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Instabilities in the relationships and hedging strategies between crude oil and US stock markets: Do long memory and asymmetry matter?

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ABSTRACT

This article uses the DCC–FIAPARCH model to examine the time-varying properties of conditional return and volatility of crude oil and US stock markets as well as their dynamic correlations over the period 1988–2013. Our results indicate that both the long memory and asymmetric behavior characterize the conditional volatility of oil and stock market returns. On the other hand, the dynamic conditional correlations (DCC) between the crude oil and US stock markets are affected by several economic and geopolitical events. When looking at the optimal design of an oil-stock portfolio, we find that investors in the US markets should have more stocks than crude oil asset in order to reduce their portfolio risk. Finally, the use of the DCC–FIAPARCH model that explicitly accounts for long memory and asymmetric volatility effects enables the investors to effectively hedge the risk of their stock portfolios with lower costs, compared to the standard DCC–GARCH model.

1. Introduction

Research devoted to volatility spillovers and dynamic correlations between crude oil (CO) and stock markets has recently attracted a particular attention from academics and practitioners, especially following recent heightened fluctuations in crude oil and stock prices. The context of macroeconomic and geopolitical uncertainty, and economic and financial crises contributes significantly to these price tendencies in both markets. Recent statistics show that international nominal prices of all major energy commodities reached their highest levels in nearly 50 years during the first quarter of 2008, while the prices in real terms were the highest in nearly 30 years. These unprecedented increases in oil prices, coupled with substantial increases in volatility, reflect uncertain markets and volatile environment.

The theory predicts the interactions between CO and stock markets by the impact of crude oil prices on the present value of a firm's expected future cash-flows. Indeed, oil price increases can lead to higher production cost and thus lower expected

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cash-flows which in turn depress the firm's share price. On the one hand, rising oil prices can result in higher consumer price index (inflation) which often requires central banks to raise interest rates in order to stabilize the price level and thereby increases the discount rate used in the stock pricing models. The increase in the discount rate then causes the reduction in the firm's market value and, all other things being equal, the decrease in stock prices. Chang et al. (2010) analyze the impact of CO volatility shocks on stock prices via expected cash-flows, the discount rate and the equity pricing model, and assess that the direction of the stock price effect depends on whether the firm under consideration is a producer or a consumer of oil and oil-related products. The oil prices can also influence stock prices via their effects on company's operating costs and household's income. For example, higher energy costs may lead to lower oil usage and decreases in the productivity of capital and labor (Hamilton, 1983). Equally, higher costs of imported oil would reduce the disposable income of the household (Chang et al., 2013), which has a negative effect on stock investment. Finally, from the demand side, oil prices movements may directly affect the consumer's discretionary spending on durable goods, which would, in turn, cause changes in corporate earnings and consequently stock prices (Gogineni, 2010). This indirect relationship between consumers' discretionary spending and stock prices can be explained by the fact that consumers tend to purchase durable goods only after they pay their energy bills (Kilian, 2009). For instance, Edelstein and Kilian (2009) show that, in the United States, the actual share of energy in consumer expenditures fluctuates between 4% and 10%. Accordingly, the discretionary spending effect will be large if the elasticity of the demand for oil (and energy in general) is low.

The relationships between CO and stock markets have also been the headlines of prestigious financial newspapers such as Financial Times and Wall Street Journal. On August 21, 2006, the Financial Times reported for example that U.S. stock prices declined due to an increase in oil prices caused by geopolitical risk in the Middle East (including the Iranian nuclear program and terrorist attacks by Islamic militants). The Wall Street Journal on March 31, 2013 reported that "the close ties between daily movements of commodities and stock markets, which have persisted mostly uninterrupted since the financial crisis, have frayed." It is also noted that the daily correlation between the S&P 500 and the S&P GSCI commodities indices has fallen to the lowest level since October 2008. This stylized fact may signal the end of the crisis and associated recession period or a new dynamical phase for these markets.

Past studies in the related literature have provided insightful information about the links between CO and stock markets (e.g., Jones and Kaul, 1996; Ewing and Thompson, 2007; Driesprong et al., 2008; Park and Ratti, 2008; Aloui and Jammazi, 2009; Arouri et al., 2011; Aloui et al., 2012). The majority of these studies generally show that stock price changes can be explained by the movements in the price of oil, but the CO effects typically depend upon the nature of firms, economic sector and market with respect to their dependence on crude oil and oil-related products. Exogenous factors such as macroeconomic conditions, business cycle, geopolitical tensions, and OPEC production quotas have also been found to exert important influences on the behavior of both CO and stock prices.

This article aims to analyze the time-varying interdependence between the CO prices and US stock markets and to discern this interdependence between the bullish and bearish phases in the US economy. For this purpose, we empirically rely on the use of the DCC-FIAPARCH model which allows for capturing the dynamic market linkages through the dynamic conditional correlations (DCC) as well as asymmetric effects and long memory property in the conditional volatility processes. Past studies such as Aloui and Mabrouk (2010), Christensen et al. (2010), and Chkili et al. (2014) have shown that long memory and asymmetry properties are important stylized facts which need to be accounted for when modeling and forecasting the conditional volatility of both stock and commodity markets. Moreover, the link between oil and stock markets can greatly differ across market states owing to different economic conditions. Under the extreme market state, for example, this link may be severely affected by, in addition to the oil supply and demand shocks, other factors including strong herding, differential market power and excessive price regulations imposed by governments (Aloui et al., 2013).

In this way, our study contributes to the related literature in several aspects. First, we investigate the dynamic linkage between the CO and US stock markets over a relatively long period from 1988 to 2013. This period is characterized by the occurrence of successive crises and turbulent episodes including, among others, several geopolitical tensions and social unrest (e.g., the Iraq evasion on 1991, the US military intervention in Iraq in 2003, the Arab Spring in 2010), the Mexican crisis in 1994, the Asian financial crisis 1997–1998, the Russian and Brazilian crisis 1998–1999, the September 11, 2001 terrorist attacks, and the last global financial crisis 2007–2009. These events have significant effects on the dynamics of CO and stock prices and may therefore influence their underlying relationships. Second, while the interactions between CO and stock markets have been extensively examined in recent years, none of the previous studies have explicitly accounted for the impacts of the long memory (LM) and volatility asymmetry on these cross–market interactions. Finally, we use the empirical results obtained from our bivariate LM-based model to build optimal and hedged portfolios of stocks that immunize against the oil risk.

Using daily price data from January 1988 to April 2013 for the S&P500 index and the two CO benchmarks (the West Texas Intermediate, and Brent), we mainly find that the DCC–FIAPARCH successfully captures the dynamic relationships between the CO and US stock markets. The DCC between the oil and stock markets is found to exhibit shift behavior and significantly affected by major economic and geopolitical extreme events. In addition, from a portfolio management perspective, we uncover that American investors should take more stocks than oil in their investments in order to reduce their portfolio risk and that hedging with Brent oil is slightly more effective than with WTI oil.

The rest of this article is organized as follows. Section 2 offers a short overview of the major studies in the related literature. Section 3 introduces the econometric methodology. Section 4 describes the data and their properties. Section 5 reports and discusses the empirical results. Section 6 provides some concluding remarks.