OIL PRICES CHANGES AND VOLATILITY IN SECTOR STOCK RETURNS: EVIDENCE FROM AUSTRALIA, NEW ZEALAND, CHINA, GERMANY AND NORWAY

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Abstract

The paper examines the exposure of sectoral stock returns to oil price changes in Australia, China, Germany, New Zealand and Norway over the period 2000-2015 using weekly data drawn from DataStream. The issue of volatility has important implications for the theory of finance and as is well-known accurate volatility forecasts are important in a variety of settings including option and other derivatives pricing, portfolio and risk management (e.g. in the calculation of hedge ratios and Value-at-Risk measures), and trading strategies (David and Ruiz, 2009).
This study adopts GARCH and EGARCH to understand the relationship between the returns and volatility. The findings using GARCH (EGARCH) models suggests that in the case of Germany eight (nine) out of ten sectors returns can be explained by the volatility of past oil price in Germany, while in the case of Australia, six (seven) out of ten sector returns are sensitive to the oil price changes with the exception of Industrials, Consumer Goods, Health care and Utilities. While in China and New Zealand five sectors are found sensitive to oil price changes and three sectors in Norway, namely Oil & Gas, Consumer Services and Financials. Secondly, this paper also investigated the exposure of the stock returns to oil price changes using market index data as a proxy using GARCH or EGARCH model. The results indicated that the stock returns are sensitive to the oil price changes and have leverage effects for all the five countries. Further, the findings also suggests that sector with more constituents is likely to have leverage effects and vice versa. The results have implications to market participants to make informed decisions about a better portfolio diversification for minimizing risk and adding value to the stocks.

Keywords: Oil price, Sector returns, Volatility, GARCH, EGARCH

1. INTRODUCTION

Two issues that inspired this research: Firstly, sector specific studies and secondly, studies from a mix of countries that are popular in Europe and Asia-pacific regions. Due to the crucial role of the oil in the world economy and the dynamics of oil price changes, it is necessary to study the relation between oil price and stock returns in sectors. Following (Sadorsky, 2001), the focus of research on oil prices and stock market returns shifted from examining the impact of oil shocks on the entire market to the specific oil and gas sector. This approach provides an in depth understanding and enables identification of the commonalities/systematic effects in the region surrounding the oil price and equity value dynamics. Basher and Sadorsky (2006) have undertaken an extensive study by including 21 countries from emerging markets and examined the relationship between oil price risk and emerging stock market return. Their study was not sector specific and it did not include China, Japan, Malaysia and Singapore.

The five countries of the study includes: Australia, New Zealand, China, Germany and Norway and each of them have different degree of dependence level on oil. Besides, not many researchers selected Germany and New Zealand as the target markets to do the study at the sector level.

There are several contributions in this study. Firstly, this study can be used to illustrate the sensitivity of the sectoral stock price in five countries to the oil price change. Although some researches have paid attention to study the relation between oil price and stock return, this study has three different aspects comparing with previous researches. The first aspect is that includes a set of countries from developed and emerging economies. The second aspect is it presents a context to look into the sensitivities of the ten sectors as a consequence of oil price changes.

The paper is organized as follow. Section 2 presents review of literature. Section 3 describes the data source and methodology. Section 4 presents the findings and Section 5 concludes.

2. LITERATURE REVIEW

According to the stock dividend discount model, the stock price is the discounted value of future enterprises net profit, so the oil price shocks can quickly be reflected in the stock market for short-term and long-term impact on the economy. As a consequence, studying the volatility on stock market to the oil price is more meaningful. The previous literature show researchers studied the impact and influence on oil price fluctuations on the stock market. Most of them believe that oil price changes have a certain degree of influence on the stock market.

2.1 Findings with national or regional type of sensitivity

Previous studies have proved that market returns have impacts on oil price changes. For example, Fayyad and Daly (2010) investigate the relationship between oil prices and stock market returns in seven countries (Kuwait, Oman, United Arab Emirates, Bahrain, Qatar, UK and US). They find the tripled oil prices created a solid currency cash impact on the GCC countries which lead to a lack of cash flow problems in US and UK economy. Empirical survey using daily data from September 2005 to February 2010, authors discovered and confirmed that at the time of the impact of the global financial crisis, oil prices on the stock market returns in the trend of rising oil prices have increased, Qatar, the United Arab Emirates in the GCC countries and UK reacted more strongly to the oil market comparing with other countries.

Miller and Ratti (2009) analyzed the long term relationship between the world oil price and international stock markets using vector error correction model, excluding the data in three years which are 1980:5, 1988:1 and 1999:9 using VAR model. They find the stock markets have a negative reaction to the rising oil prices. However, after the year 1999:9, this relationship did not exist which confirms a speculation that the relationship between the stock markets and oil market have changed in recent decades. What is more, the findings in this study also explain the stock market bubble and oil market bubble in the beginning of this century.

In addition, Kilian and Park (2009) only focus on the U.S. stock returns to analyse demand and supply shocks in the international oil market. They divide three different causes for the oil price shocks: supply shocks, the expected demand for the information of the macroeconomic and impact of the uncertainty of the expected future oil supply and other factors specific t the formation of the oil market demand shocks. It was found that, although the overall impact of oil price fluctuations can explain 22% of the US stock market, the demand is greater than the impact of the explanatory power of supply shocks.

Further, there are several literatures that have the same markets as this paper. For instance, Park and Ratti (2008) find that the rise in oil prices for the oil exporting countries, US and 13 European countries using VAR model from Jan 1986 to Dec 2005. Norway has a positive correlation statistical significance and the impact of oil price changes impact on the real stock returns of 6%. They imply markets can be affected by oil price changes in most of sample countries and markets changes can impact on the stock price changes. For many oil importing countries in Europe, the rise in oil prices has a negative impact on stock market returns. Thus, oil price shocks have a significant influence on real stock markets in all the European countries in the sample. In terms of spillover effect, only UK shows a negative effect on the oil price. The last result is that countries, US and Norway, have small asymmetric effects on stock returns of oil shocks.

Li, Zhu and Yu (2012) examine the connection between oil prices and sectoral stock market in China from 2001 to 2010. They find an evidence to show that when oil price increase, sectoral stock can get a positive impact in the long term. No matter the long term or the short term, the interest rate and oil prices are bidirectional.

2.1.1 Using GARCH model

Arouri et al. (2011) investigate the return links and volatility transmission between oil and stock markets in the Gulf Cooperation Council (Bahrain, Kuwait, Oman, Qatar, Saudi, Saudi Arabia and UAE) with daily data. They collect the daily data in six countries that all belong to GCC from 2005 to 2010 to study the return and volatility transmission between oil prices and stock market. They find the evidence through a VAR-GARCH approach to show the shock and volatility spillovers between oil and stock markets are significant in most cases. Gomes and Chaibi (2014) use BEKK-GRACH model to analyse the transmission of shocks and volatility between oil prices and Frontier stock markets (twenty-one nations) which are coined by IFC from MSCI. They suggests significant volatility interaction between oil and some of frontier stock market and transmissions in the many sample market are bidirectional which means spillover effect can appears both from oil to stock markets and stock to oil markets. However, this findings are different from other researchers, the spillover effect in developed stock markets is usually unidirectional which runs more from oil to stock markets.

Further, Lin, Wesseh and Appiah (2014) investigate 574 weekly observations from 2000 to 2010 to exam the volatility and transmission between oil and Ghanaian stock market returns. They set the developed GARCH frameworks, like VAR-GARCH, VAR-AGARCH and DCC-GARCH. They show an existence of significant volatility spillover and interdependence between oil and stock market returns with is consisted with the findings from Arouri. Lu, Liu and Tseng (2010) use two monthly data to explore the volatility transmission between shocks to the oil price and inflation by adopting GARCH model in Taiwan from 1986-2008. They get the conclusion that oil price changes are sensitive to the inflation. One result from the GARCH model is that volatility in oil price can be used to explain the price level in the whole market.

Using EGARCH model

Lis, Nebler and Retzmann (2012) focus their topic on the impact of oil price on automotive companies in US, Germany and Japan. They use OLS and EGARCH model. They conclude that car companies stocks do not overreact to crude oil price increase and German companies are the most sensitive to the oil price changes while Japanese companies do not show any excess sensitivity to the oil price changes.

Lake and Katrakilidis (2009) investigate the impacts on oil price returns and oil price volatility on four countries, namely Greece, America, United Kingdom and Germany. They utilize the EGARCH model to find that Greek and US stock markets both are sensitivity to the oil price changes whereas German and UK stock market are not impacted. Another findings is that America and Greece are more independent on oil imports than United Kingdom.

Su (2010) investigates stock returns volatility in China during pre-crisis period and crisis period. The author applies daily data from 2000 to 2010 to both GARCH and EGARCH models. After comparing with two models, EGARCH is better fits the sample data than GARCH model to analyse the volatility. In addition, Zhang and Chen (2011) study the effect of oil price shocks on stock market in China. Daily data from 1998 to 2010 are used and EGARCH model is adopted. They also separated volatilities into three types, expected, unexpected and negatively unexpected. They find the oil decrease is not constant to the market and the jump size is sensitive to the volatility. The second finding is that stock market in China is only related to expected volatility. The last one is that the performance of stock in China is not good when the negative shock on oil market happen.

Bhar (2009) give the evidence of the relationship between equity market and the index futures market in Australia using EGARCH model. The results suggest long term equilibrium relationship can affect conditional mean returns in two markets. The information from two markets is still associated with the second moments. In addition, the spillovers in the market show asymmetric behavior.

2.2 Findings with industrial type of sensitivity

Some studies suggest that changes in the price of oil have sensitivities to the type of industry which means the effects on the stock market in different industries are different. Such as, Faff and Brailsford (1999) investigate how Australia stock returns are sensitive to oil prices using time serious data. Australia Stock Exchange and Direct Requirement Coefficients are adopted in this paper to collect data. The methodology they adopted is two factor models. They find all industries have significant positive sensitivity to market factor, but not many have significant positive sensitivity to oil price factor. Oil and gas and Diversified Resources are two sectors that have significant positive sensitivity to oil price changes. Whereas Paper and Packing, Transport industries and Banking industry have significant negative sensitivity to oil price changes. And the sensitivities seem like to be a long term phenomenon.

Future, Nandha and Faff (2008) analyse monthly frequency data in global industries indices from 1983 to 2005 to study impact of oil price shocks on stock market returns. Standard market model-oil price factor is adopted in this paper. They find oil price changes have a negative impact on equity returns in all the industries, excluding mining, oil and gas industries using global equity indices which contain 35 industries sectors. What's more, interest rates can be affected by a higher oil prices and consumer confidence can also be depressed. No matter oil prices increase or decrease, oil prices have a symmetric effect on stock markets.

2.2.1 Using GARCH model

Arouri et al. (2011) use two indices to explore do oil prices changes can react to the industry level in Europe and USA using VRA-GARCH model. They do find the evidence about significant volatility interaction in oil and stock market sectors. Generally, the spillover is only from oil market to stock market in Europe while its bidirectional in USA. Financial and Utilities in Europe and Automobile & Parts, Financial, Industrials and Utilities sectors in US, have significant impacts on oil market volatility. Automobile & Parts in Europe and oil markets have no significant direct effects with each other. However, this sector in the US has significant bilateral volatility spillovers.

Sadorsky (1999) using GARCH model proved oil price and changes in oil prices had a real impact on the stock market. He also confirms the impact of changes in oil prices have an effect on the real economy asymmetry. Especially after 1986, the oil price is even better than interest rate to explain the mistakes of variance forecast on real rate of return on equity. He suggest oil price changes can affect economic while economic activity changes have little effect on oil prices. In some aspects, this finding is similar with Arouri et al. (2011). He also believe that oil price movements can be regarded as a good variable to explain stock returns.

Broadstock and Filis (2014) also consider industrial sector indices when they exam the relation between oil price shocks and stock market returns in US and China using VAR-GARCH model and monthly data. Four sectors, namely Metals & Mining, Oil & Gas, Retail and technology, have positive effects on oil prices changes. Correlation between oil price shocks and stock returns are time-varying in both two countries. But US markets are more responsive to the oil price shocks than markets in China. Metals & Mining and Oil & Gas are positive to the oil price changes in two countries. This finding is same with some previous literature, such as Nandha and Faff (2008); Elyasiani et al., (2013); Faff and Brailsford (1999). In terms of banking sector, Chinese banking is more responsive to oil price shocks than US banking sector.

Elyasiani, Mansur and Odusami (2013) provide an analysis of the relation between equity returns in different industrial sectors in USA and oil prices changes. They investigate ten major sectors in US and use FIGARCH model to analyse. In term of sector analysis, several sectors are sensitive to the rising oil price which is coal, oil-gas services, building, air transport and depository institutions. The coal sector has a strong substitution effect when the oil price has high volatility while in the low volatility period, the substitution is weak. In addition, oil –related sectors experience higher demand and prices which can lead to high stock returns when oil returns increase. This finding is similar with Nandha et al., (2008). However, oil prices increase will have a negative effect on oil-consuming sectors.

Elyasiani et al. (2013) use the daily data from 1983 to 2006 to explore the problem of sectoral stock return sensitivity to oil changes. They employ a double-threshold FIGARCH model. They find when the oil prices with an increase trend in the volatile oil market time, the threshold values are positive. In addition, oil prices do not play an important role in determining sector returns when the oil prices are less volatile. When the oil price in oil market shows an upward trend, the threshold values are positive while in the case of downward trend, the threshold values sign mixed.

Malik and Ewing (2009) estimate mean and conditionals variance in five different sectors in US, namely financials, industrials, consumer services, health care and technology. Weekly data from 1992 to 2008 are collected and the bivariate GARCH model is adopted in this study. The volatility of oil returns is influenced by financials sector which shows a positive shock in the financials market is related to a decrease volatility in oil returns. Technology is the only sector that has a shock effect indirectly from oil returns. Thus, Consumer Services and Health care have both direct and indirect effect when oil price changes. The last returns in Industrials sector affect the oil return volatility indirectly.

3. DATA DESCRIPTION

This study focused on five countries, namely Australia, China, Germany, New Zealand, Norway, which sector stock prices data are available from Datastream. About the studies in oil price changes impact on stock returns in sector level are relatively limited. Each equity indices has 10 sectoral constituents on DataStream, and they are Oil & Gas, Basic Materials, Industrials, Consumer Goods, Healthcare, Consumer Services, Telecommunications, Utilities, Financials and Technology. The weekly data (stock returns and crude oil) of the study are drawn from DataStream for the period 2000 to 2015 are expressed in the currency of United Stated Dollars. Weekly returns of sector prices are calculated by the weekly prices data using the natural log between two successive prices. As suggested by Arouri et al. (2011), the weekly data is used because it will be able to counter potential biases which may emerge from using daily or monthly data and it also captures the movements between oil and sector prices.

Figure 1. Brent oil price

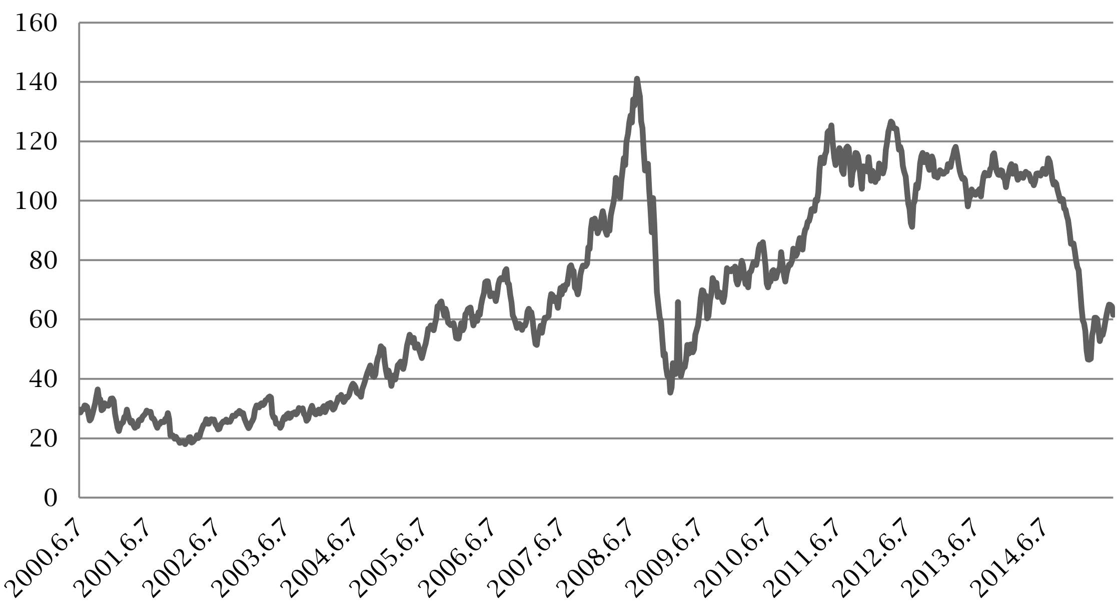

Fig. 1 illustrates the Brent crude oil price from 2000 to 2015. We can find clearly that the oil price is relative low at the beginning and there is a slow growth from 2000 to 2006 at above 20 U$/BBL. After this increase, a small fall shows up in 2007. Then, oil price climbs dramatically to the peak which the figure is about large than 140 U$/BBL. However, there is a sharply decrease between 2008 and 2009. Three years after the financial crisis, the oil price stages a recovery. From 2011 to 2014, there are several fluctuates with a wide range. It is noticeable that at the year 2014, the oil price starts dropping significantly. After 2014, a growth trend of oil price appears.

Table 1 to Table 5 show the descriptive statistics for log returns in five countries I computed before.

Table 1. Descriptive statistics of Australia sector returns

	Mean	*Standard Deviation*	*Kurtosis*	*Skewness*	*Range*	*Min.*	*Max.*
Brent Crude oil	0.0009	0.0460	13.5090	-0.2347	0.7679	-0.3684	0.3994
Oil & Gas	0.0002	0.0626	211.6874	-10.7594	1.4762	-1.2602	0.2160
Basic	0.0032	0.0545	56.8219	2.9276	1.1149	-0.3341	0.7808
Con Gd	0.0035	0.0960	185.1635	10.2072	2.3904	-0.6032	1.7872
Con Ses	0.0005	0.0389	27.8756	-2.7451	0.62947	-0.4574	0.1721
Industrials	0.0036	0.0675	351.9468	15.2336	1.8093	-0.2618	1.5475
Financials	0.0020	0.0350	5.7593	-0.7000	0.3854	-0.2283	0.1571
Health	0.0020	0.0394	84.400	-5.0704	0.8458	-0.6259	0.2199
Tele	-9.8E-05	0.0355	4.3003	-0.6913	0.3832	-0.2210	0.1622
Utilities	0.0029	0.0540	147.1816	5.2302	1.5644	-0.6043	0.9601

From the table, we can see the Industrials sector can be regarded as the best performance of all the sectors in the Australia which has the highest mean returns (0.0036). Consumer Goods sector has the second largest mean return that is 0.0035 and following is Basic Materials. The returns in Basic materials, Consumer Goods, Industrials, Health care, Utilities and Financials sectors are all higher than Brent Crude oil returns. However, Telecommunication sector has the negative mean returns in Australia. All Kurtosis coefficients are larger than three means the distribution of the observations is sharper than a normal distribution. In addition, the skewness coefficient in Oil & Gas, Consumer Services, Financials, Health care and telecommunication are all the negative figures than shows most values are concentrated on the right of the mean while the rest are all concentrated on the left of the mean.

Table 2. Descriptive statistics of China sector returns

	Mean	*Standard Deviation*	*Kurtosis*	*Skewness*	*Range*	*Min.*	*Max.*
Brent Crude oil	0.0009	0.0460	13.5090	-0.2347	0.7679	-0.3684	0.3994
Oil & Gas	0.0033	0.0507	26.8501	1.9398	0.8462	-0.2401	0.6061
Basic	0.0033	0.0631	15.8126	1.4084	0.9072	-0.2573	0.6498
Con Gd	0.0051	0.0843	104.1474	3.5070	2.2004	-0.8408	1.3596
Con Ses	0.0048	0.0616	81.2546	-3.6480	1.4165	-0.9532	0.4634
Industrials	0.0067	0.0758	86.0375	5.9612	1.4768	-0.2718	1.2050
Health Care	0.0053	0.0799	118.9415	3.6308	2.1941	-1.0198	1.1743
Financials	0.0081	0.0857	251.7875	13.2386	1.9958	-0.2110	1.7849
Technology	0.0059	0.0775	85.1592	6.0961	1.5397	-0.4296	1.1102
Tele	0.0038	0.1375	542.0436	21.2659	3.7051	-0.1960	3.5091
Utilities	0.0037	0.0502	20.2007	1.4538	0.8230	-0.3939	0.4292

In China, we can see the Financials sector has the highest mean return (0.0081) and the next sector is Industrials sector (0.0067). All the mean returns in ten sectors in China are all larger than the mean in Brent Crude oil return. Telecommunication sector has the largest standard deviation which means this sector has more volatility than other sectors. The situation of Kurtosis coefficients are as the same as the Australia which are all positive. However, only Consumer Services sector has the negative value in Skewness. This means in the historic data of Consumer Services sector there has values with extreme small values. Generally speaking, China receives more returns in all sectors than sector returns in Australia which the values are much higher than values in Australia.

Table 3. Descriptive statistics of Germany sector returns

	Mean	*Standard Deviation*	*Kurtosis*	*Skewness*	*Range*	*Min.*	*Max.*
Brent Crude oil	0.0009	0.0460	13.5090	-0.2347	0.7679	-0.3684	0.3994
Basic	0.0020	0.0379	3.4795	-0.4449	0.3856	-0.2001	0.1856
Con Gd	0.0018	0.0434	11.9037	0.0451	0.6821	-0.3059	0.3762
Con Ses	0.0007	0.0402	19.8276	-1.2012	0.7261	-0.4174	0.3087
Financials	0.0003	0.0475	51.3486	-2.7783	1.0617	-0.6432	0.4185
Health Care	0.0009	0.0382	133.1144	-8.4737	0.7885	-0.6589	0.1296
Industrials	-0.0002	0.0401	3.1153	-0.3676	0.3874	-0.1881	0.1993
Technology	-0.0003	0.0449	5.2629	-0.7413	0.5072	-0.3175	0.1898
Tele	-0.0009	0.0441	3.8582	0.0214	0.4617	-0.1799	0.2818
Utilities	0.0012	0.0442	97.0476	5.4950	0.9397	-0.2089	0.7309

It is the Basic Materials sector that has the greatest mean value among nine sectors in Germany which is almost as twice as the returns of Brent crude oil mean returns. The second greatest returns are in the Consumer Goods sector. Industrials, Telecommunication and Technology are all negative values on mean return. All the Kurtosis coefficients are all greater than three, especially the value in health care that indicate the values concentrate around the mean values and the distribution has thicker tails. There are three positive values in the skewness coefficients, Consumer goods, Technology and Utilities, which means these three sectors have extreme large values and the asymmetrical distribution has a long tail to the right.

Table 4. Descriptive statistics of New Zealand sector returns

	Mean	*Standard Deviation*	*Kurtosis*	*Skewness*	*Range*	*Min.*	*Max.*
Brent Crude oil	0.0009	0.0460	13.5090	-0.2347	0.7679	-0.3684	0.3994
Oil & Gas	0.0010	0.1018	415.6150	-15.9655	3.3917	-2.4130	0.9787
Basic	-0.0023	0.1038	435.5485	-18.1055	2.8258	-2.5074	0.3185
Con Gd	0.0015	0.0654	62.1089	-2.6083	1.4831	-0.8452	0.6380
Con Ses	0.0010	0.0333	17.7616	-1.8281	0.5350	-0.3373	0.1978
Industrials	0.0074	0.1095	402.7996	17.2789	3.1608	-0.5722	2.5886
Health Care	0.0020	0.0455	181.1534	-9.4613	1.1365	-0.8760	0.2605
Financials	0.0009	0.0344	21.4266	-2.2288	0.5444	-0.3317	0.2127
Tele	-0.0004	0.0372	2.1507	-0.5046	0.3185	-0.1916	0.1269
Utilities	0.0024	0.0368	26.6147	1.1092	0.6286	-0.2586	0.3700

Returns in Oil & Gas, Consumer Services and Financials sectors are similar with the returns in Brent Crude oil whereas returns on Basic Materials and telecommunication sectors are negative. Industrials sector has the highest mean returns and following is Utilities sector. One difference with previous three countries is that Kurtosis coefficient in Telecommunication sector is 2.1507 which are less than three. As a consequence, we can say the distribution in Telecommunication sector is flatter than a normal distribution with a wild peak. Skewness coefficients in two out of nine sectors (Utilities and Industrials) in New Zealand are positive which show a right skewed distribution in two sectors with extreme values to the right. And the rest sectors, namely, Oil and gas, Industrials, Basic materials, Consumer goods, Consumer Services, Health care and Financials are in the opposite way, the right skewed distribution.

Table 5. Descriptive statistics of Norway sector returns

	Mean	*Standard Deviation*	*Kurtosis*	*Skewness*	*Range*	*Minimum*	*Maximum*
Brent Crude oil	0.0009	0.0460	13.5090	-0.2347	0.7679	-0.3684	0.3994
Oil & Gas	0.0021	0.0552	35.0893	2.1747	0.9957	-0.3035	0.6921
Basic	0.0027	0.0927	144.3194	-1.4620	2.8376	-1.5029	1.3347
Con Gd	0.0044	0.0907	253.2004	11.1885	2.7040	-0.8097	1.8943
Con Ses	0.0001	0.0854	168.1281	-9.0792	2.0072	-1.6205	0.3867
Industrials	0.0010	0.1715	264.2309	1.3638	6.1339	-2.9679	3.1660
Financials	0.0022	0.0524	10.3096	-1.2361	0.6772	-0.3732	0.3040
Technology	0.0000	0.0982	101.6578	-5.2771	2.4039	-1.6124	0.7914
Tele	0.0051	0.1372	563.2042	21.7654	3.9857	-0.4497	3.5360
Utilities	0.0024	0.1028	72.5332	-0.2037	2.4953	-1.3087	1.1866

In Norway, the highest returns are in the sector Telecommunication and the second highest returns are in the Consumer Goods, the third is the Utilities. Standard deviation in three sectors are higher than 0.1. Compared with other four countries, sectors in Norway suffer the most volatility. All the Kurtosis coefficients are higher than three, this means high probability for extreme values. Skewness coefficients in Oil & Gas, Consumer Goods, Industrials and Telecommunication are all positive.

In general, both China and Norway have better sector returns without negative values than Australia, Germany and New Zealand. Meanwhile, industrials sector receives more returns in Australia and New Zealand than other three countries, Financials sector in China has highest returns. Sectors with highest return in Germany and Norway are Basic Materials and telecommunication separately. Among five countries, Norway has the most volatility in the sector returns because this country has the largest standard deviation. All of the kurtosis in five countries are sharper than the normal distribution due to the values are all larger than three, except Telecommunication in Norway.

4. METHODOLOGY

We can see from the above literature review, research methods about affecting the oil market on the stock market are mainly focus on three ways which are concluded as follow. Firstly, the researchers adopt the oil price as the factors that can affect the stock market into the multi-factor model; the second is using VAR (Vector Autoregression) model to study the spillover effect between rate of oil price changes and stock yields; using multivariate GRACH model to analyse mutual spillover between oil price volatility and stock price volatility is the third method. According to Engle (2001), GARCH model is the most fundamental and robust one in the volatility models, which can be extended and formed into many ways. As a consequence, this paper uses GARCH model and EGARCH model.

In the finance, a large number of data series presents non-predictability. They can showed in the formula $\varphi(y_{t-1}, y_{t-2}, \dots) = 0$. Engle (1982) proposed and used the following finite-parameter model:

$$Y_t = S(Y_{t-1}, Y_{t-2}, \dots)\epsilon_t = H_t^{1/2}\varepsilon_t$$

$$H_t = \alpha_0 + \alpha_1 Y_{t-1}^2 + \alpha_2 Y_{t-2}^2 + \dots + \alpha_p Y_{t-p}^2$$

$$\alpha_0 > 0, \alpha_i \geq 0, i = 1, 2, \dots, p$$

In this formula, $\{\varepsilon_t\}$ is the i.i.d random sequence, $\varepsilon_t \sim N(0, 1)$, ε_t and $\{Y_{t-1}, Y_{t-2}, \dots\}$are independent, in order to simplify the notation, which denoted by $H_t = S^2(Y_{t-1}, Y_{t-2}, \dots)$. This model is called autoregressive conditional heteroscedasticity model, abbreviated ARCH (p), where p is the order of the model. Although the ARCH model is simple, it can only be fit when the observations are large enough which easily lead to an estimated shortage of degrees of freedom.

After Engle (1982) ARCH model proposed, this model are concerned by the most applicators, especially the financial sector. Later years, this also has been paid attention in the theory of time series analysis. There is no doubt that ARCH model has a pioneering meaning to the study of time series analysis theory and applied researches. In GARCH model theory and application, it is natural to ask: in the formula, y_t conditional variance

$$S^2(Y_{t-1}, Y_{t-2}, \dots) = H_t = \alpha_0 + \alpha_1 Y_{t-1}^2 + \alpha_2 Y_{t-2}^2 + \dots + \alpha_p Y_{t-p}^2$$

Bollerslev (1986) made the following broader model, namely GARCH model:

$$Y_t = S(Y_{t-1}, Y_{t-2}, \dots)\epsilon_t = H_t^{1/2}\varepsilon_t$$

$$H_t = \alpha_0 + \alpha_1 Y_{t-1}^2 + \alpha_2 Y_{t-2}^2 + \dots + \alpha_p Y_{t-p}^2 + \beta_1 H_{t-1} + \dots + \beta_q H_{t-q}$$

$$\alpha_0 > 0, \alpha_i \geq 0, i = 1, 2, \dots, p;\ \beta_j \geq 0, j = 1,2, \dots, q.$$

Wherein $\{\varepsilon_t\}$ is the i.i.d random sequence, $\varepsilon_t \sim N(0, 1)$, ε_t and $\{Y_{t-1}, Y_{t-2}, \dots\}$ are independent.

ARCH and GARCH model are based on the fluctuation symmetry presentation, but according to French, Schwert and Stambaugh (1987) and Nelson (1991) noted that the existence of the phenomenon of fluctuating for asymmetry market for good news and bad news, and the bad news are more apt to cause a greater degree of volatility than good news for the next issue. In the GARCH model, the conditional variance depends on the size of the residuals instead of depending on the sign of the residuals. However, this model has the limitation. GARCH model assume the magnitude of unanticipated excess returns determines σ_t^2. There is evidence that, for example, Black (1976) pointed out that the volatility of assets and asset returns are negatively correlated. That is, when securities prices, yield positive, volatility decreased; when asset prices fall, yield losses, volatility rises. In fact, some experience has shown that the higher the volatility of that period is often closely related to the decline in the stock market, and low volatility during that period is often closely related to the rise in the stock market. To describe this situation, Nelson (1991) proposed EGARCH. Its form is as follows:

$$Log\sigma_t^2 = \omega + \sum_{k=1}^{q} \beta_{\ k} g(Z_{t-k}) + \sum_{k=1}^{p} \alpha_{\ k} log\alpha_{t-k}^2$$

$$g(Z_t) = \theta Z_t + \gamma(|Z_t| - E|Z_t|$$

Note that σ_t^2 is the conditional variance, ω, β, α, θ and γ are coefficients, and Z_t may be a standard normal variable or come from a generalized error distribution.

EGARCH conditional variance is to establish a model of asymmetric function, which allows positive and negative hysteresis values have different effects on volatility. Logarithmic allow negative residuals, but the conditional variance itself cannot be negative. This model can be expected a better estimate the volatility for the stock returns because the EGARCH counteracts the limitations on the GARCH model.

In discussing the phenomenon of asymmetric volatility model widely used by researchers, such as Nelson (1991) the exponential GARCH model proposed (Exponential GARCH, EGARCH) and Zakoian (1994) threshold type GARCH model proposed (Threshold GARCH, TGARCH).

According to the description of above, this study should be adopted GARCH and EGARCH models. GARCH model is especially suitable for analysis and forecasting volatility. Such an analysis can provide an essential guiding role for investors when they make investment decisions which the meaning is more important than the values themselves on the analysis and predictions. EGARCH model can provide better analysis of volatility clusters and leverage effect in the financial markets.

5. RESULTS

All the three distribution in both GARCH and EGARCH model are done, namely normal distribution, Student's t distribution and Generalized error distribution. According to the values of AIC and SIC, this study chooses Student's t distribution showing in this part because of this distribution with the lowest AIC and SIC. In the terms of AIC and SC, both AIC and SC penalize for the number of predictors in the model and the lower the better. All models are did the ARCH effect first and post ARCH effect.

Table 6. Oil & Gas sector Predicting Volatility using GARCH (1,1) Model-Student's t distribution

Oil & Gas	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
Conditional mean equation					
Mean Equation C	0.0039	0.0036	-0.0003	0.0031	0.0041
	(0.0017)	(0.0070)	(0.9102)	(0.0128)	(0.0019)
B	0.0291	0.0601*	0.0997*	0.0677***	0.0723**
	(0.2990)	(0.0756)	(0.0526)	(0.0072)	(0.0311)
Conditional variance equation					
Variance Equation C	5.81E-06	0.0001***	0.0039***	1.62E-05	0.0002***
	(0.1070)	(0.0069)	(0.0010)	(0.3246)	(0.0029)
$\beta\alpha^2_{0,t-1}$(ARCH)	0.0020***	0.1118***	0.2066*	-0.0002*	0.1242***
	(0.0027)	(0.0006)	(0.0697)	(0.0588)	(0.0007)
$\alpha\varepsilon^2_{t-1}$(GARCH)	0.9931***	0.8215***	0.1702	0.9929***	0.8014***
	(0.0000)	(0.0000)	(0.3659)	(0.0000)	(0.0000)
AIC	-3.5720	-3.4569	-2.6409	-3.5508	-3.4055
SIC	-3.5362	-3.4212	-2.5883	-3.5150	-3.3697

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

5.1 Findings from GARCH mode

Table 6 gives us the information about the GARCH model for oil & gas sector stock returns and crude oil returns in five countries. Because of the unavailable data in Germany, Germany has few observations than other countries. In the constant of mean equation, we can find the P value in coefficient β is significant in the New Zealand in 1% significance level which indicates significant independencies between Oil & Gas sector returns and oil returns. On the contrary, the β does not show significant interdependencies in Australia, China and Germany. However, in the variance equation, P values in β are significant in Australia, China and Norway which indicates the two variables are significant correlation. In addition, the coefficients in α term are all highly significant, except Germany. Combining with all the values, we can get a conclusion that previous oil prices can affect oil & gas sector stock now in Australia, China and Norway. The Oil & Gas sector in these three countries are sensitive to the oil price changes.

Table 7. Basic Materials Sector Predicting Volatility using GARCH (1,1) Model-Student's t distribution

Basic Materials	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
		Conditional mean equation			
Mean Equation C	0.0056	0.0020	0.0045	0.0043	0.0047
	(0.0000)	(0.2548)	(0.0000)	(0.0007)	(0.0008)
β	0.0256	0.0802	0.0019	0.0156	-0.0023
	(0.4034)	(0.0602)	(0.9361)	(0.5902)	(0.9444)
		Conditional variance equation			
Variance Equation	0.0001***	0.0004***	4.75E-05**	0.0036	0.0033***
C	(0.0036)	(0.0058)	(0.0498)	(0.6946)	(0.0000)
$\beta\alpha^2_{o,t-1}$***(ARCH)***	0.1381***	0.1871***	0.0956***	-0.0004	0.6514***
	(0.0012)	(0.0005)	(0.0007)	(0.8336)	(0.0056)
$\alpha\varepsilon^2_{t-1}$***(GARCH)***	0.7893***	0.7136***	0.8782***	-0.3407	-0.0024
	(0.0000)	(0.0000)	(0.0000)	(0.9204)	(0.2848)
AIC	-3.5082	-2.9851	-3.9108	-3.4416	-3.1345
SIC	-3.4724	-2.9493	-3.8750	-3.4058	-3.0987

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 7 illustrates the GARCH model for Basic Materials sector stock returns and crude oil returns in five countries. In the mean equation, the P values of constant are low in four countries, Australia, Germany, New Zealand and Norway. The coefficients in the mean equation are not significant. On the contrary, the P values in the variance equation are all near zero in coefficients β, implying the relation between Basic Materials sector stock returns and oil returns are significant, except New Zealand. New Zealand does not have a significant α either. What's more, the coefficients α in the four countries are all near to 1 which are Australia, China and Germany. These can provide the evidence that oil prices can influence the Basic Materials stock returns in three countries significantly, namely Australia, China and Germany. In these three countries, oil price changes can be used to explain the movements of Basic Materials sector returns.

Table 8. Industrials Sector Predicting Volatility using GARCH (1,1) Model-Student's t distribution

Industrials	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
		Conditional mean equation			
Mean Equation	0.0036	0.0036	0.0032	0.0034	0.0037
C	(0.0009)	(0.0260)	(0.0034)	(0.0003)	(0.0113)
β	0.0144	0.0321	-0.0059	0.0130	-0.0062
	(0.5187)	(0.3974)	(0.8174)	(0.5648)	(0.8480)
		Conditional variable equation			
Variance Equation C	0.0013	0.0010***	0.0001***	-0.0449	0.0174
	(0.8224)	(0.0003)	(0.0042)	(0.2481)	(0.7800)
$\beta\alpha^2_{o,t-1}$***(ARCH)***	-0.0007	0.2745***	0.1656***	0.0320***	-2.29E-05
	(0.9434)	(0.0010)	(0.0005)	(0.0000)	(0.9922)
$\alpha\varepsilon^2_{t-1}$***(GARCH)***	0.2915	0.5211***	0.7767***	-0.0395***	-0.2247
	(0.9261)	(0.0000)	(0.0000)	(0.0000)	(0.9579)
AIC	-3.8222	-2.9808	-3.8052	-3.9360	-3.0171
SIC	-3.8085	-2.9450	-3.7695	-3.8943	-2.9813

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 3 indicates the GARCH model for Industrials sector stock returns and crude oil returns in five countries. In the mean equation, none of the P-values in the coefficients β are in significant level. These values in the mean equation do not indicate the relation between Industrials stock returns and crude oil returns is significant. In the variable equation, due the P values are at 1% the significant level of coefficients β, the variables are significant relevant in China, Germany and New Zealand. Thus, the degree of correlation is quite high according to the β values show significant interdependencies between Industrials stock returns and crude oil returns. Both α and β are insignificant in the Australia and Norway. Because of the P-values in coefficients α, one finding can be get that is the past oil prices are able to have an impact on Industrials stock returns in China, Germany and New Zealand.

Table 9 reports the GARCH model for Consumer Goods sector stock returns and crude oil returns in five countries. In the mean equation, P-values of constant are significant in all five countries. However, P-values in coefficients β are insignificant which do not suggest the independence of sector returns and oil returns. In the variable equation, only two countries, Germany and Norway, show the oil prices returns significantly influence the volatility of the stock returns at 1% level.

Table 9. Consumer Goods Sector Predicting Volatility using GARCH (1, 1) Model-Student's t distribution

Consumer Goods	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
			Conditional mean equation		
Mean Equation	0.0024	0.0030	0.0041	0.0028	0.0041
C	(0.0349)	(0.0351)	(0.0002)	(0.0083)	(0.0009)
β	0.0090	-0.0313	-0.0165	0.0074	0.0529
	(0.7048)	(0.2770)	(0.5437)	(0.7686)	(0.0691)
			Conditional variable equation		
Variance Equation C	0.0067***	0.0038***	0.0001***	0.0017	0.0016***
	(0.0000)	(0.0010)	(0.0064)	(0.5343)	(0.0000)
$\beta\alpha^2_{o,t-1}$(ARCH)	-0.0003	0.2737**	0.1879***	0.0282	0.3723***
	(0.4946)	(0.0266)	(0.0000)	(0.5661)	(0.0001)
$\alpha\varepsilon^2_{t-1}$(GARCH)	-0.9857****	0.0419	0.7671***	0.7956***	-0.0008
	(0.0000)	(0.7775)	(0.0000)	(0.0000)	(0.9796)
AIC	-3.5972	-3.1406	-3.8172	-3.6247	-3.4458
SC	-3.5618	-3.1048	-3.7815	-3.6110	-3.4100

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

The coefficients α in Australia, German and New Zealand are significant and also suggest the oil price do significantly influence the stock returns in these three countries. Considering both mean equation and variance equation, the Consumer Goods stock returns can be affected by the past oil prices only in Germany, the substantial effects of past oil price can price volatility on the current stock returns.

Table 10. Consumer Services Sector Predicting Volatility using GARCH (1,1) Model-Student's t distribution

Consumer Services	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
			Conditional mean equation		
Mean Equation C	0.0032	0.0052	0.0030	0.0041	0.0062
	(0.0013)	(0.1220)	(0.0041)	(0.0000)	(0.0002)
β	0.0371	0.0597	-0.0350	-0.0092	0.0147
	(0.1223)	(0.4129)	(0.1464)	(0.6454)	(0.7098)
			Conditional variable equation		
Variance Equation C	0.0003***	0.0026	8.07E-05***	5.48E-05**	0.0017***
	(0.0007)	(0.5183)	(0.0077)	(0.0329)	(0.0001)
$\beta\alpha^2_{o,t-1}$(ARCH)	0.2376***	-0.004792***	0.1533***	0.0412**	0.2926***
	(0.0004)	(0.0000)	(0.0001)	(0.0245)	(0.0028)
$\alpha\varepsilon^2_{t-1}$(GARCH)	0.5655***	0.4211	0.7954***	0.9058***	0.3902***
	(0.0000)	(0.6405)	(0.0000)	(0.0000)	(0.0008)
AIC	-3.9961	-3.0200	-3.9354	-4.2660	-2.9327
SIC	-3.9604	-2.9842	-3.8996	-4.2302	-2.8970

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 10 illustrates the GARCH model for Consumer Services sector stock returns and crude oil returns in five countries. The remarkable value in the table is the P-value of China in the constant in mean equation, which is 0.1220 and this is the only value that is insignificant. P-values in coefficients β in five countries are all insignificant. In the variable equation, β in four countries are significant for all series at the 1% level of significance and in New Zealand is significant at 5% significance level. It shows the relation between Consumer Services sector stock returns and oil returns are significant. The ARCH term do indicates significant interdependencies between oil returns and stock returns. The coefficient α is significant in four countries, except in China. The coefficients α and β show past volatility in oil price can have an influence on the Consumer Services stock now in Australia, Germany, New Zealand and Norway.

Table 11. Health care sector Predicting Volatility using GARCH (1,1) Model-Student's t distribution

Health care	***Australia***	***China***	***Germany***	***New Zealand***
		***Conditional* mean equation**		
Mean Equation C	0.0033	0.0027	0.0033	0.00453
	(0.0006)	(0.0240)	(0.0000)	(0.0000)
β	0.0234	0.0179	0.0136	0.0050
	(0.2620)	(0.5052)	(0.4045)	(0.7992)
		Conditional variable equation		
Variance Equation C	0.0021***	0.0002*	0.0002	0.0009***
	(0.0000)	(0.0728)	(0.6597)	(0.0000)
$\beta\alpha^2_{0,t-1}$***(ARCH)***	0.0032	-0.0020*	-0.0012	0.0260
	(0.6567)	(0.0511)	(0.5285)	(0.3714)
$\alpha\varepsilon^2_{t-1}$***(GARCH)***	-0.8460**	0.9563***	0.7451	-0.0463
	(0.0310)	(0.0000)	(0.2024)	(0.3560)
AIC	-4.1327	-3.4633	-4.5104	-4.2047
SIC	-4.0970	-3.4275	-4.4746	-4.1689

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value*

Table 11 shows the GARCH model for Health care sector stock returns and crude oil returns for five countries. One thing should be mentioned in here, the data in Norway does not available in the Database, therefore in the model of this sector only has four countries. The P values in the mean equation are large, no matter constant or coefficients β. According to the insignificant values and as such do not indicate interdependence of returns in the mean equation. As we can see, all the P values in the variable equation show the insignificant correlation between Health care stock returns and oil returns in four countries, with the P-values are all large. No matter in ARCH term or the GARCH term, the P-values all large, implying the past oil price cannot affect the Health care stock returns now. In other words, past oil prices cannot be used to predict the volatility of Health care sector returns in Australia, China, Germany and New Zealand.

Table 12. Technology sector Predicting Volatility using GARCH (1,1) Model-Student's t distribution

Technology	***Australia***	***China***	***Germany***	***New Zealand***	***Norway***
		Conditional mean equation			
Mean Equation C	0.0044	0.0029	0.0021	0.0015	0.0059
	(0.0017)	(0.1516)	(0.0642)	(0.5740)	(0.0004)
β	0.0422	0.1563	0.0079	0.0297	-0.0157
	(0.1553)	(0.0003)	(0.7844)	(0.5606)	(0.6764)
		Conditional variance equation			
Variance Equation	0.0006***	0.0027***	3.72E-05**	0.0015**	0.0011**
C	(0.0046)	(0.0000)	(0.0369)	(0.0287)	(0.0427)
$\beta\alpha^2_{0,t-1}$***(ARCH)***	0.1489**	0.0974**	0.1062***	0.1776**	0.1755*
	(0.0157)	(0.0365)	(0.0000)	(0.0416)	(0.0744)
$\alpha\varepsilon^2_{t-1}$***(GARCH)***	0.6143***	-0.0231**	0.8750***	0.5855***	0.7748***
	(0.0000)	(0.0426)	(0.0000)	(0.0000)	(0.0000)
AIC	-3.3740	-3.0381	-3.7024	-2.6493	-2.7415
SIC	-3.3370	-3.0023	-3.6666	-2.5913	-2.7057

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 12 illustrates the GARCH model for Technology sector stock returns and crude oil returns for five countries. In the mean equation, the P values in β in China shows significant indicates only China has significant interdependencies between Technology sector returns and oil returns. On the variance equation side, P values in coefficients β are all significant in the at least 5% significance level, except Norway. As a consequence, the values of the variance equation β do indicate significant interdependencies between oil returns and Technology returns in four countries. The large α and β mean the substantial effects of past oil prices can influent the volatility of Technology stock returns. However, coefficient α in Norway is significant while coefficient β is insignificant. As a result, Technology sector return in Norway is not sensitive to the oil price changes. In general, we still can get the finding that oil price in Australia, China, Germany and New Zealand can predict Technology stock returns nowadays.

Table 13 illustrates the GARCH model for Telecommunications sector stock returns and crude oil returns in five countries. In the mean equation, the P value of constant is low in the Norway whereas others are quite high. Only China has significant β in mean equation. On the country, the P values in the variance equation are less than 1% in the ARCH term, implying significant interdependencies between telecommunication sector returns and oil returns. What's more, P-values in coefficients α in the Australia, China, Germany and New Zealand are all 1 and coefficient α in China, Germany and New Zealand are all above 0.90. Evenα is significant and β is insignificant, this sector in Norway cannot be impacted by oil price changes. These can provide the evidence that oil prices can influence the Telecommunications stock returns in four countries significantly, namely Australia, China, Germany and New Zealand.

Table 13. Telecommunication Sector Predicting Volatility using GARCH (1,1) Model-Student's t distribution

Telecom	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
			Conditional mean equation		
Mean Equation	0.0018	-0.0006	0.0014	0.0014	0.0049
C	(0.0830)	(0.7010)	(0.2565)	(0.2137)	(0.0005)
β	-0.0082	0.0767	-0.0277	-0.0030	-0.0314
	(0.7559)	(0.0208)	(0.3178)	(0.9177)	(0.3734)
			Condition variable equation		
Variance Equation C	4.44E-05**	0.0002*	1.54E-05	1.96E-05	0.0020***
	(0.0474)	(0.0884)	(0.1525)	(0.1401)	(0.0000)
$\beta\alpha^2_{0,t-1}$(ARCH)	0.0757***	-0.0003***	0.0414**	0.0386***	0.4260***
	(0.0011)	(0.0000)	(0.0053)	(0.0061)	(0.0001)
$\alpha\varepsilon^2_{t-1}$(GARCH)	0.8884***	0.9566***	0.9475***	0.9457***	0.0036
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.9131)
AIC	-4.0004	-3.0094	-3.6536	-3.8463	-3.2755
SIC	-3.9646	-2.9737	-3.6178	-3.8105	-3.2397

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 14. Utilities Sector Predicting Volatility using GARCH (1,1) Model-Student's t distribution

Utilities	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
			Conditional mean equation		
Mean Equation	0.0029	0.0012	0.0019	0.0038	0.0032
C	(0.5010)	(0.2971)	(0.0467)	(0.0000)	(0.0109)
β	-0.0054	0.0018	-0.0009	-0.0006	0.0504
	(0.9446)	(0.9449)	(0.9668)	(0.9767)	(0.0785)
			Conditional variable equation		
Variance Equation C	0.0021	0.0004**	0.0003**	0.0017	0.0009
	(0.4783)	(0.0158)	(0.0224)	(0.1189)	(0.4722)
$\beta\alpha^2_{0,t-1}$(ARCH)	-0.0049	0.1591**	0.0898**	-0.0080	0.0340
	(0.2666)	(0.0190)	(0.0400)	(0.1983)	(0.4745)
$\alpha\varepsilon^2_{t-1}$(GARCH)	0.5383	0.7422***	0.7396***	-0.4722	0.9403***
	(0.4147)	(0.000)	(0.0000)	(0.6170)	(0.0000)
AIC	-3.2405	-3.6523	-4.0324	-4.2035	-3.1599
SIC	-3.2047	-3.6175	-3.9967	-4.1678	-3.1242

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 14 reports the GARCH model for Utilities sector stock returns and crude oil returns in five countries. In the mean equation, New Zealand is the only country that P value of constant is low. None values in the β are significant, In the variable equation, only China and Germany have coefficients β are significant which show he significant interdependencies between the lag Utilities sector returns and the oil prices returns. In addition, coefficients α are significant in China and Germany as well. Despite βin Norway is significant, due to αis insignificant, oil prices do not influence Utilities sector in Norway. All the mean and variable equation suggest that Utilities stock returns can be affected by the past oil prices in only China and Germany, the substantial effects of past oil price can price volatility on the current stock returns.

Table 15. Financials Sector Predicting Volatility using GARCH (1,1) Model-Student's t distribution

Financials	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
Conditional mean equation					
Mean Equation	0.0042	0.0007	0.0026	0.0030	0.0053
C	(0.0000)	(0.5519)	(0.1562)	(0.0002)	(0.0000)
β	-0.0125	0.0423	-0.0373	-0.0218	-0.0130
	(0.5908)	(0.1056)	(0.1562)	(0.2334)	(0.6693)
			Conditional variable equation		
Variance Equation C	4.29E-05***	0.0002	4.59E-05**	3.11E-05*	0.0001***
	(0.0091)	(0.3852)	(0.0328)	(0.0629)	(0.0045)
$\beta\alpha^2_{0,t-1}$(ARCH)	0.1704***	0.0001	0.1239***	0.0195**	0.1746***
	(0.0000)	(0.9048)	(0.0001)	(0.0419)	(0.0003)
$\alpha\varepsilon^2_{t-1}$(GARCH)	0.7964***	0.9056***	0.8519***	0.9540***	0.7714***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AIC	-4.2125	-3.5305	-3.8609	-4.3568	-3.5736
SIC	-4.1768	-3.4948	-3.8252	-4.3210	-3.5378

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 15 shows the GARCH model for Financials sector stock returns and crude oil returns in five countries. Australia and New Zealand have fewer observations because of the unavailable data. P values in constant are significant for all series at 1% level significance in the mean equation Australia, New Zealand and Norway. No values in coefficients β are significant. In the variance equation, the coefficient β indicates significant interdependencies between the oil price returns and Financials returns in Australia, Germany, New Zealand and Norway. Meanwhile, the coefficients α are all significant in five countries. Considering all the values in this table, one finding is that the past volatility of oil prices has an effect on the Financials sector in all countries, except China.

To sum up, there are signify differences in each sector. In Oil & Gas sector, returns in this sector in Australia, China and Norway can be affected by past oil price changes. Basic Materials sector can be influenced by oil price volatilities in Australia, China, Germany and Norway. Industrials sector in three countries, China, Germany and New Zealand, can be influent by past oil prices. Oil prices changes can have an impact on the Consumer Goods sector only in Germany. Returns in Consumer Services sector are sensitive to the oil price volatilities in Australia, Germany, New Zealand and Norway. In technology sector, returns in this sector in Australia, China, Germany and New Zealand can be affected by past oil price changes. Telecommunication sector can be influenced by oil price volatilities in Australia, China, Germany and New Zealand. Oil prices changes can explain the movements of returns in Utilities sector in China and Germany. Oil prices changes can have an impact on the Financials sector in Australia, Germany, New Zealand and Norway. The above nine sector all have countries are sensitive to the oil price and the relation between oil prices and stock returns is significant. Over all, these results point out that countries and sectors listed above and crude oil price have a significant correlation with each other according to the statistics in the model. Only one sector named Health care which oil prices do not influence the returns in this sector in all five sample countries. In the country level, six sectors in Australia can significantly affected by oil prices changes, namely Oil & Gas, Basic Materials, Consumer Services, Technology, Telecommunication and Financials. Five sectors in China are sensitive to the oil price changes, which are Oil & Gas, Basic Materials, Consumer Services, Technology, Telecommunication and Utilities. Oil price volatilities have an effect on eight out of ten sectors in Germany, except Oil & Gas and Health care. The last country Norway, oil price can affect on four sectors, Oil & Gas, Basic Materials, Consumer Services and Financials. Germany has the most sectors can be impacted by the oil price changes whereas Norway has the least.

Therefore, one conclusion can be summed up that oil prices have the ability to predict the stock returns in sectors. This finding is same with the Broadstock et al. (2014), Elyasiani et al. (2013) and Kang et al. (2015). Because the sectors stock returns are sensitivity to the past oil price changes, oil price volatility can have an impact on the time horizon of investment. Consequently, investors and companies need to adjust their management portfolios accordingly.

Table 16. Oil & Gas Sector Predicting Volatility using EGARCH Model-Student's t distribution

Oil & Gas	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
			Conditional Mean Equation		
C	0.0040	0.0037	-0.0010	0.0032	0.0027
	(0.0017)	(0.0065)	(0.6755)	(0.0106)	(0.0425)
Oil returns	0.0262	0.0531	0.0849	0.0654	0.0795
	(0.3850)	(0.1077)	(0.1485)	(0.0126)	(0.0176)
			Conditional Variance Equation		
ω	-0.1738**	-0.5022***	-0.2989**	-0.8774	-0.3143***
	(0.0276)	(0.0024)	(0.0461)	(0.2600)	(0.0013)
α	0.0835***	0.2189***	0.0901**	0.0535	0.1271***
	(0.0041)	(0.0000)	(0.0153)	(0.1412)	(0.0011)
γ	0.0336	-0.0197	-0.0546*	0.0134	-0.1171***
	(0.1889)	(0.5222)	(0.0761)	(0.6312)	(0.0001)
β	0.9821***	0.9465***	0.9555***	0.8631***	0.9647***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
T-DIST	4.6765***	6.4096***	3.2543***	3.3049***	4.8051***
	0.0000	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AIC	-3.5928	-3.4576	-2.6685	-3.5521	-3.4516
SIC	-3.5511	-3.4158	-2.6070	-3.5104	-3.4099

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

5.2 Findings from EGARCH model

Table 16 shows the EGARCH model for Oil & Gas sector stock returns and crude oil returns in five countries. In the variance equation, according to the values, I can find that the leverage effect γ is negative and significant in Norway. Rest P-values in coefficients γ are all quite large. Narayan and Narayan (2007) explain if $\gamma > 0$, the meaning is positive shocks generate higher volatility than bad shocks, vice versa. As a result, this value means good shocks generate less volatility than bad shocks in Norway. Coefficients α in all countries are significant, except New Zealand. This indicates that volatility in the Oil & Gas sector stock returns are sensitive to the oil price in Australia, China, Germany and Norway. This result is similar with the finding in GARCH model in this sector. Coefficients β are quite large and significant that are all above 0.9, except New Zealand which is 0.8631.

Table 17. Basic Materials Sector Predicting Volatility using EGARCH Model-Student's t distribution

Basic Materials	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
Conditional Mean Equation					
C	0.0054	0.0014	0.0036	0.0037	0.0040
	(0.0000)	(0.4043)	(0.0006)	(0.0025)	(0.0021)
Oil returns	0.0342	0.0849	0.0064	0.0127	-0.0125
	(0.2513)	(0.0503)	(0.7907)	(0.6612)	(0.6748)
Conditional Variance Equation					
ω	-0.4817***	-0.3829***	-0.1898***	0.0134	-0.0655***
	(0.0000)	(0.0033)	(0.0014)	(0.6336)	(0.0018)
Α	0.1790***	0.1828***	0.0521*	-0.0027	0.0512***
	(0.0000)	(0.0000)	(0.0601)	(0.7720)	(0.0000)
Γ	-0.1082***	-0.0533**	-0.1155***	-0.0208***	-0.0128
	(0.0005)	(0.0323)	(0.0000)	(0.0045)	(0.2361)
Β	0.9449***	0.9574***	0.9786***	1.0025***	0.9950***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
T-DIST	4.1479***	5.4064***	4.8745***	2.8487***	3.2031***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AIC	-3.5446	-2.9980	-3.9438	-3.46678	-3.1882
SIC	-3.5028	-2.9562	-3.9021	-3.4261	-3.1465

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 17 indicates the EGARCH model for Basic Materials sector stock returns and crude oil returns in five countries. In this model, value of γ in Norway is not significant. The rest γ are significant and negative which means the past returns can influence the rest volatility of Basic Materials sector returns. This also shows where a positive shock has less effect on the conditional variance compared to a negative shock. Germany has the largest γ. Therefore, Basic Materials sector in Australia, China, Germany and New Zealand have leverage effect. In addition, coefficients α are all above 0.1 and significant as well in Australia, China and Norway. Generally, the Basic Materials sector is less sensitive to the oil price changes than Oil & Gas sector. Coefficient β are all above 0.9, especially in New Zealand that is 1.0025, which shows the volatility in this sector needs a long time to die out.

Table 18. Industrials Sector Predicting Volatility using EGARCH Model-Student's t distribution

Industrials	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
Conditional Mean Equation					
C	0.0030	0.0029	0.0030	0.0034	0.0034
	(0.0038)	(0.0765)	(0.0064)	(0.0003)	(0.0044)
Oil returns	0.0229	0.0376	0.0015	0.0130	0.0155
	(0.3568)	(0.3261)	(0.9551)	(0.5648)	(0.6581)
Conditional Variance Equation					
ω	-0.3731***	-0.8386***	-0.4718***	-0.0449	-0.2265***
	(0.0051)	(0.0020)	(0.0003)	(0.2481)	(0.0044)
Α	0.1157***	0.2566***	0.1559***	0.0320***	0.0572***
	(0.0000)	(0.0001)	(0.0001)	(0.0000)	(0.0002)
γ	-0.1061***	-0.1504***	-0.0886***	-0.0395***	0.0003
	(0.0000)	(0.0017)	(0.0010)	(0.0000)	(0.9744)
β	0.9561***	0.8823***	0.9465***	0.9966***	0.9655***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
T-DIST	3.9307***	3.6986***	4.4014***	3.0206***	2.6596***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AIC	-3.8887	-3.0135	-3.8193	-3.9360	-3.0633
SIC	-3.8469	-2.9718	-3.3337	-3.8943	-3.0216

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 18 illustrates the EGARCH model for Industrials sector stock returns and crude oil returns in five countries. From Table 18, we can find the leverage is negative and significant in Australia, China, Germany and New Zealand. As a result, there is a negative correlation between the past oil returns and future Industrials stock returns in these four countries. Coefficient γ in China is the largest which means the Industrials firms in the China suffer the greatest risk of the volatility. Thus, the coefficients α are significant which all above 0.1. This means stock returns of Industrials sector are sensitive to the past oil prices. Coefficients β are significant as well with high values which means the volatility in this sector last for a long term.

Table 19. Consumer Goods Sector Predicting Volatility using EGARCH Model-Student's t distribution

Consumer Goods	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
Conditional Mean Equation					
C	0.0025	0.0031	0.0034	0.0028	0.0037
	(0.0237)	(0.0273)	(0.0015)	(0.0089)	(0.0027)
Oil returns	0.0067	-0.0423	-0.0085	0.0095	0.0347
	(0.7848)	(0.1681)	(0.7489)	(0.7059)	(0.2443)
Conditional Variance Equation					
ω	-2.2250**	-0.3968**	-0.6281***	-0.8896*	-0.4653***
	(0.0398)	(0.0467)	(0.0001)	(0.0544)	(0.0022)
α	0.1465**	0.0878**	0.2512***	0.1181	0.1284***
	(0.0307)	(0.0331)	(0.0000)	(0.1918)	(0.0002)
γ	-0.1485**	0.0067	-0.1352***	-0.0772	-0.1007***
	(0.0208)	(0.7965)	(0.0008)	(0.2402)	(0.0002)
β	0.6251***	0.9370***	0.9342***	0.8430***	0.9389***
	(0.0008)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
T-DIST	2.4951***	2.6732***	5.1092***	2.2686***	3.5769***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AIC	-3.6048	-3.1492	-3.8350	-3.633877	-3.4741
SIC	-3.5630	-3.1074	-3.7933	-3.592146	-3.4323

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 19 indicates the EGARCH model for Consumer Goods sector stock returns and crude oil returns in five countries. As we can see, the coefficients γ in the Australia, Germany and Norway are all negative and significant at the significant level. In other words, these three countries suffer more negative shocks than positive shocks. In this sector, among these three countries, Germany has the largest γ which means the leverage effect in Germany is the most significant. What's more, all α are significant, except New Zealand which means this sector in rest four countries is sensitive to the past oil price changes. Thus, all β are significant show the Consumer Goods stock volatility cannot vanish in a short time, particularly in China and Norway.

Table 20. Consumer Services Sector Predicting Volatility using EGARCH Model-Student's t distribution

Consumer Services	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
Conditional Mean Equation					
C	0.0029	0.0018	0.0024	0.0040	0.0049
	(0.0057)	(0.1372)	(0.0123)	(0.0000)	(0.0018)
Oil returns	0.0359	0.0374	-0.0395	-0.0038	-0.0019
	(0.1599)	(0.2007)	(0.1114)	(0.8466)	(0.9611)
Conditional Variance Equation					
ω	-0.3725**	-0.0451*	-0.2599***	-0.3618**	0.0046*
	(0.0199)	(0.0758)	(0.0045)	(0.0105)	(0.0889)
α	0.0968**	0.0479***	0.0722**	0.0863**	-0.0037*
	(0.0175)	(0.0002)	(0.0198)	(0.0396)	(0.0832)
γ	-0.0409	-0.0031	-0.0845***	-0,0420*	-0.0358***
	(0.1480)	(0.7891)	(0.0000)	(0.0889)	(0.0000)
β	0.9562***	0.9977***	0.9705***	0.9573***	1.0011***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
T-DIST	4.8499***	3.1122***	5.6463***	4.0109***	3.3012***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AIC	-4.0072	-3.4776	-3.9550	-4.2815	-2.9599
SIC	-3.9655	-3.4359	-3.9133	-4.2398	-2.9182

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 20 reports the EGARCH model for Consumer Services sector stock returns and crude oil returns in five countries. One noticing thing is that only two countries which are Germany and Norway have leverage effect with all the coefficient γ are negative and significant. This indicates the Consumer Services firms in two countries, where positive oil shocks have less effects on the firms compared to negative shocks. γ in Germany is larger than Norway, the value in Germany is almost as twice as the values in Norway. There are more γ are significant in Germany. α in Australia, China, Germany and New Zealand are all significant which mean the oil price have an impact on the stock returns. β in five countries are significant means the volatility last long.

Table 21. Health care Sector Predicting Volatility using EGARCH Model-Student's *t*- distribution

Health care	*Australia*	*China*	*Germany*	*New Zealand*
		Conditional Mean Equation		
C	0.0028	0.0025	0.0031	0.0044
	(0.0029)	(0.0432)	(0.0000)	(0.0000)
Oil returns	0.0169	0.0248	0.0103	0.0056
	(0.4324)	(0.3534)	(0.5204)	(0.7769)
		Conditional Variance Equation		
ω	-0.0379	-0.3459	0.0029	-8.8562***
	(0.2475)	(0.0287)	(0.9114)	(0.0074)
α	0.0226	0.0409	-0.0044	0.0959
	(0.1502)	(0.1294)	(0.5365)	(0.2364)
γ	-0.0251	-0.0182	-0.0269***	-0.0268
	(0.1070)	(0.4745)	(0.0000)	(0.6719)
β	0.9971***	0.9423***	1.0004***	-0.2949
	(0.0000)	(0.0000)	(0.0000)	(0.5462)
T-DIST	4.2022***	2.5502***	4.3667***	3.3941***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AIC	-4.1635	-3.4594	-4.5401	-4.1967
SIC	-4.1218	-3.4176	-4.4983	-4.1550

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 21 indicates the EGARCH model for Health care sector stock returns and crude oil returns in five countries. There is on index in this sector in Norway, so this model does not include Norway. Germany has the only significant γ, implying Germany has negative returns which translates to a low equity prices. On the contrary, the statistics in other three countries do not show the evidence of leverage effect. Coefficient α in four countries are all insignificant. It is reliable to believe the Health care sector is not sensitive to the oil prices changes. This finding is same with the finding in the GARCH model in this sector. Large β with significant P-value means volatilities need long time to die out in Australia, China and Germany.

Table 22. Technology Sector Predicting Volatility using EGARCH Model-Student's *t*-distribution

Technology	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
			Conditional Mean Equation		
C	0.0034	0.0023	0.0012	0.0016	0.0051
	(0.0130)	(0.1116)	(0.3123)	(0.5583)	(0.0023)
Oil returns	0.0435	0.0517	0.0117	0.0323	-0.0156
	(0.1864)	(0.0989)	(0.6891)	(0.5278)	(0.6806)
			Conditional Variance Equation		
ω	-0.3605***	-0.5898	-0.1555***	-1,4491**	-0.2127***
	(0.0026)	(0.2057)	(0.0010)	(0.0456)	(0.0027)
α	0.1135***	0.0850	0.0903**	0.2974**	0.0632**
	(0.0020)	(0.1245)	(0.0108)	(0.0314)	(0.0467)
γ	-0.1300***	-0.0536	-0.0950***	-0.0194	-0.0654**
	(0.0000)	(0.1875)	(0.0000)	(0.8284)	(0.0155)
β	0.9544***	0.9032***	0.9876***	0.7592***	0.9671***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
T-DIST	4.5207***	2.8390***	6.8863***	3.2279***	2.7382***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AIC	-3.4106	-3.1631	-3.7163	-2.6481	-2.7733
SIC	-3.3679	-3.1214	-3.6746	-2.5804	-2.7316

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 22 measures the EGARCH model for Technology sector stock returns and crude oil returns in five countries. Only three countries, γ in Australia, Germany and Norway are significant and negative, have leverage effect. Therefore, bad shocks generate more volatilities than good shocks in Australia, Germany and Norway. Australia has the largest γ. α in China is not significant which means Technology stock returns in China is not sensitive to the oil price while oil prices volatility have an impact on the returns in rest countries. Coefficient β are all significant which means the period of volatilities is long.

Table 23. Telecommunications Sector Predicting Volatility using EGARCH Model-Student's *t*-distribution

Tele	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
Conditional Mean Equation					
C	0.0014	-0.0017	0.0009	0.0010	0.0035
	(0.1880)	(0.2934)	(0.4710)	(0.3709)	(0.0096)
Oil returns	-0.0074	0.0602	-0.0239	0.0033	-0.0201
	(0.7779)	(0.0765)	(0.4112)	(0.9111)	(0.5546)
Conditional Variance Equation					
ω	-0.3693***	-0.4219**	-0.1148***	-0.1130**	-0.1934***
	(0.0030)	(0.0362)	(0.0074)	(0.0213)	(0.0018)
α	0.1222***	0.1022**	0.0546**	0.0329	0.0818***
	(0.0036)	(0.0159)	(0.0542)	(0.1316)	(0.0002)
γ	-0.0778***	-0.1111***	-0.0583***	-0,0472***	-0.1039***
	(0.0093)	(0.0053)	(0.0019)	(0.0000)	(0.0000)
β	0.9600***	0.9358***	0.9854***	0.9872***	0.9787***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
T-DIST	6.6500***	3.2354***	7.2448***	7.7031***	4.4874****
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AIC	-4.0086	-3.0342	-3.6595	-3.8547	-3.3391
SIC	-3.9669	-2.9925	-3.6177	-3.8387	-3.2974

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 23 shows the EGARCH model for Telecommunications sector stock returns and crude oil returns in five countries. All the countries have the leverage effect, due to γ are negative and significant. In this occasion, the returns decrease, the volatilities go up. Thus, the positive oil shocks generate less effect on this sector than negative oil shocks. γ in China is larger than the rest four countries and there are more γ are significant in China. Coefficients αin four countries are significant which suggests changes in oil price can used to explain the movements in Telecommunication sector stock returns in Australia, China, Germany and Norway. Coefficients β are all significant which are all above 0.9, suggesting volatility needs long time to vanish.

Table 24. Utilities Sector Predicting Volatility using EGARCH Model-Student's *t*-distribution

Utilities	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
Conditional Mean Equation					
C	0.0043	0.0011	0.0018	0.0037	0.0024
	(0.0000)	(0.3131)	(0.0517)	(0.0001)	(0.0488)
Oil returns	-0.0121	-0.0055	0.0044	0.0006	0.0717
	(0.5874)	(0.8352)	(0.8388)	(0.9741)	(0.0104)
Conditional Variance Equation					
ω	-0.1706**	-0.3058**	-0.3792**	-10.1037***	-0.0678**
	(0.0185)	(0.0124)	(0.0104)	(0.0083)	(0.0112)
α	0.0609***	0.1469***	0.1022***	-0.0916	0.0579***
	(0.0087)	(0.0023)	(0.0008)	(0.3269)	(0.0002)
γ	-0.0504***	-0.0063	-0.0890***	-0.0430	0.0281***
	(0.0193)	(0.8156)	(0.0012)	(0.5152)	(0.0092)
β	0.9810***	0.9653***	0.9539***	-0.5045	0.9937***
	(0.0000)	(0.0000)	(0.0000)	(0.3664)	(0.0000)
T-DIST	3.2112***	2.9903***	3.4592***	3.2632***	2.3922***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AIC	-4.0374	-3.6692	-4.0688	-4.1991	-3.1905
SC	-3.9947	-3.6275	-4.0528	-4.1574	-3.1488

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 24 indicates the EGARCH model for Utilities sector stock returns and crude oil returns in five countries. According to the significant and negative γ, we can get that Australia and Germany are the only three countries which have the leverage effect where positive shocks have less effects on Utilities sector compared to negative shocks. Norway has the significant P-value with a positive coefficient γ. Therefore, Norway do have leverage effect that negative shocks have less impact on this sector than positive shocks. Germany have the largest γ as well. Meanwhile, coefficients α are significant, except New Zealand, meaning this sector is sensitive to the oil price changes in four countries. β are significant in four countries as well indicating volatilities keep for a long time.

Table 25. Financials Sector Predicting Volatility using EGARCH Model-Student's *t*-distribution

Financials	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
			Conditional Mean Equation		
C	0.0031	0.0003	0.0016	0.0028	0.0049
	(0.0010)	(0.7719)	(0.1234)	(0.0003)	(0.0001)
Oil returns	-0.0094	0.0361	-0.0142	-0.0199	0.0051
	(0.6603)	(0.1807)	(0.5825)	(0.2805)	(0.8582)
			Conditional Variance Equation		
ω	-0.5096***	-0.1133**	-0.2653***	-0.1319**	-0.3642***
	(0.0000)	(0.0310)	(0.0001)	(0.0149)	(0.0007)
α	0.2547***	0.0447**	0.0813**	0.0493*	0.1796***
	(0.0000)	(0.0185)	(0.0256)	(0.0528)	(0.0001)
γ	-0.0971***	-0.0142	-0.1384***	-0.0476**	-0.0577**
	(0.0014)	(0.3799)	(0.0000)	(0.0160)	(0.0440)
β	0.9560***	0.9862***	0.9708***	0.9860***	0.9637***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
T-DIST	11.4097**	3.1404***	7.5434***	3.1583***	4.6682***
	(0.0249)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AIC	-4.2174	-3.5617	-3.8981	-4.3822	-3.5630
SIC	-4.1756	-3.5199	-3.8564	-4.3405	-3.5213

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 25 illustrates the EGARCH model for Financials sector stock returns and crude oil returns in five countries. As we can see, financials sector in four countries have leverage effect because of the significant and negative γ. We can conclude bad shocks have more impacts than good shocks in this sector returns. γ in Germany is larger than the rest countries and there are more γ are significant in Germany. Still all α and β are significant suggest oil price changes influence Financials sector returns.

In general, in the sector level, only Norway in Oil & Gas sector has leverage effect. Australia, China, Germany and New Zealand in Basic Materials and Industrials sectors have leverage effect. In these sectors, Germany and China have the largest value respectively. In Consumer Goods and Technology sector, Australia, Germany and Norway have leverage effect. In Consumer Services, Germany and Norway have leverage effect. Four countries in Financials sector have leverage effect, namely Australia, Germany, New Zealand and Norway. Only Australia and Germany in Utilities sector have leverage effect. Germany is the only country in Health care sector has leverage effect while all countries in Telecommunications sector have leverage effect. Another finding is that past oil price play an essential role in explaining movements in certain sectors in each country which is similar with the finding in GARCH part.

From another sight, in the country level, results from EGARCH confirm that seven sectors in Australia have leverage effect, nine sectors in Germany have leverage effect, only three sectors in China and four sector in New Zealand have leverage effect, the last country Norway, six sectors all have leverage effect. Consumer Goods sector in Australia, Industrials sector in China, Financials sector in Germany, Consumer Goods sector in New Zealand and Oil & Gas sector in Norway have the largest γ among all the sectors have leverage effect. This means positive oil shocks generate less effect on these sectors comparing with other sectors in each countries. Among five sample countries, it is obvious that Germany suffer more leverage effect than other countries.

5.3 Findings from Market returns

Table 26. Constituents in each sector

Constituents	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
Oil & Gas	8	4	5	2	11
Basic Materials	20	3	20	1	3
Industrials	25	9	63	7	10
Consumer Goods	5	7	32	4	6
Consumer Services	29	2	25	9	3
Healthcare	12	1	17	5	
Telecommunications	3	1	4	2	1
Utilities	6	3	9	6	3
Financials	49	20	49	10	10
Technology	4	41	26	4	3

Organized From Datastream

Combining Table 26 with the findings from EGARCH models, we can view a trend that if the sector has more constituents, it is more likely to have leverage effect. Generally speaking, China and New Zealand have fewer constituents, it is likely that the reason to explain fewer sectors in these two countries have leverage effect than other countries. What's more, more constituents in one country in each sector, this sector in this country is more likely sensitive to the oil price changes.

Table 27. Market returns Predicting Volatility using GARCH (1,1) Model-Student's *t*-distribution

Market returns	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
Conditional mean equation					
Mean Equation C	0.0030	0.0003	0.0029	0.0031	0.0038
	(0.0012)	(0.7414)	(0.0016)	(0.0001)	(0.0010)
Oil returns	0.0110	0.0281	-0.0034	0.0032	0.0458
	(0.6219)	(0.2869)	(0.8793)	(0.8618)	(0.1165)
Conditional variable equation					
Variance Equation C	4.3E-05	4.06E-05	4.29E-05	3.69E-05	6.25E-05
	(0.0100)	(0.0275)	(0.0134)	(0.0323)	(0.0169)
$\beta\alpha^2_{o,t}$*(ARCH)*	0.1430***	0.0980***	0.1645***	0.0931***	0.1263***
	(0.0000)	(0.0006)	(0.0000)	(0.0015)	(0.0001)
$\alpha\varepsilon^2_{t,1}$*(GARCH)*	0.8137***	0.8682***	0.7978***	0.8452***	0.8354***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
AIC	-4.2995	-4.0919	-4.2397	-4.6956	-3.8419
SIC	-4.2638	-4.0561	-4.2039	-4.6598	-3.8061

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 28. Market prices Predicting Volatility using EGARCH Model-Student's *t*-distribution

Market price	*Australia*	*China*	*Germany*	*New Zealand*	*Norway*
Conditional Mean Equation					
C	0.0023	0.0005	0.0022	0.0028	0.0027
	(0.0134)	(0.6188)	(0.0197)	(0.0003)	(0.0208)
Oil returns	0.0162	0.0261	0.0012	0.0064	0.0473
	(0.4560)	(0.3142)	(0.9558)	(0.7277)	(0.1010)
Conditional Variance Equation					
ω	-0.5193***	-0.2999***	-0.5896***	-0.5724***	-0.4195***
	(0.0000)	(0.0033)	(0.0000)	(0.0035)	(0.0005)
α	0.2172***	0.1688***	0.1754***	0.1624***	0.1871***
	(0.0000)	(0.0001)	(0.0005)	(0.0016)	(0.0002)
γ	-0.1038***	0.0195	-0.1544***	-0.0614**	-0.0913***
	(0.0001)	(0.2954)	(0.0000)	(0.0382)	(0.0012)
β	0.9513***	0.9755***	0.9372***	0.9408***	0.9594***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
T-DIST	11.8325**	10.7911***	8.1055***	7.4494***	8.4282***
	(0.0157)	(0.0047)	(0.0002)	(0.0000)	(0.0000)
AIC	-4.3054	-4.0935	-4.2612	-4.6936	-3.8468
SIC	-4.2637	-4.0517	-4.2194	-4.6518	-3.8051

*Note: Superscripts *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5% and 1%, level of the significance respectively. Values in brackets are P-value.*

Table 27 illustrates the GARCH model for market returns and crude oil returns in five countries. One noticeable thing is that no matter coefficients α or coefficients β are all significant at the 1% significant level. The large values of α (all around 0.9) indicate effects of past oil price volatilities lead to conditional volatilities of the market prices. The market returns show the same results with the individual sectors as well, oil price changes can explain the market movements and the market is sensitive to the volatility of oil prices.

Table 28 indicates the EGARCH model for Market stock returns and crude oil returns in five countries. The significance of negative coefficients γ suggest that markets in five countries all have leverage effect which means negative shocks have more effect on five markets, compared to positive shocks. The values coefficients γ illustrate Germany has the largest γ which followed by γ in Australia. The largest γ means the leverage effect in Germany is the most significant compared with other countries. This finding is similar with the findings in the EGARCH model. In the EGARCH model, Germany has generally the largest γ in the majority sectors, except Oil & Gas sector. One noticeable finding is that in both GARCH model and EGARCH model, α and β in five countries are all significant. The finding is that it provide an evidence that market in five countries are sensitive to the oil price and the volatility of whole market price need long time to disappear. However, in the GARCH and EGARCH model in each sector, not all the sectors prices are sensitive to the crude oil price changes.

Finally, several suggestions and implications from this part can be get, firstly, when oil price changes and affect stock prices, investors and market participants need to adjust management portfolios with stocks in different sectors. Secondly, participants should look at the sensitivity of the sector stocks to oil price changes. Thirdly, investors need diversify their market portfolios to make optimal decision in order to get more profits.

6. CONCLUSION

This study investigated the relationship between volatility of sector returns and oil price changes in Australia, China, Germany, New Zealand and Norway. It filled the gap in the literature about studies in these countries. This study employs weekly equity data in ten sectors from Datastream from June 7, 2000 to June 7, 2015, using GARCH and EGARCH models. Ten sectors are Oil & Gas, Basic materials, Industrials, Consumer Goods, Consumer Services, Health care, Technology, Telecommunications, Utilities and Financials.

It is found that for the overall GARCH models, eight out of ten sectors returns can be explained by the volatility of past oil price in Germany. The exceptions are the Oil & Gas sector and Health care sector. Six out of ten sectors returns are sensitive to the oil prices changes, except Industrials, Consumer Goods, Health care and Utilities. China and New Zealand all have five sectors which returns can be impacted by the oil prices. Oil price changes can explain the movements in three sectors in Norway, namely Oil & Gas, Consumer Services and Financials. In another words, volatility of oil prices can influence the volatility of certain sector returns in five countries.

There are three findings from the EGARCH model. Firstly, all sectors in Germany have leverage effect, except Oil & Gas. Seven sectors in Australia have leverage effect, excluding Oil & Gas, Consumer Services and Health care. Three sectors in China have leverage effect that are Industrials, Basic Materials and Telecommunications sectors while Basic Materials, Industrials, Telecommunications and Financials sectors in New Zealand have leverage effect. The last country Norway, except Basic Materials, Industrials, Health care and Utilities sectors, the rest sectors all have leverage effect. Secondly, Germany has the largest and negative γ in all the sectors in general. These values suggest that the leverage effect in Germany is more significant than other countries. On the contrary, only one significant and positive γ shows in the Utilities sector in Norway. Positive leverage effect means negative shocks have less effects than positive shocks in Utilities sector. This result is similar with the finding in Park et al. (2008). Thirdly, Consumer Goods sector in Australia, Industrials sector in China, Financials sector in Germany, Consumer Goods sector in New Zealand and Oil & Gas sector in Norway have the largest γ among all the sectors. This means positive oil shocks generate less effect on these sectors comparing with other sectors in each countries.

Using the market index data to analyses, whether in GARCH or EGARCH model, it is surprising to know that the whole market returns are sensitive to the oil price changes and the whole market has leverage effect in each country. The last finding from constituents table tell us is that if the sector have more constituents, it is more likely to have leverage effect. And this is same to the sensitivity on sector returns to the oil price volatility.

According to the findings, there are several implications. Firstly, because of different sectors have different returns, market participants need to adjust their management portfolios with stocks in different sectors when the market environment change which is cause by the oil price changes. Secondly, participants should watch out for the sensitivity of the sector stocks to oil price changes due to the sensitivities in each sector are different. Thirdly, investors need diversify their market portfolios to make optimal decision in order to get more profits.

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