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Return distribution, leverage effect and spot-futures spread on the hedging effectiveness

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ABSTRACT

This paper proposes a revised Glosten-Jagnnathan-Runkle (GJR) model for estimating hedge ratios. The model can take into account three important characteristics in the return behavior, i.e., fat-tailed distribution, leverage effect, and spot-futures spread. Hedge performance in terms of the White's (2000) reality check is conducted. Our results demonstrate that the generalized autoregressive conditional heteroskedasticity (GARCH) model that considers both fat-tailed distribution and asymmetric effects of the spread provides the best hedging effectiveness for longer horizons.

1. Introduction

One common definition of the optimal hedge ratio is"the ratio of the covariance between spot and futures prices to the variance of the futures price" (Myers and Thompson, 1989). Previous works have demonstrated that time-varying asymmetric volatility (Brooks et al., 2002; Switzer and Khoury, 2007; Haugom et al., 2016; Tse, 2016) and spot-futures spread (Lee, 1994; Kogan et al., 2006; Lien and Yang, 2006; Chai, 2015) influence the hedge ratios estimation.

Additionally, it has been well documented in the literature that the financial returns typically are non-normal, in particular, and exhibit leptokurtic, or fat-tailed distributions (Baillie and DeGennaro, 1990; Bollerslev et al., 1992; Guermat and Harris, 2002; Niguez, 2016).

Consequently, many previous studies investigate one or two of the following three issues. First, some studies (Anders, 2006; Park and Jei, 2010; Vrontos, 2012) examine if the generalized autoregressive conditional heteroskedasticity (GARCH) models based on conditional fat-tailed distributions could provide better hedging effectiveness than the GARCH model with normal distributions. Second, some works have investigated whether using asymmetric GARCH models for leverage effect can increase the hedging performance (Brooks et al., 2002; Switzer and Khoury, 2007; Tse, 2016). Third, the spot-futures spreads on futures hedging performance have been investigated (e.g., Lee, 1994; Kogan et al., 2006; Lien and Yang, 2006; Chai, 2015).

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We contribute to the literature by setting up a revised Glosten-Jagnnathan-Runkle (GJR) model developed by Glosten et al. (1993) that can take into account three important characteristics (leverage effect, fat-tailed distribution, and spot-futures spread) in the return behavior for estimating hedge ratios. As such, our empirical results can provide clarity regarding which characteristics influence the hedge performance. This study evaluates the hedge performance of alternative models in terms of the White's (2000) reality check (RC), which can avoid a data-snooping problem. Using the Taiwan Stock Capitalization Weighted Stock Index (TAIFEX) and SIMEX MSCI Taiwan Stock Index Futures (MSCI), our results show that the GARCH model with both fat-tailed distribution and asymmetric effects of spot-futures spread presents the best hedging performance for longer horizons (e.g., 10, 30, 60, or 90 days).

2. Method and data

2.1. The model

Let S_t and F_t denote, respectively, spot and futures prices at time t. The spot returns are calculated as $R_{s,\,t} = \ln(S_t/S_{t-1})$. Following Solnik's (2000) suggestion that the futures return should reflect the fact that the return is defined relative to the actual investment in the spot market, we calculate futures returns as $R_{f,t} = \ln((F_t - F_{t-1} + S_{t-1})/S_{t-1})$. The spread ($B_t$) is defined as $B_t = \ln S_t - \ln F_t$. The first modification to the GJR model is to incorporate the asymmetric effects of the spread into the conditional mean and the conditional variance equations; that is,

$$R_{s,t} = a_0 + h^* R_{f,t} + b_1 \max(B_{t-1}, 0) + b_2 \min(B_{t-1}, 0) + \varepsilon_t \tag{1}$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 + \delta S_{t-1}^- \varepsilon_{t-1}^2 + \xi [\max(B_{t-1}, 0)]^2 + \lambda [\min(B_{t-1}, 0)]^2 \tag{2}$$

Second, in many applications of the GARCH model it has been shown that conditional normality is not enough to account for the presence of fat tails in the financial data. This study considers three fat-tailed distributions, i.e., generalized error distribution (GED), Student t distribution, and skewed generalized t (SGT) distribution, to estimate the conditional mean and variance equations. In addition, 1-, 10-, 30-, 60-, and 90-day hedging periods and dynamic hedging strategy to estimate the optimal hedge ratios (Benet, 1992) are used. The rolling window size is set to 500.

The hedging performance of the various models is in terms of the method of White's (2000) RC for data snooping instead of variance reduction (Lee and Yoder, 2007). Data snooping bias might occur when a given set of data is used more than once for purposes of inference or model selection. White's (2000) RC is used for testing the null hypothesis that the best model encountered in a specification search has no predictive superiority over a given benchmark model.

White's RC is based on the following $l \times 1$ performance statistic:

$$\bar{f}_k = n^{-1} \sum_{t=1}^{n} f_{k,t} \tag{3}$$

where l is the number of alternative models considered and $f_{k,\,t}$ is the observed performance measure for period t. $f_{k,\,t+1}$is the $k$observed performance measure for period $t+1$ and is defined as:

$$f_{k,t+1} = -\left(r_{s,t+1} - \beta_{k,t+1} r_{f,t+1}\right)^2 + \left(r_{s,t+1} - \beta_{w,t+1} r_{f,t+1}\right)^2 \tag{4}$$

where $\beta_{w,\,t+1}$ is the estimate of hedge ratio from the benchmark at time $t+1$, and $\beta_{k,\,t+1}$is the prediction of the hedge ratio from alternative models at time $t+1$.

The null hypothesis that the performance of the best dynamic hedging model is no better than the benchmark:

$$H_0 : \max_k \{E(f_k)\} \le 0 \tag{5}$$

where f_k is the performance value for each model applied to the data. Politis & Romano's (1994) stationary bootstrap resampling method is used for implementing White's RC with 1000 bootstrap simulations and a smoothing parameters of q = 0.5 (Lee and Yoder, 2007).

2.2. Data

We obtained daily closing prices and futures contracts for the TAIFEX and MSCI from the Taiwan Economic Journal database. The data of TAIFEX ranges from July 21, 1998, to September 30, 2015 (i.e., a total of 4316 observations). The data period for MSCI is from January 14, 1997, to September 30, 2015 (i.e., a total of 4732 observations).

3. Empirical results

Table 1 reports the descriptive statistics on each return series, demonstrating the average daily spot and futures returns are close to zero. We can find that the standard deviation and kurtosis statistics of the spot returns are lower than those of futures returns. The skewness statistics show that the distributions of the spot and futures returns are significantly

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