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Abstract

This paper analyzes the impact of international oil prices on Thailand's industrial production using Johansen cointegration test. The results show that U.S. dollar real exchange rate does not affect the economy's industrial production index, while oil prices, and real money supply significantly impose a positive impact on the index. The positive relationship between industrial production index and oil prices indicates that the manufacturing sector can adjust itself to higher costs of production in the long run. In the short run, industrial production are affected by real money supply, real exchange rate and international oil prices. However, any deviation from a stationary long-run equilibrium in the short run will be corrected in a short period of time.

JEL Classification: C22; E10
Keywords: *Industrial production ; oil prices, VAR; Cointegration*

1. Introduction

The continuous economic growth in Thailand was observed during the past two decades. During the period 1988-1996, the country experienced the highest average growth rate of about 9 percent (Bank of Thailand). The industrial policy aimed at promoting industrial expansion was considered as one of crucial factors that stimulate growth. However, the Thai economy was affected by the mid-1997 financial crisis, which caused the industrial production index to decline substantially. The industrial production recovered in 1999 and tended to increase thereafter.

The first and second oil shocks occurred in 1973 and 1979, following by the third oil shock in 1990. The third oil crisis caused the rate of oil prices to increase more than 100 percent since the fourth quarter of 2001, slightly higher than that of the previous quarters. The oil price hike is a well-known cause of stagflation as mentioned in the macroeconomic literature ,i.e., surges in oil prices cause not only the higher price level, but also drops in aggregate output. This causes a concern that the impact of oil shocks to developing economies facing external financial constraints will be stronger than the impact on the global economy.[1] High oil prices can trigger a rapid decline in consumption and investment confidence with a negative strong impact on real economic activity, specifically real GDP.

[1] See details in World Bank (2005).

Recently, the Thai economy has experienced an upward trend of oil prices which causes a concern that the overall cost of production will substantially increase. The adverse economic impacts from oil crisis will be more severe for oil-importing developing economies than for other industrialized countries because of the dependency on imported oil and the less efficient use of oil. Like other Asian economies, Thailand substantially relied on imports of oil as can be seen in Table 1. The intensity index of Thailand in 2003 was slightly above 50%, even though it was below the average level of oil dependency in Southeast Asian economies.[2] Since most Asian countries import a large amount of oil, they will experience a fall in aggregate output, a worsening current account balance, and a rise in inflation rate. According to the prediction by International Monetary Fund (IMF), Thailand would lose 1.8 percent of its GDP in 2004 following the year of oil price hike.[3]

Table 1. Oil Use in South East Asia, 2003

Country	Intensity of Oil Use in Energy Consumption
Cambodia	0.932
Indonesia	0.507
Lao People's Dem.Rep	0.117
Malaysia	0.445
Philippines	0.550
Singapore	0.888
Thailand	0.529
Vietnam	0.460
Average	0.554

Source: Energy Information Administration, 2005; International Energy Annual, 2003, Washington, D. C. **Note**: The intensity of oil use in energy consumption index measures the share of oil in an economy's primary consumption.

In spite of the recognition of an important role of oil in the Thai economy, most empirical research works investigating the impact of oil shocks on real GDP or industrial production are descriptive and use simple statistical tools. This study examines the impact of oil shocks on industrial production index in Thailand using cointegration and error correction mechanism. The results of this study confirm that there are two cointegrating equations which indicate stationary long-run relationships. An analysis of error correction mechanism reveals that industrial production, real money supply, real exchange rate, and international oil prices adjust to correct the disequilibrium condition in the short run.

The outline of the rest of this study is as follows. Section 2 explains the data and estimation procedure. Section 3 shows the estimated results both in the long run and the short run. The final section gives concluding remarks.

2 The intensity index mentioned above takes the value between zero and one. When the index is equal to zero, there is no dependency at all. On the contrary, the index of one means that an economy completely relies on oil as a primary energy consumption.

3 See details in International Energy Agency (2004).

2. Data and Estimation Procedure

The data used in this study are monthly series covering January 1990 to December 2004. All items are obtained from the Bank of Thailand, and IMF international financial statistic yearbook. The series are seasonally adjusted.

The equation that can examine the impact of international oil prices on industrial production index is specified as

$$LIP_t = \beta_0 + \beta_1 LRM_t + \beta_2 LRX_t + \beta_3 LOP_t + \beta_4 D_t + \varepsilon_t \qquad (1)$$

where LIP is log of industrial production index, LRM is log of real money supply by a broad definition (M2), LRX is log of real exchange rate in terms of baht per U.S. dollar, and LOP is log of international oil prices. Since there may be a structural break in the data, the dummy variable (D) should be included in the equation to capture the impact of the financial crisis. The dummy variable takes the value of zero before the financial crisis from January 1990 to July 1997, and of one thereafter.

An increase in real money supply can stimulate the economy to expand, and thus causes a rise in industrial production. If real exchange rate rises, the industrial production index should drop because the prices of imported materials rise[4]. A surge in international oil prices should hamper economic activity or a drop in industrial production.[5] The dummy variable should capture the negative impact of financial crisis on real activity, i.e., industrial production.

It is essential to determined that the four series (LIP, LRX, LRM and LOP) are integrated of order one , I(1), so that Johansen cointegration test can be performed to determine whether there is a long-run relationship between these variables. The cointegrating vector can be specified as:

$$\Delta Y_t = \prod Z_t + \sum_{i=1}^{k} \Gamma_i \Delta Y_{t-i} + e_t \qquad (2)$$

where Y is a vector of nonstationary variables, $\Pi = \alpha\beta^{/}$ which is the information on the coefficient matrix between the levels of the series, and Γ_i is the matrix of short-run parameters. The relevant elements of the α matrix are adjusted coefficients and the β matrix contains the cointegrating vectors. Johansen and Juselius (1990) procedure give two likelihood ratio test statistics to test for the number of cointegrating vectors, i.e., the maximum **eigenvalue** statistic and the **trace** statistic. The two test statistics are compared with the critical values. If the maximum eigenvalue statistic and the trace statistic are greater than the critical values, cointigrating relation(s) will exist.

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[4] Manufacturing firms that produce exported goods rely heavily on imported raw materials and semi-finished products.

[5] International oil prices are determined by world oil market. However, the oil prices in the country depend on the world oil prices, and thus this variable is used as a proxy of the country's oil prices. By this reason, LOP is treated as an endogenous variable in the model.

The Johansen procedure bases on the error correction mechanism (ECM) representation of the vector autoregressive model (VAR). An estimation of ECM representation gives the results from a dynamic adjustment which shows a short-run relationship or each period deviation from a stationary long-run equilibrium. The first step is to estimate VAR in levels of variables to determine appropriate lag length. The next step is to determine the number of cointegrating vectors or cointegration rank among variables in the model. Then cointegrating equations can be identified. The final step is to obtain results from ECM representation.

The ECM representation can be specified as

$$\Delta LIP_t = \alpha_0 + \alpha_1 \lambda_{t-1} + \sum_{i=1}^{k} \beta_i \Delta LIP_{t-i} + \sum_{i=1}^{k} \gamma_i \Delta LRM_{t-i} + \sum_{i=1}^{k} \delta_i \Delta LRX_{t-i} + \sum_{i=1}^{k} \varphi_i LOP_{t-i} + + \eta_t \quad (3)$$

where λ_{t-1} is the error correction term (ECT).

According to Granger representation theorem, the existence of cointegrating vector(s) among a set of I(1) series shows the existence of a dynamic error-correction represention. This type of representation in the short run is clearly explained in Hendry (1993). The coefficient of λ_{t-1} measures the response of LIP_t in equation (3) in each period to deviate from the equilibrium condition, and the convergence will be assured if α_1 takes the value between zero and -1. In other words, if this condition holds, any deviation from the long-run equilibrium will be corrected.

3. Empirical Results

Test for stationarity of time series proposed by Kwiatkowski, Phillips, Schmidt & Shin (1992) or the KPSS test for unit root in each series are performed in both level and first difference.[6] The results of unit root tests are reported in Table 2.

The results from KPSS test with the statement of the null hypothesis that the series is stationary. The level of all series (LIP, LRM, LRX, and LOP) are non-stationary since the null hypothesis can be rejected at the 5% level. By contrast, first differences of all series ((ΔLIP, ΔLRM, ΔLRX, and ΔLOP) are stationary at least at the 5% level, i.e., the test statistics are less than the critical values such that the null hypothesis of stationarity cannot be rejected. It should be noted that ΔLRM is only stationary from KPSS statistic with constant plus trend.

[6] The ADF test by Dickey and Fuller (1981) and PP test by Phillips and Perron (1988) are also employed but the results are ambiguous between these two tests.

Table 2. Unit Root Test (KPSS Test)		
Variables:	Constant	Constant+Trend
LIP	1.567	0.219
LRM	1.640	0.434
LRX	1.344	0.211
LOP	0.661	0.221
ΔLIP	0.599	0.058
ΔLRM	1.046	0.047
ΔLRX	0.084	0.067
ΔLOP	0.113	0.028
KPSS Critical Value:		
1%	0.739	0.216
5%	0.463	0.146
10%	0.347	0.119

Since all variables are I(1), Johansen's cointegration test (Johansen and Juselius, 1990) can be applied.[7] First, all variables in level are run in a vector autoregression (VAR), and the optimal lag length is determined by Akaike Information Criterion (AIC). According to this criterion, the optimal lag length is eight. As reported in Table 3, Max Eigen statistic and Trace statistic show that there are two cointegating equations in both the 5% and 1% level of significance.[8]

Table 3. Test for Cointegration Rank		
Rank	Max Eigen Statistic	Trace Statistic
0	41.752***	101.322***
1	38.827***	59.570***
2	14.294	20.743
3	5.499	6.449

Since the focus of this study is on the impact of variables in the right hand side of equation (1) upon the industrial production index, the first cointegrating equation results from Johansen's cointegration tests will show the impact of oil prices on industrial production while the second cointegrating equation show the impact of oil prices on real money supply. There is the long-run relationship in equation (4), while the short-run relationship from vector error correction model (VECM) can be shown in equation (5).

$$LIP_t = 0.826^{***} LRM_t + 0.40 LRX_t + 0.259^{***} LOP_t - 0.135^{**} D \qquad (4)$$

$$LRM_t = -0.986 LRX_t + 0.665^{***} LOP_t - 0.154^{**} D \qquad (5)$$

*** and ** denote significance at the 1% and 5% level respectively.

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7 Detailed discussions of cointegration are in Johansen (1992 and 1995).

8 The hypothesis that there is no or one cointegration rank is rejected.

The results from equation (4) indicate that international oil prices (LOP) and real money supply (LRM) impose a positive impact on industrial production index (LIP) at the 1% level of significant. The coefficient of dummy variable (D) is negative and significant at the 5% level which indicates that industrial production is adversely affected by the presence of the structural break. However, the coefficient of real exchange rate (LRX) is insignificant. The existence of a stationary long-run relationship indicates that the level of industrial production index depends on real money supply and oil prices. The results show that a 1 % permanent increase in real money supply will cause industrial production index to increase by 0.83%. In a similar manner, a 1% permanent increase in international oil prices will cause industrial production index to increase by 0.26%. The cointegrating equation in equation (5) also show that a 1% permanent increase in oil prices causes real money supply to increase by 0.67% besides an increase in real money supply caused by monetary policy tools. Therefore, a continuous increase in oil prices does not harm industrial production in the long-run. This implies that the Thai manufacturing sector can adjust itself to higher cost of production caused by this type of adverse supply shocks. However, the financial crisis imposes a small negative impact on industrial production.

The result from ECM representation which shows the short-run relationship between variables is[9]

$$\begin{aligned}\Delta LIP_t &= 0.001 - 0.299{*}{*}{*}\,\lambda_{t-1} - 0.141{*}\,\Delta LIP_{t-1} - 0.102{*}\,\Delta LIP_{t-8} - 0.612{*}{*}{*}\,\Delta LRM_{t-1}\\ &+ 0.576\Delta{*}\,\Delta LRM_{t-2} + 0.862{*}{*}\Delta LRM_{t-3} - 0.591{*}\,\Delta LRM_{t-4} - 1.131{*}{*}{*}\,\Delta LRM_{t-6}\\ &+ 0.964{*}{*}\Delta LRM_{t-7} - 0.612{*}{*}{*}\,\Delta LRX_{t-1} - 0.536{*}{*}{*}\,\Delta LRX_{t-3} - 0.290{*}{*}\Delta LRX_{t-5}\\ &- 0.262{*}{*}\Delta LRX_{t-8} - 0.095{*}\,\Delta LOP_{t-1} - 0.096{*}\,\Delta LOP_{t-3} + 0.115{*}{*}\Delta LOP_{t-5},\\ R^2 &= 0.556, F = 3.942\end{aligned} \quad (6)$$

From equation (6), the value of the coefficient of the error correction term (ECT=λ_{t-1}) is -0.299 and significant at the 1% level. Since the error correction is negative, this indicates that any deviation from long-run equilibrium (conintegrating equation) will be corrected in the short run. About 30% of the deviation is eliminated after one month. It should be noted that all independent variables affect industrial production index. Changes in industrial production index are adversely affected by their past changes with a quite small magnitude and with low level of significant. The sizes of past changes in real money supply that affects industrial production index are relatively large, while those of the remaining variables are relatively small.

To validate the results in equation (4), the exogeneity of the variables must be tested. The hypothesis that the first column of the feedback matrix, α, is (1, 0, 0, 0, 0) can be tested. However, the estimated coefficients of the first column of the α is (-0.009, 0.001,-0.004,0.010,-0.004). The test of weak exogeniety give a $\chi^2_{(32)} = 95.728$ compared to the critical value of 22.164 at the 99% level of confidence. Therefore,

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[9] The coefficients that are not significant at the 10% level are not reported.

there is no weak exogeneity of LRM, LRX, and LOP in a stationary long-run equation.

4. Concluding Remarks

This study examines the sensitivity of Thailand's industrial production index to changes in international oil prices. Rather than only relating industrial production to international oil prices, other variables that have a potential to influence the industrial production index are included in the model.

Using monthly data, the unit root test (KPSS test) is performed on both level and first difference of each series. The results show that industrial production index, real money supply, real exchange rate, and international oil prices are non-stationary in levels, but stationary in first differences. Thus all variables in the model to be estimated are integrated of the same order, i.e., they are I(1) series. Since the variables are cointegrated, thus there exists a long-run relationship between industrial production index and other variables (real money supply, real exchange rate, and international oil prices). The results from error correction mechanism (ECM) indicate that any deviation from the long-run equilibrium will be corrected in the short run.

The results from this study show that the negative impact of oil price changes on changes in industrial production index can be observed in the short run. In the long run, the Thai manufacturing sector can adjusted itself to higher costs of production due to an upward trend of oil prices. The positive long-run relationship between real money supply and international oil prices also implies that a surge in oil prices is accompanied by an increase in real money supply to stimulate real economic activity. The negative impact of a structural break on industrial production index is quite small compared to a positive impact of real money supply. Therefore, the industrial production index has an upward trend.

It should be noted that the results from this study may not be able to generalize the impact of oil shocks on real GDP since industrial production is only one out of various sectors in the Thai economy. The accuracy of the results also depends on the number of observations in the cointegrated system. Since the monthly data for real GDP are not available, the industrial production index is used instead. The limitation of this study is that there might be more variables that could influence industrial production such as government expenditures, and inward foreign direct investment. However, these data are not available in monthly basis.

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