: Estimation of hedging parameters[a]

Sector	Unconstrained regression					Best futures contract		
	β_{SPX}	β_{NDX}	β_{RUS}	β_{MID}	$\bar{R}^2$	Contract	β	$\bar{R}^2$
Banks	1.49	−0.16	−0.11	−0.08	0.81	SPX	1.03	0.79
Basic materials	0.67	0.07	−0.45	0.95	0.49	SPX	1.16	0.49
Biotechnology	0.77	0.26	0.75	−0.67	0.63	MID	1.12	0.51
Commodities	−0.77	−0.44	−0.13	1.70	0.14	GSCI	0.91	0.95
Consumer discretionary	0.97	0.15	0.15	−0.74	0.38	SPX	0.56	0.31
Consumer staples	0.91	0.11	−0.06	0.15	0.68	SPX	1.13	0.71
Energy	1.02	−0.20	0.04	0.10	0.42	SPX	0.92	0.47
Financial	1.49	−0.13	−0.08	−0.09	0.88	SPX	1.10	0.86
Healthcare	1.71	0.08	−0.15	−0.70	0.62	SPX	0.80	0.44
Industrial	1.52	−0.13	−0.05	−0.26	0.81	SPX	0.97	0.77
Insurance	0.86	−0.24	0.88	−0.93	0.78	SPX	0.80	0.53
Internet	0.09	0.52	0.64	−0.05	0.89	NDX	1.2	0.83
Precious metals	1.12	−1.38	0.07	2.22	0.38	GOLD	1.00	0.34
Real estate	0.89	−0.63	0.94	−0.65	0.49	MID	0.55	0.31
Technology	−0.06	0.77	0.57	−0.24	0.89	NDX	1.16	0.86
Telecommunications	0.83	−0.23	0.48	0.04	0.46	SPX	1.28	0.45
Utilities	0.14	−0.13	0.20	0.20	0.17	SPX	0.48	0.18

[a]Estimated using daily data from 21st January, 2004, to 3rd March, 2004. GOLD represents the 100oz gold futures on the CMX and GCSI represents the Goldman Sachs Commodity Index futures on the CME.

cash is just as effective as trading futures to hedge after the market close to the market open in sector funds.

Two of the sector benchmarks, commodities and precious metals, could not be hedged effectively using the liquid equity futures contracts. Thus, hedging effectiveness was examined using the Goldman Sachs Commodity Index (GSCI) futures for the commodity index and the gold futures contract traded on the CME. Using these futures contracts dramatically improves hedging. For the commodity index, the in-sample R^2 is 0.89, and it reduces the median AE to 16 bps per day. For the precious metals index, the in-sample R^2 is 0.39, and the median AE is reduced to 118 bps. In both cases, there is a significant improvement over using the equity futures contracts. Also, recently, sector futures have been introduced on the CME for financials (SPCTR Financial Future) and technology (SPCTR Technology Future). These futures contracts are relatively very illiquid, but as their liquidity improves, they will most likely provide better hedging possibilities for sector portfolio managers.

Finally, using the last 30 business days at the time of writing (up to 3rd March, 2004), the author presented the appropriate hedge parameters for the chosen sectors in Table 9. These are the most recent estimates for portfolio managers, but the author recommends that portfolio managers run their own estimations using the most recent data.

CONCLUSION

Portfolio managers typically have cash flows due to purchases and redemptions in their mutual funds. Some sector-based funds may have relatively large cash flows relative to their net asset value. These flows may occur near the end of the trading day, increasing the difficulty of purchasing the underlying securities. The author investigated the merits of using exchange-traded futures contracts and ETFs to hedge these cash flows.

It is found that some form of futures hedging is better than none at all in every sector. It is found that an optimal dynamic hedge works better than a naïve hedge of buying an equivalent $1 of the best (most correlated) futures contract available. The author also found that using four futures contracts to find the optimal hedge (Unconstrained Model) is the best recommendation for portfolio managers, although a portfolio manager will not lose much in terms of daily basis points by using just a single futures contract to hedge the sector. The author found that ETFs — at least for a one-day hedge — are not such good hedges as one would expect. They work better for hedging only certain indices, such as energy and utilities. For hedging over one day, the ETF spread may significantly reduce the effectiveness of the hedge. Thus, even though managers can now freely use ETFs to hedge exposure under the new SEC rules, index futures should still play a part in a quantitative portfolio manager's toolkit.

Note

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References and notes

1 The SEC recently provided exemptive relief to Barclays iSHARES from s. 12d-1 of the Investment Company Act of 1940, removing the percentage restriction that mutual funds had for ownership of ETFs in their investment portfolio.
2 Although results are similar when the second-nearest futures contract is used in place of the nearest-to-expiration contract, in practice it will be preferable to use the nearest-to-expiration contract, since that is where most liquidity is concentrated. All data were obtained from Bloomberg.
3 Futures contracts can be traded up to 4:15pm and again after 4:45pm US Eastern Standard Time through GLOBEX.
4 Johnson, L. L. (1960) 'The Theory of Hedging and Speculation in Commodity Futures', *Review of Economics Studies*, Vol. 27, No. 3, pp. 139–151.
5 This is essentially a zero cost investment.
6 Hedge ratios were shown to vary significantly in some cases. In another study, Malliaris and Urrutia found that using index futures contracts results in unstable hedge ratios, which suggests that there is benefit to such a dynamic hedge strategy (Malliaris, A. G. and Urrutia, J. (1991) 'Tests of the Random Walk of Hedge Ratios and Measures of Hedging Effectiveness for Stock Indexes and Foreign Currencies', *Journal of Futures Markets*, Vol. 11, pp. 55–68). These hedge ratios are then applied on a data out-of-sample estimation period.
7 The results are similar when all four futures contracts are used. Thus, it may be easier to use a less complicated strategy of buying the most liquid contract, rather than combining all four contracts.
8 The spreads were obtained from a report by Salomon Smith Barney (McNally, K., Emmanuel, D., Chiu, J. and Denisenko, J. (2002) 'ETF Insights', Working Paper, Salomon Smith Barney).
9 Lockwood, L. and Linn, S. C. (1990) 'An Examination of Stock Market Return Volatility during Overnight and Intraday Periods', *Journal of Finance*, Vol. 45, No. 2, pp. 591–601.