The impact of oil price fluctuation on 28 sectors in Thailand stock market; Asymmetric Response & the portfolio investment.

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Abstract

This paper investigates the impact of oil price change on sector stock return since 1998. We focus mainly of broader indices (sector index) and find the short-term relationship between the sector return and oil price change in Thailand. And we found that the oil play important role into the Thailand stock market. Most sector correspond to the oil price change but they reacted differently. The implication of sector based portfolio investment show that by adding the small portion of oil in portfolio help reducing overall variance of the portfolio.

1.Introduction

Identifying the factor that drive the stock market return is the key for the investor. One of the key variable to investigate is the crude oil. The crude oil play important role in the SET index since the market capitalization mostly was on the ENERGY sector. However, the overall sector that also respond to the oil price change was ignored, so this paper try to investigate all of the link between the 28 sector stock returns and the oil price change. The different sector have different characteristic and therefore different channel from the oil price change transmission into the sector indices. The major study have shown the significant impact of oil price change on the real economy. Balaz and Londarev, 2006; Lardic and Mignon, 2008; Gronwald, 2008; Cologni and Manera, 2008) but very liitle paper try to investigate the relationship between the oil price fluctuation and the single sector and also very little paper about Thailand stock market sector. Therefore, the relationship between the oil price and sector stock return in Thailand seen inconclusive. So, this paper try to provide the case in Thailand stock market by using the short term econometric technique on the time series data. The higher oil price can take many effect in each sector, the effect from oil price might be the higher cost of production, higher cost of transportation, higher selling good of the business, lower economic performance, higher price level, etc. These effects come take place in both positive way or negative way to the corporate firm in each sector. On top of that the asymmetric respond might occur for the oil price change. People may have reacted differently to the oil price increase and oil price decrease. Moreover of the linkage between stock and oil , the investment in oil might have the benefit of portfolio diversification if these sector reacted to the oil price change differently. These are interesting topic to find out.

The paper is organized as following, in section 2 we will present the preliminary analysis and the data. Section 3 will contain the methodology and the result from each analysis. Section 4 will be on the implication on the portfolio investment and the last section being the final conclusion.

Literature review

The main literature review: HEDI AROURI, M. E. AND KHUONG NGUYEN, D.(2010)

Oil prices, stock markets and portfolio investment: Evidence from sector analysis in Europe over the last decade

Which investigate the short-term relationship between the oil price and European stock sector, we follow the methodology from this paper in analysis the short-term impact of oil to sector returns, the paper show the significant impact of oil price change of many sector in EU.
There were many journal about how the oil price change affect the economy in the negative way. For the **Hamilton, (1983)** said that oil price shocks were shown to be a contributing factor in some recessions in the US before 1972, though oil price shocks did not necessarily cause economic recession. Also, **Schubert and Turnovsky (2011)** the evidence shows that recent oil price shocks have a tempered effect on economic activity. And **Jimenez-Rodriguez and Sanchez, (2005),** Increases in oil price and the resultant instability affect the economy through higher input costs, reallocation of resources, decreases in income and depreciation of currency. Also, the short run effects of oil price still play role in the economy, **et al. (2009),** The short-run effects of oil price on economic growth and inflation are statistically significant. The oil price put the pressure on the AS shock, **Carolyn Chisadza, Janneke Dlamini, Rangan Gupta(2016)** investigate the impact of the oil supply and demand shocks on the South African economy using a sign restriction-based structural Vector Autoregressive (VAR) model. Also,the **Huiming Zhu, Xianfang Su, Wanhai You & Yinghua Ren(2016)** show The asymmetric effects of oil price shocks on stock returns. There might be some asymmetric effect on oil price increase or oil price decrease**. (Imran Hussain SHAH1 and Yuanyuan WANG2 (2017)–** examines the dynamic effects of oil price shocks in addition to the aggregate supply and demand shocks on macroeconomic fluctuations in four sample economies: Indonesia, Malaysia, Pakistan and Thailand. And the causation of the oil price to the sector **Nidhiprabha (2004)** the price of the commodity good and food rise with the oil price rise and **Thai-Ha Le(2015)** The sentiment of property sector decline with higher oil price

Therefore, the higher oil price has the significant impact on the economy though higher cost, being the contributor to cause some recession into the economy. It might have some negative effect on the sector in Thailand stock market. There were also some finding about the asymmetric shock of the oil price which we will discuss later.

2. Data and preliminary analysis

We investigate the relationships of the oil prices(crudewti) and sector stock returns in Thailand. Our sample data include the Thailand (SET index) and twenty- eight Thailand sector indices, namely

AGRI(agribusiness), FOOD(food& beverage) , FASHION(fashion) ,HOME(home & office product) , PERSON (Personal Products & Pharmaceuticals), BANK(Banking) , FIN(Finance & Securities), INSUR(Insurance) , AUTO(Automotive), IMM(Industrial Materials & Machinery), PAPER(Paper & Printing Materials), PETRO (Petrochemicals & Chemicals) , PKG (Packaging), STEEL(Steel), CONMAT(Construction Materials), CONS(Construction Services) , PF&REITs(Property Fund & REITs) , PROP(Property Development), ENERG(Energy & Utilities),MINE (Mining), COMM(Commerce), HELTH(Health Care Services), MEDIA(Media & Publishing), PROF (Professional Services), TOURISM(Tourism & Leisure), TRANS(Transportation Logistics), ETRON(Electronic Components), ICT(Information & Communication Technology).

We collect stock market data from Bloomberg database. The SET index represents Thailand stock market which measure by the Market-capitalization weighted indexes of all stock in Thailand, we use data from the start of year 1998 to the April of year 2017, other same as the other 28 indices, each sector index represents a capitalization-weighted portfolio of the Thailand companies in that sector.

Industry	Sector	
Agro & Food Industry (.AGRO)	AGRI	Agribusiness
	FOOD	Food & Beverage
Consumer Products (.CONSUMP)	FASHION	Fashion
	HOME	Home & Office Products
	PERSON	Personal Products & Pharmaceuticals
Financials (.FINCIAL)	BANK	Banking
	FIN	Finance & Securities
	INSUR	Insurance
Industrials (.INDUS)	AUTO	Automotive
	IMM	Industrial Materials & Machinery
	PAPER	Paper & Printing Materials
	PETRO	Petrochemicals & Chemicals
	PKG	Packaging
	STEEL	Steel

Industry	Sector	
Agro & Food Industry (.AGRO)	AGRI	Agribusiness
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	INSUR	Insurance
Industrials (.INDUS)	AUTO	Automotive
	IMM	Industrial Materials & Machinery
	PAPER	Paper & Printing Materials
	PETRO	Petrochemicals & Chemicals
	PKG	Packaging
	STEEL	Steel

We use the weekly data, since the higher frequency data like daily will be the daily biased such as the volume traded bid ask effect, etc. And some of the day in Thailand, the stock

market is closed like holiday. Also, the daily data will bear the risk of having the stochastic variable which will cause us the problem.

The monthly data will give us the lower number of observation in some analysis and not capturing the higher frequency analysis.

Since we using the weekly data, which also can consider to be the high frequency data, the arch & garch effect will be introduced since the variance will conditional on what happen in last period. The garch model estimation will be apply to model the sector return in section 3.1.

We use the data start from year 1998 since we want to include the oil price boom after the Asian Financial Crisis 1997.

Firstly, we can see the co-movement of the oil price and SET index. As show in the Figure below the increases in oil prices effect the higher SET index, and the oil price increase also indicate of higher energy price, higher production and transportation cost, higher inflation pressure, etc. All of these reason contrast each other in whether the increase in oil price should lead to increase different sector index or decline it.

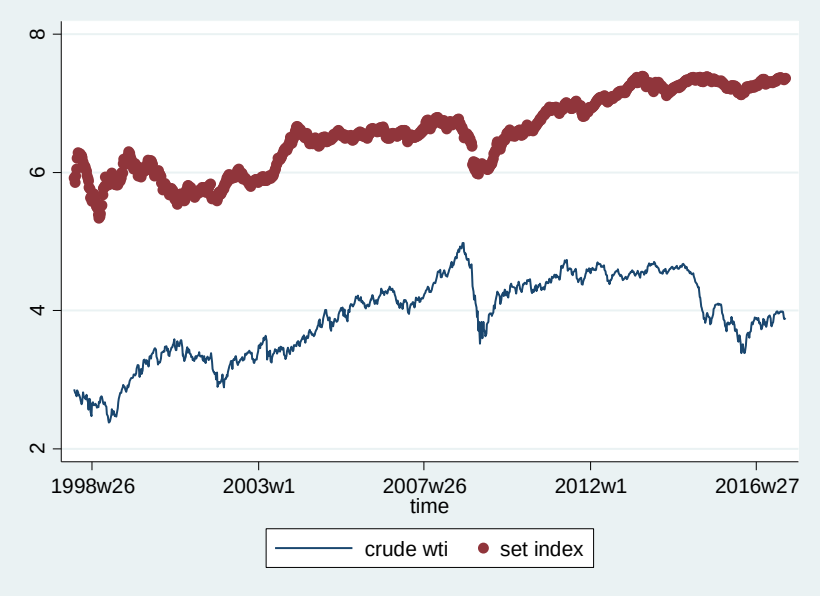
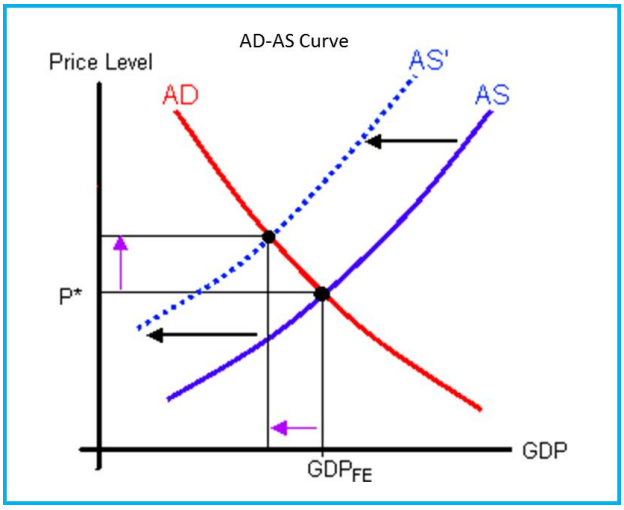


Figure 1 Setindex and oil price

Preliminary analysis: Concept of aggregate supply shock

From the real activity economy: The figure below show the real economic activity with the AD as the Aggregate demand and AS as aggregate supply. The horizontal axis being the price level or inflationary level and the horizontal axis being the output level or GDP.



The aggregate supply function are written as below:

$$\pi_t = \pi^e_t + g(Y_t - Y^*_t) + Z_t$$

Whereas: π_t **= inflation level at time t**

π^e_t **= inflation expectation at time t**

$(Y_t - Y^*_t)$ **= Output Gap at time t**

Z_t **= Aggregate supply shock at time t**

The higher oil price will put the upward pressure on the aggregate supply (**Zt** increase) lead to the upward pressure shock into the aggregate supply (shift up or leftward) that lead to the Higher Price level and lower output for Thailand.

The higher price level effect and the lower output effect will impact each sector in Thailand differently we will find out with the research hypothesis on each sector late

The preliminary analysis: Unit roots test

As we know the time series data will contain the Unit Root problem. If the variable contain Unit Root or nonstationary, regressing it will give us the spurious problem or in another word "Fake relationship" of the estimator. Therefore, in preliminary analysis we going to test the UnitRoot of all of the variable using ADF (Augmented Dfuller test) conducted in Table below:

Industry	Sectors	Variable	1st Diferrence
SET	**SetIndex**	No	Yes
Oil	**CrudeWti**	No	Yes
AGRO	**Agri**	No	Yes
	Food	No	Yes
CONSUMP	**Fashion**	No	Yes
	Home	No	Yes
	Person	No	Yes
FINCIAL	**Bank**	No	Yes
	Fin	No	Yes
	Insur	No	Yes
INDUS	**Auto**	No	Yes
	Imm	No	Yes
	Paper	No	Yes
	Petro	No	Yes
	Pkg	No	Yes
	Steel	No	Yes

Industry	Sectors	Variable	1st Diferrence
	Conmat	No	Yes
	Cons	No	Yes
	Pf&reits	No	Yes
PROPCON	**Prop Develop**	No	Yes
	Energy	No	Yes
RESOURCE	**Mine**	No	Yes
	Comm	No	Yes
	Health	No	Yes
	Media	No	Yes
	Prof	No	Yes
	Tourism	No	Yes
SERVICE	**Trans**	No	Yes
	Etron	No	Yes
TECH	**Ict**	No	Yes

Unit root check "yes" indicate stationary and "No" indicate nonstationary

We can see that all of these variables are all nonstationary, using these variable in estimation will give us spurious problem. To deal with these nonstationary series, we can do the 1st difference on all of these series and Test whether all of these differenced variable is stationary or not, the result being shown in the same table above. Note that, the 1st difference of natural logarithm variable will give us "rate of return" of that variable.

After the first difference, these series are all stationary and can be using to run the model with no spurious problem. So, we going to use the return of that series instead of the series itself in regressing the model.

The preliminary analysis: Research Hypothesis

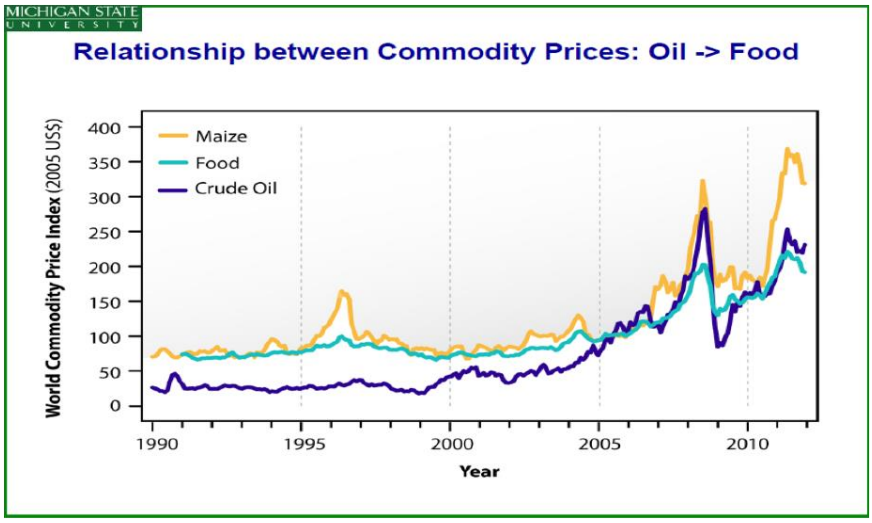
The oil price shock might have different effect on each sector in Thailand stock market. We separate the sector in to 28 sector then find the reason behind each sector respondent to the oil price change and use the reason to form the research hypothesis of each sector. Then we will use the regression analysis to see whether the model give the result that are consistent with the hypothesis that we stated here.

AGRO

For the Agriculture and food sector these 2 sector should have been pressure by the inflationary pressure. The higher oil price result in the higher commodity price and food price, as shown in the diagram below therefore the higher oil price should result in higher AGRI and FOOD indices. So, we state the hypothesis as following:

The Higher Oil price change should lead to higher AGRI index return. (1)

The Higher Oil price change lead to higher FOOD index return. (2)



Source: The End of Cheap oil and How it is changing our world, Dr. Bruce Dale (2013)

CONSUMP

For the FASHION, HOME, PERSON should not be being pressure by the oil price since the linkage between them are very ambiguous. The hypothesis is stated as following

The Higher Oil price change should not affect the FASHION index return. (3)

The Higher Oil price change should not affect the HOME index return. (4)

The Higher Oil price change should not affect the PERSON index return. (5)

FINCIAL

The lending expansion of the FIN and BANK should reflect higher sectors performance. For the FIN and BANK sector should have been negatively related to the oil price change since the credit expansion play important impact in the emerging country like Thailand (Credit Expansion in Emerging Markets: Propeller of Growth? ,Mercedes Garcia-Escribano and Fei Han, 2015). Therefore, the higher oil price reflects worse overall economy though AS shock and the BANK

and FIN indices should be lower with the higher oil price. For the insurance company, no significant causation reason that we have find so we state the hypothesis as below:

The Higher Oil price change should lead to lower BANK index return. (6)

The Higher Oil price change should lead to lower FIN index return. (7)

The Higher Oil price change should not affect the INSUR index return. (8)

INDUS

In almost every manufacturing sector, the higher oil price should reflect the higher cost of the manufacturing of these sectors. The oil price should negatively have related to the AUTO, IMM, PAPER, PKG, STEEL since it reflects the higher cost of production.

The PETRO is the only sector that should positive related to oil price since the PETROCHEMICAL price selling will rise therefore the index should also rise. We state hypothesis as below:

The Higher Oil price change should lead to lower AUTO index return. (9)

The Higher Oil price change should lead to lower IMM index return. (10)

The Higher Oil price change should lead to lower PAPER index return. (11)

The Higher Oil price change should lead to lower PETRO index return. (12)

The Higher Oil price change should not affect the PKG index return. (13)

The Higher Oil price change should lead to lower STEEL index return. (14)

PROPCON

In the property sector, from the *Thai-Ha Le(2015) journal*, the higher oil price should reflect the lower sentiment of the property market. This should negatively impact on the CONMAT, CONS, PROPDEVELOP, PF&REIT sectors. We state hypothesis as below:

The Higher Oil price change should lead to lower CONMAT index return. (15)

The Higher Oil price change should lead to lower CONS index return. (16)

The Higher Oil price change should lead to lower PROPDEVELOP index return. (17)

The Higher Oil price change should lead to lower PF&REIT index return. (18)

RESOURCE

The ENERG sector is quite straight forward the higher the oil price, higher energy price , higher performance of this sector. But for the MINE sector from Neil Hume **article in 2015** the higher oil price reflects higher cost of mining therefore reflect the lower performance of mining sector. We state hypothesis as below:

The Higher Oil price change should lead to higher ENERGY index return. (19)

The Higher Oil price change should lead to lower MINE index return. (20)

SERVICE

Almost all of service sectors should have been the least impact from the oil price shock, except the TRANS sector that totally rely on the oil as the cost of transporting. The higher oil price result in lower TRANS performance.

The Higher Oil price change should not affect the COMM index return. (21)

The Higher Oil price change should not affect the HELTH index return. (22)

The Higher Oil price change should not affect the MEDIA index return. (23)

The Higher Oil price change should not affect the PROF index return. (24)

The Higher Oil price change should not affect the TOURSIM index return. (25)

The Higher Oil price change should lead to higher TRANS index return. (26)

TECH

For the ETRON performance should depend on the energy price since it produces by using the energy and also the usage of electronic also require the energy. The negatively link between these 2 series should be stated. And for the ICT sectors, the better economy reflects the better technological investment and accessibility so the higher oil price drag this sector down. We state assumption as below:

The Higher Oil price change should lead to lower ETRON index return. (27)

The Higher Oil price change should lead to lower ICT index return. (28)

From the 28 hypotheses that we have stated corresponding to the oil price change will be summarize as follow:

Industry	Sectors	Impact	Industry	Sectors	Impact
AGRO	Agri	+	PROPCON	Conmat	-
	Food	+		Cons	-
CONSUMP	Fashion	No impact		Pf&reits	-
	Home	No impact		Prop Develop	-
	Person	No impact	RESOURCE	Energy	+
FINCIAL	Bank	-		Mine	-
	Fin	-	SERVICE	Comm	No impact
	Insur	No impact		Health	No impact
INDUS	Auto	-		Media	No impact
	Imm	-		Prof	No impact
	Paper	-		Tourism	No impact
	Petro	+		Trans	-
	Pkg	-	TECH	Etron	-
	Steel	-		Ict	-

We will later find out from regression analysis that these impact hypotheses on the index return corresponding to the oil price change were true or not on each of 28 sectors.

Preliminary analysis: descriptive statistic

Descriptive statistics of return series (Which defined as the 1st difference of natural logarithm series) are summarized in Table below. On average, the commerce sector experienced higher expected return than overall sector return, the average return of the steel being the lowest one with -1.98% for weekly return. The oil return on average yield the 0.1062% return for the week and the set index return on average yield the 0.14% for the week.

The highest volatility being the property and development sector return with 5.5% standard deviation for the week, the lowest one being the Property Fund & REIT which has the weekly standard deviation of 0.9%. The oil return has the weekly standard deviation of 5.23% and set index has about 3.41% for the week.

Industry	Variable	Obs	Mean	Std. Dev.	Min	Max	Correlation with oil
-	dcrudewti	1004	0.001062	0.052316	-0.31218	0.241221	100%
-	dsetindex	1004	0.001436	0.034156	-0.26661	0.157958	23%
	dagri	1004	0.001959	0.031382	-0.14413	0.128063	14%
AGRO	dfood	1004	0.002284	0.025957	-0.24622	0.131162	21%
	dfashion	1004	0.00058	0.022574	-0.12299	0.152427	8%
	dhome	1004	0.001509	0.033912	-0.22851	0.272654	4%
CONSUMP	dperson	1004	0.002478	0.045384	-0.56951	0.373235	22%
	dbank	1004	0.000596	0.050485	-0.29993	0.3584	6%
	dfin	1004	0.000872	0.053406	-0.31587	0.265123	5%
FINCIAL	dinsur	1004	0.001895	0.02275	-0.17355	0.113923	8%
	dauto	1004	0.00151	0.02989	-0.17688	0.140915	3%
	dimm	118	0.00033	0.031309	-0.12777	0.097194	1%
	dpaper	1004	0.002457	0.044615	-0.27219	0.242423	7%
	dpetro	1004	0.002129	0.053722	-0.36553	0.415304	38%
	dpkg	917	0.002823	0.044316	0.331903	-0.34073	-9%
INDUS	dsteel	325	-0.00198	0.030826	-0.08917	0.106644	-1%
	dconmt	1004	0.002727	0.044441	-0.22818	0.318546	11%
	dcons	169	0.001958	0.031718	-0.10768	0.126719	2%
	dpfreit	417	0.001377	0.009155	-0.03712	0.030642	8%
PROPCON	dprodevelo~t	1004	0.001065	0.055026	-0.89954	0.246734	14%
	denergy	1004	0.00135	0.039003	-0.27915	0.188533	46%
RESOURCE	dmine	118	0.001254	0.044756	-0.10141	0.142804	-2%
	dcommerce	1004	0.003217	0.031127	-0.20533	0.178638	16%
	dhealth	1004	0.00426	0.033764	-0.22195	0.196048	-2%
	dmedia	1004	0.000181	0.039045	-0.35104	0.261809	15%
	dprof	1004	0.00098	0.052953	-0.38561	0.35523	-9%
	dtours	1004	0.001621	0.027121	-0.15941	0.236148	5%
SERVICE	dtrans	1004	0.001071	0.044803	-0.34918	0.274877	4%
	detron	1004	0.001117	0.042191	-0.23337	0.190738	3%
TECH	dict	1004	0.001743	0.046798	-0.20798	0.274149	4%

The correlations between Thailand sector index return and the oil price change is quite high for some sector. Most of them are all positive, which the highest correlation with oil return being the energy sector 46%, Petrochemicals & Chemicals 38% and Personal Products & Pharmaceuticals 22% in which the SET index by itself has about 23% correlation.

The lowest correlation being the professional service -9%, packaging sector -9%, Health Care Services -2%, and Mining -2%. Which the packaging, mine, healthcare and professional service sector are much smaller capitalization compared to the energy sector in Thailand, which suggest that the increase in oil price will corresponding to the increase in SET index.

3. Empirical analysis

We investigate the relationship between the return of oil price and Thailand sector stock market returns after the Asian financial crisis. The analysis we use will be based on 2 model, the first one being The market-oil model which we include the return of oil price and the return of set index as the independent variable and will be estimated by Garch method to condition the variance. The second model being the Asymmetric market-oil model, by including the asymmetric respond to unexpected oil price that change differently.
After 2 estimation above we will find the causation result of each sector to the oil price and the last being the portfolio investment implication of the result.

3.1 Sectors, market and crude oil return with Garch estimation.

We firstly will estimate the sector return with the market sensitivity. Before we introduce the market oil model we will firstly introduce the old market model, in which it estimates the relationship between the return of each sector and return of the market. To see the sensitivity of each sectors return using garch modeling with a conditional variance of each model.
Secondly, we will have introduced the unexpected return of crude oil in the model. Lastly, we will examine the asymmetric effect between oil price change upward and downward.

a) The market model (single variable model)

The model can be written a following:

$$R_{it} = a + c*Rset_{it} + €_{it} \quad (1)$$

$$€_{it} \rightarrow f(0,H_{it}) \quad (2)$$

$$H^2_{it} = \alpha + \beta_k * \Sigma^q_{k=1} €^2_{i,t-1} + Y_1 * \Sigma^p_{l=1} H^2_{i,t-1} \quad (3)$$

Where the equation (1) is the mean equation of sectors return and (3) is variance equation.

R*it* is the weekly stock returns for sector *i*; (for each 28 sector will consist of 28 model)

Rsetjt represents the Thailand set index stock market returns;

□□*it* is a stochastic error term which we assumed to follow a GARCH(*q*,*p*)conditional variance and let *f* (.) be the density function of □*it* with mean equal to zero and conditional variance $H^2_{it.}$

q and *p* are lagged term of arch effect and garch effect respectively which are determined by using the BIC information criteria choosing the model with lagged *q*,*p* with the lowest BIC.

We estimate the regression above with each 28 sector returns and come up with the results in Table 4. The table showing the co efficient of each variable and the information criteria BIC also the arch effect LM test, Sktest for normality and skewness.

Industry	Sectors	a(constant)	c (setindex)	BIC	ARCH TEST	ARCH(q)	GARCH(p)	SKTEST(pvalue)
AGRO	Agri	-.0002948	.5210167*	-4491.885	9.105*	2	4	0.0000
	food	.0020133*	.4723082*	-4931.81	13.296*	2	2	0.0000
CONSUMP	fashion	.0001416	.4723082*	-5318.625	20.002*	3	1	0.0000
	home	-.000486	.5126918*	-4381.344	69.548*	2	4	0.0000
	person	.0011317	.3473221*	-3818.362	36.276*	4	4	0.0000
FINCIAL	bank	-.0008197	1.239349*	-4974.839	105.399*	2	1	0.0000
	fin	-.0005966	1.081957*	-4368.585	33.609*	1	4	0.0000
	insur	.0017136*	.2733243*	-5178.169	13.564*	4	4	0.0000
INDUS	auto	.0003947	.5203203*	-4687.308	36.037*	2	2	0.0000
	imm	.0003943	1.090703*	-511.1481	1.564	3	2	0.0093
	paper	.0021232*	.2824447*	-3591.586	47.875*	2	1	0.0000
	petro	.0001731	1.158966*	-4036.609	16.678*	4	2	0.0000
	pkg	.0038022*	.7681225*	-1275.986	0.104	2	1	0.0000
	steel	-.0035191*	.8923419*	-1484.265	9.858*	1	1	0.0004
PROPCON	conmat	.0001569	.9894074*	-4795.011	50.389*	2	3	0.0000
	cons	.0006274	1.404884*	-767.9687	0.477	3	2	0.0000
	pf&reits	.0011435*	.1641194*	-2854.069	9.862*	3	3	0.0000
	prop develop	-.0003474	1.188732*	-4582.802	0.004	1	3	0.0000
RESOURCE	energ	-.000184	.9953232*	-4788.511	16.167*	1	1	0.0000
	mine	-.0025519	.8785418*	-398.2382	5.397*	2	1	0.0000
SERVICE	comm	.0019834*	.6188625*	-4783.466	34.684*	1	2	0.0000
	health	.0033277*	.4741294*	-4253.839	8.808*	3	1	0.0000
	media	-0.0016789	0.8508509	-4484.442	18.918*	2	1	0.0000
	prof	-.0002331	.5437201*	-3294.011	1.688	1	1	0.0000
	tourism	.0005558	.3569358*	-4737.8	90.565*	3	1	0.0000
	trans	.0000945	.9852667*	-4409.146	24.296*	1	1	0.0000
TECH	etron	.000637	.6501544*	-4090.511	24.659*	2	2	0.0000
	ict	-.0000207	1.061466*	-4301.802	12.677*	3	2	0.0000

*indicated 5% or higher level of significant

** indicated 10% level of significant

This show the BETA of each sector returns corresponding to the market return, all of them are significant. There are offensive sectors with higher BETA than 1 Defensive sector with BETA lower than 1. Note that each sector has different lagged of arch effect and garch effect.

Next, we will include the unexpected return of oil into the model can see whether it can improve the specification of the model or not.

b) Market and oil model (multi variable model)

Now we will consider the oil price change to the sector returns, this oil price change we considering will be the unexpected change in oil price, we have the Market and oil model as the following specification:

$$R_{it} = a + c*Rset_{it} + bRoil^{u}_{it} + €_{it} \quad (4)$$

$$€_{it} \rightarrow f(0,H_{it}) \quad (5)$$

$$H^2_{it} = \alpha + \beta_k * \Sigma^{q}_{k=1} €^2_{i,t-1} + \Upsilon_1 * \Sigma^{p}_{l=1} H^2_{i,t-1} \quad (6)$$

Where the equation (4) is the mean equation for sector returns and (6) is variance equation.

The $Roil^{u}_{it}$ is the unexpected change in oil price which is the different between the observed oil price returns and the predicted value of oil price returns. The predicted value of oil price return simply the predicted value of the equation:

$$Roil_{it} = \Phi + \Sigma^{k}_{l=1} Roil_{it-k} + \Sigma^{w}_{l=1} €_{it-w} + \zeta_{it} \quad (7)$$

The equation (7) above will be estimated by the ARMA(w,k) and choosing the Model with lagged term of the lowest value BIC. And we came up with the ARMA (2,2) is the best fitted model. Therefore, we estimated the above equation using ARMA (2,2) can use the equation to predicted the expected oil price return.

The unexpected oil price component is just the different between the observe oil price return and predicted oil price return as specified as follow:

$$Roil^{u}_{it} = Roil_{it} - \text{predicted } Roil_{it} \qquad (8)$$

The definition of unexpected change in oil price return mean that the impact of previous oil price return on stock returns is implicitly include in equation (4). We estimate the regression above with each 28 sector returns and come up with the results in Table 5. The table showing the co efficient of each variable and the information criteria BIC also the arch effect LM test, sktest for skewness and kurtosis.

Industry	Sectors	a(constant)	b (oil)	c (setindex)	BIC	ARCH TEST	ARCH(q)	GARCH(p)	SKTEST(pvalue)
	Agri	-0.0001437	0.0275947*	0.508883*	-4497.104	7.896*	1	2	0.0000
AGRO	food	0.0019858*	0.0090411	0.4694998*	-4937.975	13.329*	1	1	0.0000
	fashion	0.000183	-0.0053846	0.2695455*	-5356.053	20.005*	4	3	0.0000
	home	-0.0004023	-0.0517872*	0.5154385*	-4394.914	70.317*	3	4	0.0000
CONSUMP	person	0.0007603	0.0126318	0.3573268*	-3755.146	38.317*	3	4	0.0000
	bank	-0.0008258	-0.0355989*	1.252529*	-4977.174	105.632*	2	1	0.0000
	fin	-0.000591	-0.0843344*	1.114608*	-4420.864	35.065*	1	3	0.0000
FINCIAL	insur	0.001756	-0.0010854	0.2785741*	-5175.97	13.348*	3	3	0.0000
	auto	0.000379	-0.0312556*	0.5294339*	-4686.173	38.238*	2	2	0.0000
	imm	0.0003941	-0.0509696	1.100109*	-516.4513	0.829	1	1	0.0000
	paper	0.0022943	0.0255625	0.3152269*	-3595.773	48.364*	3	3	0.0000
	petro	-0.0000466	0.0389365*	1.132384*	-4034.306	16.461*	2	4	0.0000
	pkg	0.0055933*	0.2070314*	0.4210517*	-1418.045	0.104	3	1	0.0000
INDUS	steel	-0.003909*	-0.0790673*	0.93808*	-1484.963	10.794*	1	1	0.0002
	conmat	0.00013	-0.0513178*	1.011276*	-4816.558	49.064*	1	2	0.0000
	cons	-0.0005545	-0.0556209	1.432906*	-774.5121	0.473	1	1	0.0001
	pf&reits	0.0010387*	-0.0154405*	0.1750008*	-2847.163	10.303*	1	5	0.0000
PROPCON	prop develop	-0.000153	-0.0563372*	1.190713*	-4608.119	0.005	2	5	0.0000
	energ	-0.0001359	0.1192678*	0.9532216*	-4877.948	22.281*	1	1	0.0000
RESOURCE	mine	-0.0039739	-0.1588451*	1.035963*	-396.3507	6.104*	1	2	0.0002
	comm	0.0019781*	-0.0047129	0.6233759*	-4782.445	34.713*	1	1	0.0000
	health	0.0035513	0.0035838*	0.4779201*	-4256.025	9.252*	1	1	0.0000
	media	-0.0016548*	-0.0165899	0.8539724*	-4473.242	18.783*	1	3	0.0000
	prof	-0.0008882	0.033063	0.5282283*	-3289.527	1.699	3	3	0.0000
	tourism	0.0005833	0.0225053*	0.3427813*	-4743.334	91.058*	1	1	0.0000
SERVICE	trans	0.0000454	-0.0683294*	1.010852*	-4421.757	25.354*	1	1	0.0000
	etron	0.0006421	0.0030033	0.6470807*	-4090.387	24.733*	2	1	0.0000
TECH	ict	-0.0000359	-0.0615158*	1.072705*	-4326.166	13.068*	1	1	0.0000

*indicated 5% or higher level of significant

** indicated 10% level of significant

The table show the beta of unexpected oil price return and the SET index return. This result show that 17 sectors out of 28 sectors return are significant to unexpected change in oil price. Which are AGRI, HOME, PERSON, BANK, FIN, AUTO, PETRO, PKG, STEEL, CONMAT, PF&REITS, PROPDEVELOP, ENERGY, MINE, TOUR, TRANS and ICT. Out of these 17 sector that are significant only 5 sector are positively related to unexpected oil price change (AGRI , PERSON , PETRO , ENERGY , TOURISM) and 12 sector are negatively related (HOME , BANK , FIN , AUTO , PKG , STEEL , CONMAT , CONS , PF&REITS , PROPDEVELOPMENT , MINE , TRANS ,and ICT). Some of these results are not consistent which the correlation TABLE 3 since the regression using the unexpected oil price component whereas the correlation table3 using the observed return of oil price.

According to the result, the negative sign of beta indicated the higher production cost result in the lower stock sectors returns however some of the sector contain positive sign indicate the higher price of selling goods, higher growth in the company. We will find out more in by industry analysis of each sector later.

From the market and oil model, most sectors in Thailand are significant, therefore the model market and oil model is better than the original market model. On top of that some of the BIC information criteria is model 2 is better. So, we have shown that the oil price change play important role in Thailand stocks market however there might be some asymmetric effect corresponding to the oil price change. These sectors might have reacted to the change in oil price drop and oil price increase differently, so this will be analyzing later in the model 3 Asymmetric multivariable model.

c) Asymmetric multivariable model.

The link between oil and the sectors index might not be linear. (Hamilton, 2003; Lardic and Mignon, 2006; Zhang, 2008; Cologni and Manera, 2009) have shown that the oil price increase trend to have the larger impact on the economy or sector returns. But this might not be the case in Thailand sectors. To find out, we run the asymmetric GARCH model and see whether the model will be better fitted the data or not and also looking at whether the oil price increase and decrease will affect the sector more for positive shock or not.
We have specification as follow:

$$R_{it} = a + b^{+} D_t * Roil^{u}_t + b^{-}(1-D_t) * Roil^{u}_t + c * Rset_{it} + €_{it} \quad (9)$$

$$€_{it} \rightarrow f(0, H_{it}) \quad (10)$$

$$H^2_{it} = \alpha + \beta_k * \Sigma^{q}_{k=1} €^2_{i,t-1} + Y_1 * \Sigma^{p}_{l=1} H^2_{i,t-1} \quad (11)$$

Dt is a dummy variable taking a value of one if unexpected change in oil price is positive and zero if it is negative. The beta b^+ and b^- are the coefficients that corresponding to the change in unexpected component of oil price increase and oil price decrease. We conduct 2 test , 1st there is no asymmetry between the b^+ and b^- by testing whether $b^+ = b^-$ as the null hypothesis. 2nd there is no overall significant of the unexpected oil change component by testing $b^+ = b^- = 0$ or not. These statistical tests will be shown in table 6. We will estimate the regression above with each 28 sector returns and will show the results in Table 6. The table showing the co efficient of each variable and the information criteria BIC also the arch effect LM test, SKtest normality and skewness test.

Industry	Sectors	a(constant)	b+ (oil increase)	b-(oil decrease)	c (setindex)	BIC	ARCH TEST	ARCH(q)	GARCH(p)	SKTEST(pvalue)	B+=B-	B+=B-=0
AGRO	Agri	0.0000664	0.0223158	0.0301495	0.51017*	-4419.318	7.814*	1	1	0.0000	0.03	3.6
	food	0.0034286*	-0.0352206	0.0435908*	0.4672936*	-4417.85	15.473*	1	1	0.0000	5.56*	7.6*
CONSUMP	fashion	0.000406	-0.0118555	0.0002176	0.2681838*	-5058.58	19.854*	4	4	0.0000	0.28	0.66
	home	0.0011756	-0.0789888*	-0.00976	0.5207327*	-4195.019	69.164*	2	2	0.0000	2.92**	12.99*
	person	0.0018179	-0.001465	0.0339422	0.3390191*	-3390.067	34.8*	4	4	0.0000	0.53	2.17
FINCIAL	bank	-0.0014137*	-0.0168185	-0.0502537*	1.253928*	-4784.215	105.222*	2	1	0.0000	1.17	13.93*
	fin	0.0002554	-0.1118512*	-0.0634795*	1.114399*	-4053.414	35.287*	1	3	0.0000	1.55	40.33*
	insur	0.0023195*	-0.0174811	0.0118442	0.2796267*	-5087.545	13.177*	3	3	0.0000	1.23	1.24
INDUS	auto	0.0014475	-0.0629789*	-0.0045317	0.5277052*	-4543.388	36.213*	2	2	0.0000	2.41	9.75*
	imm	-0.0023532	0.0301206	-0.1161812	1.139506*	-533.2756	1.267	1	1	0.0065	1.19	1.67
	paper	0.0030634*	-0.0039944	0.0910036*	0.2823834*	-3437.447	47.029*	4	4	0.0000	3.92*	14.87*
	petro	-0.0011817	0.0716827*	0.0071572	1.14766*	-3886.098	16.351*	5	5	0.0000	1.4	5.23**
	pkg	0.0224733*	-0.4296284*	0.2316723*	-0.238062*	-1360.339	0.109	3	1	0.0000	4.52*	8.87*
	steel	-0.0045085*	-0.1072309*	-0.1076851*	0.8677723*	-1493.768	10.64*	4	4	0.0001	0	12.17*
PROPCON	conmat	-0.0002127	-0.0411114**	-0.0597686*	1.011633*	-4549.02	49.454*	1	2	0.0000	0.32	23.98*
	cons	-0.0007193	-0.0502916	-0.059537	1.435256*	-794.5244	0.443	1	1	0.0000	1.71	21.08*
	pf&reits	0.0006192	-0.0091739	-0.0156586	0.1814386*	-2842.533	9.97*	1	1	0.0000	0.08	3.12
	prop develop	0.000715	-0.073643*	-0.0359816	1.197755*	-3794.035	0.005	3	2	0.0000	1.71	21.08*
RESOURCE	energ	-0.0008777	0.1425908*	0.1013137*	0.9560042*	-4585.797	22.44*	1	1	0.0000	1.67	135.76*
	mine	-0.0059093	-0.0259648	-0.2129885*	1.049119*	-408.1227	5.806*	3	1	0.0002	0.76	5.85*
SERVICE	comm	0.0020215*	-0.006016	-0.0036958	0.6232568*	-4668.147	34.632*	1	1	0.0000	0	0.13
	health	0.0034653*	0.0060828	0.0015942	0.4780927*	-4160.942	9.298*	1	1	0.0000	0.01	0.08
	media	-0.0002792	-0.0446714	0.0132784	0.8380382*	-4388.843	18.752*	2	3	0.0000	1.98	2.27
	prof	0.0009401	-0.0127106	0.0539273	0.5342627*	-3176.923	1.784	1	1	0.0000	0.81	1.87
	tourism	0.0039603*	-0.0692544*	0.0798369*	0.3264075*	-4612.54	85.922*	2	2	0.0000	17.37*	21.78*
	trans	0.001276	-0.1064311*	-0.0365586	1.00733*	-4155.846	24.331*	1	1	0.0000	2.8**	23.79*
TECH	etron	0.0020537	-0.0429979	0.0385243	0.6450138*	-3886.341	25.262*	2	1	0.0000	2.28	2.37
	ict	0.001086	-0.0981185*	-0.0350467	1.070861*	-4256.85	13.231*	1	1	0.0000	2.21	21.86*

*indicated 5% or higher level of significant

** indicated 10% level of significant

From the table 6 we can see that only 4 sectors out of 28 sector has the asymmetric respond to oil price change 5% level of significant (FOOD, PAPER, PKG, TOURISM) and there are 14 sectors out of 28 sector that has the overall significant with the unexpected oil price change. Whereas the multivariable model has about 17 sectors that are significant. The showing is that 21 sector out of 28 sector follow the same result of significant between 2 model. These finding will be further analyze in industry and sector analysis.

The result of only 4 sectors that having the asymmetric respond to oil price change and the lower BIC in mkt-oil model than asymmetric respond model in almost every sector indicated that the MKT-OIL model is appropriated to find the relationship between the series of return of each sector and the oil price change, furthermore the Asymmetric respond model can be use in some robustness check of our result.

Now we will use the result from the MKT-OIL model that we have come up before and compare to the theoretical impact hypothesis of oil on each sector that we already stated before.

By Industry Analysis

We start analyzing each sector by grouping them into industry and analyzing each of the result corresponding to the oil price shock based on market and oil model. Compared the result with the theory that we set up before.

Industry 1: AGRO

Consist of Agribusiness, food & beverage sectors. In this industry, we consider the baseline theory from the agriculture business is that, the price of agriculture product will be raised by the rise in oil price. Also, the food price should be rising corresponding to the rise in oil price. Therefore, both Agribusiness and Food sector indices should be rise corresponding to the price increase.

Based line theory:

Higher oil price: Higher AGRI index.
Higher oil price: Higher FOOD index.

The result is that

Sectors	a(constant)	b (oil)	c (setindex)
AGRI	-0.0001437	0.0275947*	0.508883*
FOOD	0.0019858*	0.0090411	0.4694998*

For the Agribusiness sector the significant positive relationship with oil at 5% level of significance. The result followed the baseline theory of that the Agriculture product price were rising because of the oil price rise. The oil price put the inflationary pressure on the commodity price. That result in the higher price of selling of these business, indicate better performance of the business and higher Agribusiness index.

For the Food sector the relationship aren't significant for the oil to pressure the food index. We know that the oil price didn't only lead to friendly benefit of higher price of selling food, but only lead to adverse impact on the cost of production rise. The impact of higher food price was not high enough to offset the impact of cost rising. Therefore, the positive relationship between the oil price and the food index were not significant.

Industry 2: CONSUMP

Consist of Fashion, Home & Person sectors which are the product for daily consumption. In this industry, we look the baseline theory from these 3 sectors are that they were not being pressure by the oil price, since these 3 sectors were not related to the oil price, though some of the production cost might rise, it should not significantly affect these 3 sectors indices.

Based line theory:

Higher oil price: Insignificant with FASHION index.
Higher oil price: Insignificant with HOME index.
Higher oil price: Insignificant with PERSON index.

The result is that

Sectors	a(constant)	b (oil)	c (setindex)
fashion	0.000183	-0.0053846	0.2695455*
home	-0.0004023	-0.0517872*	0.5154385*
person	0.0007603	0.0126318	0.3573268*

For the fashion sector and the person sector, the insignificant relationship was shown which are not surprising because clothing and personal product like washing foam would not be much affected by the rising in oil price. Therefore these 2 sectors relationship with oil price would not be significant enough.

For the home sector the surprising result was shown with the negative impact from oil price. The result was not followed the baseline theory of insignificant impact between these 2 series. The idea behind the result might be because of the higher oil price lead to the higher cost of home and office product like bed, table. Therefore, the index returns were negatively related to oil price.

Industry 3: FINCIAL

Consist of Bank, Financial and security, insurance sectors. In this industry, most of the lending and loan company should be negatively affected by oil price. Because the oil price acted as an aggregate supply shock for the economy that lead to the lower economic performance of overall firms. The lower economic performance and lower economic growth indicated the lower loan and lending growth. Therefore, the rising in oil price should be negatively impact on Banking sector and the Financial & security sector. But for the insurance sector, the impact should not be significant because of no direct explanatory link between these 2 series.

Based line theory:

Higher oil price: Lower BANK index.
Higher oil price: Lower FIN index.
Higher oil price: Insignificant with INSUR index.

The result is that

Sectors	a(constant)	b (oil)	c (setindex)
bank	-0.0008258	-0.0355989*	1.252529*
fin	-0.000591	-0.0843344*	1.114608*
insur	0.001756	-0.0010854	0.2785741*

For the Financial & securities sectors and banking sector which provide the loan as we said before. These 2 sectors were negatively related to the oil price shock as the theory that we have stated before. Also, both of these 2 sectors were significant to the oil price shock. The reason behind this was the lower economic performance for oil price shock lower the loan growth therefore lower these 2 sectors indices.

For the insurance sectors, the result follow the baseline theory. The relationship was not significant. The oil price increase was not resulted in a rise in the insurance sector since there were no link between these 2 variables.

Industry 4: INDUS

In this industry, it contains 6 sectors which are Automotive, Industrial Materials & Machinery, Paper & Printing Materials, Petrochemicals & Chemicals, Packaging, Steel. Most of them were manufactured product whose indices should be reduced according to the cost rising from oil price rise. However, the PETRO sectors where different. Since the rise in oil price would result in the higher price of selling Petrochemical and lead to higher index of PETRO sectors.

Based line theory:

Higher oil price: Lower AUTO index.
Higher oil price: Lower IMM index.
Higher oil price: Lower PAPER index.
Higher oil price: HIGHER PETRO index.
Higher oil price: Lower PKG index.
Higher oil price: Lower STEEL index.

The Result is that

Sectors	a(constant)	b (oil)	c (setindex)
auto	0.000379	-0.0312556*	0.5294339*
imm	0.0003941	-0.0509696	1.100109*
paper	0.0022943	0.0255625	0.3152269*
petro	-0.0000466	0.0389365*	1.132384*
pkg	0.0055933*	0.2070314*	0.4210517*
steel	-0.003909*	-0.0790673*	0.93808*

For the 5 sectors that should be reduced with oil price (AUTO, IMM, PAPER, PKG, STEEL), the result is that only the AUTO, PKG, STEEL was significant. Moreover, only the AUTO and STEEL sectors were negatively significant with oil price increase or in other word only these 2 sectors follow the baseline theory. This indicate that these sectors were not always all affected by the rising in cost form product oil price. Moreover, the asymmetric model give us the different result for PKG (positive sign) so the oil price might not be the good regressor for these 2 sectors.

For the PETRO sectors the result show the significant positive relationship between the oil price change and the PETRO sector index. This follow the baseline theory that the higher oil price reflects the higher price of selling petrochemical that result in the higher PETRO index.

Industry 5: PROPCON

In this industry is about property and construction, which have Construction Material, Construction Service, Property development, Property Fund and REITs. (4 sectors) . From the theory that we have stated before the rising in oil price effect the property sector sentiment negatively. Follow the *Thai-Ha Le(2015) journal.* All of 4 sectors should respond to the oil price change negatively.

Based line theory:

Higher oil price: Lower CONMAT index.
Higher oil price: Lower CONS index.
Higher oil price: Lower PROPDEVELOP index.
Higher oil price: Lower PF&REIT index.

The Result is that

Sectors	a(constant)	b (oil)	c (setindex)
conmat	0.00013	-0.0513178*	1.011276*
cons	-0.0005545	-0.0556209	1.432906*
pf&reits	0.0010387*	-0.0154405*	0.1750008*
prop develop	-0.000153	-0.0563372*	1.190713*

3 Sectors were followed the baseline theory (CONMAT, PF&REIT, PROPDEVELOP) which negatively significant to the oil price change, While the CONS were not significant but the result still have negative sign. This indicate the lower magnitude for the oil price change channel to the CONS sectors.

Industry 6: RESOURCE

This industry contains 2 sectors which are ENERGY, MINING. The Energy sectors is one of the biggest sector in Thailand and it should have followed the same direction as oil price change. While the mining sector, there some article for the mining and the oil price, *Neil Hume 2015* , tells that the higher oil price rise the production cost for mining result in the lower index for this sectors.

Based line theory:

Higher oil price: Higher ENERG index.
Higher oil price: Lower MINE index.

The result is that:

Sectors	a(constant)	b (oil)	c (setindex)
energ	-0.0001359	0.1192678*	0.9532216*
mine	-0.0039739	-0.1588451*	1.035963*

For the Energy sector, the result was quite clear with the theory, higher oil price, higher oil selling price for this industry, high index for the Energy sector. And the result was significant.

For the MINE sector, the result was also followed the base line theory about the higher oil price reflect the higher cost of production. The result give the negatively related between the oil price and the sector index.

Industry 7: SERVICE

Consist of 6 sectors: Commerce, Health care service, Media & Publishing, Professional Services, Tourism & Leisure , Transportation & Logistics. Most of the service sector should not be affected by the oil price change except for the TRANSPORTATION sector that should have the negative impact for the rising in transportation cost.

Based line theory:

Higher oil price: Insignificant with COMMERCE index.
Higher oil price: Insignificant with HEALTH index.
Higher oil price: Insignificant with MEIDA index.

Higher oil price: Insignificant with PROF index.

Higher oil price: Insignificant with TOUR index.

Higher oil price: Lower with TRANS index.

The Result is that

Sectors	a(constant)	b (oil)	c (setindex)
Comm	0.0019781*	-0.0047129	0.6233759*
health	0.0035513	0.0035838*	0.4779201*
media	-0.0016548*	-0.0165899	0.8539724*
prof	-0.0008882	0.033063	0.5282283*
tourism	0.0005833	0.0225053*	0.3427813*
trans	0.0000454	-0.0683294*	1.010852*

For the first 4 sector (Comm, health, Media, Prof) the result are not negatively significant with the oil price, which are consistent with the theory that should be insignificant relationship between these sectors and the oil price change.

The TRANS sector also follow the baseline theory of adversely significant impact by the oil price shock. The higher oil price the higher transportation cost and result in the lower performance of TRANS sector (lower index).

The TOUR sector has the questionable result, the Mkt-oil model give the significant positive relationship whereas the Asymmetric model give the different result for oil increase and oil decrease. So, the oil price might not be the good estimator for this tour sector.

Industry 8: TECH

This last sector consists of the Electronic Components, Information & Communication Technology. The ETRON sector should be negatively related to the oil price change since the electronic component require the energy the produce, the higher oil price result in higher cost of production and higher cost of usage. The ICT sector should be negatively related to the oil price change. The ICT sector performance depend on the overall economic performance, the better the economic growth the higher investment, accessibility to the technology. And since the oil price rise put the pressure on the economic performance.

Based line theory:

Higher oil price: Lower ETRON index.
Higher oil price: Lower ICT index.

The Result is that

Sectors	a(constant)	b (oil)	c (setindex)
etron	0.0006421	0.0030033	0.6470807*
ict	-0.0000359	-0.0615158*	1.072705*

The result tells that the oil price change was not significant for the ETRON sector, though the result has the negative relationship between them.

The result if the ICT sector was following the baseline theory of significant negative relationship between these 2 series. Higher oil price lead to the high ICT performance.

Result conclusion

20 sectors from the MKT-OIL model result follow the baseline theory which are

The Higher Oil price change should lead to higher AGRI index return. (1)

The Higher Oil price change should not affect the FASHION index return. (3)

The Higher Oil price change should not affect the PERSON index return. (5)

The Higher Oil price change should lead to lower BANK index return. (6)

The Higher Oil price change should lead to lower FIN index return. (7)

The Higher Oil price change should not affect the INSUR index return. (8)

The Higher Oil price change should lead to lower AUTO index return. (9)

The Higher Oil price change should lead to lower PETRO index return. (12)

The Higher Oil price change should lead to lower STEEL index return. (14)

The Higher Oil price change should lead to lower CONMAT index return. (15)

The Higher Oil price change should lead to lower PROPDEVELOP index return. (17)

The Higher Oil price change should lead to lower PF&REIT index return. (18)

The Higher Oil price change should lead to higher ENERGY index return. (19)

The Higher Oil price change should lead to lower MINE index return. (20)

The Higher Oil price change should not affect the COMM index return. (21)

The Higher Oil price change should not affect the HELTH index return. (22)

The Higher Oil price change should not affect the MEDIA index return. (23)

The Higher Oil price change should not affect the PROF index return. (24)

The Higher Oil price change should lead to higher TRANS index return. (26)

The Higher Oil price change should lead to lower ICT index return. (28)

The sector FOOD, HOME, IMM, PKG, PAPER, CONS, TOURSIM, ETRON have the result that did not match the baseline theory. The FOOD, IMM, ETRON, CONS were Insignificant result. The HOME has significant result with negative relationship. And the PKG, PAPER, PKG give the inconclusive result with MKT-OIL model and the Asymmetric respond model.

Overall, we can already tell that the crude oil change has the significant impact on Thailand stock market. However, it affects different sectors with different magnitude. Some being positive due to the price of selling rise, some being negative due to the rising in cost, some being no impact at all in the sector return. So, we can add the benefit of these differently impact of oil price change in the implication of portfolio investment in the next section.

4. Implication Portfolio Investment

For the implication of the result, we will show that the sector return respond differently will oil price so we might have some benefit from adding the oil into our sector-based portfolio for better diversification. We will consider 2 separate year in portfolio investment, the year 2015 and year 2016. We separate the result into 2 years because of the structural of economic change, in year 2016 some sector might not perform well in year 2015 might perform better in year 2016, vice versa. Therefore, we should separate the time period into 2 years. And Consider both the Max Sharpe ratio portfolio with the different weighted of oil and the min variance portfolio with the different weight of oil.

The result that we come up before in the regression analysis tells us that the oil price movement have caused both positive movement from the sector returns and negative movement for other stock. Therefore, we consider adding the oil into portfolio that contain the index based investment. And see whether the diversification benefit will occur or not. The result shown in the table below. (We using the Risk-free rate of 2%)

2015 Portfolio		Mean of Return	Standard deviation	Sharpe Ratio
Max Sharpe Portfolio				
No constraint Portfolio		15.99%	7.70%	1.8174
100% Stock	0% Oil	15.99%*	7.70%	1.8174*
95% Stock	5% oil	13.68%	7.52%*	1.5530
90% stock	10% oil	13.47%	9.29%	1.2349
85% stock	15% oil	13.39%	11.49%	0.9912
Min variance Portfolio				
No constraint Portfolio		-1.10%	5.56%*	-0.5574
100% stock	0% Oil	0.42%*	5.58%	-0.2831*
95% stock	5% oil	-1.23%	5.76%	-0.5617
90% stock	10% oil	-3.10%	6.39%	-0.7980
85% stock	15% oil	-5.00%	7.40%	-0.9458

0% Oil Weighted

0.131% Oil Weighted

* Indicated the best portfolio among only oil weight portfolio.

No constraint Portfolio indicate the portfolio that did not put the constraint on oil weighted.

The portfolio in year 2015 the Max Sharpe & no oil portfolio have the return of 15.99% with SD of 7.70% and Sharpe ratio of 1.8174.

Including the oil into the portfolio result in a lower SD of 7.52% with the lower return of 13.68% since in that year the oil price performance badly with the -30% of yearly return. This might sound benefit for our diversification portfolio. However, increase the oil weighted to 10% and 15%, the portfolio won't have the lower standard deviation anymore.

Next, we consider the min variance portfolio, the 100% stock portfolio with min variance still have the lower standard deviation compare to portfolio with 5% oil include. Then we put no constraint on oil weight. The result that the little bit of oil weighted 0.131% help reduces the portfolio variance to the lowest.

The 2015 portfolio conclusion was that the inclusion in oil result in the lower return and lower Sharpe ratio, since year 2015 oil perform badly. However, including the small portion help reduce the standard deviation of overall portfolio.

The year 2015 indicated the bad performance of oil investment. However, in year 2016 was entirely different with the much higher return on oil about 40% yearly return. Then we consider the 2016 portfolio investment shown in table below:

2016 Portfolio		**Mean of Return**	**Standard deviation**	**Sharpe Ratio**
Max Sharpe Portfolio				
No constraint Portfolio		44.50%	8.11%*	5.2392*
100% Stock	0% Oil	44.06%	8.24%	5.1020
95% Stock	5% oil	44.50%	8.11%	5.2392
90% stock	10% oil	45.39%	8.50%	5.1072
85% stock	15% oil	46.34%*	9.33%	4.7537
Min variance Portfolio				
No constraint Portfolio		12.70%	4.65%*	2.3025
100% stock	0% Oil	12.33%	4.67%	2.2124
95% stock	5% oil	14.02%	4.88%	2.4633
90% stock	10% oil	20.18%	6.51%	2.7914*
85% stock	15% oil	22.10%*	7.76%	2.5913

4.95% Oil Weighted

1.25% Oil Weighted

* Indicated the best portfolio among only oil weight portfolio.

No constraint Portfolio indicate the portfolio that did not put the constraint on oil weighted.

The portfolio in year 2016 first we consider the max Sharpe ratio with the no oil weighted, which has the return of 44.06% and the standard deviation of 8.24% and the Sharpe ratio of 5.1020. Including the 5% oil into the portfolio the return has increase to 44.50% with lower SD of 8.11% and the higher Sharpe ratio of 5.2392. Also, we ask whether including more will result in lower variance of portfolio or not. The result also being the same as year 2015, increase the oil weighted to 10% and 15% won't lower the variance for the max Sharpe portfolio.

Next, we consider the min variance portfolio, the 100% stock portfolio, in this year the 100% stock portfolio has worse performance than 95% stock/5% oil portfolio in every part and also has the higher variance for 100% stock portfolio. The optimal weighted for the oil in the min variance portfolio is the 1.25% weight portfolio, which again the only small portion of oil weighted in this portfolio.

The conclusion about the implication of portfolio diversification is that many sector in SET corresponding to the oil price change differently. Therefore, adding oil provide some benefit of diversification. As shown in year 2015 and 2016 that the 5% oil weighted has lower variance than the 0% oil weighted. However, including more portion of oil like 10% or 15% won't benefit more for this portfolio, on top of that the oil price was very fluctuated therefore we should not include the oil weighted too much in the portfolio, which we can see the optimal min variance portfolio in year 2015 and 2016 have small portion of oil weighted.

5. Final Conclusion

We have investigated the various sector relationship corresponding to the oil price change, this focus on the broadly market index and investigate though the short term weekly relationship though Garch estimation. We introduce 3 model, the first model being the sector market model which look alike the CAPM model for the sector. The second model (MKT-OIL) was introduced by adding the oil price change into the model, which the result show significantly relationship of oil price change and the sectors return in 21 sector out of 28. The last model being the asymmetric model whether the market act differently to the oil price increase and decrease. The result show only 4 sector (5% level of significant) have the asymmetric respond to oil price. On top of that the BIC information criteria (which show the goodness of fit to the data) of 2nd model (MKT-OIL) was better than the 3rd model (ASYMMTERIC RESPOND) therefore the 2nd model will be used to compare with the baseline theory of each sector correspondent to the oil price shock. The result show that 20 sectors was respond with the same way as the theoretical hypotheses that we have stated. The sectors act differently to the oil price shock; therefore, we might invest in oil to reduce our portfolio risk. The implication of portfolio investment show that the inclusion of small portion of oil (like5%) into sector-based portfolio help reduce overall variance, However, the oil price was very fluctuated and increase the weight size too much won't reduce the variance of our portfolio anymore. So, the small portion in oil weighted was optimal. Even though we come up with the conclusion of the sector respondent to the oil price change, there are still many research question available to be answer in the future.

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