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Oil Price Risk in Selected ASEAN Markets

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Abstract

This paper analyzes the oil price risk in four ASEAN markets using a two-factor "market and oil" model and EGARCH(1, 1) variance specification. In the analysis, three alternative non-linear measures of oil prices are used and robustness check of basic results is also performed. The results suggest a direct relation between oil price changes and stock market returns and indicate no evidence for asymmetric oil price risk for Indonesia. Meanwhile, the asymmetric oil price risk seems apparent for the markets of Malaysia, Singapore and Thailand. For an oil exporting Malaysia, the oil price decline tends to compromise its market performance while the oil price increase does not seem to be beneficial. In contrast, for oil-importing Singapore and Thailand, the oil price shocks tend to adversely affect their market returns. The contrasting experiences of these markets in the face of oil price fluctuations are attributed to the degree of oil dependency, level of financial development, and trade openness.

Key words: Asymmetry, EGARCH, oil price risk
JEL classification: C22, G12, Q43

1. Introduction

The interest in financial investments and diversification has stimulated substantial research on financial asset pricing or factors that contribute to stock price fluctuations. In addition to the market, interest rate and exchange rate risks, oil price fluctuations have recently attracted attention as a potential risk factor in equity prices. Indeed, looking at the oil price risk and its relation to stock markets seems to be a natural extension of a much-debated issue on the oil price – macroeconomy relations ever since the first OPEC oil embargo in 1973. The standard present value model posits that stock prices fundamentally reflect the discounted future cash flows, which essentially depend on future macroeconomic conditions. Hence, any macroeconomic event that has significant bearings on the macroeconomy can affect the stock prices as well. Notably, the oil price shocks are transmitted to real activities through a variety of channels, among which include production costs, productivity, terms of trade, wealth transfer, inflation, consumption and investments, and interest rate. Since these channels are arguably linked to firms' cash flows, it is natural to posit significant impacts of oil price shocks on stock price variations. The overall effect,

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however, tends to depend on the nation's oil dependency, trade structure, market structure, and level of financial development.

Following periodic sharp swings in the global oil market in the last two decades, a string of empirical studies has emerged to address the oil price risk in the asset pricing for developed markets. Despite the expected oil-stock market relations, the oil sensitivity of aggregate market returns seem to receive mixed support. Jones and Kaul (1996) examined the sensitivity of stock returns in four developed markets – Canada, Japan, the UK and the US. They document evidence suggesting significant adverse effects of oil price shocks on the markets of the US and Canada and inconclusive evidence for Japan and the UK. Huang, Masulis and Stoll (1996) applied an unrestricted vector autoregressive model to the US data and document insignificant relations between oil prices and the S&P500 market index. In contrast, using a similar approach, Sadorsky (1999)demonstrates significant relations between oil price changes and the US market returns. More recently, Park and Ratti (2008) demonstrate significant adverse effects of oil price shocks for the US and twelve European markets and significant positive effect for the Norwegian market while Apergis and Miller (2009) suggest no significant impacts of structural oil shocks on eight developed markets.

The interest in the issue has also motivated researchers to extend the analysis to markets outside the US and Europe, notably, to markets of oil-exporting countries and to emerging markets. Based on the available but still relatively limited studies on emerging markets, the evidence supporting significant oil price risk in their market returns seems to be scanty. Employing a VAR approach to evaluate dynamic interactions between oil prices and twenty-two emerging markets, Maghyereh(2004) document no significant role of oil prices in causing stock market fluctuations. Similarly, looking at 5 GCC markets (Bahrain, Kuwait, Oman, Saudi Arabia and UAE), Hammoudeh and Aleisa (2004) were able to find significant relations only for Saudi Arabia. El Hedi Arouri and Nguyen (2010) also performed the analysis for the GCC countries. While there seems to be a short run causal relation that runs from oil prices to stock markets in several GCC countries, their long run relation is absent except for Bahrain.

Nandha and Hammoudeh (2007) did a recent notable study on 15 Asia-Pacific markets. Applying the international market model, they evaluated the short-run sensitivity of stock returns in these markets to changes in oil prices where oil prices are expressed in local currencies and in the US dollar. In addition, the differential effects of oil price increases and decreases are also examined. The results they obtained indicate limited evidence for the presence of oil price risk in the Asia-Pacific markets when the oil prices are in local currencies. More specifically, the evidence of oil price risk is limited to only few countries, namely, Indonesia, Malaysia, the Philippines, South Korea and Sri Lanka under some model specifications. Surprisingly, when the oil prices are expressed in the US dollar, the oil price risk is virtually absent in these markets. More likely, as they note, these markets tend to be affected more by gyrations in the exchange rates.

In this paper, we relook the issue for the main four ASEAN markets,that is, Indonesia, Malaysia, Singapore and Thailand, using a two-factor 'market and oil' price model as a basic framework. While we adopted the standard market model, we depart from Nandha and Hammoudeh (2007) in several aspects. First, instead of using data series at weekly frequency, we employ monthly data that cover a longer period. The use of monthly data is a reasonable complement to their study and is quite common in the literature (Park & Ratti, 2008; Faff & Brailford,1999; Nandha & Faff, 2008). We extend the period back to 1988 to include the 1990-1991 oil disruptions due to the Gulf War and to the most recent years, that is, 2010, to cover recent episodes of oil price escalation especially in 2008. We believe that the effect of oil price will be more apparent as more episodes of oil price sharp swings are included. Second, we measure the oil price in the US dollar and not in domestic currencies as used in many studies. Our contention is exchange rate changes may stem from a myriad of factors not related to oil prices and accordingly should be treated as a separate risk factor. By bundling them together through the conversion of US dollar price of oil to domestic price of oil may result in erroneous attribution of stock pricing risk to oil price when the changes in domestic oil price arise from variations in the exchange rate. Moreover, the use of domestic oil prices in the model is mis-specified if the oil price risk and exchange rate risk are not equal (Faff & Brailford, 1999). Third, we employ alternative non-linear specifications of oil price (Park & Ratti, 2008; El Hedi Arouri,2011). Namely, in addition to the positive and negative changes in oil price used by Nandha and Hammoudeh (2007), we employ the scaled oil price shock and net oil price shock as proposed respectively by Lee et al. (1995) and Hamilton (1996). Fourth, while the two factor "market and oil" model is supported, we perform a sensitivity analysis by augmenting the model to include alternative risk factors. In this way, the robustness of the oil risk factor could be evaluated. And fifth, we account for volatility clustering in stock returns and asymmetric volatility, which are commonly observed in financial time series, by using the exponential GARCH or EGARCH model.

As a precursor to the analysis, the next section provides a brief background of the markets under investigation. Section 3 describes the empirical models employed. Section 4 presents data and estimation results of the analysis. Finally, Section 5 concludes with a summary of the main findings and some concluding remarks.

2. Background

The Association of Southeast Asian Nations (ASEAN) was formed in 1967 with the main aims of promoting political stability, active collaboration, mutual assistance and cooperation and accelerating economic growth, social progress and cultural development of the region. Initially, the political stability and cooperation took centre stage in the ASEAN agenda. While economic ties among the members of ASEAN have been close, their economic cooperation has been formally established by the formation of the ASEAN Free Trade Area or AFTA in 1992 in Singapore. The present paper focuses on the four major ASEAN economies which have demonstrated remarkable progress at various fronts including their stock markets. They are Indonesia, Malaysia, Singapore and Thailand.

Table 1 presents selected stock market indicators for the four markets, namely, number of listed firms, market capitalization in billion USD and as a ratio of GDP, and the value of stocks traded in billion USD and as a ratio of GDP. On the basis of these indicators, the markets of Singapore and Malaysia are relatively more advanced while the market of Indonesia stands at the other end of the stock market development level. Notwithstanding the 1997/1998 Asian financial crisis that they succumbed to, their market sizes have expanded over the 1990-2009 period. The expansion of market capitalization and of the value of stocks traded, both in current US dollar and as ratios of GDP, was remarkable prior to the occurrence of the Asian crisis. As may be noted from Table 1, they experienced many-fold increases from 1990 to 1995. Then, with the exception of Singapore, the performance indicators of these stock markets dropped substantially during the Asian crisis. The drop remains noticeable even in 2000. While these markets seem to resume their uptrend pattern after the Asian crisis, their progress seems to be forestalled by the recurrence of financial crises and uncertainties in the past decade, notably during the subprime crisis. More specifically, with the exception of Indonesia, the market capitalization

$$D_t = \begin{cases} 1 & \text{if } \max(0, {}^{v_t}/_{\sigma_t}) > 0 \\ 0 & \text{otherwise} \end{cases} \tag{7}$$

Based on Equation (3), the parameters β_{oil} and β_D capture respectively the risk of scaled oil price decline and the incremental risk of scaled oil price increase. Asymmetry is said to exist if β_D is significantly different from 0. Again, the total oil price risk during the scaled oil price increases is $\beta_{oil} + \beta_D$.

Finally, Hamilton (1996) suggests comparing the current oil price level with the peaked level recorded over previous periods as an indicator of oil price shocks. In the present analysis, the oil price shocks are said to take place when the current price exceeds its peak over the last 12 months, which is termed as the net oil price increase (NOPI). Taking the NOPI as an alternative non-linear oil price specification, we specify the dummy variable as

$$D_t = \begin{cases} 1 & \text{if } \max(0, p_t - \max(p_{t-1}, p_{t-2}, \ldots, p_{t-12})) > 0 \\ 0 & \text{otherwise} \end{cases} \tag{8}$$

where p_t is the level of oil price at time t. In this case, the coefficient β_{oil} measures the market return – oil price relations under the normal conditions of oil price changes while β_D reflects asymmetry in the oil price risk when shocks occur. The total effect of oil price shocks on the market return under the NOPI specification is given by $\beta_{oil} + \beta_D$.

3.3 Robustness

Despite the statistical support for the two-factor "market and oil" model by Faff and Brailford (2000), we examine the robustness of oil price risk by considering three other risk factors in the model. These are the 1997/1998 Asian crisis dummy, exchange rate risk and interest rate risk. It is well-noted that the 1997/1998 financial crisis was characterized by a sharp increase in financial volatility of the equity markets and, accordingly, can independently influence the stock market returns during the period. To avoid the crisis episode from driving the results, we control for the crisis risk in the analysis by introducing the Asian crisis dummy variable. The dummy takes the value of 1 for July 1997 to December 1998 and 0 otherwise (CR). In addition, there is voluminous literature on the exchange rate risk exposure, which suggests the potential presence of exchange rate risk in the stock markets. Finally, the changes in interest rates constitute a domestic source of risk reflecting possibly monetary policy uncertainty. Thus, the additional potential sources of risk factors considered in the analysis are the exchange rate risk (EX) and interest rate risk (INT).

We formed all possible combinations of these risk factors to augment the specified asymmetric framework, namely, (i) CR; (ii) EX; (iii) INT; (iv) CR, EX; (v) CR, INT; (vi) EX, INT; and (vii) CR, EX, INT. Hence, we have a total of 8 regressions (i.e. the basic model and the 7 augmented models), for each market index-oil price specification. In other words, with three non-linear oil price specifications, we ran 24 regressions for each market. Our intention is to examine whether the measured oil price risk is sensitive or robust to the inclusion of these factors.

4. Data and Results

The data are monthly from January 1988 to December 2010. The following indexes were employed– the Indonesia Stock Exchange composite index for Indonesia (ISE), the Kuala Lumpur composite index for Malaysia (KLCI), the Strait Times Index for Singapore (STI) and

Stock Exchange of Thailand composite index for Thailand (SET). The MSCI global market index is used to represent the world market index (MSCI). For the oil price, we use the Brent spot crude oil price in the US dollar. With the exception of Malaysia, the exchange rates are the bilateral exchange rates of respective countries *vis-à-vis* the USD. For Malaysia, due to its fixed exchange rate over an extended period (i.e. September 1998 to June 2005), we use the nominal effective exchange rate instead. Finally, the interest rates are measured by the money market interest rates. These data were sourced from Datastream database. With the exception of interest rates, all series are expressed in natural logarithm. The first difference of the series is then computed to capture the market returns and changes in other variables.

4.1 Basic Model

Table 3 reports the results from estimating the basic model. The adequacy of the mean equation and variance equation in the form of EGARCH(1, 1) is supported respectively by the absence of auto-correlated errors and of ARCH effects. The Q Ljung-Box-Pierce test statistics for serial correlation up to lag 12 are not significant in all markets. By the same token, the LM ARCH tests suggest no remaining ARCH effects once time-varying variances were accounted for. While we noted evidence for asymmetric volatility only for Singapore,

Table 3
Estimation Results – Basic Model

	Countries			
Coefficient	Indonesia	Malaysia	Singapore	Thailand
(a) Mean Equation				
β_0	0.0136 (0.000)	0.0076 (0.005)	0.0042 (0.102)	0.0062 (0.158)
β_m	0.8585 (0.000)	0.5793 (0.000)	0.9392 (0.000)	0.9783 (0.000)
β_{oil}	0.0965 (0.019)	0.0344 (0.227)	-0.0027 (0.905)	-0.0375 (0.324)
(b) Variance Equation				
γ_0	-0.2795 (0.216)	-0.8221 (0.001)	-0.3496 (0.004)	-0.2131 (0.027)
γ_1	0.1604 (0.042)	0.4299 (0.000)	0.1809 (0.010)	0.1343 (0.018)
γ_2	-0.0175 (0.648)	-0.0028 (0.946)	-0.0828 (0.007)	-0.0432 (0.125)
γ_3	0.9681 (0.000)	0.9173 (0.000)	0.9664 (0.000)	0.9794 (0.000)
(c) Diagnostics Statistics				
Adj-R^2	0.1256	0.1747	0.4145	0.2075
Q(3)	5.983 (0.112)	4.970 (0.174)	4.270 (0.234)	6.647 (0.084)
Q(12)	7.935 (0.790)	11.702 (0.470)	11.268 (0.506)	14.647 (0.261)
ARCH(3)	0.299 (0.960)	2.398 (0.494)	0.882 (0.830)	2.954 (0.399)
ARCH(12)	6.793 (0.871)	5.104 (0.954)	7.887 (0.794)	14.057 (0.297)

Notes: Numbers in parentheses are p-values.

Mean equation: $R_t = \beta_0 + \beta_m R^a_{mt} + \beta_{oil} R_{oil,t} + \varepsilon_t$,

Variance Equation: $\log h_t = \gamma_0 + \gamma_1 \left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right| + \gamma_2 \frac{\varepsilon_{t-1}}{h_{t-1}} + \gamma_3 \log h_{t-1}$. The coefficient of thickness indicates deviation from the normal distribution for the markets of Indonesia and the Philippines. Hence the Generalized Error Distribution is specified for the two markets. For the remaining markets, the errors are assumed to be normally distributed since the thickness coefficients are not distinguishable from 2.

we retained the EGARCH specification since the EGARCH requires no non-negativity restrictions on the parameters of the variance equation. Moreover, the asymmetric volatility seems to be apparent in almost all markets when asymmetric effects of oil price shocks are examined. From the variance equation, we may note that the market volatilities tend to be driven more by their past volatilities.

The coefficients of the world market return are distinguishable from 0 in all markets. Among these markets, Malaysia seems to stand out in that its market return is less correlated with the orthogonalized world market. This may be due to capital control measures implemented by Malaysia in its attempt to stabilize the financial markets following the 1997/1998 financial crisis. In evaluating the role of capital controls in contributing to Malaysia's market integration or segmentation, Ibrahim (2008) concludes that capital controls played some role in insulating the Malaysian market from international disturbances originating from the US and Japan. Turning to our main theme, in line with Nandha and Hammoudeh (2007), we note limited evidence for the oil price risk in the ASEAN markets. While the coefficient of oil price return was positive in oil-producing countries (Indonesia and Malaysia) and negative in the oil-importing countries (Singapore and Thailand), it was significant at 5% only for the market of Indonesia. It is likely that this limited evidence may be due to inappropriate specification of the oil price variable, which we explore next.

4.2 Asymmetric Models and Robustness

The results from introducing non-linear transformations of oil price changes through an interactive dummy based on positive oil price increase (OPI) by Mork (1989), scaled oil price increases (SOPI) by Lee et al. (1995) and net oil price increases (NOPI) by Hamilton (1996) are given in Table 4. Since other estimated parameters are largely similar to the basic results except that more evidence of asymmetric volatility is apparent, we report only the coefficients of oil price risk in the table. By incorporating non-linear measures of oil price in the specification, our results seem to depart from those documented by Nandha and Hammoudeh (2007) More specifically, we note more evidence for the presence of oil price risk in these markets. At the same time, conforming to our expectation, the oil price risk tends to vary across the markets.

To add credence to these general results, we also performed robustness check by adding all possible combinations of the Asian crisis dummy, exchange rate risk and interest rate risk alternatively to the models. This means that, together with the results from Table 4, we ran 8 regressions for each non-linear oil price specification. The results of these regressions are summarized in Table 5. Each entry in the table indicates the number of significant coefficients out of the total positive [+] or negative [-] coefficients. Thus, [Sig/+] = [*a*/*b*] indicates that there are *b* positive coefficients, out of which *a* are significant at conventional levels. The general results from the asymmetric models (Table 4) seem to prevail in this robustness exercise. In what follows, we discuss these markets in turn and highlight notable differences among them.

For Indonesia, we note no asymmetric effects of oil price risk in its market returns. While the coefficient β_{oil} is positive and significant, the coefficient of the oil price interactive dummy is indistinguishable from 0 across all non-linear measures of oil price changes (see Table 4). This means that oil price increases, scaled oil price increases, or net oil price increases exert no incremental oil risk on the Indonesian markets. From Table 5, while the number of significant and positive coefficient of oil price changes (β_{oil}) is only 2 out of 8 regressions in the model using Mork's oil price specification, its significance prevails in the

Table 4
Estimation Results – Asymmetric Models

	Countries			
Coef.	Indonesia	Malaysia	Singapore	Thailand
(a) MORK				
β_{oil}	0.2011 (0.004)	0.1089 (0.008)	0.0773 (0.092)	0.1617 (0.029)
β_D	-0.1658 (0.188)	-0.1768 (0.029)	-0.1583 (0.025)	-0.4235 (0.001)
H_0: β_{oil}+β_D=0	—	-0.0679 (0.242)	-0.0810 (0.052)	-0.2617 (0.001)
(b) LEE				
β_{OIL}	0.0141 (0.0522)	0.0113 (0.002)	0.0067 (0.117)	0.0152 (0.058)
β_D	-0.0176 (0.197)	-0.0177 (0.009)	-0.0161 (0.082)	-0.0347 (0.007)
H_0: β_{oil}+β_D=0	—	-0.0064 (0.214)	-0.0094 (0.038)	-0.0195 (0.008)
(c) HAMILTON				
β_{oil}	0.1057 (0.074)	0.0803 (0.031)	0.0358 (0.298)	0.0695 (0.217)
β_D	-0.1527 (0.163)	-0.1795 (0.040)	-0.1264 (0.029)	-0.3392 (0.002)
H_0: β_{oil}+β_D=0	—	-0.0992 (0.164)	-0.0907 (0.041)	-0.2697 (0.002)

Notes: Numbers in parentheses are p-values.

Mean equation: $R_t = \beta_0 + \beta_m R^a_{mt} + \beta_{oil} R_{oil,t} + \beta_D (D_t \times R_{oil,t}) + \varepsilon_t$

Variance equation: $\log h_t = \gamma_0 + \gamma_1 \left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right| + \gamma_2 \frac{\varepsilon_{t-1}}{h_{t-1}} + \gamma_3 \log h_{t-1}$

majority of cases in the models with other oil price shock measures. Moreover, the coefficient of the interactive dummy capturing the asymmetric effects remains insignificant in all regressions except in four regressions when the Hamilton's NOPI is used. In the cases of significant β_D, we find the coefficient sum β_{oil}+ β_D to be indifferent to zero. Based on these results, Indonesia's market performance is likely to move in parallel with oil price movements. However, when the oil price rises over its previous 12-month peak, it is likely that its positive effect on the market will be absent.

The direct relation between oil price changes and market returns for Indonesia are in line with the view that an oil-producing or oil-exporting country should benefit from an oil price boom. While this view can be challenged on the Dutch disease ground, Usui (1997) applauds Indonesia's handling of oil price boom in his comparative study of Indonesia and Mexico. More specifically, Indonesia succeeded in sterilizing the oil revenue boom and redirected it towards strengthening the tradable sector such as agriculture and manufacturing. This finding is also in line with Abeysinghe (2001). He notes that the direct effect of oil price on real activity is positive for Indonesia. Its effect remains positive after four quarters even if the influences of trade matrix are accounted for.

Unlike Indonesia, we note supporting evidence for the asymmetric oil price risk for Malaysia. From Table 4, the coefficients of oil price changes (β_{oil}) are positive in all specifications. This means that both oil price decrease and scaled oil price decrease tend to depress the market returns. Additionally, as long as the changes in oil price do not constitute a shock as defined by Hamilton's NOPI, the market of Malaysia is likely to be directly related to the movements of oil price. However, we note that oil price increase (OPI), scaled oil price increase (SOPI) and net oil price increase (NOPI) interactive dummies are significant at better than 5% significance level, reflecting differing oil price risk when

Table 5
Robustness Analysis

(a) Indonesia Oil	β_{OIL}		β_D		$\beta_{OIL}+\beta_D$	
Measures	[sig/+]	[sig/-]	[sig/+]	[sig/-]	[sig/+]	[sig/-]
Mork	2/8	0/0	0/1	0/7	—	—
Lee	6/8	0/0	0/0	0/8	—	—
Hamilton	5/8	0/0	0/0	4/8	0/0	0/4

(b) Malaysia Oil	β_{oil}		β_D		$\beta_{oil}+\beta_D$	
Measures	[sig/+]	[sig/-]	[sig/+]	[sig/-]	[sig/+]	[sig/-]
Mork	8/8	0/0	0/0	4/8	0/0	0/4
Lee	8/8	0/0	0/0	5/8	0/0	0/5
Hamilton	8/8	0/0	0/0	8/8	0/0	0/8

(c) Singapore Oil	β_{oil}		β_D		$\beta_{oil}+\beta_D$	
Measures	[sig/+]	[sig/-]	[sig/+]	[sig/-]	[sig/+]	[sig/-]
Mork	8/8	0/0	0/0	8/8	0/0	2/8
Lee	4/8	0/0	0/0	8/8	0/0	7/8
Hamilton	0/8	0/0	0/0	8/8	0/0	8/8

(d) Thailand Oil	β_{oil}		β_D		$\beta_{oil}+\beta_D$	
Measures	[sig/+]	[sig/-]	[sig/+]	[sig/-]	[sig/+]	[sig/-]
Mork	8/8	0/0	0/0	8/8	0/0	8/8
Lee	8/8	0/0	0/0	8/8	0/0	8/8
Hamilton	0/8	0/0	0/0	8/8	0/0	8/8

Notes: the entry indicates the number of significant coefficients out of the total positive [+] or negative [-] coefficients. Thus, [Sig/+] = [*a*/*b*] indicates that there are *b* positive coefficients, out of which *a* are significant at conventional levels.

oil shocks occur. More specifically, under the conditions of OPI, SOPI and NOPI, the market does not seem to benefit from the oil shocks despite the fact that it is an oil-exporting country. The coefficient sum $\beta_{oil}+\beta_D$, capturing oil price risk under episodes of OPI, SOPI or NOPI, is not distinguishable from zero. These results are further substantiated by our robustness analysis as reported in Table 5. For Malaysia, we may conclude that the oil price decrease may compromise its stock market performance. Meanwhile, the oil price increase does not exert any impact on Malaysia's market returns. At best, it boosts the market returns only when the increase does not exceed the previous 12-month peak.

Based on these results, oil price increases are not necessarily translated into better market performance for Malaysia despite it being an oil exporting economy. Two reasons may be offered to account for Malaysia's contrasting experience. First, Malaysia is heavily dependent on international trade and highly open compared to Indonesia. Accordingly, the effects of oil price through the trading partners may counter any potential benefits from oil price boom. Computing the indirect effect of oil price through the trading partners or trading matrix, Abeysinghe (2001) notes the negative indirect oil price effect to be substantially higher for Malaysia. And second, despite being an oil exporting country, the oil tax revenue makes up only a small portion of total public revenue, i.e. averaging slightly over 10% during 1981-2009 (BNM, 2010) At the same time, the domestic retail oil price is heavily subsidized by the government. Thus, in contrast to the observation made by Usui (1997) for Indonesia, the petroleum tax revenue gains may be nullified by increasing public fiscal burden to subsidize petroleum consumption in the face of global oil market increases.

The oil influences on the stock markets of Singapore and Thailand seem to portray similar patterns. Namely, while the oil price changes are significant only in a few cases, the oil interactive dummies have significant and negative coefficients in all oil price non-linear specifications. In addition, the coefficient sum $\beta_{oil}+\beta_D$ is negative and significant (Table 4). This means that the oil price reduction or scaled oil price reduction may have not benefited these markets. The oil price increase, however, tends to adversely affect the market returns in Singapore and Thailand and, accordingly, it is a potential source of risk in these markets. These results should be expected as both Singapore and Thailand are oil-importing countries. Apart from these common results, we may also note stronger influences of oil price increases on the Thai market. Notably, the coefficients of the oil interactive dummies for Thailand are more than twice those estimated for Singapore. Moreover, the results for Thailand remain robust under alternative augmentations of the basic model (Table 5). Meanwhile, for the case of Singapore, convincing evidence for the negative effects of oil price shocks is uncovered only when the SOPI and NOPI are used. The moderated negative effect on the Singapore market may be due to its relatively advanced financial markets. In other words, Singapore tends to be in a better position to hedge against oil price risk, though not completely.

5. Conclusion

The present paper re-examines the oil price risk of four ASEAN stock markets with the contention that the relations between market and oil price returns may be asymmetric and varying across the markets examined. While taking the two-factor "oil and market" model as a point of departure, we examined whether the use of three standard non-linear transformations of oil prices yields new insights. Robustness of the basic results is also examined by incorporating alternative risk factors to the basic model. The basic results that we obtained tend to confirm the limited presence of oil price risk in these markets (Nandha & Hammoudeh, 2007). However, the oil price risk tends to be more apparent when we allow for asymmetry in the relations between oil price changes and stock market returns and when the scaled oil price and net oil price increases are used in the models. Additionally, based on our results, these markets tend to exhibit different responses to oil price variations. From a methodological point of view, our analysis suggests the importance of properly specifying oil price shocks and of allowing time-varying variances in the analysis of the risk factors that contribute to variations in market returns.

From the analysis, we find no evidence of oil-stock market asymmetry for Indonesia. Indeed, the Indonesian market returns tend to move in parallel with oil price variations. The effects of oil price changes on the Malaysian market are positive under normal oil market conditions. Meanwhile, the Malaysian market does not seem to benefit from oil price increases. While Indonesia and Malaysia are oil-producing or oil-exporting countries, the differing results that we obtain may be attributed to the more open nature of the Malaysian economy. For the case of Singapore and Thailand, the oil price shocks tend to adversely affect their market performance as should be expected for oil-importing countries. The effects on Thailand, however, are stronger. We explain this finding in terms of the level of financial development. We content that, being an international financial center and having relatively advanced financial markets, Singapore is in a better position to hedge against oil price risk.

Based on these findings, we content that the nature of oil dependency (oil-exporting or oil-importing), trade openness, and financial development level may be important parameters in explaining the relations between oil price and stock market performance. This contention, however, requires further investigation and could serve as an interesting avenue for future research.

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