Finance Research Letters 18 (2016) 89–99

Contents lists available at ScienceDirect

Finance Research Letters

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

Modelling oil and gas stock returns using multi factor asset pricing model including oil price exposure

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ARTICLE INFO

Article history:
Received 22 December 2015
Revised 25 March 2016
Accepted 3 April 2016
Available online 9 April 2016

JEL classification:
G12

Keywords:
Asset pricing model
Brent crude oil
Asymmetry in oil price
Size effect
Book to market ratio
Oil and gas sector
Oil price exposure
Structural breaks

ABSTRACT

Oil and gas is one of the most important sectors in every economy and the valuation of oil and gas companies becomes quite challenging due to the volatility of crude oil price. The paper investigates the determinants of the UK oil and gas stock returns using multi factor asset pricing model and the existence of asymmetric effects in the Brent crude oil price. Our results show that market risk, oil price risk, size and book-to-market related factors are all relevant in the determination of asset returns of the oil and gas companies quoted on the London stock exchange. Oil price increases and decreases decomposed separately have more effect on the oil companies' stock returns than the normal log changes of the price which show the presence of asymmetric effect. However, the oil price shocks in general do not seem to strongly affect stock returns in oil and gas sector possibly due to horizontal and vertical integration of bigger companies in the sector.

1. Introduction

One of the biggest challenges in the field of finance is how to effectively model the risk and return of financial securities. Researchers have formulated various asset pricing models that tend to explain the determinants of asset returns. Markowitz's (1952) mean-variance analysis provides the foundations of portfolio optimisation. Sharpe (1964) and Lintner (1965) developed a single factor model commonly known as the Capital Asset Pricing Model (CAPM). The main assumption in this model is that asset return is determined by an asset's systematic risk since unsystematic risks of individual assets can be eliminated by diversification in an efficient portfolio. The main criticism of the CAPM is its failure to consider size, value and momentum effect in asset returns. These anomalies have resulted in modifications to the single factor model. Multi-factor asset pricing models such as that of Fama and French's (1993) three factor model and Fama, French and Carhart's (1997) four-factor asset pricing models have been developed to consider other relevant factors in the determination of asset returns. In recent years, the impact of underlying commodity prices such as oil price and its shocks have been incorporated

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http://dx.doi.org/10.1016/j.frl.2016.04.005
1544-6123/

into the multi-factor asset pricing models to analyse stock price dynamics. Broadstock et al (2016) had made an assessment of oil shocks and stock returns of Chinese firms using Fama-French factors. For other similar studies see also Narayan and Sharma (2011), Phan et al (2015a) and Melichar (2016).

In this study we aim to investigate the determinants of asset pricing in the UK oil and gas stocks quoted on the London stock exchange. We plan to adopt a multi-factor asset pricing model like Fama-French-Carhart (1997) model augmented with oil price represented by the Brent crude oil price. The asymmetry in the oil price will also be tested in the model to find the influence of oil price increases as well as decreases. Structural breaks were incorporated into the models to account for the global financial crisis of 2007 to 2008 and the recent falling oil prices between 2014 and 2015.

2. Review of literature

The initial proposition of the Capital Asset Pricing Model (CAPM) was derived from the works of Sharpe (1964) and Lintner (1965) as an extension of Markowitz's mean-variance analysis model (also supported by Mossin (1966)). Fama and French (1993) proposed a three factor asset pricing model designed to overcome some of the limitations observed in CAPM by introducing additional factors like firm size and book to market ratio along with the market risk. Since then, scholars have been confirming the power of the new model in the determination of stock returns than the original CAPM, (Lawrence et al (2007); Gregory et al (2013)). Carhart (1997) suggested that a firm's recent performance has a significant contribution in the determination of its performance in the near future, and thus introduced the fourth factor of momentum effect. The models have been subject to rigorous testing over the years and multi-factor models seem to have slightly more explanatory power than the simple CAPM.

The multi-factor asset pricing models have also been used by researchers to assess the impact of commodity prices on stock returns of firms presumed to have association with that commodity. Oil price risk exposure is one of the most tested in the literature because of the pervasive nature of oil prices. Faff and Brailsford (1999) investigated the impact of oil price on the Australian stock market using a two-factor model including beta and oil price as risk factors. The oil price risk factor's was found to be significant in the oil and gas, paper, packaging and transport sectors. Other firms seemed to be able to transfer most of the oil price risk to customers or managed it with hedging. Phan et al (2015b) investigated the effect of oil price changes on stock returns of oil producers and oil consumers using a similar methodology adopted by Narayan and Sharma (2011) and Arouri (2011). Stock returns of oil producers were found to be positively affected by oil price changes regardless of whether it was an oil price increase or decrease. Asymmetric effects in oil shocks were tested by scholars such as Mork et al (1994) and Mendoza and Vera (2010). Mork et al (1994) studied the macroeconomic responses to the asymmetry in oil prices in some OECD countries and discovered the presence of asymmetric effects in the correlation between oil price and GDP fluctuations. Oil price increases were found to be negatively correlated with GDP fluctuations in most of the countries. Mendoza and Vera (2010) found that oil price increases has more effect on the Venezuelan economy than oil price decreases. Ramos and Veiga (2011) have also confirmed that the oil and gas returns respond to asymmetrical changes in oil price.

The relationship between oil shocks and oil and gas stock returns of Central and Eastern Europe (CEE) markets (Czech Republic, Hungary, Poland, Romania, Slovenia, and Austria) was examined by Mohanty et al (2010) using a two-factor model similar to the one used by Faff and Brailsford (1999). Contrary to the findings of Faff and Brailsford (1999), Mohanty et al (2010) found no significant relationship between oil prices and stock returns over the period of the study between 1998 and 2010. Mohanty and Nandha (2011) estimated the oil price risk exposure of the US oil and gas sector using Fama-French-Carhart's four factor asset pricing model. The model was expanded by an additional risk factor of the monthly changes in oil price using West Texas Intermediate (WTI). The results of this study show that systematic risk, size, book-to-market ratio and fluctuation in oil price are all significant in explaining the variations in the US oil and gas stock returns. The impact of oil price fluctuation varies over time and also depends on firm type and industry subsectors (exploration, equipment services and integrated oil and gas). The risk exposure was found to be higher in exploration and oil equipment services companies. In addition, periods of economic crisis and oil market instability are also found to have resulted in higher risk exposure in the US oil and gas stock returns. The findings comply with that of Manning (1991) who found changes in oil price to have a significant influence on UK oil and gas stocks. Elyasiani et al (2011) examined the association between oil price and stock returns using GARCH (1,1) which is a different technique from the conventional multi-factor pricing model. Mohanty et al (2014) applied Fama-French-Carhart's four factor model augmented with changes in the oil price as an additional risk factor on the US travel and leisure industry. Oil risk exposure was found to be negative in most of the cases and vary considerably over gambling, hotels, airlines, restaurants, recreational services, travel and tourism. The impact of the oil price was found to be more significant on airlines, restaurants and bars and recreational services.

The most common methods used to study the relationship between oil price and oil companies' stock returns are co-integration analysis, multifactor regression model and volatility spill-over analysis (See Chou et al (2012) and Asteriou and Bashmakova (2013)). Structural VAR analysis was employed by scholars such as Wang et al (2013) to investigate the relationship between oil price shocks and stock returns from the perspective of oil importing countries as well as exporting countries.