Volatility Forecasting of Crude Oil Market: Which Structural Change Based GARCH Models have Better Performance?

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GARCH-type models have been widely used for forecasting crude oil price volatility, but often ignore the structural changes of time series, which may lead to spurious volatility persistence. However, when we focus on relevant research in the crude oil market, it can be found that most of existing methods can only recognize the abrupt structural changes caused by strong external shocks, but they hardly recognize the smooth structural changes caused by the slow response to external shocks. But in other financial markets, some relevant research have found the presence of smooth structural changes in the varying price series and recognized that the flexible Fourier form (FFF) GARCH models can capture various degrees and forms of structural changes in light of different external shocks.

Therefore, it is necessary to apply the FFF-GARCH-type models considering smooth shift to crude oil price volatility modeling and forecasting. Specifically, this paper focuses on the smooth and sharp structural changes in crude oil price volatility, i.e., smooth shift and regime switching, respectively, and investigates which structural change based GARCH models have better performance for forecasting crude oil price volatility.

The empirical results indicate that, first, the flexible Fourier form (FFF) GARCH-type models considering smooth shift can accurately model structural changes and yield superior fitting and forecasting performance to traditional GARCH-type models. Second, the Markov regime switching (MRS) GARCH model incorporating regime switching exhibits superior fitting performance compared to the single-regime GARCH-type models, but it does not necessarily beat the counterparts for forecasting. Finally, the FFF-GARCH-type models outperform MRS-GARCH for forecasting crude oil price volatility and portfolio performance, indicating that compared to regime switching, the incorporation of smooth shift can better capture structural changes, thereby improving the forecasting accuracy of GARCH-type models.

The conclusions above have clear policy implications for modeling the volatility in crude oil market. In particular, for energy economists, energy policymakers and energy market practitioners, they can consider the smooth shift to identify the various degrees and forms of structural changes in crude oil price volatility more efficiently, in such a way to generate more accurate volatility forecasting results and make more accurate strategic decision. In addition, the incorporation of regime switching does not perform significantly better than the single-regime GARCH models when they are used to forecast crude oil price volatility, and it is not necessary to prefer the complicated models.

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The Energy Journal, Vol. 44, No. 1