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OIL PRICE VOLATILITY, INVESTMENT AND SECTORAL RESPONSES: THE THAI EXPERIENCE

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ABSTRACT

This paper investigates the nexus between investment and oil price volatility in the context of a developing industrialised economy, Thailand. In the post Asian Crisis era, Thailand has been on a steady phase of recovery with industrial expansion as well as revival of investment and output growth. A significant portion of such growth is attributable to investment growth in metal products, machineries and other transportable goods which are the energy dependent industries. Implicit in these phenomena is the need to further scrutinise the impact of the exogenous shock emanating from uncertainty in oil market on the scale of investment in various sectors of the Thai economy. Using a threshold-based components generalized autoregressive conditional heteroskedasticity (CGARCH) model, the oil price volatility is decomposed into permanent and transitory volatilities. The oil price volatility components are then analysed in a structural vector autoregression (SVAR) framework, along with investment and other key macroeconomic variables. Dynamic impulse response functions obtained from the SVAR model reveal significant dampening effects of the conditional and transitory oil price volatility shocks on Thailand’s aggregate and sectoral level investments. The impulse responses clearly indicate that as the temporary volatility in oil price rises, total investment decreases significantly. At sectoral level, the responses of investments in food and textiles products suggest a significant dampening effect on investments due to shocks in both the conditional and transitory volatilities of oil prices. In contrast, a shock in the permanent volatility leads to only a small decline in investment in this sector, and for only about a quarter. Similar effects were also observed for other transportable goods, consisting primarily of wood products, furniture, and cork, straw and plaiting materials. The investment in the business services sector, which comprises investment in real estate services, does not exhibit any significant effects of shocks in the conditional, permanent and transitory volatilities of oil prices. The findings of this study have important implications for policy. Firstly, since the Thai economy is relatively energy intensive, any dynamic shock emanating from energy market will be detrimental to investment and economic growth. Secondly, the significant and stronger adverse effects of the temporary oil volatility point to the absence of insurance markets for guarding against any volatility risks, or the lack of managerial expertise for identifying and accommodating the negative impacts of a heightened transitory or permanent oil price volatility. Thirdly, firms operating in energy-dependent industries ought to remain vigilant especially in regards to weather adverse impacts of any transitory volatility of oil prices.

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INTRODUCTION

The effect of exogenous shocks such as oil price changes has been brought under comprehensive scrutiny by researchers, as oil prices have been subject to frequent fluctuations in recent decades and due to the widespread effects of oil price shocks on both short and long run economic activities. Against this backdrop, a plethora of studies have emerged in the last decades examining the nature and magnitude of the effects of oil price changes on consumption, investment and output in various economies around the world. While the effects of oil prices and oil price uncertainties on aggregate economic activities are well documented in the literature (Kellogg, 2010; Elder and Serletis, 2010; Ferderer 1996; Rafiq et al., 2009), there seems to be a limited number of research conducted with regard to the patterns of oil price volatility effects on sectoral investment activities. In a recent study, Timilsina (2015) examines the economic impacts of rising levels of oil prices on various sectors of the global economies. However, their study does not focus on the volatility impact of oil price on sectoral investment activities.

Bernanke (1983) maintains that the main effect of oil price changes on the short run economic performance is to disrupt purchases of expensive consumption and investment goods. In his seminal work, Hamilton (1983) showed that almost all of the recessions in the US in the post World War II period followed sharp rises in oil prices. Hamilton (2003) further shows that major oil price changes increase uncertainty, lowering consumers’ spending on cars, appliances and housing, as well as firms’ spending on investment goods. An intriguing aspect of the oil price- economic activity nexus is the asymmetric nature of the macroeconomic responses to oil price shocks, which entails declining output with increased oil prices, and a non-responsive output and investment (with no increases) as oil prices fall (Ferderer, 1996; Elder and Serletis, 2009; Cunado and Perez de Gracia, 2003; Cunado and Perez de Gracia, 2005; Lee et al., 1995; Davis, 1987; Davis and Haltiwanger, 2001; Mork et al., 1994). In the last couple of decades there has been a major surge in the studies of the effects of oil price uncertainty on economic activities (Ferderer, 1996; Elder and Serletis, 2009; Pindyck, 1991). However, the majority of these studies have been conducted in developed countries.

In this study we examine the effect of oil price uncertainties in the Thai economy. An apparent interest in this issue derives from Thailand’s development journey based on energy-dependent industrial growth over the last few decades, characterised by its more volatile records in the recent past. In particular, we attempt to delve into the effects of oil price uncertainties in a disaggregated framework, on the various sectors of the Thai economy, with an aim to further understand the sectoral growth patterns and contribute to the policy environments. Thai economy recorded rapid industrialization led by energy intensive sub-sectors associated with significant economic growth in the 1980s and over about the first three quarters of the 1990s. The Asian crisis brought about a sudden cessation in Thailand’s steady economic growth in the late 1990s as the country suffered from large declines in output and then succumbed to a regime with increased uncertainties in the new millennium. These uncertainties were sourced from global events and recessions as well as Thailand’s own changing domestic political scenarios devoid of stability and sustained democratic practices. However, political uncertainty did not work much in detriment in the country’s transformation from an agrarian economy to a modern industrialized state. Despite being one of the worst affected economies during the Asian
Crisis, Thailand’s post crisis recovery effort seems to have been somehow paid off, with growth in manufacturing and exports. Thailand’s real gross fixed capital formation (total investment) rose by about 5.5% annually from 2000, nearly reaching its pre-crisis 1994–1996 average investment level by 2012. Much of the recent investment growth in the Thai economy is attributable to investment in metal products, machinery, and other transportable goods. In view of the growth of these highly energy dependent industries, Thailand’s energy consumption, and oil consumption in particular, has increased significantly over the last decades. Thailand is the second largest net oil importing economy in South East Asia, after Singapore. As a net importer of crude oil and a net exporter of petroleum products, any changes or uncertainty in the oil price may have a significant impact on its economy. The country imports over 60% of its total petroleum needs and almost 85% of its crude oil consumption, making it highly dependent on global oil markets and volatile prices. About 78% of its crude oil imports originate from the Middle East, while another 8% are from other Asian suppliers. Figure 1 provides Thailand’s dynamic consumption-production patterns of energy and oil over the period 1990–2014. Hence, with apparent insensitivity of Thailand to its domestic political instability, exogenous shocks such as oil price changes could be subject to further scrutiny to substantiate Thailand’s macroeconomic and sectoral policy environment.

Rafiq et al., (2009) examine the impact of oil price volatility on key macroeconomic indicators of Thailand including aggregate output, unemployment, investment and interest rate using quarterly data from 1993 to 2006. However they use realized volatility of oil prices and do not examine the sectoral investment or output responses. In a related study, Rafiq, and Salim (2011) examine the short- and long-run causal relationships between energy consumption and GDP of six emerging economies of Asia including Thailand. Their study has not looked into the effects of oil price volatility as well as the sensitivity of various sectors of the Thai economy. Hence, in view of the extant literature, the contribution of our paper is threefold. Firstly, given the limited number of studies that have been conducted on the effects of oil price uncertainties in the newly industrialised developing economies and unlike other studies, this paper provides evidence on the sectoral investment response patterns of a developing economy such as Thailand, a country characterised with a number of anomalous political and economic circumstances. Secondly, from a methodological standpoint, this study applies the component-GARCH (CGARCH) model (Nelson, 1991) to measure oil price volatility for the Thai economy. An advantage of the CGARCH modelling is that it allows decomposition of the oil price volatility into the transient and permanent components, which more effectively facilitates alienation of short and long term economic impacts. This also marks another advantage of our current study over those of Rafiq et al., (2009) and Rafiq and Salim (2011). Thirdly, compared to the existing studies that consider macroeconomic responses, this paper examines investment dynamics at both the aggregate and sectoral levels, which provides insights that are conducive to more comprehensive micro and macro policy formulations.
Our results indicate that oil price shocks, measured by the conditional volatility, have a negative and prolonged effect on both aggregate and sectoral level investments. The results also suggest that the negative impact on aggregate and sectoral investments is mainly caused by the transitory volatility of oil prices, especially for the more energy-dependent sectors. The rest of the paper is structured as follows. Section 2 reviews the literature. Section 3 describes the methodology of the asymmetric-based CGARCH, the SVAR framework, and the data used to model the oil price volatility. Section 4 discusses the findings of the study and Section 5 concludes the paper.

RELATED LITERATURE

In explaining oil price uncertainty effects on macroeconomic activities Bernanke (1983) and Henry (1974) contend that higher uncertainty could depress current investment thereby exerting a prolonged effect on aggregate output. On the other hand, Friedman (1977) suggests that if inflation is responsible for the decline in the real rate of return and output, uncertainty in oil prices will also have a negative impact on the rising level of inflation and the declining output. Pindyck (1991) argues that the changes in energy prices create uncertainty about future energy prices, thus causing firms to postpone irreversible investment decisions. Bernanke (1983), Pindyck and Solimano (1993), Pindyck (1991) and Dixit and Pindyck (1994) demonstrate theoretical reasons for uncertainty having a
negative impact on firms’ investment. Huang et al., (2005) show that oil price changes explain macroeconomic activities better than the volatility of the oil price. Elder and Serletis (2010) analyse the impact of oil price uncertainty on investment, consumer durables and aggregate output in the US and find that uncertainty about oil prices tends to depress investment. Guo and Kliesen (2005) find that increased oil price uncertainty leads to lower non-residential business investment in the US. Kellogg (2010) finds that uncertainty has an important impact on drilling in the oil industry. In an attempt to analysis the effect of oil price volatility on US industrial production, Ahmed et al. (2012) maintain that permanent volatility is due to shifts in fundamentals, while temporary volatility stems from random events such as sudden disruptions in oil markets and incidents of political unrest. Hence, firms tend to be affected more by transitory volatility than by permanent volatility.

**Literature on Developing Economies**

From the perspective of developing economies, several studies have investigated the uncertainty–investment nexus, focusing on the linkage between macroeconomic uncertainty and aggregate investment (Serven, 2003; Pradhan et al., 2004; Ang, 2010; Fatima and Waheed, 2011; Ibrahim, 2011; Ahmed and Wadud, 2011 and Ibrahim and Ahmed, 2014). In their study, Rafiq et al., (2009) suggest that oil price volatility has significant impact on unemployment and investment, over the period from 1993 to 2006. Rafiq and Salim (2011) show that there exists unidirectional short- and long-run causality running from energy consumption to GDP for China, uni-directional short-run causality from output to energy consumption for India, whilst bi-directional short-run causality for Thailand. More recently, Ibrahim and Ahmed (2014) investigate the relationships between aggregate investment and oil volatility and its permanent and transitory components for a developing country, Malaysia. Adopting a structural vector autoregression (SVAR) framework, the paper shows that the real effects of permanent oil volatility tend to be stronger for Malaysia.

While these studies differ in terms of the countries covered (developed versus developing countries), data structure (time series versus panel data), time periods, and the measurement and sources of uncertainty, they seem to provide mixed evidence of the effects of oil price volatility on economic activities in developed and developing economies. However, these studies provide a fairly consistent view that oil price uncertainty depresses real investment and output.
MODELLING OIL PRICE VOLATILITY

The literature on the choice of a measure for uncertainty is quite diverse, and there appears to be no consensus as to the choice of a single measure of oil price volatility. Ferderer (1996) uses the conventional standard deviation to measure oil price volatility in an effort to examine the impact of oil price uncertainty on macroeconomic activities, while Kuper (2002) presents a GARCH (1,1) model for measuring the oil price volatility at the daily and monthly frequencies. In this study we use CGARCH, as introduced by Engle and Lee (1999). There are two reasons for this preference of CGARCH over GARCH (1,1) models. First, the standard GARCH models assume that positive and negative error terms have a symmetric effect on the volatility. In other words, in the model, good news and bad news have the same effect on the volatility. However, given the oil price behavior, the oil price volatility may react differently to bad and good news, due to the asymmetric nature of the effects of the oil price volatility. Second, as its name suggests, the CGARCH decomposes the volatility into its transitory and permanent components. Since GARCH modelling and estimation require the relevant variable to be stationary, we tested the oil price for stationarity. Both the ADF and Phillips-Perron tests revealed that the oil price series possesses a unit root in levels and is stationary in first differences. Hence, the first difference of the oil price is used for CGARCH modelling.

The CGARCH specification for the oil price \( OP_t \) is as follows:

\[
\Delta OP_t = \mu_0 + \sum_{i=1}^{p} \mu_i \Delta OP_{t-i} + \varepsilon_t
\]

\[
\sigma_t^2 = \bar{w} + \alpha (\varepsilon_{t-1}^2 - \bar{w}) + \beta (\sigma_{t-1}^2 - \bar{w})
\]

\[
\sigma_t^2 - q_t = \alpha ((\varepsilon_{t-1}^2 - q_{t-1}) + \beta (\sigma_{t-1}^2 - q_{t-1})
\]

\[
q_t = w + \rho (q_{t-1} - w) + \phi (\varepsilon_{t-1}^2 - \sigma_{t-1}^2)
\]

where \( \Delta \) is the first difference operator and \( \varepsilon \) is the error term with a time-varying variance (i.e., a measure of conditional volatility) \( \sigma_t^2 \). Equation (1) is the conditional mean equation, specified to follow an autoregressive process, of the order \( p \), which is selected based on un-correlated errors. Equations (2) represents the conditional volatility of oil prices to a constant mean \( w \). Equations (3) and (4) capture the transitory and permanent components of the conditional volatility, respectively. As proposed by Engle and Lee (1993, 1999), the CGARCH model allows for the reversion of the conditional volatility to a time-varying trend component \( q \). Note that the conditional volatility \( \sigma_t^2 \) is mean-reverting around the permanent volatility \( q_t \), and accordingly, \( \sigma_t^2 - q_t \) measures the transitory component of the volatility, with the speed of mean reversion represented by \( \rho \).
Since the permanent volatility is more persistent than the transitory volatility, it is assumed that $0 < (\alpha + \beta) < \rho < 1$.

The standard CGARCH model is based on the assumption of symmetry between positive and negative shocks, but this may not always be appropriate here. For example, there could be empirical evidence of a negative oil shock causing increased uncertainties due to heightened expectations of a speculative attack. To accommodate this possibility in our model, we allow for temporary asymmetries in our explanatory variables, in order to test whether a shock due to the bad news effect (price reduction) can explain the conditional volatility of oil prices. Ideally, this asymmetric effect will be incorporated in the transitory volatility equation. The threshold based CGARCH model is given as follows:

$$
\sigma_t^2 - q_t = \alpha (e_{t-1}^2 - q_{t-1}) + \gamma (e_{t-1}^2 - q_{t-1})d_{t-1} + \beta (\sigma_{t-1}^2 - q_{t-1})
$$

$$
q_t = \omega + \rho (q_{t-1} - \omega) + \varphi (e_{t-1}^2 - \sigma_{t-1}^2)
$$

(5)

where $d$ is a dummy variable indicating a negative shock and takes the value 1 if $e_{t-1} < 0$, and 0 otherwise. Note that $\alpha$ and $(\alpha + \gamma)$ measure the effects of positive and negative news on the volatility, respectively.

**Econometric Model**

**Unit Root Test and Order of Integration**

We first test the stationarity properties of the variables and ascertain their order of integration in order to model the short and long run dynamics of these variables. Table 1 reports the unit root test results of the total and sectoral investments, interest rate, exchange rate and the components of oil price volatility. As reported in the table, the null hypothesis of unit root is rejected for total volatility, transitory volatility and the exchange rate. Hence these three variable are stationary. On the contrary, the permanent volatility, interest rate, total and sectoral investments are $I(1)$ or non-stationary variables. The findings that all the variables are not $I(1)$ imply that the variables at their levels may not convey important long run relationship, i.e., estimating a cointegrating regression followed by vector error correction model (VECM) is not a valid option. Instead, we choose to model the variables in the VAR framework. Since objective of this paper is to examine the responses of aggregate investment and sector specific response to oil price volatility rather than parameter estimates per se, estimating VAR with variables in non-stationary forms may give not necessarily lead to spurious regression and instead may provide important insights as suggested by Sims (1980). Sims, Stock and Watson (1990) show that the estimated coefficients in a VAR model involving non stationary variables are consistent and have asymptotic normal distribution. Hence, it is important to realise that the inclusion of the non-stationary level variables in the VAR system does not pose any serious problem of statistical inferences and does not jeopardise the objective of capturing the dynamic interaction among the variables within the VAR system.
TABLE 1. ADF UNIT ROOT TEST RESULTS AND ORDER OF INTEGRATIONS OF THE VARIABLES

<table>
<thead>
<tr>
<th></th>
<th>Level Data</th>
<th>First Difference</th>
<th>Integration Order</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T-value</td>
<td>P-value</td>
<td>T-value</td>
</tr>
<tr>
<td>CVDLOP</td>
<td>-2.6791</td>
<td>0.0825</td>
<td>---</td>
</tr>
<tr>
<td>TVDLOP</td>
<td>-4.158</td>
<td>0.000</td>
<td>---</td>
</tr>
<tr>
<td>PVDLOP</td>
<td>-2.554</td>
<td>0.107</td>
<td>-9.76</td>
</tr>
<tr>
<td>IR</td>
<td>-2.447</td>
<td>0.133</td>
<td>-4.855</td>
</tr>
<tr>
<td>LEX</td>
<td>-2.613</td>
<td>0.095</td>
<td>---</td>
</tr>
<tr>
<td>LNINV</td>
<td>-1.778</td>
<td>0.388</td>
<td>-6.203</td>
</tr>
<tr>
<td>LNINVS1</td>
<td>-1.598</td>
<td>0.478</td>
<td>-5.338</td>
</tr>
<tr>
<td>LNINVS2</td>
<td>-1.544</td>
<td>0.507</td>
<td>-8.676</td>
</tr>
<tr>
<td>LNINVS3</td>
<td>-1.739</td>
<td>0.407</td>
<td>-6.624</td>
</tr>
<tr>
<td>LNINVS4</td>
<td>-1.611</td>
<td>0.472</td>
<td>-8.196</td>
</tr>
<tr>
<td>LNINVS5</td>
<td>-1.688</td>
<td>0.433</td>
<td>-8.02</td>
</tr>
</tbody>
</table>

**SVAR Framework**

Incorporating the key macroeconomic variables and oil price volatility, we define the vector of endogenous variables as follows:

\[ Y_t^i = [\text{VOP}, \text{INV}, \text{CPI}, \text{IR}, \text{EX}] . \]

Here, \text{VOP} represents the volatility of oil prices in general, which could be specified in terms of the conditional, transitory and permanent volatilities; \text{INV} is the aggregate and sectoral level investments; \text{CPI} is the price level; \text{IR} is the interest rate; and \text{EX} measures the exchange rate of the local Thai currency against US dollars. In this paper, we develop and examine a 5-variable SVAR model based on a modification of Kim and Roubini’s (2000) model that accounts for an external shock emanating from oil price shocks. Such a model is expected to portray more appropriately the way in which a small open economy such as Thailand, with vulnerabilities to exogenous shocks, will respond to oil price uncertainties. More importantly, the adoption of SVAR for this study is motivated by the idea that SVAR models are useful tools to analyse the dynamics of a model by subjecting
it to an unexpected shock. Also, SVAR uses economic theory to sort out the contemporaneous links between the variables (Bernanke, 1986; Blanchard and Watson, 1986; Sims, 1986). SVARs require “identifying assumptions” that allow correlations to be interpreted causally. These identifying assumptions can involve the entire VAR, so that all of the causal links in the model are spelled out, or just a single equation, so that only a specific causal link is identified. To capture the sensitivity of the Thai economy to oil price uncertainties, we include Thailand’s aggregate and sectoral investments, as well as the core consumer price indexes. The interest rate is used to help evaluate monetary policy responses, while the exchange rate is used to represent Thailand’s external transactions.

A SVAR has the following general form:

\[ A_0 X_t = A_1(L) X_t + B \varepsilon_t, \quad (6) \]

where \( X_t \) represents an \( n \)-vector of relevant variables as follows:

\[ X_t = [VOP_t, INV_t, CPI_t, IR_t, EX_t]' \]

\( A_0 \) and \( B \) are \( 5 \times 5 \) matrices of coefficients; and \( A_1(L) = \sum_{i=1}^{q} A_{i1}L^i \) represents a matrix polynomial in the lag operator, with \( A_{i1} \) being a \( 5 \times 5 \) matrix of coefficients. Here, matrix \( A \) is used to define the impulse responses of endogenous variables to structural shocks, denoted by \( \varepsilon_t = [\varepsilon_t^{VOP}, \varepsilon_t^{INV}, \varepsilon_t^{CPI}, \varepsilon_t^{IR}, \varepsilon_t^{EX}]' \).

Matrix \( B \) contains the structural form parameter of the model. \( \varepsilon_t \) is an \( n \)-vector of serially uncorrelated, zero mean structural shocks with an identity covariance matrix,

\[ \sum_{\varepsilon} = E[\varepsilon_t \varepsilon_t'] = I. \]

**Reduced Form VAR**

The reduced form of the VAR model can be represented as:

\[ X_t = C(L) X_t + u_t, \quad (7) \]

where \( C(L) = A_0^{-1} A_1(L) \), with:

\[ A_0 u_t = B \varepsilon_t. \quad (8) \]
The residuals \( u \) in the reduced model are also presumed to be white noise, but they may be correlated with each other due to the contemporaneous effect of the variables across equations. We estimate the AB model proposed by Amisano and Giannini (1997).

**Identification and Contemporaneous Restriction**

In order to recover the structural parameters, the reduced form equation (7) has to be estimated. However, restrictions need to be imposed in order for equation (8) to be identified. We impose the restrictions on contemporaneous relationships among the variables in the SVAR model based on the work of Kim and Roubini (2000). To examine the impact of the oil price volatility on investment at the aggregate and sectoral levels, we consider the following identification scheme and contemporaneous restriction:

\[
\begin{bmatrix}
1 & 0 & 0 & 0 \\
* & 1 & 0 & 0 \\
* & * & 1 & * \\
* & * & 0 & 1 \\
* & 0 & * & 1
\end{bmatrix}
\begin{bmatrix}
\epsilon_{VOP} \\
\epsilon_{INV} \\
\epsilon_{CPI} \\
\epsilon_{IR} \\
\epsilon_{EX}
\end{bmatrix} =
\begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
\eta_{VOP} \\
\eta_{INV} \\
\eta_{CPI} \\
\eta_{IR} \\
\eta_{EX}
\end{bmatrix},
\]

where the asterisks represent the coefficients to be estimated. The residuals obtained from the reduced form VAR are represented by the vector of \( u \)'s presented on the left hand side of the equation system above. The structural shocks, the \( \epsilon \)'s, are shown on the right hand side of the system, and represent shocks to the oil price volatility, investment, CPI, the interest rate and exchange rates. Row (1) of the SVAR system represents (exogenous) shocks from oil price fluctuations, while row (2) represents the aggregate and sectoral investment levels to be affected by the oil price shock contemporaneously. We would expect a possible negative demand shock generated from oil price uncertainty as a result of individuals' and households' postponements of consumption for big ticket items such as cars, housing, appliances, and investment goods. Row (3) of the system shows that consumer prices are affected by oil price uncertainty, investments and interest rates contemporaneously.

Row (4) of the SVAR equation system (9) shows that Thai interest rates, and hence Thai monetary policy, are affected contemporaneously by exogenous shocks of oil price fluctuations and investment. The last row of the system (row 5) represents the external sector, and shows that Thai exchange rates are affected contemporaneously by oil price volatility, CPI and interest rates. Hence, overall, we allow the oil price volatility shock to affect Thailand’s domestic investment, price level, monetary policy and exchange rate contemporaneously.

**Impulse Response Functions**

The impulse response functions are derived and used to examine the dynamic responses of the variables \( (VOP, INV, CPI, IR, EX) \) to various shocks within the SVAR system. Having identified the structural shocks, we can then find the impulse response of a variable to a one-off shock to any variable included in the model, which can be obtained from the following:
\[ \begin{align*}
X_t &= C^*(L)\varepsilon_t \\
C^*(L) &= C(L)A_0^{-1},
\end{align*} \]

where \( C^*(L) = C(L)A_0^{-1} \) generates the impulse response function of \( X_t \) to structural shocks to \( \varepsilon_t \). At this stage, it should be mentioned that, since the primary objective of using the SVAR system is not to estimate the VAR coefficients, but rather to examine the impacts of dynamic shocks generated by oil price changes and volatility, the estimates of the VAR coefficients are deemed unbiased without transforming the variables to be stationary.

**Data and Variable Descriptions**

Following Hamilton and Herrera (2004) and Bernanke et al., (1997), we use quarterly data from 1994 to 2012 in this paper. The choice of 1994 as a starting point is due partly to the fact that most of Thailand’s macroeconomic and sectoral level data at a monthly or quarterly frequency are available starting from 1993–1994. All variables except for the interest rate are expressed in natural logarithms. The data on aggregate and sectoral investments are obtained from the databases of the Office of the National Economic and Social Development. Data on exchange rates and interest rates are obtained from the Bank of Thailand. The core CPI series is used to measure consumer prices, and is taken from the Bureau of Trade and Economic Indices, Ministry of Commerce, Thailand. The oil price volatility is estimated using a crude oil price index derived from the simple average of three spot prices, viz. Dated Brent, West Texas Intermediate and the Dubai Fateh.

Total investment and sectoral investments are measured as seasonally adjusted real gross fixed capital formation, expressed in 1988 constant prices. The sectoral investments are categorised by the type of capital. Exchange rates and interest rates are real effective exchange rate measures in Thai Baht per US dollar and the Bank of Thailand’s policy rates, respectively.¹

**ESTIMATIONS AND RESULTS**

In this section, we begin by briefly discussing estimation results from the CGARCH model. This is followed by the results based on SVAR framework.

**CGARCH Results**

The estimated results for the CGARCH model show that the autoregressive parameter \( \rho \) is highly significant (Table 2). This indicates a slow convergence of the permanent oil price volatility. The parameter \( \varphi \) in the permanent volatility equation is also highly significant, which suggests that arrival of new information about the oil price affects the trend component of the oil price volatility. An interesting finding is that the parameter \( \alpha \) is also highly significant, which indicates that both positive and negative oil price shocks raise the oil price volatility temporarily. Likewise, the threshold parameter \( \gamma \) is not statistically significant, indicating that there are no obvious asymmetric effects of a shock in oil price. The estimates in Table 2 also show that the parameter \( \beta \) is statistically insignificant, which suggests that there is no GARCH effect in the transitory component of oil price volatility.
TABLE 2. COMPONENTS GARCH ESTIMATES OF THE OIL PRICE

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Coefficients</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho$</td>
<td>0.974</td>
<td>0.000</td>
</tr>
<tr>
<td>$\varphi$</td>
<td>-0.105</td>
<td>0.000</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.124</td>
<td>0.000</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.325</td>
<td>0.474</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0.007</td>
<td>0.963</td>
</tr>
</tbody>
</table>

Figure 2 plots the dynamics of the oil price volatility for the sample period. The permanent volatility looks relatively stable compared to conditional volatility, as we would expect, since the former is meant to portray the longer term trend pattern of the oil price volatility. While the permanent volatility tends to follow a more smoothed out trail, it does experience periodic rises, in addition to the frequent sparks in the transitory volatility (TV). It is also worth noting that both the conditional and permanent volatility of oil prices seem to have increased slightly in recent years. An important observation, however, is that both the upswings in the temporary volatility and the rise in the permanent volatility tend to coincide with various major financial and political events, such as the 1997/1998 Asian crisis, the Dot Com bubble in early 2000, the 9/11 attack and Enron bankruptcy in 2001, and the latest subprime mortgage crisis that led to the global financial crisis (GFC) and the subsequent recession since 2008. Given the circumstances, it would be interesting to see whether exogenous shocks such as oil price volatilities are detrimental to investment growth in Thai industries, and, if so, whether the temporary component or the permanent component of the oil price volatility exerts a more significant impact on Thai investment and other macroeconomic fundamentals.

FIGURE 2. CONDITIONAL, PERMANENT AND TRANSITORY VOLATILITY OF OIL PRICES

Note: CV= Conditional oil price volatility; PV= Permanent oil price volatility; TV= Transitory oil price volatility
Impulse Responses

Impulse Responses to Oil Price Volatility Shocks

Figure 3 presents the impulse responses of total investment, CPI, interest rates and exchange rates due to shocks in the conditional oil price volatility. The first of the diagrams shows that a one-off increase in the conditional oil price volatility results in a decrease in total investments. Specifically, investment declines significantly immediately following the rise in conditional volatility, until the 2nd quarter after the shock. The effect on CPI is similar, as the consumer prices decline significantly from quarter 1 to quarter 4 following the shock. Interest rates tend to decline significantly immediately after the increase in conditional volatility, remaining low until quarter 3.

The responses of the exchange rate, however, do not look significant. The responses to an increase in the permanent volatility, as shown in Figure 4, seem to be inconspicuous, in general. As the permanent volatility rises, there is a marginally significant fall in total investment for about six months. Expansionary monetary policy responses, with marginal statistical significance, are noticeable for a very brief portion of a quarter following the shock in the permanent volatility. Over a shorter time horizon, there does not seem to be any significant dampening impact of a shock in the permanent oil price volatility on the exchange rate. However, it then tends to depreciate between 6 to 8 quarters after the rise in the permanent volatility. Furthermore, note that the response of CPI to a one-period shock in the permanent volatility is not significant (Figure 4).

The evidence of the responses of investment and other macroeconomic variables, as presented in Figure 5, appears to be more overt and intriguing. The impulse responses clearly indicate that, as the temporary volatility in oil price rises, the total investment decreases significantly for about six months following the volatility shock. Timilsina (2015) suggests that countries like China, India, Indonesia and Thailand are more susceptible to the oil price shock because of their high oil intensities. Hence, Thai firms’ postponement of investment in view of the heightened transitory volatility is quite apparent, and the short-lived nature of the adverse impact is indicative of the firms’ rapid adjustment, accommodating the effects of the increased temporary volatility. As expected, with the increased transitory volatility exerting detrimental pressure on the aggregate demand, CPI also falls significantly for about a year or so after the shock in the temporary volatility. Similarly, there is a significant fall in interest rates, reflecting monetary expansions as an anticipated policy response, in view of the negative impact of the increased temporary volatility on investment and aggregate demand (Figure 5). Overall, there appears to be clear evidence that it is the transitory volatility of oil prices, not the permanent volatility that exerts the more significant effects on some of the key macroeconomic variables in Thailand, such as investment, CPI and interest rates. In other words, the significant adverse effects on investment and other variables that are due to increases in the conditional or total volatility are caused primarily by the adverse responses of these variables to the increased transitory volatility.
FIGURE 3. IMPULSE RESPONSES OF THAI INVESTMENT AND THE MACROECONOMIC VARIABLES TO A SHOCK IN THE CONDITIONAL OIL PRICE VOLATILITY

Note: The solid lines represent the mean responses and the dotted lines indicate 95% confidence interval bounds obtained through Hall’s bootstrap confidence intervals based on 1000 repetitions. CV = Conditional oil price volatility; LINV = Investment; LCPI = Consumer price index; IR = Interest rates and lex = Exchange rates.
FIGURE 4. IMPULSE RESPONSES OF THAI INVESTMENT AND THE MACROECONOMIC VARIABLES TO A SHOCK IN THE PERMANENT OIL PRICE VOLATILITY

Note: The solid lines represent the mean responses and the dotted lines indicate 95% confidence interval bounds obtained through Hall’s bootstrap confidence intervals based on 1000 repetitions. PV = Permanent oil price volatility; LINV = Investment; LCPI = Consumer price index; IR = Interest rates and lex = Exchange rates.
FIGURE 5. IMPULSE RESPONSES OF THAI INVESTMENT AND THE MACROECONOMIC VARIABLES TO A SHOCK IN THE TEMPORARY OIL PRICE VOLATILITY

- TV$\rightarrow$LINV
- TV$\rightarrow$LCPI
- TV$\rightarrow$IR
- TV$\rightarrow$lex

Note: The solid lines represent the mean responses and the dotted lines indicate 95% confidence interval bounds obtained through Hall's bootstrap confidence intervals based on 1000 repetitions. TV = Transitory oil price volatility; LINV = Investment; LCPI = Consumer price index; IR = Interest rates and lex = Exchange rates.
Investment Responses by Sectors

The effects of oil price uncertainty can be further examined by delving into the sectoral responses to oil price uncertainty, which could lay the foundation for the formation of more effective policies. In addition, the advent of the new millennium marked a number of policy liberalisations, leading to freer international trade and escalated competition. Hence, the investment sensitivities of various sectors to external shocks such as the oil price convey information that is important from a policy perspective.

Figures 6a and 6b report the impulse responses of various sectors to a shock in the oil price volatility. The responses of investments in food and textiles products (sector 1) are reported in the first column of Figure 6a. It is evident from these graphs that there is a significant dampening effect on investments in food and textiles products within the first three quarters, due to shocks in both the conditional and transitory volatilities of oil prices. In contrast, a shock in the permanent volatility leads to only a small decline in investment, and for only about a quarter. The graphs in the middle column of Figure 6a represent the impulse responses of sector 2, which is other transportable goods, consisting primarily of wood products, furniture, cork, straw and plaiting materials. These graphs show that investment in these products declines significantly for about a quarter following a shock in the conditional volatility. However, a one-off shock in the transitory volatility tends to cause investment in these products to decline significantly for an extended period of about five quarters. While the investment responses to an increase in the permanent volatility generally remain insignificant, there does seem to be a small increase in investment between the 6th and 10th quarters following a shock in the permanent volatility. Given the large export-oriented furniture and wood products industries in Thailand and the relatively low dependence of these industries on oil consumption, it is possible that investment responds positively over a longer horizon due to an increased trend volatility, with an influx of investment from other sectors and consistent demand growth. The three graphs in the right-most column of Figure 6a show the impulse responses of investments in metal, machineries and equipment. It is apparent that investment in these products declines significantly for about a year following an increase in the conditional volatility. It is also evident that such a response is influenced overwhelmingly by the declining investment due to a rise in the transitory volatility. Compared to this, the effect of the permanent volatility on investment in the sector appears to be significantly negative for the shorter duration of a couple of quarters. Overall, an increase in the transitory volatility seems to have a more intense and prolonged adverse impact on investment in this sector than an increase in the trend volatility of oil prices (Figure 6a). This is to be expected, especially in view of the fact that metal, machinery and equipment rely heavily on the use of oil, thus exerting a significant influence on investments in Thailand’s growing manufacturing and other industries.
FIGURE 6a. IMPULSE RESPONSES OF THAI INVESTMENT AND THE MACOECONOMIC VARIABLES TO A SHOCK IN THE CONDITIONAL, TRANSITORY AND PERMANENT OIL PRICE VOLATILITY

Note: The solid lines represent the mean responses and the dotted lines indicate 95% confidence interval bounds obtained through Hall’s bootstrap confidence intervals based on 1000 repetitions.

CV = Conditional oil price volatility; PV = Permanent oil price volatility; TV = Transitory oil price volatility; LINVS1 = Investment of sector 1 (Food & Textiles); LINVS2 = Investment of sector 2 (Wood, furniture and other transportable goods); LINVS3 = Investment of sector 3 (Metal, machine & equipment).
FIGURE 6b. IMPULSE RESPONSES OF THAI SECTORAL INVESTMENT DUE TO SHOCKS IN THE CONDITIONAL, TRANSITORY AND PERMANENT OIL PRICE VOLATILITY

As shown in Figure 6b, the impulse responses of investment in the construction and land development sector (sector 4), indicate that investment growth is not significantly affected by oil volatility shocks, for about a year or so, and then tends to rise significantly for about a year (six months), due to increase in trend volatility (transitory volatility). Investments in Thai construction and land developments have also seen consistent growth over the post Asian Crisis period, with a minimal adverse response to the more recent crises or the global economic downturn. It is evident that while investment in this sector remains rather less responsive to short term external shocks, it could still increase due to its long term return prospects, should investment in more vulnerable and oil-dependent sectors falter due the increased oil price uncertainty. Finally, investment in the business services sector (sector 5), which comprises investment in real estate services, does not exhibit any significant effects of shocks in the conditional, permanent and transitory volatilities of oil prices. This is to be expected, since real estate services are unlikely to respond with reduced investment or growth as the oil price uncertainty rises, due to the low energy dependence of this sector. This is consistent with the findings documented by Edelstein and Kalian (2007).
CONCLUSIONS

This paper empirically examines the effects of oil price volatility on total and sectoral investments in Thailand, as well as on a range of macroeconomic variables, based on a SVAR model. Our analysis proceeds by developing and estimating a threshold-based CGARCH model for modelling oil prices, thereby isolating the conditional, permanent and temporary oil price volatilities. We model these volatility measures, along with the aggregate and sectoral real investments, consumer prices, the real policy rate and the exchange rate in a SVAR framework, and generate impulse-response functions for predicting and forecasting the effects of volatility shocks on investment and other macroeconomic variables. Our results indicate that the oil price volatility has an adverse effect on aggregate real investment in Thailand, which is generally in accord with the predictions of the theory of irreversible investment. We find that both the consumer prices and the real interest rate tend to decline significantly following positive shocks in oil market volatility, indicating a reduced aggregate demand and required monetary expansions by the Bank of Thailand. Sectoral response patterns reveal that investment in the textiles, wood and furniture, and machineries and equipment industries falls significantly in response to an increase in the oil price volatility. Another important finding of this study is that the aggregate and sectoral investment, consumer prices and interest rates are found to have been affected by positive shocks in transitory oil price volatility, not by shocks in the permanent volatility. Essentially, this evidence is in accord with the findings documented for the US and other developed markets. However, these results conflict with those of Ibrahim and Ahmed (2014), who find permanent oil price volatility shocks to have an adverse effect on aggregate investments in Malaysia.

The findings of this study have important implications for policy. Firstly, since the Thai economy is relatively energy intensive, any dynamic shock emanating from energy market will be detrimental to investment growth and economic performance. Thus from policy perspective, prudent management of the economy, in view of reduced investment and deflationary pressures, is important. Secondly, while firms should be able to cope better with a temporary increase in the oil price volatility, the significant and stronger adverse effects of the temporary oil volatility point to the absence of insurance markets for guarding against any volatility risks, or the lack of managerial expertise for identifying and accommodating the adversities of a heightened transitory or permanent oil price volatility. Thirdly, firms operating in energy-dependent industries such as textiles, furniture, wood products, metal, machinery and mining ought to remain vigilant with regard to changes in oil prices, and oil price volatility. These firms need to pursue well-developed dynamic plans in order to weather and manage the effects of increased transitory volatilities. At the same time, there should be a focus on upgrading human capital promoting targeted managerial skills such as those that are needed for analysing patterns and sources of business risks.
ENDNOTES

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1 Since the introduction of Thailand’s constitutional monarchy in 1932, Thailand experienced 25 general elections and 19 coups d’état, including 12 successful. To-date, Thailand has had the highest number of coup attempts than almost any other country in the world.

2 For the period since 2005, we construct the interest rate variable using the policy rates published by the Bank of Thailand. For the period prior to 2005, interbank lending rates available for the maximum time horizon up to 6 months are used, due to the non-availability of policy rates published by the Bank of Thailand. However, these figures correspond closely to the Bank of Thailand’s policy rates.

REFERENCES


