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# Hedging with the IFOX Long Gilt Future: A Note

JOHN HOGAN
*University College, Dublin*

*Abstract:* Traditional theory emphasises the risk avoidance potential of futures. An alternative hypothesis (Working's hypotheses) emphasised expected profit maximisation. Portfolio theory is a combination of the first two hypothesis, focusing on risk return characteristics of futures, helping explain the co-existence of hedged and unhedged portfolios. The purpose of this paper is to examine the efficiency of using the IFOX long gilt future as a hedge against exposure in the cash market to medium and long dated Irish Government stocks. The relative efficiency of different hedge ratios is also examined.

## I INTRODUCTION

This is a preliminary study of the efficiency of using the first IFOX long gilt future as a hedge against exposure in the cash market to medium and long dated Irish Government stocks.

## II BACKGROUND

The Irish Futures and Options Exchange became operational on 29th May 1989. Four long gilt futures were announced; September 1989, December 1989, March 1990 and June 1990. Until early September, however, dealings only occurred in the September contract. Our study is thus confined to the September future which traded from 29th May to 18th September, the contract terminating on 20th September 1989. Average daily volume was approximately 25 contracts or £1.25m. The notional coupon on the long gilt future was 8 per cent and four stocks were deliverable on settlement on 20th September.

| | |
|---|---|
| 9.00% Capital | 1.9.2006 |
| 8.25% Capital | 30.7.2008 |
| 8.50% Capital | 1.10.2010 |
| 8.75% Capital | 30.9.2012 |

Turnover in medium and long gilts was extraordinarily low during the period, averaging £27m per day. The only active stocks that traded from end May through mid-September were the 9 per cent Capital 2006 and the 8.50 per cent Capital 2010. Our analysis had of necessity to be confined to these stocks.

It is perhaps useful at this stage to look briefly at the operations of the Irish gilt market. The Authorities have for some years been withdrawing from their role as market makers and have been quoting only buying prices in the vast majority of gilts. Normally these buying prices have been below the market level so that stock has not been offered back to the Authorities but traded in the secondary market. Unusually in the current year, official buying prices have been above secondary market dealing prices but no arbitrage has been possible because the Authorities have not been prepared to deal at the quoted prices. Effectively the Authorities appear to have withdrawn from any role in market making and no alternative market making mechanism has been substituted. The availability of a market price in a gilt is dependent on secondary market activity.

## III DATA PROBLEMS

Closing daily futures prices were taken from IFOX and closing daily prices of the cash gilts studied were taken from the Stock Exchange – Daily Official List, where prices of dealings in the secondary market are recorded. Even in the case of the most active gilts, however, no trades took place in 10 per cent of the days studied. With the added problem of infrequent dealing the problems of synchronising dealings in the cash and futures market is accentuated. It is not surprising therefore that use of daily data gave extremely poor results, while the use of weekly data provided much more reliable hedge positions.

## IV RESEARCH METHODOLOGY

The purpose of hedging is to reduce the volatility of returns. This, however, can only be achieved at a cost, i.e., lower expected returns. We will see later how this applied in practice in the June-September 1989 period. Hedging is particularly useful for market makers who take positions to facilitate trading but who wish to preserve capital on a daily basis. Preserving capital rather than maximising returns on inventories is their prime objective.

The optional hedge ratio, 0, is one that provided the minimum risk position.

This is achieved when:

$$\text{Eqn I} \qquad 0 = \frac{\text{Covariance } (\Delta Pc \text{ with } \Delta Pf)}{\text{Variance } (\Delta Pf)}$$

where $\Delta Pc$ = change in the price of cash gilt
$\Delta Pf$ = change in the price of future

The value of "0" can be estimated by regressing changes in the price of the cash stock against changes in the price of the future.

$$\text{Eqn II} \qquad Pc = a + b\Delta Pf + \text{error}$$

The estimated slope of the regression line, "b" is the optional hedge ratio. "a" has no significance for hedging purposes. The error term quantifies basis risk. However, the data problems mentioned earlier may overstate the true level of basis risk.

Futures contracts should be chosen which have the highest "$R^2$" with the cash stock being hedged. Generally this is the nearest to deliver future and in the case of IFOX, dealings have been largely confined to that stock, no dealings having taken place in the longer dated futures in the first three months of the Exchange.

The fact that the maturity of cash stocks shortens over time whereas the life of the future remains unchanged means that optional hedge ratios will not remain constant and will require periodic adjustment. Futures are valued daily and profits or losses settled daily. If allowance is not made for this factor, too many futures will be sold against an underlying position in the cash stock. Marking to market can be allowed for by reducing the hedge factor by the discount factor for the continuously compounded risk free rate of return over the life of the future. This adjustment factor will need to be calculated daily. On the 29th May the factor was:

$$e^{-rt} = e^{-(0.095)\,(113/365)}$$

$$= 0.9710$$

where r = 3 month interbank rate, 9.5 per cent
t = number of days to expiry of the futures contract divided by 365.

Hedge ratios were constructed between the long gilt future and the 9 per cent Capital 2006 and the 8.50 per cent Capital 2010 using three techniques, the conversion factor, slope of regression line and duration. The conversion factor is simply the price in relation to 100 that a gilt will deal at if the gross redemption yield is 8 per cent (the same as the coupon on the future). Regression equations were calculated using daily and weekly price changes for the

gilt future and the two cash stocks. The slope of the regression line is the hedge factor. Finally, the duration of the future (using the cheapest to deliver stock, the 8.75 per cent Capital 2012) and the two cash stocks were calculated. Adjusting by the redemption yield and relative prices a hedge factor was calculated. In all three cases the hedge factor was multiplied by

$$\frac{(\text{Price} + \text{Accrued})}{100} \times \frac{£1\text{m}}{£50{,}000}$$

This is defined as the number of short positions in the future needed to hedge a long position of £1m nominal in the cash stock. The hedge factor was further reduced by .971 to allow for marking to market of the future.

The efficiency of each hedge was measured by calculating the percentage reduction in the variance of returns on the cash stock achieved through hedging at the different hedge ratios.

## V FINDINGS

Hedge ratios using the three different methods are shown below:

Table 1: *Futures to Sell to Hedge £1m Nominal Cash Stock*

| | *Conversion Factor* | *Regression Analysis (Weekly)* | *Duration* |
|---|---|---|---|
| 9.00% Capital 2006 | 21.3 | 21.3 | 19.7 |
| 8.50% Capital 2010 | 19.5 | 19.3 | 19.9 |

Hedge ratios based on daily data were discarded as the day to day relationship between the cash stocks and the future was extremely poor.

9% Capital 2006

$$Pc = -0.00092 + 0.740181\Delta Pf \quad R^2 = 0.49 \quad \text{Durbin-Watson} = 2.44$$
$$(0.098235) \quad SER = 0.30$$
$$(60 \text{ observations})$$

8.5% Capital 2010

$$Pc = -0.00937 + 0.901167\Delta Pf \quad R^2 = 0.52 \quad \text{Durbin-Watson} = 2.32$$
$$(0.117744) \quad SER = 0.35$$
$$(56 \text{ observations})$$

The very low $R^2$ indicated substantial basis risk when daily data are used. This is in line with findings in other futures markets. Good results, however, were obtained using weekly data.

9% Capital 2006

$$Pc = -0.03231 + 1.092500\Delta Pf \quad R^2 = 0.90 \quad \text{Durbin-Watson} = 2.85$$
$$(0.098891) \quad SER = 0.45$$
$$(15 \text{ observations})$$

8.5% Capital 2010

$$Pc = -0.00723 + 1.044354\Delta Pf \quad R^2 = 0.84 \quad \text{Durbin-Watson} = 1.73$$
$$(0.126872) \quad SER = 0.58$$
$$(15 \text{ observations})$$

The high $R^2$ in both cases showed that the future tracked the cash stocks extremely well during the period. The standard errors of 0.45 per cent and 0.58 per cent (reflecting the weekly standard deviation of optimally hedged positions) compared with weekly standard deviations on the cash stocks of 1.35 per cent and 1.39 per cent respectively.

The different hedge ratios were applied (see appendices) to nominal holdings of £1m in each of the cash stocks with the following results.

Table 2: *Variance of Weekly Returns (%)*

| | *Unhedged* | *Hedged* | | |
|---|---|---|---|---|
| | | *Conversion Factor* | *Regression Factor* | *Duration* |
| 9.00% Capital 2006 | 1.81 | 0.18 | 0.18 | 0.19 |
| 8.50% Capital 2010 | 1.93 | 0.31 | 0.31 | 0.31 |
| | | (29-05-89 – 12-09-89) | | |

The usual test of hedge efficiency is the percentage reduction in variance of returns from a fully hedged position.

Table 3: *Per cent Reduction in Variance*

| | *Conversion Factor* | *Regression Analysis (Weekly)* | *Duration* |
|---|---|---|---|
| 9.00% Capital 2006 | -90.1 | -90.1 | -89.5 |
| 8.50% Capital 2010 | -83.9 | -83.9 | -83.9 |

All three hedging methods produced very similar results; this, however, has to be seen in the context of the stocks, whose characteristics were very similar to the future in terms of coupon and maturity.

Risk reduction through hedging has a cost. In the case of the 9 per cent Capital 2006 and the 8.50 per cent Capital 2010, the fully hedged position giving the lowest variance gave returns of 2.2 per cent and 2.7 per cent respectively over the fifteen-week period. This compares with unhedged returns of 7.2 per cent and 7.6 per cent. The cost of hedging over the fifteen-week period was 4.9 per cent/5.0 per cent. Hedged returns, however, were significantly below the risk free rate (as measured by the Dublin interbank three month offered rate), which averaged 2.86 per cent over the fifteen-week period.

## VI POSTSCRIPT

A review was made of trading in the June '90 long bond futures contract. Volumes had roughly doubled to 50 contracts per day (or £2.5m) compared with the May-Sept 1989 period. Dealings, however, in medium and long gilts remained at low levels with the two stocks studied earlier, the 9 per cent Capital 2006 and the 8.50 per cent Capital 2010 being the only stocks which traded with any degree of frequency. Indeed the poor liquidity of the market has now prompted the Authorities to include a provision in the 1990 Finance Bill which enables them to offer terms to existing gilts holders with a view to consolidating the large number of issues which do not trade into a small number of marketable stocks. $R^2$ of changes in weekly prices for gilts and futures was 0.77 for the 9 per cent Capital 2006 (0.90 in our earlier study) and 0.85 for the 8.50 per cent Capital 2010 (0.84 in our earlier study). The $R^2$ for changes in daily prices were extremely low at 0.44 for both stocks.

## VII CONCLUSIONS

The key findings were:

1. The September 20th long gilt future provided an effective hedge against weekly volatility of long dated cash stocks.
2. Fully hedged positions dramatically reduced volatility but the cost was approximately 5 per cent over a fifteen-week period.
3. The correlation between daily price changes for cash stocks and the future was poor indicating considerable basis risk in day to day pricing. This limits the usefulness of the future for dealers who wish to hedge cash positions on a daily basis.
4. The results support earlier studies in the US which found that futures are not perfect hedges for cash stocks and even risk minimisers may wish to hedge only portion of their portfolios.

5. The period studied was one of exceptionally low volume in the cash market. In fact, throughout the period studied there were only two stocks which traded actively. This prevented the study of a broader range of maturities which could have significant implications for the choice of hedge ratios.
6. On the basis of the limited stocks studied, calculation of hedge ratios based on conversion factors, weekly regression analysis or duration were almost equally efficient. This finding, however, is limited by the similarity of the coupons and maturities of the cash stocks studied to the gilt future.

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## APPENDIX 1

*Hedging 9% Capital 2006*
*Total Return*

| | *Unhedged* (%) | *1* *Hedged* (%) | *2* *Hedged* (%) |
|---|---|---|---|
| Total – 15 Weeks | 7.2 | 2.2 | 2.6 |
| Variance of Returns | 1.81 | 0.18 | 0.19 |

1. Conversion Factor & Regression Analysis gave hedge factor of 1.0925. Number of futures sold 21.2947.
2. Duration Method gave hedge factor of 1.0128. Number of futures sold 19.7412.

$$\text{Number of futures sold} = \text{Hedge Factor} \times \frac{(\text{Price} + \text{Accrued})}{100} \times \frac{£1\text{m}}{£50{,}000} \times 0.971$$

In practice hedge will have to be based on nearest round number, 21 and 20 respectively.

## APPENDIX II

*Hedging 8.50% Capital 2010*
*Total Return*

| | *Unhedged* (%) | *1* *Hedged* (%) | *2* *Hedged* (%) | *3* *Hedged* (%) |
|---|---|---|---|---|
| Total – 15 Weeks | 7.6 | 2.8 | 2.8 | 2.7 |
| Variance of Returns | 1.93 | 0.31 | 0.31 | 0.31 |

1. Conversion factor was 1.0506. Number of futures sold 19.4588.
2. Hedge factor based on regression analysis was 1.0444. Number of futures sold 19.3440.
3. Duration method gave hedge factor of 1.0725. Number of futures sold 19.8644.

$$\text{Number of futures sold} = \text{Hedge Factor} \times \frac{(\text{Price} + \text{Accrued})}{100} \times \frac{£1\text{m}}{£50{,}000} \times 0.971.$$

## APPENDIX III

*Conversion Factor Hedge*

This is calculated by estimating the price of a gilt to give a redemption yield of 8 per cent (the notional coupon on the future) and dividing by 100.

*Duration Based Hedge*

Duration is a measure of actuarial life of a gilt and provides an index of its relative interest rate sensitivity. Hedge factor reflects the sensitivity of the cash stock relative to that of the future.