Estimation and performance evaluation of optimal hedge ratios in the carbon market of the European Union Emissions Trading Scheme

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Abstract

Overview

Following the introduction of the European Union Emissions Trading Scheme, CO2 emissions have become a tradable commodity. As a regulated party, emitters are forced to take into account the additional carbon emissions costs in their production costs structure. Given the high volatility of carbon price, the importance of price risk management becomes unquestioned. This study is the first attempt to calculate hedge ratios and to investigate their hedging effectiveness in the EU-ETS carbon market by applying conventional and recently developed models of estimation. These hedge ratios are then compared with those derived for other markets.

Methodology

This paper applies hedge ratio estimation models which have been widely used in calculating hedge ratios in other markets. These are the naive approach, the ordinary least squares (OLS), the error correction model (ECM), and the generalized autoregressive conditional heteroscedasticity models (GARCH).

The effectiveness of each estimated hedge ratio is assessed based on two criteria: (a) variance reduction, and (b) utility maximization. To calculate the percentage variance reduction, the difference in variance of the unhedged portfolio and each hedged portfolio (constructed using different hedge ratios resulted from diverse models) is divided by the variance of the unhedged portfolio.

The utility maximization method incorporates the risk aversion of investors. Using this method, the level of investors' utility that computed differently from the hedged portfolio is compared and ranked by the degree of utility improvement from the unhedged portfolio

Results

The number of approaches towards the estimation of the optimal hedge ratios in the EU-ETS carbon market is used in this paper, including Naïve, OLS, ECM, VECM and VECM-GARCH. Significant

reduction of volatility can be attained if spot positions are hedged in futures market independent of the hedge ratio estimation method that is applied. However, the performance of models was not uniform. For example, the findings from this paper do not favour the use of the VECM-GARCH model for the hedging of EUA price risk. If the emitter chooses the minimum variance as the objective, the hedge ratio calculated by OLS estimation should be selected as it provides the greatest variance reduction compared to other models. However, if the hedger (not limited to emitters) expects to incorporate the return as well as minimum variance, a choice between OLS, Naive and ECM can be made.

The results in terms of utility improvement are quite mixed in different hedging horizons. Nevertheless, the use of VECM-GARCH is also not recommended as it produces the lowest level of utility improvement overall.

Comparing values of hedge ratios with hedge ratios obtained in other markets, no significant differences were found. Thus, in spite of the uniqueness and novelty of carbon markets, the estimated hedge ratios also fall in the range of 0.5 to 1 in line with those of other markets.