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Article

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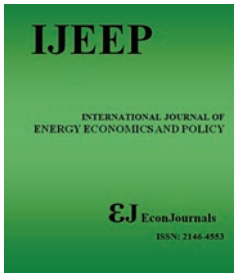

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Economic Growth, Oil Consumption and Import Intensity: Factor Decomposition of Imported Crude Oil Model Approach[#]

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ABSTRACT

Taiwan became a member of the WTO in 2002. Trade is the engine of growth in Taiwan, accounting for nearly 96.41% of gross domestic product in 2016. Taiwan's economy is highly export-oriented. On the other hand, Taiwan depends on imports for near 98% of its energy consumption. This paper analyzes the changes in the intensity of crude oil imports between 1981 and 2016. This research sets several main topics: (1) Estimating the imported crude oil intensity of final demand for a quantity analysis. (2) Measure of imported crude oil intensity of final demand. (3) Factor decomposition model for the imported crude oil intensity of final demand. (4) The study could provide an understanding of the properties and production technologies of various industries. The result shows that imported goods intensity is the largest in the crude oil and gas sector. Changes in imported crude oil intensity factors mainly from domestic production structure and final demand structure.

Keywords: Economic Growth, Imported Crude Oil intensity, Factor Decomposition
JEL Classifications: C51, F14, Q43

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1. INTRODUCTION

Rapid economic growth in world has contributed toward substantial increase in foreign trade. Taiwan also had experience of rapid economic growth. Taiwan's economy has increasingly evolved from one dependent on manufacturing to services-orientated economy. Taiwan's economy is highly dependent on international trade (Hong and Li, 2015).

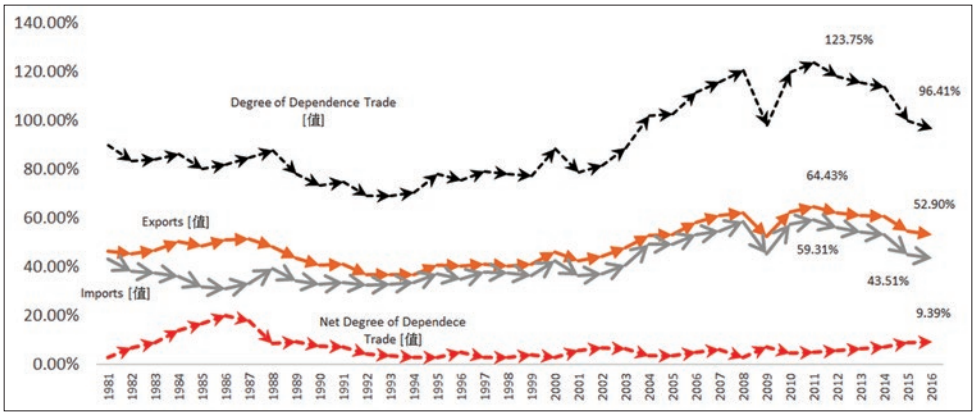
Taiwan's economic dependence on foreign trade (Figure 1). Taiwan's degree of dependence on foreign trade increased from 89.52% to 96.41% in the period 1981-2016.

During the same period, the ratio of dependence on export increased from 46.24% to 52.90%. The ratio of dependence on import increased from 43.28% to 43.51%.In terms of imports, over 70% of Taiwan imports are of agricultural goods and raw material. That is to say, Taiwan's economic characteristics are the lacks energy resources and highly depends on import, which is the most representative of crude oil imports. The stability of crude oil prices influences production costs and has become a key factor in its economic development "change in initial price of imported product" was the most significant factor behind price increases (Hong et al., 2017; Hong et al., 2012).

After two crude oil crises in the 1970s, which upset the economy in Taiwan, the international prices of crude oil remained relatively stable; this drove Taiwan's economic development. Taiwan, as an independent economy, became a member of the WTO (World Trade Organization, WTO) in 2002.

Following 2000, international crude oil prices rose gradually, peaking in July 2008, before beginning to fluctuate wildly. These price increases differ from those of the oil crises in the 1970s. Newly industrialized countries and an expanding global supply chain are driving the rapid growth in crude oil demand. In addition, the development of international financial markets is also increasing speculative demand in the crude oil market.

Figure 1: Changes in degree of dependence on foreign trade



Whether Taiwan's energy efficiency would improve with economic development remains unknown. The efforts of the government and businesses are evident in the annual decline in domestic energy intensity. However, the sustainable development of a country's economy relies on improvements in energy-saving technologies and on efficient responses to changes in the international economic environment and to industrial restructuring.

Considering the aforementioned concerns, in the present study, we examined the influences of changes in international imported goods prices on industry costs and prices over a period in which international imported goods prices doubled (Hong et al., 2012). Improvements in industrial imported goods utilization technology were investigated from the perspectives of quantity and price. To achieve these objectives, we used the imported goods intensity of final demand model and the factor decomposition model, estimating the imported goods intensity of final demand for a quantity analysis. These analyses facilitated observations of the changes in crude oil dependence by Taiwanese industries and of the responsiveness to crude oil prices over 30 years.

2. LITERATURE REVIEW

Many studies point out that economic growth is affected by oil prices and demand.

This phenomenon has not changed in the twenty-first century because the economic growth of newly industrialized countries has substantially increased energy demand, prompting speculation in energy futures markets and increasing the instability of international energy prices (Blanchard and Gali, 2007). Since initiating market reforms in 1978, China has experienced rapid economic and social development. China's oil consumption has increased with economic growth. Lee and Chang (2007) analyze the linear and nonlinear effects of energy consumption on economic growth. The study indicated that the relationship between energy consumption and economic growth is characterized by an inverse U-shape in Taiwan between 1955 and 2003.

Asafu-Adjaye (2000) analyzes the relationship between energy consumption, energy prices and economic growth. Other studies on economic growth and oil consumption include Ghosh (2009), Fisher-Vanden et al. (2004), Hang (2007), Mehrara (2007) and Yuan et al. (2008).

After entering the 21st century, economic development and globalization have destabilized international energy prices. Some studies have documented the effects of changes in crude oil prices on economic development and societies from various perspectives, focusing on the extent to which asymmetries in energy price elasticity have affected economic growth rates and domestic prices. Price asymmetries can be used to estimate the direction of changes in economic variables (Gately and Huntingtonet, 2002; Adeyemi and Hunt, 2007; Ma et al., 2008; Inglesi-Lotz, 2011; Neto, 2012). Alternatives between factors of production have also been used to analyze asymmetries (Roy et al., 2006).

According to the premise that the relationship between crude oil prices and gross domestic product (GDP) is nonlinear. Hamilton (2003) performed econometric analysis. Bernanke et al. (1997) indicated that appropriate financial policies can be implemented to reduce the impact of crude oil prices. Balke et al. (2002) used the VAR model to analyze asymmetries in crude oil prices and indicated that adjustment costs and financial policies cause asymmetries. However, Hamilton and Herrera (2004) reported contrasting results. Dalsgaard et al. (2001) and Hunt et al. (2001) documented the influence of changes in international crude oil prices on the global economy, estimating that the elasticity values of each country's GDP in response to oil prices were between −0.01 and −0.02. Bohi (1991) maintained that rises in energy prices reduce enterprise production and GDP; this reduction is attributable to the direct impact and the indirect influence of capital and labor substitution effects.

Ozturk and Arisoy (2016) analyzes the relationship between economic growth and energy consumption through research on crude oil import demand. In addition, the study of renewable energy sources analyzes the relationship between economic growth and energy consumption (Ocal and Aslan, 2013; Ozturk and Bilgili, 2015).

3. EMPIRICAL MODEL

The present study used the industry-related model to estimate imported goods intensity and factor decomposition of imported

crude oil. It was based on the year 2011 industry-related table released by the Taiwanese government in 2015.

3.1. Measure of Imported Goods Intensity of Final Demand

The measure of the imported goods intensity of final demand ($\bar{m}$) for an individual industry is:

$$\bar{m} = \mathrm{MA}\bar{x} = MAB\bar{f}_d \tag{1}$$

Equation (1) represents the imported goods per final demand production for an individual industry, where $\bar{x}$ represents the final demand production of individual industry; B is a Leontief inverse matrix. *M* and *K* are the import coefficient and the input coefficient of an individual industry, respectively. $\bar{f}_d$ denotes a change in the one-unit domestic final demand as the ratio for individual industry as equation (2)

$$(1,\ldots,1)\bar{f}_d = 1 \tag{2}$$

3.2. Factor Decomposition of Imported Crude Oil Model

Next, we will establish a research model. Factor decomposition model for the imported goods intensity of final demand. The intensity of imported would change as time passes. To uncover the change in the factors, the difference in two periods of imported goods and the intensity of final demand $(d\bar{m})$ could be stated as equation (3)

$$d\bar{m} = \bar{m}(1) - \bar{m}(0)$$

$$= M(1)A(1)B(1)\bar{f}_d(1) - M(0)A(0)B(0)\bar{f}_d(0)$$

$$= M(1)A(1)B(1)\bar{f}_d(1) - M(0)A(0)B(1)\bar{f}_d(1) + M(0)A(0)B(1)\bar{f}_d(1)$$

$$-M(0)A(0)B(1)\bar{f}_d(1) + M(0)A(0)B(1)\bar{f}_d(1) - M(0)A(0)B(0)\bar{f}_d(0)$$

$$= \left[M(1)A(1) - M(0)A(0)\right]B(1)\bar{f}_d(1) + M(0)A(0)\left[B(1) - B(0)\right]\bar{f}_d(1) + M(0)A(0)\ B(0)\bar{f}_d(1)\ - \bar{f}_d(0)] \tag{3}$$

Where $\left[M(1)A(1) - M(0)A(0)\right]B(1)\bar{f}_d(1)$ is the factor of input technology change of imported goods: $M(0)A(0)[B(1) - B(0)]\bar{f}_d(1)$ is the factor of efficiency change in domestic production structure; $M(0)A(0)B(0)[(1) - \bar{f}_d(0)]$ denotes the factor of structure change in final demand.

4. EMPIRICAL RESULTS

4.1. Changes in the Imported Goods (Crude Oil) Intensity of Final Demand

Overall, Table 1 indicates the ratio of imported goods required for each incremental increase in final demand in Taiwan, which increased from 25.55% in 1981 to 29.32% in 2016. However, 1981 was only 1 year after the second oil crisis, during which Taiwan was forced to improve production efficiency and reduce energy dependence. Therefore, industrial restructuring became its economic policy. Between 1986 and 2001, the imported goods intensity decreased annually, indicating that Taiwan's industrial restructuring improved production efficiency.

Nevertheless, imported goods intensity increased substantially between 2006 and 2011, reflecting an increase in Taiwan's import dependence that was caused by a rapid increase in international crude oil prices after 2004. In addition, Taiwan's imports increased substantially after it joined the WTO in 2002. Regarding the crude oil and gas sector, the imported crude oil intensity in 1981 was 6.64%; dependence on crude oil was high compared with that in other industries but declined substantially between 1986 and 2001, illustrating that the industry's energy efficiency improved slightly.

Table 1: Imported goods intensity of final demand (unit: %)

Sector	1981	1986	1991	1996	2001	2006	2011	2016
Fishery products	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
Other poultry production	0.08	0.08	0.05	0.04	0.02	0.01	0.01	0.01
Feed	0.21	0.19	0.14	0.11	0.07	0.06	0.07	0.05
Crude oil and gas	6.64	2.03	1.54	1.6	2.65	4.92	5.25	5.47
Petrochemical	1	1.29	1.31	1.24	0.89	1.59	1.63	1.86
Chemical fertilizers	0.08	0.03	0.02	0.02	0.01	0.03	0.04	0.05
Synthetic fiber	0.12	0.13	0.05	0.04	0.03	0.03	0.03	0.04
Plastics	0.37	0.37	0.43	0.38	0.32	0.24	0.3	0.38
Petroleum refining	0.96	0.69	0.72	0.51	0.62	0.93	1.63	1.87
Transportation	0.12	0.2	0.24	0.25	0.21	0.08	0.09	0.11
Pig iron and crude steel	0.81	0.83	0.74	0.48	0.56	1.09	1.03	1.12
Electronic products	0.86	1.41	1.23	2.2	3.3	0.47	3.2	3.51
Food service	0.07	0.03	0.03	0.03	0.03	0.08	0.07	0.66
Hospitality services	0	0.12	0.2	0.14	0.11	0.39	0.35	0.31
Electricity	0	0	0	0.01	0	0.01	0.01	0.01
Communication	0.08	0.09	0.11	0.1	0.06	0.05	0.25	0.33
Financial industry	0.02	0.03	0.02	0.03	0.03	0.03	0.12	0.21
Total industry	25.55	19.1	19.41	19.29	18.8	24.68	26.62	29.32

Data source: This study

Table 2: Factor decomposition for change in imported crude oil intensity (unit: %)

Period	Factor			
	(1) Technology change imported goods	(2) Efficiency change in production structure	(3) Structure of final demand	(4) Total
1981-1984	−2	−2.3	−0.3	−4.6
1986-1989	−0.09	−0.49	−0.11	−0.69
1991-1994	0.01	−0.05	7.47	7.43
1996-1999	0.04	−0.13	−0.08	−0.17
2001-2004	0.78	0.18	0.61	1.57
2004-2006	0.45	0	0.97	1.42
2006-2011	−1.49	3.84	2.6	4.95
2011-2016	−1.22	3.73	3.2	5.71

Data source: This study

The intensity of the imported crude oil and gas sector again increased substantially between 2006 and 2016, reaching 5.47% by 2016. Although we used an input-output table for 2016, we conducted this study in early 2017; thus, there was a gap of more than 1 year, and the current imported crude oil intensity may be even higher.On the other hand, from 1981 to 2016. The empirical results show the changes in the intensity of imported petroleum refining and petrochemical sectors.

4.2. Factor Decomposition on Changes in Imported Crude Oil Intensity

After the second international oil crisis, as shown in Table 2, Taiwan's imported crude oil intensity decreased continually, reaching 1.67% in 2004. The decline was most apparent between 1981 and 1984. The factors affecting the imported crude oil intensity are the change in input technology of imported goods, the efficiency change in domestic production structure, and the structure change in final demand; these factors accounted for −2%, −2.3%, and −0.3%, respectively, of the decline in imported crude oil intensity.

The most significant factor in the decrease in imported crude oil intensity in 1986-1989, 1991-1994, and 1996-1999 was the improvement in structural efficiency of domestic production, yielding contributions of −0.49%, −0.05%, and −0.13%, respectively, to imported crude oil intensity during each period. In addition, another crucial factor affecting imported crude oil intensity was the adjustment in the structure of final demand. With the exception of 1991-1994, when the change in the structure of final demand was positive because of the great amount of consumption caused by the economic bubble, the adjustment in the structure of final demand reduced imported crude oil intensity in 1986-1989 and 1996-1999, yielding contributions of −0.11% and −0.08%, respectively.

Since 2000, newly industrialized economies have grown substantially, driving a rapid rise in crude oil prices. In 2001-2004 and 2004-2006, technology of imported input, efficiency of domestic production structure, and final demand structure all influenced the rise in imported crude oil intensity in Taiwan. These three factors were all positive, indicating that the international economic situation affected Taiwan's economic structure and that Taiwan is an economic entity with high economic uncertainty.

Contributions by efficiency of domestic production structure and final demand structure were positive between 2011 and 2016, increasing imported crude oil intensity. Only improvements in technology of imported input decreased imported crude oil intensity effectively. The global financial crisis of 2007 severely affected Taiwan's exports, which relies heavily on trade. Imports also declined sharply, causing continual increases in crude oil import intensity.

5. CONCLUSION

A full 98% of Taiwan's energy is imported, costing the equivalent of nearly 15% of the entire GDP. In other words, there is a very close relationship between economic development and oil imports. The empirical results of this study show that, domestic energy intensity has declined annually. However, imported crude oil intensity has increased. In particular, after Taiwan joined the WTO, a rise in international trade has increased energy dependence to approximately 30-40%. In addition, energy dependence is also reflected in responsiveness to international crude oil prices. The government is also seeking to reduce Taiwan's reliance on trade as a driver of growth by increasing domestic demand and encouraging greater private sector investment in Taiwan.

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