



Equity market implied volatility and energy prices: A double threshold GARCH approach



Steven J. Cochran^{a,1}, Iqbal Mansur^{b,*}, Babatunde Odusami^{b,2}

^a Department of Finance, Villanova School of Business, Villanova University, Villanova, PA 19085, USA

^b School of Business Administration, Widener University, Chester, PA 19013, USA

ARTICLE INFO

Article history:

Received 5 August 2014

Received in revised form 1 April 2015

Accepted 29 May 2015

Available online 7 June 2015

JEL classification:

Q40

G12

Keywords:

VIX

Energy prices

Double threshold GARCH

ABSTRACT

This study investigates the role of VIX in determining the returns and return volatilities of oil, heating oil, gasoline, and natural gas. A double threshold GARCH(1,1) methodology is utilized where the VIX index is used as the threshold regime change indicator. Daily data from January 4, 1999, to December 31, 2013, are used. A sub-period analysis covering only the financial crisis period of January 2, 2007, to December 31, 2009, is also performed. This study provides evidence that the level of equity market volatility (i.e., VIX) that triggers a regime shift is commodity specific. The results also indicate that the threshold VIX values are time varying. Furthermore, natural gas prices appear to withstand considerably more volatility in the equity market than do the prices of other energy commodities. This relationship is even more pronounced during the financial crisis period. Approximately 70% and 50% of the estimated coefficients display asymmetric sensitivities due to regime changes during the entire period and the crisis period, respectively. The findings have practical implications as the underlying volatility of an asset plays a significant role in determining its associated activity in the futures markets.

© 2015 Elsevier B.V. All rights reserved.

1. Introduction

For hedging, speculative, and investment purposes, investors have sought a greater exposure to commodities in recent years. This has been accomplished by directly purchasing commodities, by investing in commodity futures, and by acquiring positions in pooled commodity investment instruments such as exchange-traded funds (ETFs), commodity index mutual funds, and commodity index swaps. According to Barclays Capital, worldwide assets under management in pooled commodity investment products stood at \$426 billion in November 2011, compared to \$156 billion in November 2008. By the end of 2010, total sales in commodity spot markets were \$6.35 trillion. Similarly, by October 2011, the trading volume in futures and options markets stood at \$10.96 trillion (www.ici.org/pdf/per18-03.pdf). The index value of the widely tracked Standard and Poor's Goldman Sachs Commodity Index (S&P GSCI®), which is designed to be an investable instrument, increased from 3985 to 5161 during the September 2009 to April 2014 period (www.goldmansachs.com). This index comprises the principal physical commodities that are traded in active, liquid futures markets and provides diversification with low correlations to other asset classes.

One obvious question to explore is whether this sharp increase in investor demand for commodities has affected the dynamics of information flow between the commodity markets and the equity market. In this study, this issue is examined by analyzing the role of the implied volatility on the S&P 500, as measured by VIX, in determining the returns and return volatilities of four energy commodities. There are several reasons why these relationships may have been changed by the increased investor demand for commodities. First, since the influx of money is being directed through index-linked commodity investments into the commodity markets, this increased financialization may alter benchmark commodity returns and market factors. Second, Basak and Croitoru (2006) determined that the scope of cross-market arbitrage is inversely related to the level of the arbitrageur's market power. As a result, if large financial institutions such as commercial banks, hedge funds, pension funds, etc., participate in the commodity market, this will reduce the scope of cross-market arbitrage and strengthen the link between these markets. Third, if these financial institutions respond differently than traditional commercial traders to extreme stock market events, the underlying relationships between the commodity markets and the stock market may be affected. For example, a sudden downward movement in the stock market may induce hedge funds or pension funds to liquidate their positions in the commodity markets in order to raise cash for margin calls. In 2008, the S&P 500 index declined nearly 50% from peak to trough. During the same period, the S&P GSCI index experienced a maximum decline of nearly 75%, while the S&P 500 implied volatility (VIX) increased significantly and set record highs.

* Corresponding author. Tel.: +1 610 499 4321; fax: +1 610 499 4614.

E-mail addresses: steven.cochran@villanova.edu (S.J. Cochran), imansur@widener.edu (I. Mansur), boodusami@widener.edu (B. Odusami).

¹ Tel.: +1 610 519 6914; fax: +1 610 519 6881.

² Tel.: +1 610 499 1175; fax: +1 610 499 4614.

It has become increasingly evident that investors concurrently monitor commodity and stock market movements along with the implied volatility of the stock market in order to determine the direction of both commodity and equity indices. While energy commodities (oil, heating oil, gasoline, and natural gas) have always had a large number of industrial applications, they have received an increased interest from investors in recent years.³ Oil, in particular, is viewed as an alternative investment instrument by global investors. These commodities (and, in particular, commodities futures) serve as potential hedges against inflationary pressures as well as providing portfolio diversification opportunities. Given the various roles these commodities play, it is critical to understand their return and volatility-generating processes and, in particular, the extent to which these processes are influenced by equity market volatility. In an environment of high uncertainty in the equity market, investors tend to add alternative assets, viewed as safe havens, to their portfolios in an attempt to reduce or avoid risk. This paper investigates the role of the equity market implied volatility (VIX) in determining the risk and return levels of energy commodities. This is accomplished by estimating the a double threshold (DT)-GARCH (1,1) model for each commodity where the VIX index serves as the threshold regime change indicator for the commodity return and volatility series.

To the best of our knowledge, this study is the first to utilize VIX as the threshold regime change variable and to determine the effects of VIX on commodity return and return volatility. The major findings of this study are as follows: i) commodity returns and return volatilities are threshold regime-dependent and the (DT)-GARCH model is superior to both the single regime GARCH and the threshold return models; ii) due to varying market dynamics across commodities, the magnitude of VIX that triggers the regime change is commodity specific and the use of an arbitrary and uniform value of VIX to denote high and low volatility regimes is inappropriate; iii) the threshold VIX values are also time varying, being considerably greater during the financial crisis period of 2007–2009 as compared to the entire sample period; and iv) natural gas exhibits return and volatility patterns that are different from the other energy commodities studied both in terms of the magnitude of the VIX threshold value and in the impact of a change in VIX on natural gas returns.

The remainder of this paper is organized as follows. Motivation for the use of the threshold model is presented in Section 2, followed by data and methodology in Section 3. Section 4 presents the empirical results, and the conclusions are presented in Section 5.

2. Why use threshold models?

The Generalized Autoregressive Conditional Heteroskedastic (GARCH) model, developed by Bollerslev (1986), has been used extensively in the literature to examine return volatility. Sadorsky (2006), Tully and Lucey (2007), Narayan and Narayan (2007), Hammoudeh and Yuan (2008), and Cochran et al. (2012), among others, have employed the basic GARCH model and several of its variations in the modeling of commodity (primarily oil) returns and return volatility in a single regime framework. There is, however, a major limitation associated with the single regime GARCH family of models that calls into question the accuracy of the estimates from such models. In the presence of structural breaks, financial time series may appear to be piecewise linear but are, in fact, jointly non-linear. Lamoureux and Lastrapes (1990) have shown that structural breaks in the variance may produce spuriously high persistence in volatility in a GARCH model. If the variance is high and remains so for a period and then low and remains so for a period, persistence of such piecewise homoskedastic periods results in volatility persistence. In such an event, a correction procedure is required to detect sudden changes in volatility, which may be accomplished by introducing binary variables exogenously into the model (see, e.g., Aggarwal et al. (1999); Mansur

et al. (2007)). Although GARCH volatility does capture the time-varying nature of the conditional variance, it cannot address issues associated with volatility if there is structural discontinuity in the level of variance. While volatility may be persistent, there could be frequent and unpredictable regime shifts that a single regime GARCH model cannot take into account.

In this study, regime-dependent GARCH volatility is examined using double threshold GARCH(1,1) ((DT)-GARCH) models where the threshold values are estimated using the Tsay (1998) methodology. The implied volatility index of the S&P 500 (VIX) is utilized as the regime switching indicator and will provide evidence of the effects of financialization on the commodity markets. A powerful risk management and trading tool, VIX is considered to be the implied volatility benchmark for the stock market. A high (low) level of VIX corresponds to more (less) market volatility in the near future. In general, investors are motivated by fear and greed. When investors' fear is dominant relative to their greed, they will buy put options in order to hedge their portfolios from possible declines in the market. As more put options are purchased, VIX attains higher values. High values of VIX often coincide with market bottoms and may, in fact, indicate that the market may decline to an unreasonable level. Although investors are rational, extremely high levels of VIX may signal buying opportunities and traders may take long positions in anticipation of market increases (see, e.g., Giot (2005)).

Evidence suggests that the relationship between contemporaneous returns on the market index and the level of implied volatility is negative (see, e.g., Whaley (2002); Giot (2005)). This relationship is also asymmetric in the sense that negative stock index returns yield larger changes in implied volatility than do positive returns of equal size (see Giot (2005)). The relationship between implied volatility and future returns, however, is less conclusive. While Giot (2005) obtains evidence for a weak positive relationship, Banerjee et al. (2007), after accounting for market, size, value, and momentum factors, find that a strong positive relationship exists between portfolio returns and both VIX levels and innovations in VIX. Banerjee et al. (2007) also examine whether the relationship between VIX and portfolio returns is dependent on the magnitude of volatility, that is, whether volatility is relatively high or low. Banerjee et al. (2007) categorize the market into “bull market” and “bear market” states based on whether market returns fall above or below the median return. Similarly, “high volatility” and “low volatility” regimes are defined based on the median value of VIX. The findings show that there is a general lack of significant differences in the VIX coefficients across the two regimes. This suggests that market states based on directional movement or volatility levels do not possess differing VIX coefficient sensitivities.

Sari et al. (2011) used VIX as a proxy for global risk perception and investigated the information transmission mechanism between the world oil, gold, silver, and dollar–euro exchange rate markets. Three methods, the autoregressive distributed lag (ADRL), the generalized forecast-error variance decomposition (GVD), and the generalized impulse response functions (GIRF), were employed in examining the relationships between the variables. The ADRL and GIRF methods demonstrate that the impact of the VIX index on oil prices is negative and significant. However, the GVD analysis shows that most of the volatility in each of the variables is due to its own shocks. Using two and three state Markov chain techniques, Bhar and Malliaris (2011) studied oil price movements during the 2004–2009 period, which was characterized by extreme price volatility. The findings indicate that changes in VIX adversely affected oil price dynamics and that the effects are regime dependent.

3. Data and methodology

3.1. Data

Daily energy price data are used in the analysis and the sample period is from January 4, 1999, to December 31, 2013. The energy data, obtained from www.Globalfinancialdata.com, include the

³ As of the end of the first quarter of 2014, global commodity exchange-traded funds held a record high of \$189 billion in assets.

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات