Energy Economics 39 (2013) 271–282

Contents lists available at SciVerse ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

The causal nexus between oil prices and equity market in the U.S.: A regime switching model ☆

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ARTICLE INFO

Article history:
Received 7 March 2011
Received in revised form 3 September 2012
Accepted 27 April 2013
Available online 25 May 2013

JEL classification:
Q43
E44
C32

Keywords:
Oil price
Equity markets
Markov-switching model
Time-varying Granger causality

ABSTRACT

The aim of this paper is to analyse the causal link between monthly oil futures price changes and a sub-grouping of S&P 500 stock index changes. The causal linkage between oil and stock markets is modelled using a vector autoregressive model with time-varying parameters so as to reflect changes in Granger causality over time. A Markov switching vector autoregressive (MS-VAR) model, in which causal link between the series is stochastic and governed by an unobservable Markov chain, is used for inferring time-varying causality. Although we do not find any lead–lag type Granger causality, the results based on the MS-VAR model clearly show that oil futures price has strong regime prediction power for a sub-grouping of S&P 500 stock index during various sub-periods in the sample, while there is a weak evidence for the regime prediction power of a sub-grouping of S&P 500 stock indexes. The regime-prediction non-causality tests on the MS-VAR model show that both variables are useful for making inference about the regime process and that the evidence on regime-prediction causality is primarily found in the equation describing a sub-grouping of S&P 500 stock market returns. The evidence from the conditional non-causality tests shows that past information on the other series fails to improve the one step ahead prediction for both oil futures and stock returns.

1. Introduction

There are mainly two reasons that might affect the stock market concerning the oil prices. Oil prices are the main determinant of global economic activities. The oil price shocks have a great impact on the economy implying that, oil has always been an essential part of economy. The higher the oil prices, the more channels appear to play vital roles in global economy. One of the significant roles is the transmission of prosperity from oil consumers to oil producers. The other factor is the increase in the cost of services and goods. Moreover, the effect of oil price shocks can be observed on consumer confidence, financial markets and inflation. The studies by Hamilton (1983) and Gisser and Goodwin (1986) reveal that the macroeconomy is adversely affected by oil price shocks, leading to economic recession. Unravelling the roles oil has in the economies of countries such as the US, one may infer that oil and stock prices are in a way interrelated. Provided that stock and oil markets are efficient, a contemporaneous correlation between stock and oil prices exists because of the swift reaction of markets to information shocks and the nature of investor expectations.[2] Such markets are considered to be sensitive to the new information, yet a contemporaneous relationship between these markets is expected from a broader perspective. Therefore, this study aims to investigate the linkage between the stock and oil futures markets.

Some of the empirical studies on the association between oil price and stock market are Chen et al. (1986), Kaul and Jones (1996), Sadorsky (1999, 2001), Huang et al. (1996), Papapetrou (2001), Ciner (2001), El-Sharif et al. (2005), Boyer and Filion (2007) and Nandha and Faff (2008). Kaul and Jones (1996) and Sadorsky (1999) find that oil price movements affect U.S. stock returns. Huang et al. (1996) examine the dynamic linkages between the oil price and the U.S. equity market from a financial market perspective. They find that there is an only predictive power from oil futures to stocks of individual oil companies. However, the study by Ciner (2001) challenges Huang et al. (1996) referring to the further research on the international equity markets. Sadorsky (2001) asserts that oil price increases are sensitive to the stock returns of Canadian oil and gas companies. Papapetrou (2001) used impulse response functions and exhibited that the stock price movements in Greece is affected by

☆ We acknowledge helpful comments from Richard Tol, Editor of Energy Economics, and two anonymous referees. Any errors are our own.
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[2] An efficient stock market is characterized by a random walk process. This point out that market returns cannot be predicted based on its historical observations (Ozdemir, 2008).

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http://dx.doi.org/10.1016/j.eneco.2013.04.014

the oil prices, and that a positive oil price shock is liable to depress the returns. El-Sharif et al. (2005) illustrated that how oil price has exerted a significantly positive impact on oil and gas returns in the UK. However, they found that the sensitivity of non-oil and gas sectors to the oil price shocks in the UK is weak. The forward and futures prices regarding contracts relating to oil have been discussed by a number of researchers, including but not limited to Bopp and Lady (1991), Farmer (1993), Moosa and Al-Loughani (1994) and Foster (1996). The part an oil price factor takes in the elucidation of the systematic impact on the price in equity markets has moreover been discussed in such empirical studies as Hamao (1989), Kaneko and Lee (1995) and Faff and Brailsford (2000).

The inverse association between the oil prices and economic growth is documented effectively in the relevant literature (e.g. Gisser and Goodwin, 1986; Hamilton, 1983; Jones et al., 2004; Zhang, 2008). Much of the research (e.g. Guidi et al., 2006; Mork, 1989; Mork et al., 1994; Mory, 1993; Nandha and Faff, 2008) reveals that the impact of oil price changes on the macro-economy is asymmetric. This imply that oil price increases exert a negative impact on GDP, but the falling tendencies in oil prices do not necessarily result in a positive impact on the output. This suggests nonlinear linkages between oil prices and the stock market. Silvapulle and Moosa (1999), Ciner (2001), and Hammoudeh and Li (2004), noted that the results from the Granger causality tests appear to be sensitive with respect to the countries analysed, the sample period and the methodology employed. They point out that direction of causality is sensitive to the choice of the sample period. Also there are periods where no causality is found along with periods where bidirectional causality between oil futures returns and equity returns is found. Based on these findings, our strategy, then, consists of identifying the periods during which a particular type of causality holds, i.e., a period in which oil futures returns Granger causes stock market returns and vice-versa. This approach also allows us to identify the periods of non-causality and bidirectional causality. The methodology we adopt is based on a VAR model with time-varying parameters, which, given our objectives, directly reflects changes in causality. In this approach, the changes in causality are treated as random events governed by an exogenous Markov process, leading to the Markov switching VAR (MS-VAR) model. In the MS-VAR model, inferences about the changes in causality can be made on the basis of the estimated probability that each observation in the sample comes from a particular causality regime.[3]

The main purpose of this paper is to investigate the regime switching causal nexus between oil and equity markets for the US. The data used are the log returns of monthly crude oil futures contracts traded on the New York Mercantile Exchange and a sub-grouping of S&P500 index. This subgrouping includes the Industry Sector, Energy Sector, Energy Equipment & Services, Oil & Gas & Consumable fuels, Oil & Gas Exploration & Production and Oil & Gas Storage & Transportation indexes. The sample starts on 1995:01 and ends on 2011:07. However, for the Oil & Gas Exploration & Production Index and Oil & Gas Storage & Transportation Index the sample period starts on 1990:02 and ends on 2005:05. Our sample period covers at least five events[4] that had large impacts on stock markets. In practice, contractions and expansions do take time. Empirically we would then expect switches between a normal regime and a transition regime. The causal links between the oil and the stock markets are likely to change and be asymmetric, which are better captured by nonlinear models, such as the MS. For that reason, we use the Markov-switching model partly motivated by the recent success of Markov switching (MS) models in describing time series properties of oil and stock market data. Both the oil and the stock markets frequently switch between contractions and expansions. MS-VAR models are, therefore, natural tools to study whether such switches may have occurred, and if they did, whether the causal links between the series have changed. The type of MS-VAR model we use not only indicates whether there are regime shifts and whether the causal links have changed over the sample period, it also allows us to make formal tests of mean-variance Granger causality within this time-varying parameter approach.

The results obtained from the MS-VAR model clearly show that oil futures price has strongly positive predictive content for each of S&P 500 sub-index during various sub-periods in the sample, while there is weak evidence on the case of vice-versa. Moreover, the results of the empirical analysis suggest that there seems to be an asymmetric relation from oil futures price to each of S&P 500 sub-index returns during various sub-periods in the sample. The tests based on the MS-VAR model rejects the conditional Granger causality in both directions. The regime-prediction causality tests show that while both variables are useful in making inference about the regimes there is support only for regime-prediction Granger causality from oil price shocks to stock market.

The rest of the paper is organised as follows. The next section presents the methodology. Section 3 estimates the model and evaluates the empirical results. The final section concludes.

2. Methodology

The starting point in this paper is not to assume a permanent causal relation between oil and stock markets, but rather adopt a notion of "regime switching" Granger causality. In this approach, a certain type of causality may hold during some periods but not in others. For instance, one regime may allow one way causality from oil futures prices to stock market and another in the opposite direction, leading to time varying causality as the process allows switches between these regimes. Previous researchers have noted that results from Granger causality tests tend to be sensitive with respect to changes in the sample period.[5] They have also observed that the direction of causality is sensitive to the choice of the sample period and also there are periods where no causality found along with periods where there is bidirectional causality between the oil futures and stock market prices. Based on these findings, our strategy then consists of identifying the periods during which a particular type of causality holds, i.e., the periods in which oil futures Granger causes stock prices and vice versa. This approach also allows us to identify the periods of unidirectional, bidirectional causality, and non-causality. The methodology we adopt is based on a VAR model with time-varying parameters where, given our objectives, parameter time-variation directly reflects the changes in causality. In this approach changes in causality are treated as random events governed by an exogenous Markov process, leading to the MS-VAR model. In the MS-VAR model, inferences about the changes in causality can be made on the

[3] The MS-VAR model has several features that make it better suited to study time-varying causal links. First, it allows us to identify the direction of causality for each period in the sample. Second, unlike the conventional Granger causality test, which either rejects or does not reject the non-causality hypothesis, the MS-VAR model provides a more elaborate lead–lag investigation among the variables. For one, the MS-VAR model allows to test both the direct and indirect causality. In the direct test, the lead–lag relationship is investigated conditional on one regime, which is determined by the smoothed probability of the MS-VAR. This test is often called as the conditional Granger causality test. In the conditional Granger causality test, causality may be rejected in one regime while accepted in another. Using other information an MS-VAR system uniquely possesses, the indirect Granger causality test investigates whether a successful prediction can be made about the regime of the next period. This is often referred to as regime prediction Granger causality test. In our case, if we are able to predict the next regime of the stock market using the lagged information from the oil market, then this is the indirect support of the causality. If we cannot, then the regime-prediction or the indirect causality is rejected.

[4] First Gulf Crisis in 1991, Asian financial crises in 1997–98, 9–11 Terrorist Attack in 2001, second Gulf War in 2003, and the global financial crises in 2007.

[5] Several studies found that the Granger causality tests for futures and spot returns are sensitive to sample period. Ciner (2001) finds strong linkage between oil prices and the stock market in the 1990s, but not in the 1970s and 1980s. Silvapulle and Moosa (1999) using daily data covering the period of 1985–1996 reported that futures prices lead spot prices but more importantly there may be a changing pattern of leads and lags over the time period considered.