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Can modeling the natural gas futures market as a threshold cointegrated system improve hedging and forecasting performance?

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Abstract

The calculation of the hedge ratio, and therefore the effectiveness of the hedge, is dependent upon the correct specification of the relationship between the futures and spot price. Likewise, a forecast of the future spot or futures price is dependent upon the model specification. This article investigates the appropriateness of using a threshold cointegrated model of the natural gas markets as the basis for hedging and forecasting. The findings suggest that the threshold model is more appropriate for longer contract length and that the threshold model does not offer much improvement in hedging or forecasting efficiency.

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1. Introduction

One of the most important roles of a futures market is to provide a means of risk reduction. It is possible for participants in the spot market to hedge the risk associated with unexpected

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shocks to the spot price by simultaneously participating in the futures market. By selling an amount of futures contracts equal to the hedge ratio for each spot position held a hedger minimizes risk. The calculation of the hedge ratio, and therefore the effectiveness of the hedge, is dependent upon the correct specification of the relationship between the futures and spot price. Likewise, a forecast of the future spot or futures price is dependent upon the model specification. Therefore, the time series properties of the relationship play a key role in the ability of the model to be used in both hedging and forecasting.

In the long run, the futures price will eliminate the possibility of arbitrage, equaling the spot price, plus a carrying charge consisting of a storage cost, risk premium, and convenience yield. Speculators in a futures market attempt to capitalize on arbitrage opportunities that occur when short-run deviations from the long-run equilibrium condition are present. For speculators to profit, the difference in the futures and spot price (the basis) must be large enough to account for the associated costs of carry. Without the costs of carry, the long-run equilibrium would result in a zero basis. A standard error correction (EC) model of the market implicitly assumes that a zero basis is the correct equilibrium condition. The time series properties of this model imply movement toward the zero-basis equilibrium anytime a nonzero basis exists.

Alternatively, a threshold model allows for multiple non-zero-basis regimes. A nonzero basis may correctly reflect an equilibrium in the market where the associated costs of carry explain the nonzero basis. However, if the size of the basis is large enough that it is misrepresenting the costs of carry, speculators will attempt to profit from the arbitrage opportunity that is present. In other words, the response of the market to a relatively small basis may be different than the response to a large basis. The deviations from a zero-basis no-arbitrage condition can therefore be characterized as belonging to two possible regimes, separated by whether the associated costs of carry are correctly identified. The time series relationship between the spot and futures prices would thus differ by regime and therefore, so would the hedge ratio. This article compares the effectiveness of hedge ratios and forecasting ability of a threshold EC model of the futures market for natural gas to other commonly adopted approaches.

A simple and common estimation of the optimal hedge ratio is accomplished with ordinary least squares (OLS) analysis. This method fails to account for the possibility that the price history is a determinant of the current price. Therefore, a vector autoregressive model (VAR) may be a better representation of the relationship. The spot and futures prices, represented in levels, are generally considered nonstationary while the first difference of each series is stationary. Therefore, the estimation of a VAR representation of the futures market is usually accomplished using the first difference of the price series.

Engel and Granger (1987) showed that the standard VAR representation is not correct if cointegration is present in a time series. Alternatively, a vector error correction model (VECM) of the spot and futures price series would account for the cointegration via the use of the basis as the EC term. Gosh (1993) showed that hedge ratios estimated via a VECM outperformed the standard VAR estimation. This was supported by Lien (1996). The VECM assumes that the EC term is always significant. In contrast, a threshold representation allows for the possibility that the relationship between the spot and futures prices may differ based on the action of speculators in the market. Therefore, a threshold representation of the VECM may provide a better estimate of the hedge ratio. This article compares a no-hedge strategy to