REALISED HEDGE RATIO PROPERTIES, PERFORMANCE AND IMPLICATIONS FOR RISK MANAGEMENT: EVIDENCE FROM THE SPANISH IBEX 35 SPOT AND FUTURES MARKETS

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REALISED HEDGE RATIO PROPERTIES, PERFORMANCE AND IMPLICATIONS FOR RISK MANAGEMENT: EVIDENCE FROM THE SPANISH IBEX 35 SPOT AND FUTURES MARKETS

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Abstract

This paper analysis the properties and performance of daily realised futures hedge ratios. Using five-minute data for the Spanish IBEX-35 equity spot and futures market realised variances, covariances and hedge ratios are constructed. To measure performance we compared a hedged portfolio based upon the realised hedge ratio with hedged portfolios constructed using a constant regression based hedge ratio, a time-varying rolling regression hedge ratio favoured within the finance industry and a time-varying bivariate-GARCH hedge ratio favoured within the academic community. Our results suggest that solely in terms of minimising portfolio variance the static regression, rolling regression and GARCH based methods obtain the smallest portfolio variances; however, this was often at the expense of negative mean values. In contrast, measuring performance that takes into account portfolio mean and variance using the Sharpe ratio, the portfolio based on the realised hedge ratio is almost unanimously favoured.

Keywords: Realised Variance, Hedge Ratio, Futures Market
JEL classification: C22, G13

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1. Introduction.

It is argued that futures markets are one of the most important innovations that affect the quality of information about future price movements (Figlewski, 1984). A futures contract is an agreement between two parties in which they commit to engage in trade at a point in the future for a prespecified price. Thus, futures markets provide two main functions, risk transfer and price discovery. Risks are transferred to those willing to bear them, that is, hedgers reduce their risk by paying a premium to speculators. While the existence of futures trading enhances the ability of traders to form expectations about future spot prices (Silber, 1985). Thus, the analysis of futures markets tends to focus on either risk management and the appropriate use of futures contracts to optimally hedge risk or price discovery, the aim of this paper is to examine the former.

The traditional approaches to the use of futures for hedging purposes has been either to adopt a naive one-to-one hedging ratio, where an equal and opposition position in futures is taken relative to the position in cash, or to determine the optimal hedge ratio using simple regression techniques but to assume that this ratio will remain constant over the relevant time horizon. However, empirical financial markets research over the past two decades has supported the view that asset returns volatility is time-varying and, in particular, exhibits ‘clustering’, such that large (small) returns follow large (small) returns of random sign (Mandelbrot, 1963, Fama, 1965). The development of the academic literature has been conducted along lines such that the standard way of specifying volatility is through the generalised autoregressive conditional heteroscedasticity (GARCH) model (Engle, 1982, Bollerslev, 1986) and its variants. However, such a model is typically viewed as too cumbersome in risk management practice due to the large number of parameters required in estimated and various other restrictions required to ensure stability of the model. Standard risk management practice is thus to estimate the least squares model and introduce time-variation through windowed estimation.

Thus, a key question remains, given time-variation in variances and correlations, how is it best to understand and formally characterise their properties, and estimate and forecast their values, in order to obtain optimal hedge ratios. Furthermore, recent developments in the academic field on volatility prediction have provided methods to obtain both accurate volatility forecasts and characterisations of volatility dynamics, including the nature of time-variation and its persistence properties, which are simple in construction and avoid large parameterisation. This recent literature should be more appealing to risk management practice and the finance industry at large.

The aim of this paper is thus to apply these recently developed techniques, which come under the general heading of 'realised volatility' to the study of time-variation in the Spanish futures market. In particular, we apply intra-day five-minute observed data to the question of the appropriate daily hedge ratio. The Spanish market is chosen as, in addition to a standard futures contract, in November 2001 the Spanish Official Exchange for Financial Futures and Options launched the mini IBEX-35 futures. The purpose of introducing this contract was to complement the pre-existing futures contract operating in the market by allowing smaller investors and individual traders access to futures markets, and thus allowing for enhanced portfolio management amongst these trader types. Specifically, the mini futures differs from the pre-existing futures contract by having a larger tick size and a smaller multiplier (that is, the tick size of the mini contract is five index points as opposed to one index point on the standard contract, and the multiplier is one euro per index point on the mini contract, as opposed to ten euros per index point on the standard contract). Therefore, this gives us a further opportunity to examine the impact of this new futures contract on the existing contract and whether improved opportunities for hedging arise from its introduction.

The remainder of the paper is as follows. Section 2 reviews the principles underlying hedge ratios and the recent empirical literature. Section 3 reviews the realised variance literature, while Section 4 introduces the data and examines the properties of the constructed realised series. Section 5 presents our main empirical results on the performance of portfolios constructed using different hedge ratios. Section 6 summarises and concludes.

2. Optimal Hedge Ratio and Recent Literature.

Futures contracts play an important role in financial markets by allowing market agents the opportunity to introduce assets that exhibit a negative correlation with their portfolio, which is not typically found with cash markets only. Thus, futures contracts allow market agents to avoid, or hedge, market risk that they otherwise could not avoid due to restrictions upon short selling. The return on a portfolio of an investor who wishes to hedge some of their cash position by holding futures contracts can be represented by:

(1) $$r_t^p = r_t^c - \beta_{t-1} r_t^f$$

where r_t^p is the return on the portfolio from time period *t-1* to *t*, r_t^c is the return on the cash position over the same period, r_t^f the return on holding the futures position over the time period *t-1* to *t* and where β_{t-1} is the hedge ratio. The conditional variance of the hedged portfolio, h_t^p, using information up to time *t-1* is given by:

(2) $$h_t^p = h_t^c - \beta_{t-1}^2 h_t^f - 2\beta_{t-1} h_t^{cf}$$

where h_t^p, h_t^c, h_t^f represent the conditional variances of the portfolio, cash and futures positions respectively, while h_t^{cf} represents conditional covariance between the cash and futures position. The optimal hedge ratio is defined as the value of β_{t-1}, which minimises the conditional variance of the hedged portfolio (2) and is given by:

(3) $$\beta_{t-1}^* = h_t^{cf} / h_t^f$$

where β_{t-1}^* is the optimal hedge ratio (OHR). Where the conditional variance-covariance matrix is assumed to be constant (for example, see the earlier work of Ederington, 1979; and Anderson and Danthine, 1981), such that the optimal hedging ratio will also be constant, then an estimate of β_{t-1}^* can be found by the estimated slope coefficient, *b*, in the simple linear regression of:

(4) $$r_t^c = a + b r_t^f + u_t \, .$$

However, as noted in the Introduction, the existing empirical consensus is that both variance and covariance from which the hedge ratio is constructed are time-varying, such that the parameter *b* in equation (4) which is fixed will not be optimal at each point in time. Moreover, Park and Switzer (1995) argue that if the joint distribution of cash and futures prices is changing over time then a constant hedge ratio may not be appropriate, while Baillie and Myers (1991) likewise suggest that hedge ratios will vary over time as the conditional distribution between cash and futures price changes. Whilst, therefore, common practice in the risk management industry is to estimate equation (4) over a rolling window, the preference within the academic research is to estimate such time-variation through a bivariate-GARCH model.

Consequently, several researchers have examined the ability of time-varying optimal hedge ratios, typically estimated through the GARCH methodology, to outperform constant hedge ratios in risk reduction effectiveness. The majority of this extant research has focused upon bond or equity cash and futures markets, examples of which include Cecchetti, Cumby and Figlewski (1988), Park and Switzer (1995), Butterworth and Holmes (2001), Brooks, Henry and Persand (2002) and Choudhry (2003), while Baillie and Myers (1991) examined time-variation in the optimal hedge ratios of six commodities. Furthermore, while the work of Cecchetti, Cumby and Figlewski estimated individual GARCH models for the returns volatility of cash and futures markets and assumed a constant correlation between cash and futures prices, the remaining papers allowed for time-variation in the conditional covariance matrix by employing a bivariate GARCH specification. Additionally, Brooks, Henry and Persand allowed for asymmetry of positive and negative shocks in the GARCH specifications, while Choudhry allowed for the influence of short-run (squared) deviations from a cointegrating cash-futures relationship on the conditional covariance matrix.[1]

3. Realised Volatility and Correlation.

As noted in the Introduction one drawback of the GARCH methodology in estimating time-varying variances, covariances and hedge ratios is the large number of parameters required to obtain estimates. Thus, conventional risk management practise is to prefer a model such as that given by equation (4) and introduce time-variation by conducting estimation of the model over a rolling sample, typically 60 days. Although, and furthermore, both these approaches suffer from the drawback that volatilities are constructed from

[1] Also see Abdulnasser and Roca (2006), Lien et al (2002) and Ahmad and Manesh (2006).

past values, and that volatility itself is essentially unobserved. However, recent developments in academic research have provided a methodology in which volatility can in essence be observed and thus allow for direct modelling. Building upon a line of research that began with Andersen and Bollerslev (1998), Andersen, Bollerslev, Diebold and Labys (2003) define realised volatility on day *t* as:

(5) $$h_t^{rv} = \sum_{j=1}^{1/\Delta} r_{t-1+j\Delta,\Delta}^2$$

where Δ is the intra-day frequency, such that 1/Δ is the number of intra-day intervals. Thus, realised volatility is the sum of squared intra-day returns. In principle, letting Δ go to zero, that is continuous sampling, then the measure approaches the true integrated volatility of the underlying continuous time process, and theoretically free from measurement error. This measure thus allows a market participant to essentially treat volatility as an observed variable and to allow direct estimation.

Generalising the realised volatility idea, we can similarly obtain realised covariances between two assets, say asset *i* and asset *k*, in the following fashion:

(6) $$h_t^{rcv} = \sum_{j=1}^{1/\Delta} r_{i,t-1+j\Delta,\Delta}\, r_{k,t-1+j\Delta,\Delta} .$$

As with the realised variance term, the realised covariance can be treated as observed and directly used in estimation. Finally, and for the purposes within the current paper, we can use the realised variances and covariances to construct the realised hedge ratio:

(7) $$\beta_{t-1}^{*rv} = h_t^{rcv} / h_t^{frv}$$

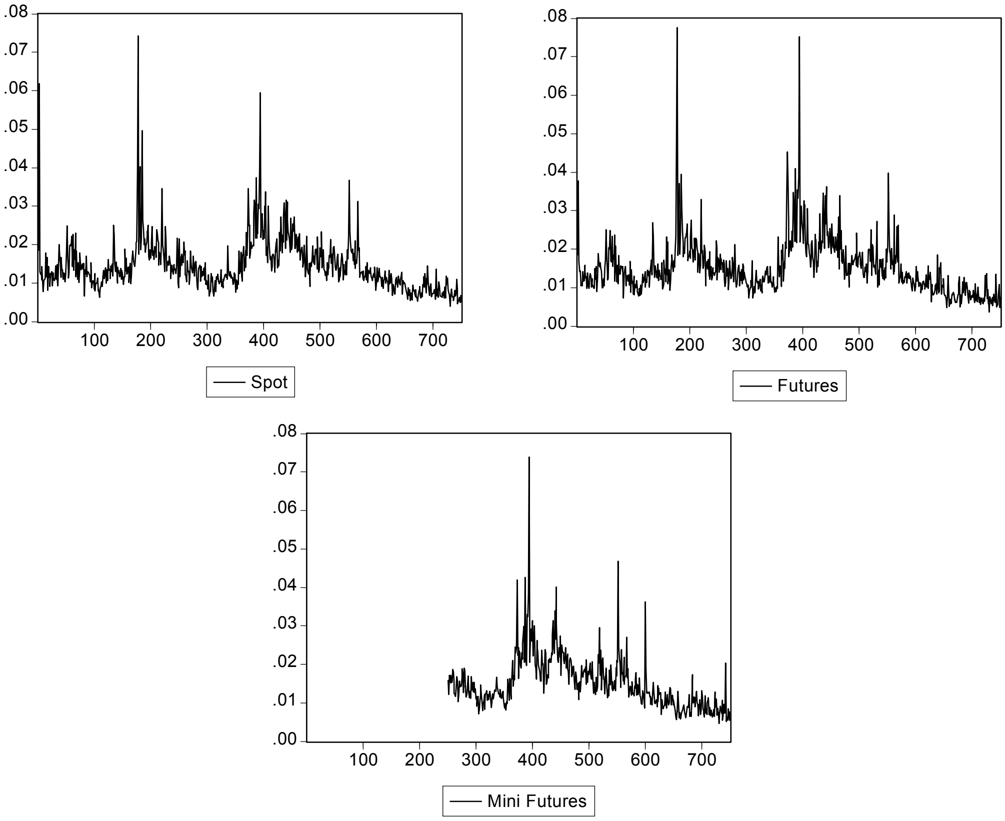
where h_t^{rcv} and h_t^{frv} are used to represent the realised covariance between the spot and futures returns and the realised variances of the futures return respectively. As with the realised variance series, the realised covariance and realised hedge ratio can be regarded as the realisations of the underlying integrated processes and be consistent for the integrated covariance and hedge ratio respectively.

4. Data and Properties of Realised Variables.

In this work we use data from the Ibex 35 index, which is the most important index within the Spanish stock market as it contains the top 35 stocks on the basis of market capitalisation. We also use the data from the futures contracts negotiated in the Spanish derivative market which have the Ibex 35 as underlying asset. There are two Ibex 35 index future, the Ibex plus, with a multiplier of 10€, and the Ibex mini, with a multiplier of 1€. The Ibex mini started in November 2001, while the Ibex plus started in 1992. The data from the index has been taken from the website www.agmercados.com which is used by market participants to operate in the market. The data of both derivative contracts has been facilitated by MEFF, S. H.[2] The period of study goes from January 2nd, 2001 up to December 31st, 2003, and we have used five minutes prices for every asset. For the mini future there is only data from 2nd January, 2002, while as its negotiation started on November 2001, it is not until 2002, when the contract became liquid.

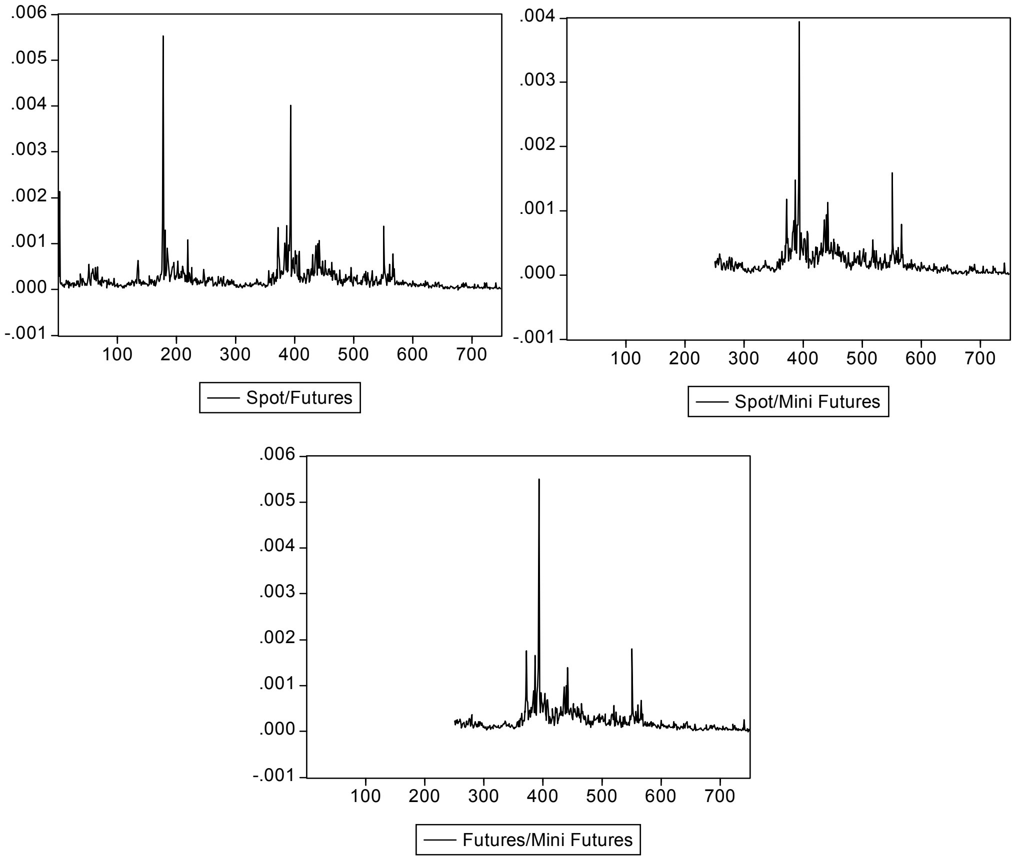
[2] Mercado Español de Futuros Financieros, Sociedad Holding.

Figure 1. Realised Variance



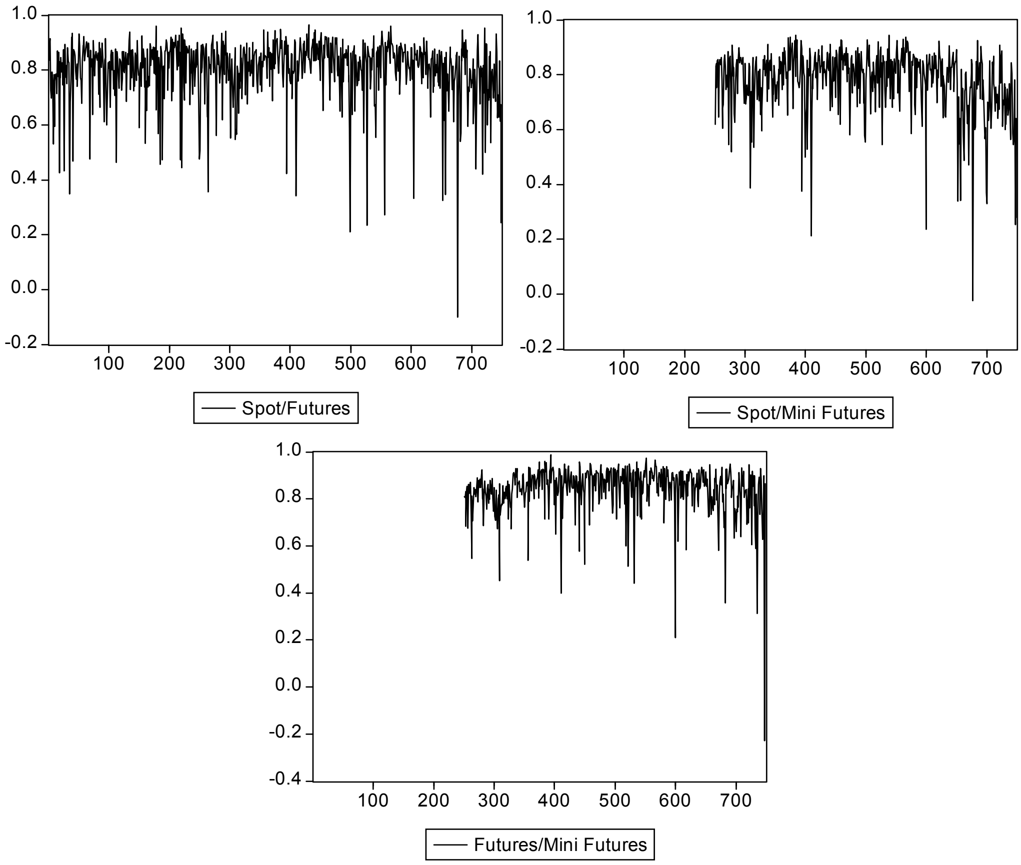
In order to generate the realised series, the 5-minute data is transformed into continuously compounded returns by taking logs and then first differences. The realised variance series is then generated using equation (5) where the returns are squared and summed over the trading day. The realised covariances are generated using equation (6), that is, in turn the Ibex spot and two futures series are multiplied and summed over the day. Finally, using equation (7) we generate the realised hedge ratio from the realised covariance and realised variance series.

Figure 2. Realised Covariance



Plots of the daily realised variance and covariance between the spot, futures and mini-futures are presented in Figures 1 and 2 respectively. As can be seen from these plots the realised variance of each series is similar, with infrequent but large spikes, which tend to be more pronounced in the futures market. Similarly, the time series patterns associated with the realised covariances between the three variables are similar. Finally, Figure 3 plots the realised hedge ratios between the three assets. Here we can see that although the three hedge ratios follow roughly the same pattern, of having a mean close to 0.8 with departures therefrom, there is much greater diversity in the timing and extent of the deviations.

Figure 3. Realised Hedge Ratios



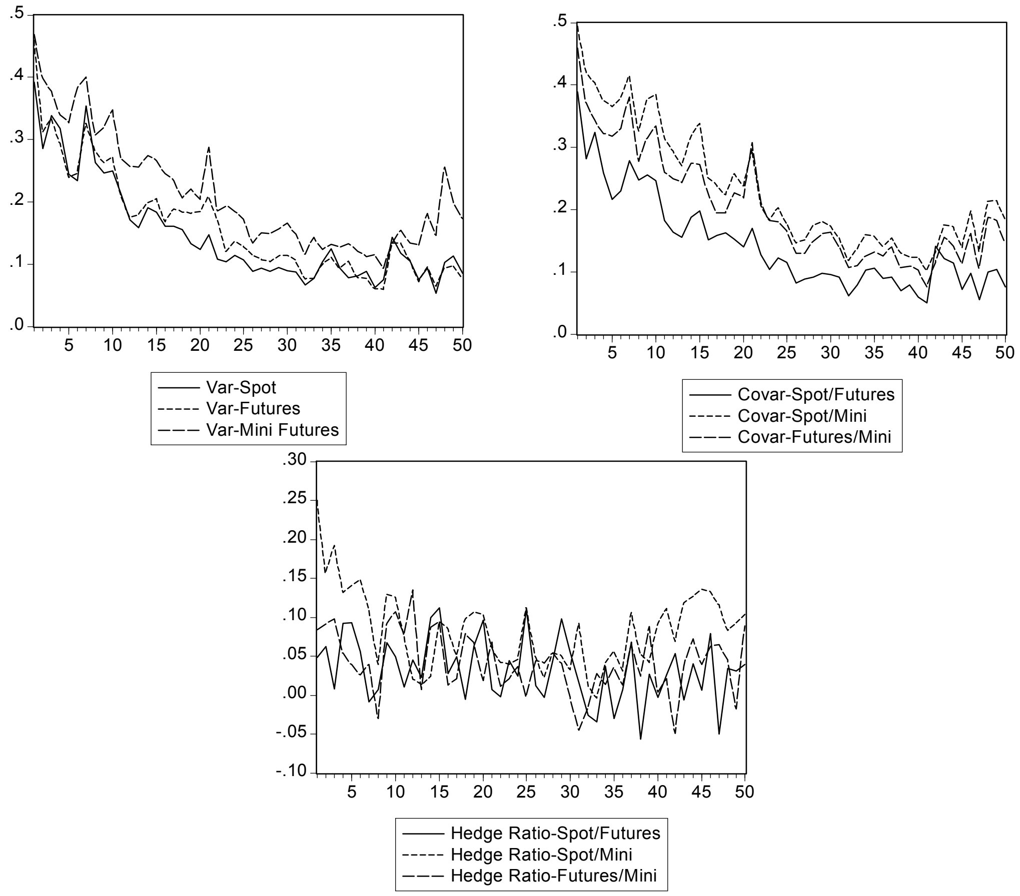
To compliment this analysis, Table 1 presents some summary statistics for the realised variance, covariance and hedge ratios, and the correlations between each series. From this table we can see that the mean and standard deviations for the realised variance, realised covariance and realised hedge ratios respectively are of a similar magnitude for the three series. Furthermore, the realised variance and covariance series are characterised by very strong autocorrelation at both short and longer lags, the latter indicating the possibility of long memory. However, for the realised hedge ratios the autocorrelations are much reduced, especially for the spot/futures and futures/mini hedge ratios. Nevertheless, all variances, covariances and ratios are stationary. Finally, an examination of the correlation coefficients between the variances, covariances and hedge ratios supports the graphical evidence that while the generated realised variance and covariance series are similar between the three stock market series, this cannot be said for the realised hedge ratios. That is, correlations for the former two measures are in the region of 0.91-0.98, while correlations for the latter measure range from 0.27-0.67 suggesting wide variation in the produced ratios.

Table 1. Realised Data Descriptive Statistics									
Country	Realised Variance			Realised Covariance			Realised Hedge Ratio		
	Spot	Futures	Mini	S/F	S/M	F/M	S/F	S/M	F/M
Mean	0.026	0.028	0.027	0.022	0.20	0.23	0.81	0.77	0.84
Std Dev	0.035	0.039	0.034	0.032	0.26	0.33	0.12	0.12	0.11
Q1	115.7	158.8	110.4	113.7	123.0	106.1	1.76	31.39	3.52
Q12	723.7	776.3	763.6	625.6	891.3	682.1	26.96	119.1	39.02
ADF	-4.89	-5.36	-3.60	-9.85	-3.54	-3.80	-25.6	-8.54	-20.5
d	0.49 (0.15)	0.55 (0.15)	0.53 (0.17)	0.49 (0.10)	0.53 (0.10)	0.49 (0.10)	0.17 (0.07)	0.24 (0.12)	0.19 (0.07)
	Correlations								
		Futures	Mini		S/M	F/M		S/M	F/M
Spot		0.91	0.93	S/F	0.98	0.97	S/F	0.67	0.27
Futures			0.94	S/M		0.98	S/M		0.47

Notes: Mean and standard deviation for realised variance and covariance multiplied by 100. Q refers to serial correlation Q-statistics of lags one and twelve. ADF is the augmented Dickey-Fuller test with lag length selected by the BIC and a 5% critical value of –2.86. *d* is the estimated fractional integration parameter, with standard errors in parentheses.

The evidence from the Q-statistics and the ADF tests suggests the possibility of long-memory dynamics within the realised variances and covariances. Moreover, Andersen et al (2003) have argued that realised volatility measures exhibit long memory and possible fractional behaviour. To compliment the above analysis and to test for possible fractional integration we plot in Figure 4 the first 50 lags of the autocorrelation function for the realised variance, covariance and hedge ratio respectively. These figures suggest that the autocorrelation functions for the realised variance and covariance series decay only very slowly, such that long lags still have a (albeit weak) conditioning effect on current values. The same, however, is not true for the realised hedge ratios, where the autocorrelation function decays towards zero relatively quick.

Figure 4. ACF for Realised Series



These results are consistent with potential fractional integration behaviour in the realised variance and covariance. Furthermore, the fact that the hedge ratio, which is a combination of these two variables, does not appear to exhibit the same long memory property suggests possible common factors, or fractional cointegration. That is, in the language of Engle and Kozacki (1993), the potential for common features (co-persistence) between variance and covariance exists, where two variables exhibit a characteristic (i.e. long-memory) that a combination of them (the hedge ratio variable) does not.[3]

[3] If we accept the possibility of fractional integration in realised variances and covariances, then this suggests the presence of fractional cointegration (Cheung and Lai, 1993). A result similar to this was reported by Andersen et al (2004) in the context of realised CAPM betas.

To provide further evidence of this we estimate the fractional integration parameter. Specifically, we implement the (log-)periodogram regression estimator proposed by Geweke and Porter-Hudak (1983; d_{GPH}), based on the smoothed periodogram using the Parzen window. More formally, the spectral density of a time series can be given by:

$$f(\lambda) = \left|1 - \exp(-i\lambda)\right|^{-2d} f^*(\lambda) \tag{8}$$

where d is the long memory parameter and $f^*(\lambda)$ represents short-run dependency. Geweke-Porter-Hudack (1983) propose the following estimator based on the first m periodogram ordinates:

$$I_j = \frac{1}{2\pi n}\left|\sum_{t=1}^{n} y_t \exp(i\lambda_j t)\right|^2 \quad for\ j = 1,...,m \tag{9}$$

where $\lambda_j = 2\pi j / n$, $j=0,1,2,\ldots,m$, defines the set of harmonic frequencies. The least squares regression is thus:

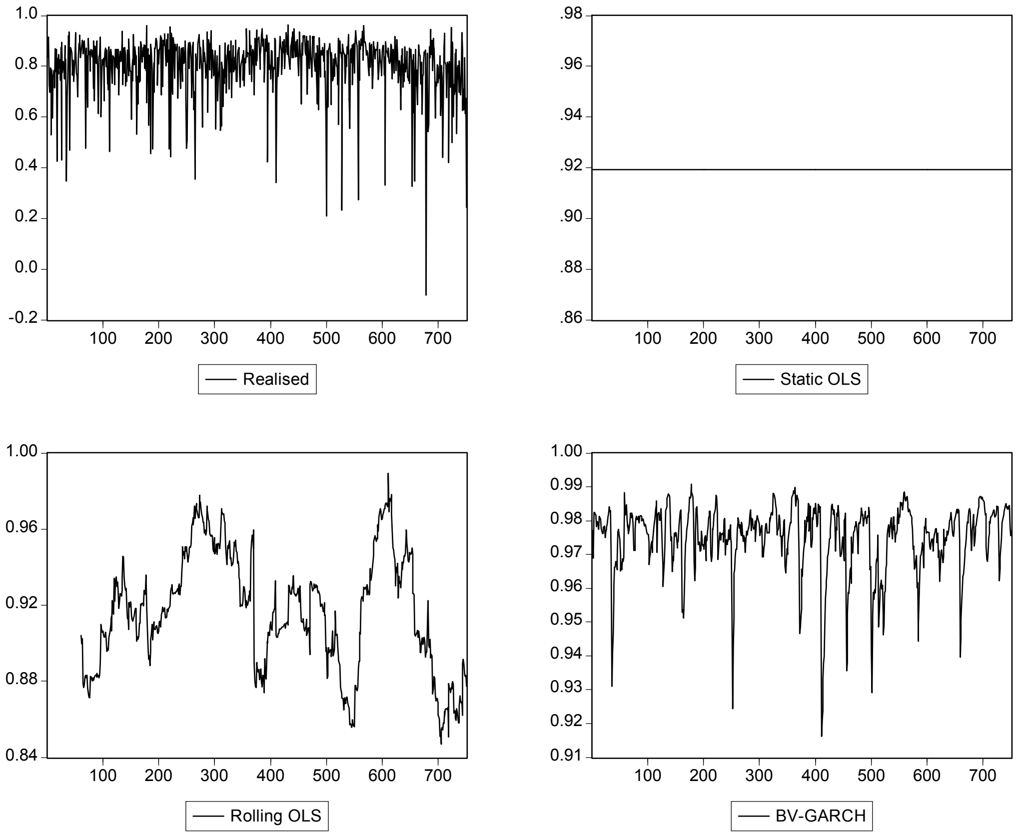
$$\{\log(I_j) : j = 1,...,m\} = \alpha_0 + \alpha_1[\log\left|1 - \exp(-i\lambda_j)\right|] + e_j \tag{10}$$

where $\hat{d} = -(\hat{\alpha}_1 / 2)$. Estimates of d are presented in Table 1 and these support the general observations made from the Q-statistics and the plots of the autocorrelation function. That is, there appears to be long-memory fractional integration in the realised variance and covariance series but not the realised hedge ratios, supporting the belief that the variances and covariances exhibit common fractional integration behaviour in the ratio

5. Hedge Ratio and Portfolio Performance.

The hedge ratios based upon the realised variance and covariances are plotted in Figure 3 as noted above. These show substantial time-variation in the optimal hedge ratio and thus in the appropriate number of futures contracts to buy. The aim of this section is to note whether taking into account this measure of the optimal hedge ratio improves portfolio performance over more traditional measures of computing the hedge ratio, such as the static OLS regression which produces a constant hedge ratio, a 60-day rolling OLS regression and a bivariate-GARCH model. Of particular note, the first measure is usually considered as a base measure against which to compare the other, time-varying, methods, the second method is simple to compute and preferred within the finance industry, while the final method is more involved but preferred within the academic community.

Figure 5. Spot/Futures Hedge Ratios



For comparison, Figure 5 presents the hedge ratios for the full sample spot/standard futures calculated by each method. As can be seen from this figure the hedge ratio obtained from the realised variance and covariance series exhibits a much greater degree of variability than that obtained by the other methods. More specifically, the range of values taken by the realised hedge ratio is from –0.1 to 0.96, whilst for the rolling regression model ranges from 0.85 to 0.99 and 0.92 to 0.99 for the bivariate-GARCH model. Furthermore, the mean value for the realised hedge ratio is 0.8 while for the regression, rolling regression and GARCH model the mean values are 0.92, 0.92 and 0.98 respectively.

In order to assess the ability of each method of constructing the hedge ratio, we examine the performance of the portfolio described by equation (1) in terms of the average daily return, standard deviation and the Sharpe ratio based on annualised values. These values are presented in Table 2 for the spot and standard futures contract and for both the full sample and the two sub-samples either side of the introduction of the mini-futures contract. Table 3 presents similar statistics of hedged portfolios involving the mini-futures contract.

Table 2. Hedged Portfolio - Spot and Standard Futures

	OLS	Rolling OLS	GARCH	RV
	Full Sample			
Mean	-0.002	0.0001	-0.0002	0.003
Std Dev	0.35	0.34	0.36	0.41
Sharpe	-0.07	0.002	-0.01	0.12
	Pre-Mini			
Mean	0.001	0.007	0.002	0.006
Std Dev	0.34	0.34	0.36	0.43
Sharpe	0.03	0.34	0.09	0.21
	Post-Mini			
Mean	-0.003	-0.003	-0.001	0.002
Std Dev	0.35	0.34	0.36	0.40
Sharpe	-0.12	-0.12	-0.06	0.07

Notes: Spot and futures portfolios constructed on the basis on hedge ratios constructed using the static regression model (OLS), a rolling regression model (Rolling OLS), a bivariate-GARCH model (GARCH) and the realised variance method (RV). Sharpe is the Sharpe ratio obtained by the annualised mean dividend by the annualised standard deviation.

The results from Table 2 for both the full sample and two sub-samples suggest the following broad conclusions. First, for all hedged portfolios the daily mean value is close to zero, although typically higher for the portfolio constructed using the realised hedge ratio. Furthermore, for the constant regression based portfolio and the GARCH portfolio the mean values are negative over the full sample and the sample after the introduction of the mini-futures, indeed in this latter period only the realised hedge ratio based portfolio has a positive mean value. Second, the standard deviation of the regression, rolling regression and GARCH portfolios are all of a similar magnitude, while the realised hedge ratio based portfolio has a higher standard deviation. Finally, examining the performance of the portfolio through the Sharpe ratio then the realised hedge ratio based portfolio outperforms all the other constructed portfolios over the full sample and the post-mini futures introduction sample. Only in the sample prior to the introduction of the mini futures contract does the rolling regression outperform the realised hedge ratio portfolio, which inturn outperforms the remaining two portfolios.

Table 3. Hedged Portfolio - Spot and Standard Futures With Mini Futures

	OLS	Rolling OLS	GARCH	RV
	Spot and Mini Futures			
Mean	-0.003	0.001	-0.002	0.003
Std Dev	0.35	0.34	0.35	0.44
Sharpe	-0.13	0.03	-0.10	0.10
	Standard Futures and Mini Futures			
Mean	-0.0002	0.0004	-0.0002	0.009
Std Dev	0.17	0.16	0.17	0.35
Sharpe	-0.02	0.04	-0.02	0.43

Notes: Spot and futures portfolios constructed on the basis on hedge ratios constructed using the static regression model (OLS), a rolling regression model (Rolling OLS), a bivariate-GARCH model (GARCH) and the realised variance method (RV). Sharpe is the Sharpe ratio obtained by the annualised mean dividend by the annualised standard deviation.

Turning to Table 3 which reports the portfolio mean, standard deviation and Sharpe ratio for the spot/mini-futures and the two futures hedged portfolios, the results are broadly similar to those reported for the spot/standard futures hedged portfolio. More specifically, the mean values are all close to zero and negative for the constant OLS regression based hedge ratio and the GARCH based measure, while the highest mean values are found for the realised hedge ratio based portfolio. The standard deviations for the OLS regression, rolling regression and GARCH based hedge portfolio are similar while the standard deviation for the realised hedge ratio portfolio is higher. Finally, the Sharpe ratio of portfolio performance is highest for the realised hedge ratio portfolio for both the spot/mini futures hedged portfolio and the two futures hedged portfolio.

In sum, the results from this exercise suggest that the best performing hedged portfolio is constructed by obtaining the realised hedge ratio. Although portfolio variance is lower for portfolios constructed using regression and GARCH techniques, these often produce negative mean values for the portfolio, the best return-risk combination occurs for the realised hedge ratio based portfolios. Furthermore, the realised hedge ratio is relatively simple in construction and so the results here will be of interest to the finance industry as improved hedging performance could be obtained through using realised hedge ratios as opposed to rolling regressions. Finally, the introduction of the mini futures contract appears to have no significant impact on hedging performance of the existing futures contract.

6. Summary and Conclusion.

The introduction of futures markets are one of the most important innovations within the finance industry, allowing for improved quality of information about future price movements and risk transfer. The traditional approaches to the use of futures for hedging purposes had been to adopt constant hedge ratios either though a naive one-to-one hedging ratio, or to determine the optimal hedge ratio using a simple regression. However, it is well known that asset variances and covariances are time-dependant and can vary substantially over even short periods of time. This has led to the question of what is the most appropriate technique to model such time-variation. The academic literature has typically focussed on the GARCH methodology as providing the most accurate methods to model variances and covariances. However, the finance industry has shied away from these techniques as they are highly involved and require a large number of parameters in estimation as well as constraints on parameter values to ensure non-negativity and stationarity. Furthermore, there are a variety of GARCH models that can capture different aspects of the data (for example, asymmetry, long memory). As such the finance industry typically introduces time-variation into hedge ratio estimation through rolling regression techniques that are simple to execute.

The aim of this paper is to re-examine the ability of several models to estimate hedge ratio in the light of recent academic research that has led to the development of realised variance and covariance modelling techniques. Furthermore, realised volatility measures are simple in construction, do not involved estimating a large number of parameters and allow for straightforward construction of realised hedge ratios and so are of interest to those engaged within the finance industry.

Using five-minute data for the Spanish IBEX-35 equity spot and futures market daily realised variances, covariances and hedge ratios are constructed. This data is chosen as during our sample the Spanish Official Exchange for Financial Futures and Options launched the mini IBEX-35 futures. The purpose of introducing this contract was to complement the pre-existing futures contract operating in the market by allowing smaller investors access to futures markets, and thus allowing for enhanced portfolio management amongst these investors. Hence, this gives us a further opportunity to examine the impact of this new futures contract on the existing contract. Preliminary results within this paper show that daily realised variances and covariances for the Spanish IBEX-35 equity spot and futures market exhibit long memory dependency consistent with extant research on other markets, while the constructed hedge ratios do not exhibit the same property. Furthermore, while the realised variances of the three assets and the realised covariances between the three assets all follow a similar time series pattern, and exhibit a high correlation, the realised hedge ratios differ across time and exhibit a lower correlation.

In terms of hedge ratio performance we compared a hedged portfolio based upon the realised hedge ratio for the spot/futures portfolio, spot/mini futures portfolio and a standard future/mini future portfolio with hedged portfolios constructed using a constant regression based hedge ratio, a time-varying rolling regression hedge ratio favoured within the finance industry and a time-varying bivariate-GARCH hedge ratio favoured within the academic community. Our results suggest the following conclusions. First, on the basis on solely minimising portfolio variance then the static regression, rolling regression and GARCH based methods obtain smaller portfolio variances than the realised volatility based method, however, this was often at the expense of negative mean values, whereas the portfolio utilising realised hedge ratios always yields positive mean values. Second, and perhaps most importantly, a comparison of portfolio performance which takes into account both portfolio mean and variance using the Sharpe ratio, almost unanimously supports the portfolios constructed using the realised hedge ratios, in only one case does the rolling regression based portfolio outperform the realised hedge ratio based portfolio and this was prior to the introduction of the mini-futures contract and so characterised by a market environment which no longer exists. Finally, the introduction of the min-futures contract appears to have had almost no impact on the hedging performance of the spot-standard futures contract market, although of note portfolios constructed by any means other than the realised hedge ratio exhibit a negative mean value in the post-mini period to the end of the sample. In this respect the mini-futures contract could be regarded as successful in allowing new participants to the market but without diminishing the hedging efficiency of the original contract.

In sum, the results presented here have important implications for the practice of risk management and the calculation of futures market hedge ratios. That is, the finance industry has typically shied away from models preferred within the academic community designed to capture time-variation in asset variances and covariances due to their complexity, instead preferring models that are relatively simpler in construction. Our results suggest that the recent development within the academic literature for the calculation of realised variances, covariance and in this case, realised hedge ratios provides for improved performance and yet are simple in construction.

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