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On the impacts of oil price fluctuations on European equity markets: Volatility spillover and hedging effectiveness

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ABSTRACT

The objective of this paper is to investigate the volatility spillovers between oil and stock markets in Europe. As not all industries are expected to be equally affected by oil price changes, we conduct our study at both the aggregate as well as sector levels. Empirically, we make use of a recently developed VAR–GARCH approach which allows for transmissions in volatilities. In addition, we analyze the optimal weights and hedge ratios for oil–stock portfolio holdings based on our results. On the whole, our findings show significant volatility spillovers between oil price and sector stock returns, and suggest that a better understanding of those links is crucial for portfolio management in the presence of oil price risk.

1. Introduction

The analysis of the relationships between oil price shocks and stock markets has recently received much attention from finance practitioners and researchers. The primary economic rationale is the potential impacts of oil price changes on stock prices through their effects on corporate cash-flows and earnings, particularly being forced by the context of spectacular oil price fluctuations over the last years. The extent to which stock markets are affected by oil prices can be explained by referring to the theory of equity valuation where stock price is obtained by simply discounting all expected future cash-flows at the investors' required rate of return. Since corporate cash-flows and discount rate reflect economic conditions (inflation, interest rates, production costs, income, economic growth, and market confidence, etc.) which can be influenced by oil shocks (Apergis and Miller, 2009; Park and Ratti, 2008), stock prices may react significantly to patterns in oil price changes.

This present study contributes to the extant literature by investigating the links between oil prices and stock markets in Europe. Unlike previous papers, which focus essentially on the impacts of oil price movements on stock returns using global or country market indices (Basher and Sadorsky, 2006; Fayyad and Daly, 2011; Papapetrou, 2001; Sadorsky, 1999), we use the European equity sector indices to examine the volatility transmission between oil and stock prices. The use of equity sector indices is, in our opinions, advantageous because market aggregation may mask the characteristics, not necessarily uniform, of various sectors. Sector sensitivities to changes in oil price volatility can be asymmetric. Some sectors may be more severely affected by this volatility than the others, depending on whether oil and oil-related products are an input or an output for the industry as well as on the indirect effect of oil prices on the industry, on the degree of competition and concentration in the industry, and on the capacity of the industry to transfer oil price shocks to its consumers. Further, the results of studies based on national stock market index such as Park and Ratti (2008) are likely to reflect considerable differences in industrial structure from one European market to another. Large European markets such as France and Germany are more diversified, whereas small markets such as Switzerland usually concentrate on a few industries. From a portfolio management point of view, identifying the heterogeneity of sector sensitivities to oil implies that there are sectors which can still provide a channel for international diversification during the periods of large swings in oil prices. Our analysis is also motivated by the lack of related attempts in the previous literature, while a better understanding of volatility transmission between oil and stock markets is important for building accurate asset pricing models, generating accurate forecasts of the volatility of both markets, and evaluating the oil risk exposure via

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value-at-risk calculation. Moreover, empirical insights from such study are equally crucial for hedging strategies and derivatives management.

To achieve the objectives of our study, we make use of a recent multivariate econometric technique, vector autoregressive — generalized autoregressive conditional heteroskedasticity model (VAR–GARCH), introduced by Ling and McAleer (2003). One of the main advantages of this model is that it allows us to investigate the shock transmission, the dynamics of conditional volatility, and the volatility spillovers between series. It also provides meaningful estimates of the unknown parameters with less computational complication than several other multivariate specifications, such as the full-factor multivariate GARCH model (Hammoudeh et al., 2009). Furthermore, we are able to employ our empirical findings to compute the optimal weights of an oil–stock portfolio and optimal hedge ratios, as well as to analyze hedging effectiveness. This modeling framework has, to the best of our knowledge, never been employed to study the volatility transmission between oil prices and stock markets.

The remainder of the article is organized as follows. Section 2 discusses the findings of selected previous works on the links between oil price and stock markets. Our empirical methodology is introduced in Section 3. Section 4 presents the data and reports their statistical properties. Section 5 discusses the obtained results. Section 6 provides summary conclusions.

2. A short review of literature

A number of studies have extensively investigated the effects of oil price changes on real economic variables since the 1970s oil price shocks (Hamilton, 1983, 2003; Kilian, 2008; and references therein). It is generally shown that oil price changes significantly affect economic activities for various developed and emerging countries. Inversely, the strand of research on the potential links between oil prices and stock markets has gained ground only recently, and its focus is essentially on broad market indices (national, regional, or global stock market indices).

The study by Jones and Kaul (1996) was the first contribution to examine the reaction of stock markets to oil shocks. The authors consider four developed markets (Canada, Japan, UK and US) and draw empirical results from a standard present value model. They find that changes in stock prices can be partially accounted for by the effect of oil price movements on the current and future cash-flows. Subsequently, Apergis and Miller (2009), Fayyad and Daly (2011), Huang et al. (1996), Park and Ratti (2008), and Sadorsky (1999), among others, also provide evidence of significant responses of stock returns to oil shocks from making use of various approaches such as vector autoregressive (VAR) model, international multifactor asset pricing models, cointegration, and vector error-correction model (VECM). As to emerging markets, oil shocks cause significant changes in stock returns over both the short-run and long-run (Basher and Sadorsky, 2006; Narayan and Narayan, 2010; and Papapetrou, 2001).

Several studies have examined whether oil price changes affect sector stock returns. These studies are also mostly country-specific, and therefore do not permit to conclude on a regional and/or global perspective. For example, the papers of Boyer and Filion (2007) and Sadorsky (2001) show that oil price increases positively affect the stock returns of Canadian *Oil & Gas* companies. El-Sharif et al. (2005) reach the same conclusion for *Oil & Gas* returns in the UK. Non-*Oil & Gas* sectors are, however, weakly linked to oil price changes. Nandha and Faff (2008) question the short-run link between oil prices and thirty-five Datastream global industries and show that the rise in oil price has a negative impact for all industries except *Oil & Gas*. Nandha and Brooks (2009) are concerned by the reaction of the transport sector to oil prices in thirty-eight countries around the world. Their results show the different roles of oil regarding the determination of the transport sector returns for developed countries, but indicate no such evidence in Asian and Latin American countries. More recently, Arouri and Nguyen (2010) use different econometric techniques to examine short-term links between oil and stock prices in the aggregate as well as sector by sector levels in Europe. Their findings reveal two interesting facts: *i*) the reactions of stock returns to oil price changes differ greatly depending on the activity sector; *ii*) the out-of-sample analysis shows that adding oil asset into a diversified portfolio of stocks allows to significantly improve its risk-return characteristics.

To date, little is known about the volatility spillover effects between oil and stock markets. Agren (2006) uses an asymmetric version of the BEKK–GARCH(1,1) model to study the volatility transmission from oil prices to stock markets in five major developed countries (Japan, Norway, Sweden, the U.K., and the U.S.). The author shows strong evidence of volatility spillover from oil to all stock markets studied, except for Sweden. However, the news impact surfaces, which illustrate the estimated one-period ahead forecast impact of an oil shock, reveal only small effects. Using the same model, Malik and Hammoudeh (2007) look at the volatility transmission among the US equity markets, the global crude oil market, and three Gulf equity markets including Bahrain, Kuwait, and Saudi Arabia. They show that Gulf equity markets receive volatility from the oil market, but stock market volatility only spills over into the oil market in the case of Saudi Arabia. In their recent contribution, Malik and Ewing (2009) examine the volatility transmission between oil prices and five US sector indices by adopting bivariate BEKK–GARCH(1,1) models. The sectors considered include Financials, Industrials, Consumer Services, Health Care, and Technology, and the empirical results support the existence of significant transmission of shocks and volatility between oil prices and different stock market sectors. Finally, Chang et al. (2009) use various multivariate GARCH(1,1) models to study volatility spillovers between WTI (West Texas Intermediate) crude-oil futures returns and stock returns of ten worldwide oil companies. Surprisingly, the empirical findings show no volatility spillover effects in any pairs of return series.

The study of Ewing et al. (2002), albeit not directly related to ours, offers for its part several interesting insights about the volatility transmission between the oil and natural gas markets. More precisely, their results show significant direct and indirect transmission of volatility from the natural gas market to the oil market, but only weak evidence of volatility spillover in the inverse direction. According to the authors, these findings can be typically explained by differences in the volatility behavior of the oil and natural gas markets.

Overall, compared to the previous literature, our investigation builds on the recent VAR–GARCH model, and moves from the market-level analysis to a sector-level analysis by taking the stock market sectors in Europe as a case study. It also offers insights into the potential gains of cross-market hedging as well as the sharing of common information by market operators.

3. Econometric method

GARCH-type approach has received a particular interest from almost all previous papers in modeling financial volatility (Agnolucci, 2009; Hassan and Malik, 2007; and Kang et al., 2009). It is commonly accepted that multivariate GARCH specifications such as BEKK, CCC or DCC models are more relevant than univariate models as far as we are concerned by the volatility transmission issue among multiple financial variables.

In this article, we propose to use the VAR(1)–GARCH(1,1) model, introduced by Ling and McAleer (2003) and applied by Chan et al. (2005), Chang et al. (2011) and Hammoudeh et al. (2009) to various economic issues, to investigate the volatility transmission between oil and sector stock prices in Europe as well as to determine the optimal weights and hedge ratios for oil–stock portfolio holdings. Apart from the fact that this model performs quite well in empirical modeling of volatility spillovers as noted by the aforementioned studies, one should remark its two major advantages. First, it permits a multivariate analysis of conditional volatility of the studied series as well as of conditional