Market Fundamentals and the Dynamics of Natural Gas Futures Volatility: An Augmented GARCH Approach

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Overview

Financial markets have been witnessed highly volatile energy prices in the last two decades. Considering that energy commodities have irreplaceable role in any economy, researchers have been trying to analyze and understand the determinants of swings in energy prices. This highly volatile nature of energy markets resulted in creation and trading of derivative products in energy markets for the purpose of hedging, risk management, as well as investment purposes. In that regard, it is important to examine the dynamics of energy prices and their volatility for proper risk management, since volatility plays a central role in derivative pricing. In order to be able to model volatility properly, we need to understand price determinants and the underlying factors behind those price fluctuations.

There is a general consensus in the energy finance about the inverse relationship between storage levels and volatility, since low storage level is mostly regarded as tight supply condition, which raises concerns about the amount of natural gas will be available in the future. For example, Chiou-Wei et al (2013) find that there exists an inverse empirical relation between changes in futures prices and surprises in the change for natural gas in the storage for time span 2002-2011. Moreover, Linn and Zhu (2004) prove that weekly gas storage report announcements during 1999-2002 were responsible for considerable intraday volatility at the time of their releases. Although the impact of storage surprises on short-term volatility have been documented in many studies, to the best our knowledge there is not any that analyzes the impact of the interaction between storage surprises and seasonality. In this paper, we intend to close the gap and contribute to the literature by addressing the effect of this interaction in the following sections. By taking this interaction into account, we were able to document asymmetric impact of storage surprises across different seasons.

Methods

In this study, we used GARCH models as an econometric tool in order to account for the dynamic nature of short-term market volatility. Some of the more recent studies on natural gas volatility augment the GARCH models with market fundamentals in order to isolate the determinants of volatility (Ates and Wang 2008; Mu 2007; Pindyck 2004; Murry and Zhu 2004). However, the literature does not address the out-of-sample forecasting accuracy of GARCH models augmented with market fundamentals. In this paper, we fill the gap by testing the out-of-sample forecasting accuracy of several simple GARCH models together with augmented GARCH models using a constant-size sliding-sample methodology. We found that augmentation with market fundamentals improves the forecast accuracy evidenced by reduced mean absolute error and mean squared error compared to standard GARCH models with no market fundamentals.

Results

We find that storage levels have an asymmetric effect on short-term volatility across the seasons. During the winter months, storage levels that are lower than the five-year historical average were found to increase the short-term volatility. In contrast, it is high storage levels that cause excess volatility in other seasons. This can be attributed to the changing concerns of market actors during different seasons. In the winter, low storage levels are perceived as signaling an environment of scarce supply, which causes excess volatility. At other times, the market is mainly concerned with the supply of storage space. Therefore, high storage levels cause excess volatility. Besides, the maturity effect for natural gas nearby month futures is found to be a significant determinant of volatility in the winter months only. This result is confirmed by both data analysis and econometric estimation of the GARCH models that included the variables capturing the maturity and its interaction with the seasonality. Since demand is highly inelastic in winter, traders might be overreacting to new information arriving closer to the maturity, thus causing excess volatility.

Conclusions

Recently, a new body of literature emerged on modeling the short-term volatility dynamics of natural gas futures. This research focuses on the augmentation of GARCH models and its variants with the natural gas market fundamentals in order to isolate the sources of high volatility in natural gas prices. In this paper, several new findings that contribute to this literature have been presented, and more importantly the forecasting accuracy of these models is analyzed for the first time. Overall, the results suggest that volatility forecasting performance can be improved by augmenting the GARCH models, whereas a simple GARCH model may be preferable for risk measurement of linear portfolios when one considers the advantages of simplicity.

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