

The Effect of Petroleum and Petrochemical Prices on Abnormal Return and Firm Profitability

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ABSTRACT

This paper extends the understanding of an impact of oil prices on stock market and financial performance of oil and gas firms over the past decade. Firstly, this paper investigates the impact of crude oil, petroleum and petrochemical prices on accounting measures of firm performance using a sample of refinery and petrochemical firms in Thailand. Secondly, it examines whether these commodity prices are an essential factors in explaining abnormal returns. The findings show that the price of crude oil and petrochemicals positively and significantly affect firm profitability performance as represented by Gross Integrated Margin (GIM), return on equity (ROE), and return on asset (ROA). Although commodity prices drive the firm's profitability, these commodity prices have a negative impact on abnormal returns. Investors tend to obtain lower abnormal returns during the period of high commodity prices. On the contrary, they tend to earn higher abnormal returns when the prices fall. This study seeks to advance knowledge in oil price and firm performance by considering the impact of output prices. Also, exploring the implications for investors when making investment decisions in the stock market. Investors have no incentive to invest in refinery and petrochemical stocks when the commodity price rises since they would not earn a higher abnormal return.

INTRODUCTION

1.1. Background, Significance of the Problem and Objective

The refinery business is one of the main driving forces in the world economy. Crude oil is an essential input refined into a variety of output petroleum products including gasoline, diesel, jet, and fuel oil. Petroleum is the raw material used to produce petrochemicals, which are aromatics, including benzene, paraxylene, toluene, and olefins, such as ethylene and propylene. These chemicals can also be applied in the apparel industry as raw materials for goods such as clothing and fabric bags and plastic products. Petrochemicals are utilized across all industries, including construction, automotive, agriculture, electrical, and electronics, and significantly impact the growth and development of these industries.

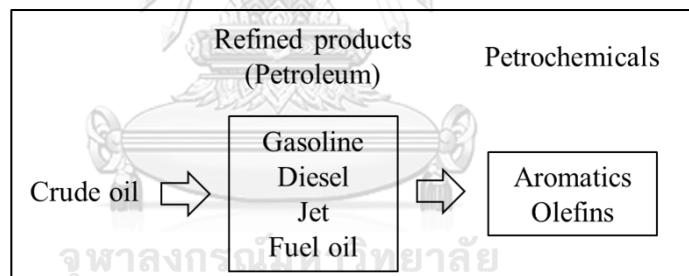


Figure 1. Refinery and petrochemical process

The oil and gas industry's supply chain consists of an upstream sector (exploration) and a downstream sector (Refinery & Petrochemical). Refineries are indispensable not only in the oil and gas industries but also in many other sectors. Products are essential for many industrial sectors and end-users. However, refinery companies historically face high volatility of refining margin thus generating a severe strain on the investment scene. The refining margins are a result of the difference between the prices of refined products and crude oil. The unitary of refining margin is

measured in dollars per barrel (\$/ bbl), and any small price fluctuation in its components will create a chain reaction of wide variation in the refining value. However, to mitigate the risk of margin depression due to the sensitiveness of the crude oil price, refiners seek an opportunity in petrochemical business since aromatics and olefins have a minimal correlation with the crude oil that helps reduce their earnings volatility (Quintino, Catalao-Lopes, Lourenco 2019). Therefore, their profitability not only depends on crude oil price but also depends on other channels of output prices of their core business. Thus, the company's total margin resulted from the combination of refining margin and petrochemicals margin known as Gross Integrated Margin (GIM).

Thailand is predominantly an oil-importing country. Crude oil imported from the Middle East accounts for roughly 70% of Thailand's total import volume. The refining and petrochemical sector is a well-established sector with a capacity of 1.235 million barrels per day, it ranks second in the ASEAN region, behind Singapore. There are six operators in the sector shown in **Table 1**; all of them run complex refineries to serve the demand for petroleum and petrochemicals in Thailand.

Table 1
List of refinery and petrochemical firms in Thailand

Stocks	Firm's Name	Market Share 2019
TOP	Thaioil Public Company Limited	22%
GC	PTT Global Chemical Limited	23%
IRPC	IRPC Public Company Limited	17%
BCP	Bangchak Corporation Public Company Limited	10%
ESSO	ESSO Public Company Limited	14%
SPRC	Star Petroleum Refining Public Company Limited	13%

From the significance mentioned above of refining and petrochemical business, it is undeniable that this industry has a tremendous influence on our lives. Furthermore, the size of the Thai industry has exponentially grown in the past few years, as well as

petroleum and petrochemical demand growth. This continuous growth may attract investors to pay attention to this sector.

Investor attention reflects investors' psychological changes and may significantly influence the price fluctuations in stock and commodity markets. Investors often make buying or selling decisions based on their beliefs about the fundamentals. However, the fundamentals of assets are hard to observe; in the end, investors tend to infer the fundamentals by processing related information that may affect the stock price. From the point of view, this is a fascinating area of investigation since it will provide new information to the value investors who are interested in refinery and petrochemical stocks listed in the Stock Exchange of Thailand (SET) about the usage of commodity price that firm use to operate their business. It would be beneficial to investors when making and investment decision in the stock market in order to earn abnormal returns.

Objective of the study

The objective of the study can be divided into two categories. First, this paper investigates the effect of crude oil, petroleum and petrochemical prices on firm's profitability performance measured by Gross Integrated Margin (GIM), Return on Equity (ROE) and Return on Asset (ROA) of refinery and petrochemical firms in Thailand. Second, we explore whether these commodity prices are an essential factors in explaining abnormal returns.

LITERATURE REVIEW

2.1 Concept, Theory and Relevant Research

The works of literature have been studying the relationship between oil price, stock market, and financial performance of oil and gas companies. It can be traced back to the 1970s, where the topic was initially discussed in the time of oil price shock. Hamilton (1983) was one of the first to investigate such impacts and whose work induce debate on this topic.

Recent research studied the impact of oil prices on the accounting profits of oil and gas companies. The findings show that crude oil prices have a positive impact on the return on equity (ROE) of oil and gas firms (Dayanandan & Donker, 2011; Bagirov & Mateus, 2019). The study by Wattanatorn and Kanchanapoom (2011) investigates the impact of crude oil prices on firm profitability performance. They found that oil prices have a significant impact on Return on Asset (ROA) of the energy sector in Thailand.

Besides, the profitability of refinery and petrochemicals firms can be estimated from their Gross Integrated Margin (GIM). This is the combination of the difference between crude oil prices and refining petroleum product prices and the difference between a refined product and petrochemical products. The unitary of Gross Integrated Margin (GIM) is measured in \$/ bbl. The profitability of refineries depends on many factors such as the prices of crude oil and other raw material inputs, also the characteristics of the regional markets in which the refinery operates and sells its products.

Seissian, Gharios, and Awad (2018) study factors influencing the profitability of the listed company in New York. They found that size (Total asset) and leverage ratio have a significant impact on firm profitability (ROA). In addition, Bagirov and

Mateus (2019) study the effect of oil prices on oil and gas firms from Europe. They found the statistical significance of the lagged dependent variable's coefficient hence indicates considerable persistence over time. Total asset and leverage ratios also have a negative impact on return on equity.

Furthermore, the macroeconomic variables influenced everyone on the market, and their effects are unavoidable. Recent literature studies the relationship between foreign investment and firm performance in Japan. The empirical result show that GDP growth and exchange rate are the key drivers of firm performance (Likitwongkajon and Vithessonthi (2020)).

Several studies have examined the relationship between crude oil prices and stock returns. The empirical results in this field show that oil prices harm market returns and positively impact the stock price of producers of oil and gas (Kilian & Park 2009; Malik & Ewing 2009; Nandha & Faff 2008; Weir, Laing, & McKnight 2002). Park & Ratti (2008) found that oil prices have a positive effect on oil-exporting countries' stock prices compared to those oil-importing countries where oil prices have a negative effect. Nevertheless, previous research investigates investors' behavior in the stock market. The literature found a negative impact of oil price and stock return. The proponents of negative relationships suggest that higher oil prices increase the cost of production, resulting in lower earnings and dividends and hence reduces stock prices. A few studies have documented a positive relationship between commodity price and stock returns supported by the suggestion that rising in oil price can be interpreted as a signal of more reliable business performance by investors (Kollias et al. (2013)). The latest study by Cheema and Scrimgeour (2019) suggest that the relationship between oil prices and stock market depend on investors' interpretation of the impact of the oil prices on the economy and individual firm.

Literature gap and contribution

The existing literature in this field can be broadly divided into three major categories, such as (i) impacts of oil price on economic indicators like economic growth, inflation (ii) impact on stock returns, and (iii) impact on the financial performance of oil and gas firms. This study is seeking to advance knowledge in oil price and firm performance by studying the impact of the output prices, including petroleum and petrochemicals on firm performance.

Since systematic factors cannot predict abnormal returns, and there is no evidence whether other factors i.e. commodity price, are the factors influencing abnormal return of the stocks. Therefore, this paper investigates whether oil, petroleum, and petrochemical prices can contribute abnormal returns of Thai refinery and petrochemical stocks. This study contributes to the literature by exploring the implications to investors when making investment decision in the stock market.

2.2 Research Hypothesis and Conceptual Framework

The paper examines the effect of oil, petroleum, and petrochemical prices on abnormal returns and profitability performance of refinery and petrochemical stocks in Thailand. Basically, oil (as a major input) and their products (as output) should reflect firm financial performance and investor's behavior in the stock market. Therefore, this paper addressed the following research questions:

- 1.) Do oil, petroleum, and petrochemical prices affect the profitability of Refinery and Petrochemical companies in Thailand?
- 2.) Do oil, petroleum and petrochemical prices influence abnormal returns?

To answer research question 1, we develop hypothesis 1 as following:

Hypothesis 1: Oil, petroleum and petrochemical prices positively affect the profitability of refinery and petrochemical firms in Thailand.

Several studies have examined the relationship between crude oil prices and firm performance. The results are still inconclusive whether the increase in crude oil price points positive or negative impact on firm's performance. Basically, the increase in oil price will cause an increase in cost of production which in turn lower firms profitability. As the supply of oil is inelastic due to the specialized investments, firms have to keep on producing even when the price rises. Thus, leads to the higher cost of production. However, refineries business in Thailand can be considered as monopoly, therefore having market power to set the price, giving an opportunity for the firms to transfer their extra cost to customers by enhance pricing flexibility to offset their additional costs. Firms could possibly end up gaining more profits. Similarly, petroleum and petrochemical prices are priced based on demand for products. Moreover, if the demand for petroleum and petrochemical increases, firms could add up margin or increase in the price further which will result in greater firms' profitability.

Figure 2-13 illustrates positive relationship between firm profitability represented by Gross Integrated Margin (GIM), Return on Equity (ROE) and Return on Asset (ROA) and the prices of oil, petroleum and petrochemical.

Relationship between firm profitability and the commodity prices

Figure 2

Plot of GIM and Dubai crude oil price

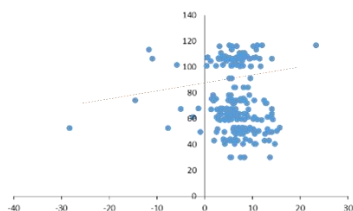


Figure 3

Plot of ROE and Dubai crude oil price

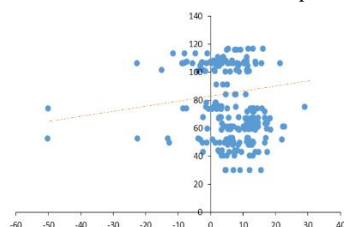


Figure 4

Plot of ROA and Dubai crude oil price

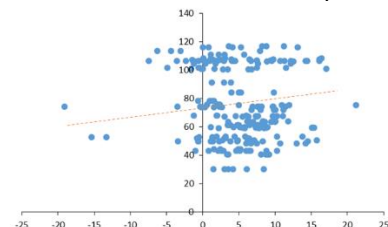


Figure 5

Plot of GIM and petroleum price

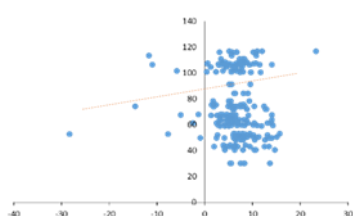


Figure 6

Plot of ROE and petroleum price

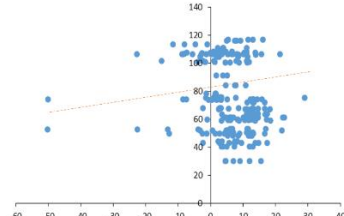


Figure 7

Plot of ROA and petroleum price

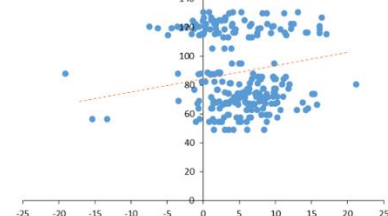


Figure 8

Plot of GIM and aromatics price

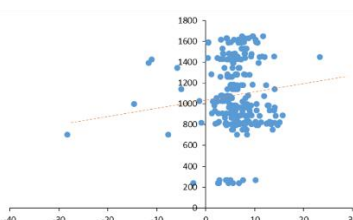


Figure 9

Plot of ROE and aromatics price

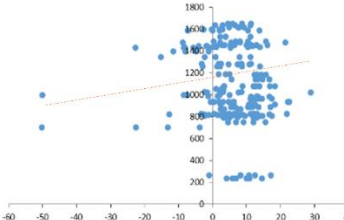


Figure 10

Plot of ROA and aromatics price

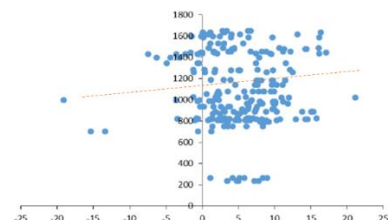


Figure 11

Plot of GIM and olefin price

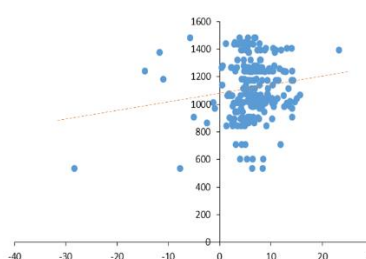


Figure 12

Plot of ROE and olefin price

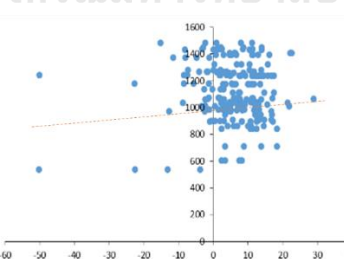
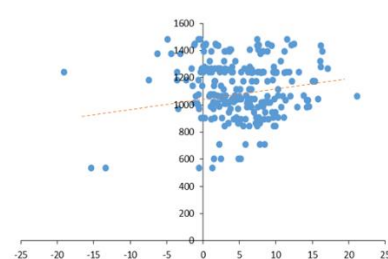


Figure 13

Plot of ROA and olefin price



To answer research question 2, we develop hypothesis 2 as following:

Hypothesis 2: Oil, petroleum and petrochemical prices positively affect abnormal returns

Theoretically, abnormal return of stock is generated by an unexpected news or event. The positive or negative abnormal return depends on types of the news and/or investors' perception on that particular event. Yet, there's no consensus on whether the relationship between commodity prices and stock returns is positive or negative. Previous studies also fail to find evidence to support the effect of commodity price on stock market returns (Nandha and Faff, 2018). If the change in commodity price goes in the same direction as anticipated by the market, stock price will remain unchanged. On the other hand, unexpected sharp movements, including sharp rise and fall of commodity prices will arouse the overreaction of stock markets, resulting in overpricing. And hence investors should expect to earn such unexpected profit in that specified period. To the extent that the increase or decrease in oil prices due to oil demand shock should be viewed as a good or bad surprising news for stock markets, we expect stock to be overpriced during the period of higher oil prices and hence generating higher abnormal return. Furthermore, there is substantial evidence in the literature (Stambaugh, 2012) suggest that the primary form of mispricing is overpricing when investors are optimistic toward positive news. Similarly, higher petroleum and petrochemical prices due to demand shock could be an indication of rising petroleum and petrochemical consumption in Thailand due to economic expansion which would be interpreted as unexpected news by investors. In addition, oil, petroleum, petrochemical prices experienced a sharp rise and fall over time as shown in **figure 14-17**. Therefore, such abrupt movements in these commodity price should stimulate the stock markets overreact to these commodity prices; hence, result in abnormal return for a specific period. However, two-way relationship between quarterly abnormal returns and commodity prices shown in **figure 18-21** don't seem to resemble any kind of pattern.

Trend of oil, petroleum and petrochemical prices

Figure 14
Trend of Dubai crude oil price

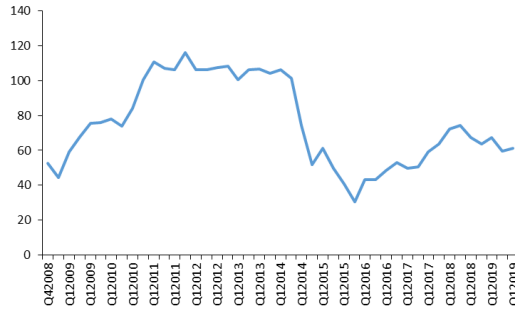


Figure 15
Trend of petroleum price

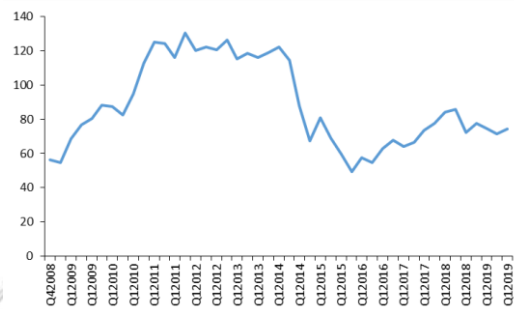


Figure 16
Trend of aromatics prices

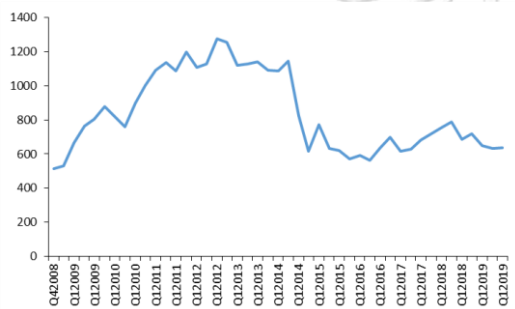
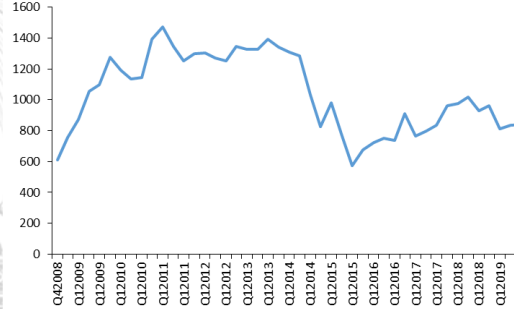


Figure 17
Trend of olefin price



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Relationship between commodity prices and abnormal returns

Figure 18
Trend of Alpha and Dubai crude oil price

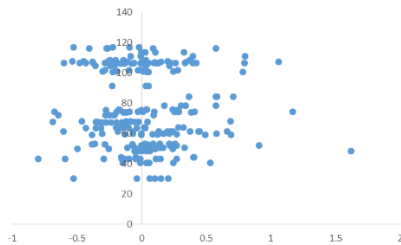
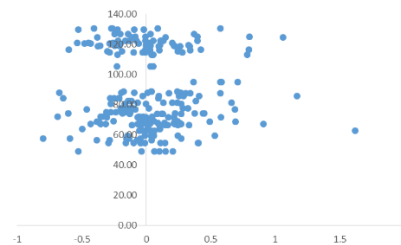
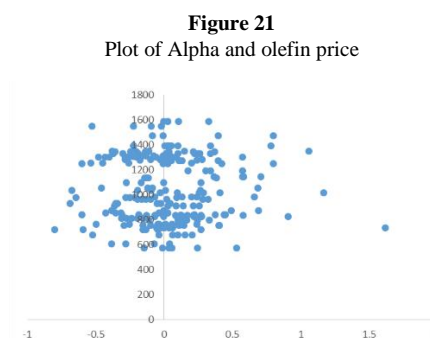
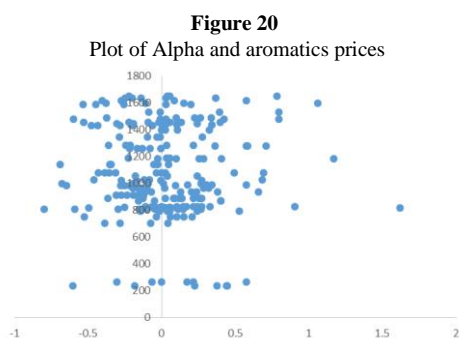


Figure 19
Plot of Alpha and petroleum price





DATA

3.1 Data Sample

The paper examines the effect of oil, petroleum, and petrochemical prices on abnormal returns and profitability of refinery and petrochemical stocks in Thailand. The six largest refining firms considered in the study including Thairoil (TOP), PTT Global Chemicals (PTTGC), Bangchak Petroleum (BCP), ESSO, International Refinery and Petrochemical Complex (IRPC) and Star Petroleum Refining Company (SPRC). The refined products and petrochemical products considered in this paper incorporate a typical refinery production in Thailand. Since firm's profitability as represented by GIM, ROE and ROA are reported quarterly in financial statement, which are available since 2008. Therefore, the dataset in the analysis is structured as a panel and consists of six refinery and petrochemical firms with 241 observations quarter 1 of 2008 to quarter 4 of 2019.

3.2 Independent variables

The independent variables used in the study are consisting of oil, petroleum, aromatics, and olefin prices. Dubai crude oil price was chosen for this study as it is mainly imported from the Middle East and actively traded among the region, while petroleum, aromatics and olefin prices are refer to the Mean of Platts Singapore

(MOPS) since product prices leaving from Thai refinery (Ex-refinery price) depends on the reference price of Singapore market, which are collected from Platts database. Average quarterly prices data were considered to eliminate daily noise in analyzing performance of the oil and gas companies; specifically since profitability of these firms were reported quarterly in financial statements. **Table 2** summarizes all Independent Variables in abbreviations, unit and data sources. The descriptive statistics of independent variables are presented in **Table 3**.

Table 2
Independent Variables

Variables	Description	Unit	Source
<u>Oil & Petroleum</u>			
Oil	Average daily Dubai crude oil price by quarter	\$/ bbl	Platts
ULG95	Average daily Gasoline price by quarter	\$/ bbl	Platts
GO	Average daily Diesel price by quarter	\$/ bbl	Platts
JET	Average daily Jet price by quarter	\$/ bbl	Platts
HSFO	Average daily Fuel oil price by quarter	\$/ bbl	Platts
<u>Aromatics</u>			
Px	Average daily Paraxylene price by quarter	\$/ Ton	Platts
Bz	Average daily Benzene price by quarter	\$/ Ton	Platts
Tol	Average daily Toluene price by quarter	\$/ Ton	Platts
<u>Olefins</u>			
Ethyl	Average daily Ethylene price by quarter	\$/ Ton	Platts
Propyl	Average daily Propylene price by quarter	\$/ Ton	Platts

Table 3
Descriptive Statistics of Independent Variables

Variables	Observations	Mean	Standard deviation	Min	Max
Oil	241	77.37	25.28	30.41	116.64
ULG95	241	90.19	25.32	27.25	130.44
GO	241	93.09	29.27	40.02	157.52
JET	241	92.88	28.73	42.68	154.34
HSFO	241	71.44	24.24	25.53	116.90
Px	241	1,100.14	337.31	237.65	1,649.76
Bz	241	901.11	303.88	107.227	1,379.70
Tol	241	851.36	230.68	512.36	1,276.01
Ethyl	241	1,128.29	215.64	537.25	1,482.22
Propyl	241	1,066.91	268.62	572.89	1,584.87

3.3 Dependent variables

Dependent variables considered in the study comprises of Gross Integrated Margin (GIM), calculated by subtracting the cost of crude from the combined value of the output products. Return on Equity (ROE) defined as quarterly return on equity (net profit divided by total equity), and Return on Asset (ROA) defined as quarterly return on assets (net profit divided by total asset). The figures are manually collected from company financial statement. Furthermore, Alpha is obtained by regress the Fama-French model using daily returns to generate quarterly abnormal returns.

Fama and French model

$$R_t^i - R_t^f = \text{Alpha}_q^i + \beta_{1,q}^i (R_t^M - R_t^f) + \beta_{2,q}^i \text{SMB}_t + \beta_{3,q}^i \text{HML}_t + \varepsilon_t^i$$

Where Alpha_q^i represents abnormal return for the period (q) of stock (i)

Table 4 summarizes all Dependent Variables in abbreviations, unit and data sources. The descriptive statistics of dependent variables are presented in **Table 5-8**.

Table 4
Dependent Variables

Variables	Description	Unit	Source
GIM	Gross Integrated Margin per quarter	S/ bbl	Company financial statement
ROE	Return on Equity per quarter	%	Company financial statement
ROA	Return on Asset per quarter	%	Company financial statement
Alpha	Abnormal return per quarter	%	Generated from Fama & French model

Table 5
Descriptive Statistics of Dependent Variables: GIM (\$/bbl)

Company	Observations	Mean	Standard Deviation	Min	Max
TOP	48	6.91	2.03	2.40	12.00
PTTGC	33	5.06	1.97	2.38	8.08
IRPC	48	9.36	4.21	-7.70	15.70
BCP	48	6.41	2.15	1.47	14.03
ESSO	47	3.26	8.33	-28.30	23.30
SPRC	17	6.00	2.23	2.49	10.41
Total	241	6.27	4.79	-28.30	23.30

Table 6
Descriptive Statistics of Dependent Variables: ROE (%)

Company	Observations	Mean	Standard Deviation	Min	Max
TOP	48	3.73	5.12	-16.99	16.98
PTTGC	33	2.74	1.74	-1.99	5.81
IRPC	48	0.77	4.81	-25.92	5.79
BCP	48	4.35	5.67	-6.99	29.56

ESSO	47	1.09	10.39	-39.85	24.97
SPRC	17	3.28	4.30	-9.42	7.13
Total	241	2.58	6.39	-39.85	29.56

Table 7
Descriptive Statistics of Dependent Variables: ROA (%)

Company	Observations	Mean	Standard Deviation	Min	Max
TOP	48	1.89	2.58	-8.59	9.30
PTTGC	33	1.66	1.04	-1.17	3.32
IRPC	48	0.34	2.91	-16.93	3.63
BCP	48	2.13	2.72	-3.06	14.13
ESSO	47	0.53	3.08	-9.11	5.35
SPRC	17	2.14	2.92	-6.46	4.84
Total	241	1.35	2.75	-16.93	14.13

Table 8
Descriptive Statistics of Dependent variables: Alpha (%)

Company	Observations	Mean	Standard Deviation	Min	Max
TOP	48	0.00	0.80	-1.49	2.18
PTTGC	33	0.06	0.72	-0.90	2.48
IRPC	48	-0.03	0.84	-1.54	2.46
BCP	48	0.20	0.61	-1.26	1.95
ESSO	47	0.01	1.29	-2.28	6.04
SPRC	17	0.37	1.16	-1.65	3.33
Total	241	0.07	0.91	-2.28	6.04

3.4 Control variables

A set of control variables comprises of the variables of company-specific fundamental and economic conditions, which are expected to influence a firm's profitability. First, we follow the literature by using *Size*, which can be measured in terms of the natural logarithm of total assets, leverage ratio measured by total debt divided by total equity, shown in *Lev*. In addition, profitability of the firm also depends on how well economy is doing, we further control oil demand and supply in Thailand, exchange rate (Fx) and Thailand real GDP growth year on year basis (GDP). Furthermore, to account for other factors that may influence investor perception in stock market, we further control market capitalization, and leverage, or D/E to assess the effect related to the firm's amount of leverage and account for an additional market reaction that may result from the company's leverage position (Dhaliwal and Reynolds (1994), Hong (2017)). Book-to-market is used to control the firm's market valuations by comparing it to other firms within the same competitive landscape on a relative basis. **Table 9** summarizes all Control Variables in abbreviations, unit and data sources. The descriptive statistics of control variables are presented in **Table 10**.

Table 9
Control Variables

Variables	Description	Unit	Source
Fx	Exchange rate baht/ US average by quarter	THB/ USD	BOT
GDP	Thailand real GDP growth by quarter (YoY)	%	BOT
Dem	Thailand oil demand	Barrels/ Day	EPPO
Sup	Total oil production in Thailand	Barrels/ Day	EPPO
Size	Natural logarithm of total asset	MTHB	Company financial statement
Lev	Leverage ratio (D/E)	Ratio	Company financial Statement
BTM	Natural logarithm of Book to market	Log form	Datastream
Cap	Market capitalization	Log form	Bloomberg

Table 10
Descriptive Statistics of Control Variables

Variables	Observations	Mean	Standard deviation	Min	Max
Fx	241	32.59	1.75	29.80	35.84
GDP	241	3.15	3.33	-4.64	15.29
Dem	241	863,438.01	90,777.72	675,783	1026,571.73
Sup	241	1,017,988.32	106,638.31	822,129.95	1,201,138.03
Size	241	158,462.33	117,443.4	11,703.55	469,255.30
Lev	241	1.02	0.14	0.79	1.29
BTM	241	1.22	0.31	0.44	2.28
Cap	241	127,398.52	35,163.64	48,144.66	211,140

Table 11 Pairwise Correlation of all Variables

Variables	Dubai	ULG95	GO	JET	HSFO	Px	Bz	Tol	Ethyl
Dubai	1.000								
ULG95	0.976	1.000							
GO	0.973	0.987	1.000						
JET	0.974	0.987	0.990	1.000					
HSFO	0.988	0.990	0.993	0.993	1.000				
Px	-0.233	-0.295	-0.270	-0.274	-0.245	1.000			
Bz	-0.222	-0.277	-0.256	-0.260	-0.231	0.987	1.000		
Tol	-0.252	-0.311	-0.287	-0.291	-0.262	0.985	0.982	1.000	
Ethyl	-0.415	-0.455	-0.432	-0.436	-0.421	0.309	0.317	0.312	1.000
Propyl	-0.357	-0.403	-0.376	-0.380	-0.364	0.335	0.339	0.339	0.979
Fx	-0.542	-0.480	-0.496	-0.496	-0.522	-0.163	-0.151	-0.183	0.017
GDP	0.056	0.059	0.033	0.036	0.044	0.097	0.127	0.106	0.031
Dem	-0.362	-0.364	-0.403	-0.398	-0.398	-0.116	-0.111	-0.100	0.151
Sup	-0.427	-0.432	-0.461	-0.457	-0.466	-0.156	-0.156	-0.156	0.139
Size	-0.440	-0.477	-0.451	-0.454	-0.443	0.484	0.487	0.497	0.647
Lev	0.159	0.197	0.176	0.179	0.170	-0.241	-0.234	-0.240	-0.326
BTM	-0.108	-0.116	-0.160	-0.158	-0.141	0.304	0.303	0.286	0.032
Cap	-0.440	-0.498	-0.468	-0.472	-0.457	0.545	0.540	0.546	0.799
Variables	Propyl	Fx	GDP	Dem	Sup	Size	Lev	BTM	Cap
Propyl	1.000								
Fx	-0.056	1.000							
GDP	0.021	-0.165	1.000						
Dem	0.100	-0.035	0.145	1.000					
Sup	0.077	0.131	0.141	0.899	1.000				
Size	0.639	-0.015	0.007	0.198	0.177	1.000			
Lev	-0.336	0.005	-0.122	-0.032	-0.060	-0.208	1.000		
BTM	0.026	-0.194	0.309	0.413	0.370	0.149	0.017	1.000	
Cap	0.795	-0.081	0.047	0.232	0.216	0.755	-0.388	0.252	1.000

Table 11 presents the correlation among variables. It is observed that crude oil prices (Dubai) and petroleum prices (ULG95, GO, JET and HSFO) are highly correlated. Prices of aromatics (Px, Bx, and Tol) and olefin (Ethyl and Propyl) are also correlated among one another. The estimated pairwise correlations are higher than 0.9. In addition, the correlation coefficient among control variables is higher than 0.8, which causes a concern of multicollinearity problems. Therefore, we decide to exclude prices of petroleum, paraxylene, benzene, ethylene, supply, and market capitalization from the regression as all of them are less correlated with dependent variables in order to avoid the problem.

METHODOLOGY

This study's main interest is to determine the influence of crude oil, petroleum, and petrochemical prices on abnormal returns and profitability performance of refinery and petrochemical stocks in Thailand. The first hypothesis tests whether oil and petrochemical prices have a positive impact on firm profitability. We develop profitability model as measured by GIM, ROE, and ROA as a function of oil price (Dubai), aromatics price (Tol), olefin price (Propyl), economic condition (Fx, GDP, Dem) and firm's specific characteristics (Size, Lev). Since firms typically stock some crude oil as an input for the next period of production and the raw material acquisition process starts about one or two months ahead of the refining process. Therefore, we decide to include a first-lagged of oil price as an explanatory variable. In order to avoid endogeneity problem due to the firm's fixed effects. We employ Fixed Effects estimator and estimate the following form:

$$Y_{i,q} = \alpha_i + \beta_1 Dubai_q + \beta_2 Dubai_{q-1} + \beta_3 Tol_q + \beta_4 Propyl_q + \beta_5 Fx_q + \beta_6 GDP_q + \beta_7 Dem_q + \beta_8 Size_{i,q} + \beta_9 Lev_{i,q} + \varepsilon_{i,q} \quad (1)$$

Where α_i represents firm's fixed effects. $Dubai_{q-1}$ represents a first-lagged of Dubai crude oil price and Y represents GIM, ROE and ROA varies across models.

In addition to avoid endogeneity problem, previous literature suggest that current profitability also depends on its own previous value. Therefore, we follow the literature by using GMM dynamic-panel estimation or Arellano-Bond estimator, where first-lagged dependent variable were included as explanatory variable. This framework was successfully implemented by Bagirov and Mateus (2019) to test the impacts of oil prices on accounting performance measures of oil and gas companies in Western Europe. We conduct the model and estimate the following form:

$$Y_{i,q} = \gamma Y_{i,q-1} + \alpha_i + \beta_1 Dubai_q + \beta_2 Dubai_{q-1} + \beta_3 Tol_q + \beta_4 Propyl_q + \beta_5 GDP_q + \beta_6 Fx_q + \beta_7 Dem_q + \beta_8 Size_{i,q} + \beta_9 Lev_{i,q} + \varepsilon_{i,q} \quad (2)$$

Where $Y_{i,q-1}$ represents a first-lagged dependent variable, Y represents the dependent variables of GIM, ROE and ROA varies across models.

To examine whether oil and product price have an impact on firm profitability. We conduct the regression to test the following hypothesis.

$$H_0 : \beta_1 \leq 0 \text{ versus } H_1 : \beta_1 > 0$$

$$H_0 : \beta_2 \leq 0 \text{ versus } H_1 : \beta_2 > 0$$

$$H_0 : \beta_3 \leq 0 \text{ versus } H_1 : \beta_3 > 0$$

β_1 , β_2 and β_3 represent coefficient of oil, aromatics and olefin prices respectively, which should be positive according to our hypothesis.

To test the second hypothesis, we begin by calculating quarterly abnormal returns by regressing the Fama and French model:

Fama and French model:

$$R_t^i - R_t^f = \text{Alpha}_q^i + \beta_{1,q}^i (R_t^M - R_t^f) + \beta_{2,q}^i \text{SMB}_t + \beta_{3,q}^i \text{HML}_t + \varepsilon_t^i$$

Where Alpha_q^i represents abnormal return for the period (q) of stock (i)

The second hypothesis is to test whether oil and petrochemical price have an impact on abnormal returns. We characterize abnormal returns as a function of crude oil price, aromatics price, olefin prices, log of total asset, leverage ratio (D/E) and log of Book-to-market. We estimate the following form using Fixed Effects and GMM dynamic panel or Arellano-Bond estimator.

Fixed Effects:

$$\text{Alpha}_q^i = \alpha_i + \beta_1 \text{Dubai}_q + \beta_2 \text{Tol}_q + \beta_3 \text{Propyl}_q + \beta_4 \text{Size}_{iq} + \beta_5 \text{Lev}_{iq} + \beta_6 \text{BTM}_{iq} + \varepsilon_{iq} \quad (3)$$

Where α_i represents fixed effects of a particular stocks

GMM dynamic panel or Arellano-Bond:

$$\text{Alpha}_q^i = \gamma \text{Alpha}_{i, q-1} + \alpha_i + \beta_1 \text{Dubai}_q + \beta_2 \text{Tol}_q + \beta_3 \text{Propyl}_q + \beta_4 \text{Size}_{iq} + \beta_5 \text{Lev}_{iq} + \beta_6 \text{BTM}_{iq} + \varepsilon_{iq} \quad (4)$$

Where $\text{Alpha}_{i, q-1}$ represents a first-lagged dependent variable

To examine whether oil and product prices have an impact on abnormal returns. We conduct the regression to test the following hypothesis.

$$H_0: \beta_1 \leq 0 \text{ versus } H_1: \beta_1 > 0$$

$$H_0: \beta_2 \leq 0 \text{ versus } H_1: \beta_2 > 0$$

$$H_0: \beta_3 \leq 0 \text{ versus } H_1: \beta_3 > 0$$

β_1 , β_2 and β_3 represent coefficients of oil, aromatics and olefin prices respectively, which should be positive according to our hypothesis.

EMPIRICAL RESULT AND DISCUSSION

The results that estimated by Fixed Effects and One-step system GMM (Arellano-Bond) are shown in **Table 12 – 13**. We prefer One-step system GMM or Arellano-Bond to Fixed Effects. The estimation from Arellano-Bond captures the effect of these commodity prices on oil and gas firm's performance and abnormal returns efficiently. The Hansen test of over-identifying restrictions indicate that instruments are valid, while the corresponding results from Fixed Effects had lower explanatory power.

Table 12
Empirical results estimated by Fixed Effects

Variables	Expected sign	GIM	ROE	ROA	Alpha
<i>Dubai</i>	+	0.016* (0.007)	-0.004** (0.094)	0.003** (0.008)	-0.008** (0.003)
<i>Dubai (-1)</i>	+/-	-0.095 (0.023)	-0.232** (0.033)	-0.106** (0.013)	
<i>Tol</i>	+	-0.002 (0.002)	-0.008 (0.018)	0.005** (0.001)	-9.95e-05 (0.002)
<i>Propyl</i>	+	0.016 (0.011)	0.032*** (0.010)	0.019*** (0.004)	-0.002** (0.000)
<i>Fx</i>	+	0.411 (-0.150)	0.366* (0.177)	0.166** (0.059)	
<i>GDP</i>	+	0.151** (-0.053)	0.070 (0.080)	0.060 (0.040)	
<i>Dem</i>	+	1.23e-05* (4.98e-06)	1.13e-06 (6.09e-06)	1.03e-06 (2.92e-06)	
<i>Size</i>	+	0.231 (0.410)	-1.398* (0.642)	-0.871** (0.234)	-0.096 (0.029)
<i>Lev</i>	-	-0.823 (0.652)	-1.749 (1.040)	-0.434* (0.353)	-0.004 (0.089)
<i>BTM</i>	+				0.176* (0.159)
<i>Constant</i>	+/-	-21.910 (10.920)	6.547 (11.755)	4.480 (4.954)	1.711 (0.280)
Observations		241	241	241	241
Number of Stock		6	6	6	6
R-squared		0.084	0.053	0.085	0.021

*Robust standard errors in parentheses *** p<0.01, ** p<0.05, *p<0.1*

Table 13
Empirical results estimated by One-step system GMM or Arellano-Bond

Variables	Expected sign	GIM	ROE	ROA	Alpha
<i>Y(-1)</i>	+	0.252 (-0.216)	0.365* (-0.020)	0.015 (0.123)	-0.012 (0.038)
<i>Dubai</i>	+	0.022* (0.008)	-0.072** (-0.034)	0.004** (-0.005)	-0.006* (0.003)
<i>Dubai (-1)</i>	+/-	-0.0778 (0.0770)	-0.2199** (0.0650)	-0.1031** (0.0255)	
<i>Tol</i>	+	0.003 (-0.003)	0.004 (0.009)	0.001* (0.002)	-0.001*** (0.028)
<i>Propyl</i>	+	0.001 (-0.008)	0.0002* (-0.013)	0.0002 (-0.002)	-0.0003** (0.001)
<i>Fx</i>	+	0.377 (-0.112)	-0.283* (-0.348)	0.176* (-0.077)	
<i>GDP</i>	+	0.066** (-0.053)	0.049 (-0.112)	0.033 (-0.041)	
<i>Dem</i>	+	0.000* (-4.98e-06)	-2.11e-05 (-2.31e-05)	1.86e-06 (-3.35e-06)	
<i>Size</i>	+	0.231 (-0.410)	-2.554* (-4.432)	-0.487** (-0.147)	-0.079** (0.012)
<i>Lev</i>	-	-0.823 (-0.652)	-2.554 (-6.263)	-0.804* (-0.341)	-0.061 (0.044)
<i>BTM</i>	+				0.125 (0.197)
<i>Constant</i>	+/-	-20.01 (-10.92)	1.532 (7.556)	0.133 (-3.552)	1.453*** (0.221)
Observations		235	235	235	235
Number of Stock		6	6	6	6

Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Hansen test of overidentifying restrictions: Prob > chi2 = 1.000

5.1 The effect of petroleum and petrochemical prices on firm's profitability

GIM (Gross Integrated Margin)

There has been virtually no research on the impact of petroleum and petrochemical prices on Gross Integrated Margin (GIM) for refining and petrochemical companies in Thailand. Therefore, the obtained empirical results are, in some sense, unique. The empirical results estimated from One-step system GMM indicate that the impact of crude oil price on GIM is significantly positive as expected. The explanation is that, when oil price raises, refineries will increase their level of investment on production to produce more oil, and consequently, firms can transfer extra cost of production to their customers by enhance pricing flexibility and profit maximization to offset additional cost. Eventually, firms can increase their profits. Conversely, GIM is unaffected by the lagged variable of Dubai and petrochemical prices. Besides, the coefficients of economic variables of GDP, and Dem, indicating how well economics condition is, are significant at a 5% level with an expected sign. It can be concluded that, economic growth is one of the key drivers for the profitability performance of the refinery and petrochemical companies in Thailand.

Return on Equity (ROE)

Oil prices have a positive impact on ROE in the same way as GIM. Higher cost would demand greater profit due to opportunity cost. The finding is consistent with Bagirov and Mateus (2019) who find a positive impact of oil price on ROE of Western European Oil and Gas Companies. On the contrary, result of the lagged term of Dubai is negative and statistically significant, indicating that stock loss and lower profit occurs when crude cost for the stock used for refining are higher than current crude prices. As predicted, olefin prices have a positive impact on ROE. Normally, prices of refined products leaving from refinery in Thailand are set based on Singapore market price (MOPS) plus additional premium. Due to an inelastic of products demand, firms can

increase the premium when pricing their products. The statistical significance of the lagged dependent variable's coefficient hence indicates considerable persistence over time. Furthermore, the Fx's coefficients are statistically significant at a 10% level with an expected sign, indicating that baht depreciation benefits the firm's profitability performance. For the financial performance variables, Size is statistically significant with a negative sign, implying that an increase in total assets affects the company's return on equity. The result is consistent with previous research (Bagirov and Mateus (2019)).

Return on Asset (ROA)

ROA is positively influenced by Dubai crude oil as firm can realize their profit after pass through the cost to customers over time, while the lagged variable of Dubai negatively affect ROA, firms would experience inventory loss when crude cost for the stock used for refining are higher than current crude prices. In addition, ROA also positively affected by aromatic prices (Tol) as expected. Higher products demand induced firms to increase margin on their products and sales. Firm's ROA is also impacted by economic condition, and financial performance variables. The exchange rate has positive impact on ROA of the firms. Size is statistically significant with a negative sign, implying that an increase in size affects the return on asset negatively. Leverage ratio is statistically significant with an expected sign, suggesting that leverage ratio is perceived by the market as unsuccessful mechanism to monitor management, since the performance of firm is negatively impacted by it (Bagirov, Mateus; 2019).

5.2 The effect of petroleum and petrochemical prices on quarterly abnormal returns

Prices of oil have a negative impact on quarterly abnormal returns, implying that higher oil prices result in lower quarterly abnormal returns. The result is inconsistent with Cheema & Scrimgeour (2019), who have found a positive impact of crude oil prices on abnormal returns in the Chinese stock market. Furthermore, aromatics and olefin prices also have inverse relationship with quarterly abnormal returns, which is contrast with the expectation. It can be seen that, the movement of commodity prices significantly explain abnormal return. However, during the period of rising in commodity prices, some determinant might put downward pressure on stock prices causing difficulty of stock return to increase, resulting in lower abnormal return. Adversely, some factors might push up the stock return even during the period of lower commodity prices. In addition, *Size* negatively affects quarterly abnormal returns, indicating that higher total assets leading to lower abnormal returns. However, there is no significant evidence that leverage ratio and book to market can explain abnormal returns of refinery and petrochemical stocks.



CONCLUSION

The objective of the study is categorized into two groups. First, this paper examines the impact of crude oil, petroleum and petrochemicals prices on firms' profitability performance measured by Gross Integrated Margin (GIM), Return on Equity (ROE) and Return on Asset (ROA) of refinery and petrochemical companies in Thailand. Second, we investigate whether petroleum and petrochemical prices are essential factors in explaining abnormal returns. Our study finds that higher oil price benefit refineries performance. Nevertheless, firms should keep appropriate inventory

level, as higher inventory level can cause inventory loss. In addition, prices of aromatics and olefins also positively and significantly impact the profitability performance of refinery and petrochemical firms in Thailand. It can be seen that, all of these commodity drive refineries firm's performance. The unexpected movement of these prices should be beneficial to investors investing in refineries and petrochemical stocks when commodity prices rise to make higher abnormal profit. Surprisingly, higher oil and product prices cause reduction in quarterly abnormal returns. It can be concluded that, the movement of oil and petrochemical prices can explain abnormal return. However, investors tend to obtain lower abnormal returns during the period of high commodity prices. On the contrary, they tend to earn higher abnormal returns when the prices fall. Since abnormal return cannot be predicted by market movement alone, there might be some determinants that pressure stock return during the period of high commodity prices. On the contrary, there might also be some factors that push up the stock return during the period of low commodity prices, which can lead to higher abnormal return.

The findings obtained should be interesting to market participants. This study provides implications to investors when making investment decisions in the stock market. Investors have no incentive to invest in refinery and petrochemical stock when the commodity price is rising since they would not earn a higher abnormal return. However, this study has a few limitations. We do not provide complete explanations on an indicator that investors should use to gain a higher profit; it would be better for future research.

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