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Correlations and volatility spillovers across commodity and stock markets: Linking energies, food, and gold

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ABSTRACT

This paper employs a VAR-GARCH model to investigate the return links and volatility transmission between the S&P 500 and commodity price indices for energy, food, gold and beverages over the turbulent period from 2000 to 2011. Understanding the price behavior of commodity prices and the volatility transmission mechanism between these markets and the stock exchanges are crucial for each participant, including governments, traders, portfolio managers, consumers, and producers. For return and volatility spillover, the results show significant transmission among the S&P 500 and commodity markets. The past shocks and volatility of the S&P 500 strongly influenced the oil and gold markets. This study finds that the highest conditional correlations are between the S&P 500 and gold index and the S&P 500 and WTI index. We also analyze the optimal weights and hedge ratios for commodities/S&P 500 portfolio holdings using the estimates for each index. Overall, our findings illustrate several important implications for portfolio hedgers for making optimal portfolio allocations, engaging in risk management and forecasting future volatility in equity and commodity markets.

1. Introduction

Over the past two decades, international markets have become increasingly volatile after the financial liberalization and opening of economies, and this phenomenon has generated increasing interest in the analysis of market volatility. With both the increasing integration and high level of volatility of major financial markets, commodity behavior and equity prices grew more sensitive to innovations, such as deregulation, weather, war, political economic, investors' psychological expectations (Yu et al., 2008), revolutions and unforeseen events. In recent years, commodity markets have experienced a rapid growth in liquidity and an influx of investors who are attracted to commodities purely as investments (financial assets and securities), rather than as a means to support "real" economic activity via the hedging of risks (Vivian and Wohar, 2012 p. 395). The large swings in gold, oil and wheat prices are associated with financial crashes, wars and adverse weather conditions. For example,[1] the wheat unit price began trading at $107 in January 2000 and reached a high of $306 in December 2011. Brent prices have displayed a similar behavior, trading at $23.95 per barrel in January 2000 and reaching $108.09 per barrel by December 2011.

This volatility is puzzling for researchers, academicians, and portfolio managers. Understanding time-varying volatility and the volatility transmission mechanisms found across different types of markets was essential to both international investors and policy makers. Most studies test volatility spillover among different key stock markets or between the crude oil market and financial markets (e.g., Arouri et al., 2012; Du et al., 2011; Hassan and Malik, 2007; He and Chen, 2011; Kumar et al., 2012; Lien and Yang, 2008; Malik and Ewing, 2009; Sadorsky, 2012; Serra, 2011; Singh et al., 2010; Syllignakis and Kouretas, 2011; Yilmaz, 2010). Several empirical methods were used in these studies. However, a Multivariate Generalized Autoregressive Conditional Heteroskedasticity (MGARCH) model was employed to analyze the relationship between political and economic news on the conditional volatility of financial variables (Fornari et al., 2002) and the effect of macroeconomic shocks on financial sectors (Ewing et al., 2003). More recently, the vector autoregressive-Generalized Autoregressive Conditional Heteroskedasticity model (VAR-GARCH) has been commonly used to examine temporal volatility spillovers between developed and emerging stock markets (Singh et al., 2010). Studies of volatility spillovers have important implications for portfolio

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[1] Wheat and Brent prices were extracted respectively from International Grains Council (IGC) and Energy Information Administration (EIA) websites.

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managers, the development of accurate asset pricing models and the forecasting of future equity and the volatility of oil price return (Malik and Hammoudeh, 2007). Moreover, previous studies focused on volatility spillovers by investigating volatility in emerging and developed financial markets (Wang and Wang, 2010; Yilmaz, 2010).

The aim of this paper is to investigate the joint evolution of conditional returns, the correlation and volatility spillovers between the markets for beverages, agricultural commodities, crude oil, and metal and the stock exchange in the last twelve turbulent years. To the best of our knowledge, this study is the first to simultaneously examine the volatility transmission among these markets. The S&P 500 index and gold, crude oil, wheat and beverage markets are the main representatives of the large commodity markets, and it is of fundamental practical significance to analyze how volatility and shocks are transmitted among these markets. Volatile metal, oil, and agricultural commodity prices concern governments, traders, producers, and consumers. To perform this analysis, a developed econometric methodology was used; thus, a VAR-GARCH model that was introduced by Ling and McAleer (2003) was used for the S&P 500 index, oil spot prices, and the commodity indexes for beverages, food and metal from January 3, 2000 to December 31, 2011. One of the main advantages of this model is that it allows us to investigate the shock transmissions, the dynamics of conditional volatility and volatility spillovers between series. The model also provides meaningful estimates of the unknown parameters with less computational complications than several other multivariate specifications, such as the full-factor multivariate GARCH model (Hammoudeh et al., 2009). This aspect of the model allows us to observe the impact of commodity market events or news on the S&P 500 index returns, as well as the impact of market events or news on commodity market returns. The empirical results support evidence of transmission volatility among commodity markets and the stock exchanges.

This paper is structured as follows: Section 2 presents recent empirical studies. Section 3 specifies the VAR-GARCH model used in this study. The data and reports on the empirical results are described in Section 4, and Section 5 provides the economic implications of the results for designing optimal portfolios and formulating optimal hedging strategies. Summary conclusions are presented in Section 6.

2. Literature review

Liberalization and cointegration were the main elements of transmission shocks and volatility between markets. However, market participants were mostly concerned with volatility spillovers between commodity markets and equity markets. There is a body of literature devoted to the interactions between international markets and across sectors (see Hassan and Malik, 2007; Malik and Ewing, 2009; Sadorsky, 2012). Maghyereh and Al-Kandari (2007) used nonparametric rank tests for nonlinear co-integration analysis and concluded that oil prices directly impact the stock price indices in the GCC countries in a nonlinear fashion. Using daily closing spot prices from 1994 to 2001 and a multivariate GARCH model with BEKK parameterization on US equity, the global crude oil market, and the equity markets of Saudi Arabia, Kuwait, and Bahrain, Malik and Hammoudeh (2007) tested the volatility and shock transmission mechanism and found significant volatility spillovers between the US equity market and global oil markets. Their results also revealed that equity markets in the Gulf receive volatility spillovers from the oil market, with the exception of Saudi Arabia, for which their data indicated a significant volatility spillover from the Saudi market to the oil market. Moreover, Park and Ratti (2008) looked into the effect of the shocks that occurred in oil prices on stock exchange returns in USA and 13 other European countries using VAR model and the data between 1986 and 2005. They found that the oil price shocks had a strong effect on stock returns with the exception of USA. In other work, Malik and Ewing (2009) employed bivariate GARCH models to test the volatility transmission between five US sector indexes[2] and the oil market from January 1, 1992 to April 30, 2008, which provided evidence for the significant transmission of shocks and volatility between oil prices and some of the market sectors.

Lien and Yang (2008) tested dynamic minimum variance hedge ratios (MVHRs) using a bivariate GARCH model for ten commodity futures contracts[3] from January 1, 1980 to December 31, 1999, suggesting that the positive basis has a greater impact on the variance and covariance structure than the negative basis. Separating the effect of the positive and negative bases on the time-varying variance–covariance in spot and future markets provides better descriptions of the joint dynamic behaviors of commodity prices and plays an important role in determining optimal hedging strategies.

Applying the cointegration test approach and an error correction model, Zhang and Wei (2010) tested the relation between the crude oil and gold markets from January 2000 to March 2008, and their results suggested that there were trends between the two markets with a significant positive correlation coefficient of 0.929 (see also Aruga and Managi, 2011). Chan et al. (2011) used a Markov switching model to measure the level of interdependence across financial assets, commodities and real estate assets using monthly data from January 1987 to December 2008. Consistent with the results of earlier research, the following two distinct regimes were detected: a 'tranquil' regime, which is characterized by low volatility and significantly positive stock returns, and a 'crisis' regime, which is characterized by high volatility and sharply negative stock returns, coupled with evidence of contagion between stocks, oil and real estate. Using Bayesian Markov Chain Monte Carlo methods and weekly crude oil, corn, and wheat future prices from November 1998 to January 2009, Du et al. (2011) tested the factors that have a potential influence on the volatility of crude oil prices and the relationship between this volatility and agricultural commodity markets. They found evidence of a volatility spillover among crude oil, corn, and wheat markets after the fall of 2006. The obtained results were explained by the tightened interdependence between crude oil and these commodity markets that was induced by ethanol production. Serra (2011) used a semiparametric GARCH approach to test the volatility transmission between crude oil, ethanol, and sugar prices in Brazil from July 2000 to November 2009. The author provides evidence for strong volatility dependences between the markets in the study. Further, Serra et al. (2011) find that agricultural commodity prices (corn, cotton, and soybeans, but not wheat) are linked to energy prices.

Recently, Vivian and Wohar (2012) investigated the existence of structural breaks in commodity spot return volatility using an iterative cumulative sum of squares procedure and a GARCH model of a broad cross-section of 28 different commodities from January 1985 to July 2010. The empirical results showed high commodity volatility persistence for many commodity returns, even after structural breaks. Arouri et al. (2012) tested the volatility spillovers between oil and sector stock prices in Europe from January 1998 to December 2009 using a VAR-GARCH model and found that there were significant volatility spillovers between oil prices and sector stock returns.

On the other hand, Kumar et al. (2012) argued that the variation in the indices of clean energy stocks is explained by past movements in oil prices, the stock prices of high technology firms and interest rates. More recently, Awartani and Maghyereh (2013) investigate return and volatility spillover effects between oil and equities in the Gulf Cooperation Council Countries during the period from 2004 to 2012. Information flow from oil returns and volatilities to the Gulf

[2] They used financial, industrial, consumer, services, health care, and technology.

[3] The futures contracts are the CBOT corn (CN) and soybeans contracts (SOY); the NYBOT cotton (CT) and coffee (COF) contracts; the CME frozen pork bellies (PB) and lean hog (LH) contracts; and the NYMEX heating oil (HO), light sweet crude oil (CL), Copper (CP), and Silver (SIL) contracts.