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# THE IMPACT OF INCREASE IN ENERGY PRICES ON SECTORAL COSTS OF ECONOMY



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**ABSTRACT**

*This paper examines the impact of an increase in the petroleum price on the sectoral costs of production. Three components of costs of production, which comprise domestic materials, imported input, and labour have been identified. By using the input-output model, different scenarios of the petroleum price changes on sectoral costs of production were stimulated. The simulation results indicated that the fishing, forestry, and logging product, electricity and gas, cement, lime and plaster, and transport sectors are mostly affected by the increase in petroleum price. These sectors are expected to show large impact on costs of production as a result of petroleum price increase because these industries highly consume petroleum products as an intermediate input in their production process.*

**ABSTRAK**

*Artikel ini mengukur kesan peningkatan harga petroleum ke atas kos pengeluaran sektoral. Artikel ini mengambil kira tiga komponen kos pengeluaran iaitu kos bahan mentah domestik, import dan buruh. Dengan mengunakan model input-ouput, artikel ini membuat simulasi kesan perubahan harga petroleum yang berbeza ke atas kos pengeluaran sektoral. Keputusan simulasi menunjukkan keluaran sektor perikanan, perhutanan dan pembalakan, elektrik dan gas, simen, lime dan kapur, dan pengangkutan merupakan sektor yang terjejas teruk akibat kesan peningkatan harga petroleum. Sektor-sektor ini dijangka akan menerima kesan yang besar ke atas kos pengeluaran kerana sektor-sektor ini mengunakan bahan-bahan daripada keluaran petroleum dalam kuantiti yang tinggi sebagai input perantaraan dalam proses pengeluaran mereka.*

## INTRODUCTION

Malaysia's economy, like the other developing economies substantially depend on energy input in its production processes. The rapid expansion of the economy stimulates the consumption of energy in general and in its manufacturing and transport sectors in particular, growing at 7.8 percent annually from 1,167.1 petajoules[1] (PJ) in 2000 to 1,699.8 PJ in 2000 as shown in Table 1. Among all the energy types used in the country, petroleum products is the most common and accounted for 67 percent of the total energy used in 2000.

**Table 1**
Final Commercial Energy Demand by Source, 1995-2005.

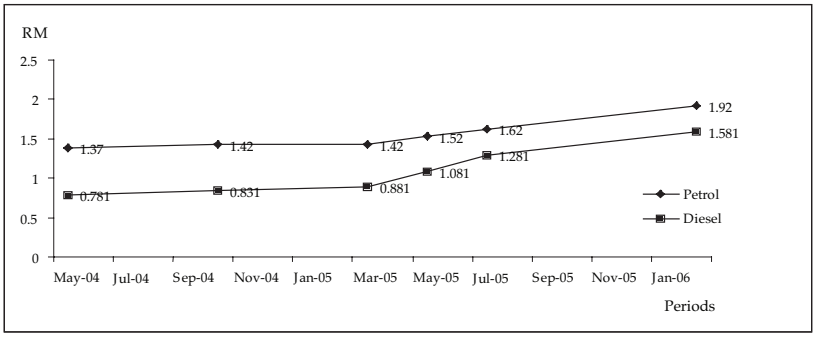
| Source | 1995 | | 2000 | | 2005 | |
|---|---|---|---|---|---|---|
| | PJ | % | PJ | % | PJ | % |
| Petroleum products | 676.0 | 72.8 | 804.3 | 68.9 | 1,139.1 | 67.0 |
| Natural gas | 81.1 | 8.8 | 120.0 | 10.3 | 184.4 | 10.9 |
| Electricity | 141.3 | 15.2 | 205.0 | 17.6 | 320.0 | 18.8 |
| Coal and coke | 29.8 | 3.2 | 37.8 | 3.2 | 55.9 | 3.3 |
| Total | 928.2 | 100 | 1,167.1 | 100 | 1,699.8 | 100 |

Source: Economic Planning Unit, 2006.

Petroleum products, on the other hand, are mainly consumed locally by industrial, transport, and household sectors which as a group absorb nearly one-half of the total production. The industrial sector was the largest energy consumer, utilising 37.1 percent of the total final energy demand in 2000, and this increased to 38.2 percent in 2005. The main industries that contributed to the rise in energy demand are rubber, wood, glass, cement, and food processing (Economic Planning Unit, 2006).

Recently, the increase in petroleum product prices has attracted interest from many sectors of the economy, even though they are still relatively low within the ASEAN region, except for Brunei. During the last two years, there has been a significant rise in the domestic petroleum prices in Malaysia. Petroleum product price of retail petrol, diesel, as well as liquefied petroleum gas (LPG) had increased six 6 times, as announced by the government between October 2004 and Mac 2006. Within this period, the price of petrol and diesel had increased about 40 percent from RM 1.37 to RM 1.92 per liter and from RM 0.781 to RM 1.581 per liter, respectively. (Figure 1).

The impact of higher oil prices on the economy can be traced through direct and indirect effects. Direct impact, for instance are the increased expenses for purchased oil or oil products for manufacture while, indirect impact are the changed prices paid for other products and services, which pass along the higher fuel costs in the production process. Manufacture would tend to increase the goods and services prices because increase in the cost of production of goods and services in the economy as a result of increase in the petroleum price inputs, putting pressure on profit margins. However the impact of increase in the petroleum price on sectoral costs of production largely depends on the interdependencies of the industries in the economy. The industry which consumes large amount of petroleum energy as an input in its production process is expected to show a large effect of increase in costs of production.




Source: Authors' database.

**Figure 1**
Increase in petrol and diesel prices in Malaysia between May 2004 and February 2006

Therefore, considering the above scenario, the purpose of this study was to analyse the effect of the petroleum price increase on the costs of production of various industries in the Malaysian economy. In addressing this issue, we examined the effects of increase in the petroleum price from different scenarios of changes in the domestic and imported petroleum price on costs of production. The general equilibrium of the input-output price model, which captures both direct and indirect production effects, was employed.

This paper is organised as follows. Section 2 describes the background of the petroleum industry and its linkages to Malaysian economy.

Section 3 outlines the analytical framework of the input-output price model together with data coverage associated in the study. Section 4 presents the empirical findings of the price simulations. Concluding remarks follow in section 5.

## PETROLEUM INDUSTRY AND ITS ECONOMIC LINKAGES

The petroleum industry in Malaysia can be categorised by their downstream and upstream activities. The extraction of crude petroleum and natural gas activities are categorised under the downstream phase whereas the upstream phase involves the manufacture of coke oven, refined petroleum products, and nuclear fuel. The economy's production of crude petroleum is mainly for export, accounting for more than 65 percent of total production. The attraction for export is due to the fact that the country's crude petroleum is superior in quality with low sulphur content (i.e. sweet and light variety), which would fetch premium prices as compared to the world crude petroleum.

The local refineries, having a total capacity of about 214, 800 b/d and with a utilisation rate of more than 80 percent, are insufficient. Local refineries are increasing their activities of refining local crude petroleum. For example, in 1991, 66 percent of refining activities used local crude petroleum whereas in 2000, the proportion of local crude petroleum refined had increased to more than 78 percent.

Oil development in Malaysia can be traced back to the early 1970s. During that time, oil exploration was done by multinational oil companies such as Shell and Esso. The 1974 oil price hike sparked the emergence of substantial contribution of petroleum to the Malaysian economy. As a result, petroleum exports which accounted only 4 percent in 1973 had increased to 7.9 percent in 1975. Although lagging behind natural rubber, the traditional number one source of foreign exchange, in 1980, petroleum overtook natural rubber as Malaysia's chief foreign exchange earner and still remains the leading export item commanding 13.9 percent of total exports in the economy in 1987.

Since the petroleum industry had become increasingly important to the development of the Malaysian economy in 1970s, the government introduced the Petroleum Development Act in 1974 to ensure that the development of the petroleum industry including the arena of activities related to petroleum is fully in-line with the national interest and objectives. Under this Act, PETRONAS was established by the

government which is responsible for all aspects of petroleum operations from exploration to final sales.

Today's petroleum industry contributes significantly to the Malaysian economy. The industrial economic linkages among the industries revealed that the petroleum industry is one of the key industries for Malaysia's economy as shown in Table 2. This industry recorded high indices (greater than 1) for both the backward and forward linkages;

**Table 2**
Industrial Linkages Indices of the Malaysian Economy, 2000

| Industries | Linkage effects | | | |
|---|---|---|---|---|
| | Backward | Rank | Forward | Rank |
| 1. Agriculture primary products | 0.8016 | 37 | 1.2275 | 10 |
| 2. Rubber primary products | 0.8759 | 31 | 0.9618 | 17 |
| 3. Oil palm primary products | 0.8147 | 35 | 0.8127 | 27 |
| 4. Livestock etc. | 1.4420 | 2 | 1.0332 | 15 |
| 5. Forestry and logging products | 0.7566 | 42 | 1.0729 | 13 |
| 6. Fishing | 1.0161 | 18 | 1.0627 | 14 |
| 7. Crude petrol, natural gas and coal | 0.7389 | 43 | 1.2959 | 7 |
| 8. Other mining | 0.9123 | 27 | 0.8609 | 24 |
| 9. Meat and dairy products | 1.3520 | 3 | 0.8318 | 25 |
| 10. Preserved food | 1.2902 | 4 | 0.6739 | 41 |
| 11. Oils and fats | 1.6465 | 1 | 1.7046 | 3 |
| 12. Grain mills products | 1.1944 | 5 | 0.7526 | 32 |
| 13. Bakery and confectionary products | 1.0737 | 13 | 0.7173 | 37 |
| 14. Other foods | 1.0851 | 12 | 1.2202 | 11 |
| 15. Beverages | 1.0890 | 11 | 0.6973 | 38 |
| 16. Textile products | 0.9860 | 24 | 0.8768 | 22 |
| 17. Wearing apparels | 0.9922 | 23 | 0.6759 | 39 |
| 18. Wooden products | 1.1103 | 8 | 0.8010 | 29 |
| 19. Furniture | 1.0718 | 14 | 0.6686 | 42 |
| 20. Paper and printing products | 1.0106 | 19 | 1.1710 | 12 |
| 21. Chemical products | 1.1270 | 7 | 1.3335 | 6 |
| 22. Petrol products | 1.0307 | 17 | 1.7540 | 2 |
| 23. Rubber products | 1.0685 | 15 | 0.7247 | 36 |
| 24. Plastic products | 0.8982 | 30 | 0.8152 | 26 |
| 25. China, glass, and clay products | 1.0042 | 21 | 0.8102 | 28 |
| 26. Cement, lime, and plaster | 1.0989 | 9 | 0.9182 | 18 |
| 27. Other non-metal products | 1.1726 | 6 | 0.7342 | 33 |
| 28. Metal products | 0.9286 | 26 | 1.2839 | 8 |
| 29. Non-electrical machinery | 0.7758 | 41 | 0.7730 | 31 |
| 30. Electrical machinery | 0.8209 | 34 | 0.9682 | 16 |
| 31. Transport equipment | 0.9802 | 25 | 0.9145 | 20 |
| 32. Other manufacturing products | 0.8997 | 29 | 0.7326 | 34 |
| 33. Electricity and gas | 0.8687 | 32 | 1.5558 | 5 |
| 34. Water | 1.0079 | 20 | 0.7312 | 35 |
| 35. Buildings and constructions | 1.0483 | 16 | 0.8925 | 21 |
| 36. Wholesale and retail trade | 0.7759 | 40 | 2.1821 | 1 |
| 37. Hotels and restaurants | 1.0933 | 10 | 0.9157 | 19 |
| 38. Transport | 1.0042 | 22 | 1.2310 | 9 |
| 39. Communication | 0.8007 | 38 | 0.8625 | 23 |
| 40. Financial services | 0.7799 | 39 | 0.7801 | 30 |
| 41. Private services | 0.8135 | 36 | 1.6607 | 4 |
| 42. Public services | 0.8312 | 33 | 0.6753 | 40 |
| 43. Private non-profit services | 0.9110 | 28 | 0.6322 | 43 |

Source: Input-Output Table, 2000

implying that it plays an important role in the economic development in supporting as well as boosting other industries in the Malaysian economy.

A high backward linkage indicated that the petroleum industry ranked number 17 among the rest of the industries which recorded an average index of 1.0307. This implies that the output of this industry has a large impact on industries that supply inputs in the production of this industry output. The crude petroleum and natural gas, chemical product, and wholesale and retail trade among the industries will get more benefit from increase in petroleum industry output because these industries have strong connections with the petroleum industry in supplying inputs. On the other hand, the forward linkage effects revealed that the petroleum industry ranked number 2 after the oils and fats industry with an average index of 1.7540. This implies that this industry contributes significantly in supplying its input to the other industries' output. The fishing, electricity and gas, and transport industries are among the industries which have found substantial use for energy inputs from the petroleum industry in their production. Since the industrial linkage effect revealed that the petroleum industry is a key sector in the Malaysian economy, it implies that the petroleum industry contributes significantly to the development of the Malaysian economy. The inter-industry linkages also point to the fact that the industry which has strong connection in the forward linkages with the petroleum industry is expected to suffer a large impact from the increase in petroleum price because these industries utilise intensive petroleum energy in its production process as an input.

## INPUT-OUTPUT PRICE MODEL

The input-output price model which developed by Leontief (1951) has been widely used both in developed and developing countries to analyse the nature of cost-price inter-relationships within a sectoral framework. This model is well documented in Miller and Blair (1985). Using the same approach, Han, Yoo, and Kwak (2004) investigated the potential impact of the rise in electricity rates on the Korean economy. Moreover, Valadkhani and Mitchell (2002) applied the input-output price model to assess the petroleum price shocks on inflation and household expenditure in Australia. While the previous studies had fully applied the input-output price model, in this study we adopted the cost-based input-output model which was introduced by Mathur (1977) and later enhanced by Rashid (1989). In this model, we examined

the impact of petroleum price on costs of production which comprise costs of domestic materials, imported materials, and labour.

Every process of production involves the use of a combination of factors of production such as domestic materials, labour, and capital. The costs of production are the value of inputs used and may be obtained by multiplying the amount of inputs used by their per unit prices. In an input-output analysis, the input-output coefficients of a structural matrix describe the amount of inputs used per unit of output. These coefficients multiplied by its input prices, would give the costs of production per unit costs of output produced. In order to obtain per unit costs for each sector of the economy, we need as many prices as the number of sectors indicated by the tables.

Similarly, the production statement for a particular sector of an economy would have the value of purchases from other sectors. When each of them is divided by the sector's value of output, the results will give the structure of inputs used in production. Its costs of production would, therefore, equal to the sum of the products of its input coefficients and its respective per unit prices. The costs of production can be represented by:

$$\sum_j a_{ij} P_j \qquad (1)$$

where $a_{ij}$ and $P_j$, respectively are column vector of sector $j$ input coefficients and the producer prices of the respective input for the total of $n$ sectors, $i$ is the sector providing inputs to sector $j$.

**Costs of Production**

The model has identified three components of total costs, which are domestic materials, imported input, and labour (Rashid, 1989). The structure of each of the first two inputs is represented by their respective input coefficient matrices, namely the structural and imported inputs matrices. Since labour is not normally aggregated by sectors, the structure of labour used in the production is represented by its labour coefficient vector. Based on the above formulation, the total cost of production of sector $j$ output that can be expressed as;

$$\sum_j P_j a_{ij} + \sum_j w_j L_j + \sum_j^m P_j^m a_{ij} \qquad (2)$$

where,

| | | |
|---|---|---|
| $a_{ij}$ | = | domestic input coefficient |
| $L_j$ | = | labour input coefficient |
| ${}^m a_{ij}$ | = | imported input coefficient |

$P_j$ = price of domestic input
$w_j$ = price of labour
${}^{m}P_j$ = price of imported input

Equation (2) represents the index of per unit costs of production in sector *j* in the base year. In addition, due to some limitations in the way the producer prices were provided and the manner in which the model has been developed, all prices of inputs have to be re-expressed in index form. In deriving each of the cost components in equation (2), the study presented the detailed procedures in Appendix 1.

**Price Simulations**

In our model, we have determined the total per unit cost of production of each sector by three constant coefficients and variables. All the input coefficients, namely domestic material, imported inputs, and labour are treated as constants, whereas the variables are the indices of prices of inputs. Since all the three pairs of input coefficients are constants, the total per unit costs of production after price shocks can be easily determined by substituting new price vectors into the base year model of equation (2).

Assuming other sectoral prices are constant, in this paper we simulated three different scenarios of the petroleum price changes on sectoral costs of production. Firstly, we stimulated the effect of costs of production by allowing changes in the domestic petroleum product price while the rest of the sectoral price components remain unchanged. This is expressed by the following equation;

$$\sum_j \delta P_j a_{ij} + \sum_j w_j L_j + S_j^{m} P_j^{m} a_{ij} \qquad (3)$$

Secondly, the model simulated the increase in imported petroleum price on costs of production while assuming other sectoral costs components remain unchanged, by using the following expression;

$$\sum_j P_j a_{ij} + \sum_j w_j L_j + \sum_j^{m} \delta P_j^{m} a_{ij} \qquad (4)$$

Finally, in the third simulation, we simulated the effect costs of production by allowing changes in both domestic and imported petroleum prices that can be shown in equation (5)

$$\sum_j \delta P_j a_{ij} + \sum_j w_j L_j + \sum_j^{m} \delta P_j^{m} a_{ij} \qquad (5)$$

Since this paper has limited the analysis on the petroleum product price effects, thus, in all simulations we assumed that the sectoral labour wage rate is constant, *ceteris paribus*.

In the model, while equation (2) implies that prices in all industries of the input-output table are treated as endogenous variables, in equation (3), (4), and (5), the price in the petroleum product industry (industry 22) is entirely exogenous whereas the prices in the other $n$-1 industries are endogenous. It should be borne in mind that when the petroleum product price is equal to 1, this implies that there is no deviation in the price of petroleum product industry from its baseline value. However, when, for example, the price of petroleum products double, the shock is introduced to the model as 2. While assuming that the petroleum price has doubled (either domestic or imported prices) and solving either equation (3) or (4), and expressing the resulting price deviations from unity in percentage form, one can determine the impact of this price shock on the $n$-1 endogenous industries. In each simulation run, we imposed three scenarios of price changes; 30 percent, 60 percent and 90 percent, respectively.

**Data Sources**

In this study, we collected published data from the 2000 input-output (I-O) tables, which are the latest tables published for Malaysia. The original 2000 I-O table was compiled with 92 industries, however for simplicity, the aggregated version of 31 industries is employed in this study. This table was compiled using the new industrial classification, the Malaysian Standard Industrial Classification (MSIC) on the basis of the 1993 System of National Accounts (SNA), which is the latest international standard for compiling I-O proposed by the United Nations.

## RESULT AND DISCUSSIONS

Petroleum is an important source of energy which is essentially used as intermediate goods. An understanding of the impact of higher energy prices requires careful consideration of the energy's relationship with the production cost structure. It is important that the analytical framework be that of a general rather than partial equilibrium. By using the expressions for calculating the costs of production described above, Table 3 shows the result of the industrial indices of total costs. The changes in the costs of production are expected to show corresponding

movement in the input prices through the input-output relationship which the coefficients are fixed.

**Table 3**
Index of Costs of Production of the Malaysian Economy

| Industries | Components of costs of production | | | Total costs |
|---|---|---|---|---|
| | Dom. materials | Imports | Labour | |
| 1. Agriculture primary products | 0.0267 | 0.0132 | 0.0123 | 0.0522 |
| 2. Rubber primary products | 0.0686 | 0.0280 | 0.0189 | 0.1155 |
| 3. Oil palm primary products | 0.0515 | 0.0179 | 0.0325 | 0.1019 |
| 4. Livestock, etc. | 0.1118 | 0.0064 | 0.0010 | 0.1192 |
| 5. Forestry and logging products | 0.0131 | 0.0102 | 0.0004 | 0.0237 |
| 6. Fishing. | 0.0727 | 0.0061 | 0.0042 | 0.0829 |
| 7. Crude petrol, natural gas, and coal | 0.0035 | 0.0029 | 0.0000 | 0.0065 |
| 8. Other mining | 0.1205 | 0.0569 | 0.0024 | 0.1798 |
| 9. Meat and dairy products | 0.1686 | 0.0526 | 0.0005 | 0.2217 |
| 10. Preserved food | 0.3977 | 0.1083 | 0.0081 | 0.5141 |
| 11. Oils and fats | 0.0210 | 0.0014 | 0.0000 | 0.0224 |
| 12. Grain mills products | 0.2760 | 0.1158 | 0.0024 | 0.3942 |
| 13. Bakery and confectionary | 0.1531 | 0.1071 | 0.0070 | 0.2672 |
| 14. Other foods | 0.0619 | 0.0466 | 0.0007 | 0.1093 |
| 15. Beverages | 0.1894 | 0.0907 | 0.0026 | 0.2827 |
| 16. Textile products | 0.0399 | 0.0385 | 0.0006 | 0.0789 |
| 17. Wearing apparels | 0.0481 | 0.0435 | 0.0027 | 0.0943 |
| 18. Wooden products | 0.0394 | 0.0070 | 0.0009 | 0.0472 |
| 19. Furniture | 0.0764 | 0.0397 | 0.0028 | 0.1190 |
| 20. Paper and printing products | 0.0298 | 0.0223 | 0.0006 | 0.0527 |
| 21. Chemical products | 0.0184 | 0.0093 | 0.0001 | 0.0279 |
| 22. Petrol products | 0.0155 | 0.0082 | 0.0000 | 0.0238 |
| 23. Rubber products | 0.0572 | 0.0256 | 0.0011 | 0.0839 |
| 24. Plastic products | 0.0308 | 0.0403 | 0.0007 | 0.0718 |
| 25. China, glass, and clay products | 0.0739 | 0.0307 | 0.0014 | 0.1060 |
| 26. Cement, lime, and plaster | 0.1985 | 0.0880 | 0.0014 | 0.2880 |
| 27. Other non-metal products | 0.1677 | 0.0563 | 0.0019 | 0.2259 |
| 28. Metal products | 0.0116 | 0.0152 | 0.0002 | 0.0270 |
| 29. Non-electrical machinery | 0.0021 | 0.0074 | 0.0000 | 0.0095 |
| 30. Electrical machinery | 0.0014 | 0.0037 | 0.0000 | 0.0052 |
| 31. Transport equipment | 0.0206 | 0.0205 | 0.0010 | 0.0421 |
| 32. Other manufacturing products | 0.0225 | 0.0309 | 0.0003 | 0.0537 |
| 33. Electricity and gas | 0.0175 | 0.0059 | 0.0001 | 0.0235 |
| 34. Water | 0.2183 | 0.0357 | 0.0053 | 0.2592 |
| 35. Buildings and constructions | 0.0098 | 0.0051 | 0.0004 | 0.0153 |
| 36. Wholesale and retail trade | 0.0031 | 0.0019 | 0.0004 | 0.0055 |
| 37. Hotels and restaurants | 0.0212 | 0.0092 | 0.0014 | 0.0318 |
| 38. Transport | 0.0113 | 0.0073 | 0.0003 | 0.0189 |
| 39. Communication | 0.0116 | 0.0091 | 0.0002 | 0.0209 |
| 40. Financial services | 0.0051 | 0.0021 | 0.0002 | 0.0074 |
| 41. Private services | 0.0036 | 0.0030 | 0.0003 | 0.0069 |
| 42. Public services | 0.0056 | 0.0019 | 0.0004 | 0.0080 |
| 43. Private non-profit services | 0.2614 | 0.3902 | 0.0334 | 0.6849 |
| Total | 3.1580 | 1.6227 | 0.1513 | 4.9320 |

Source: Computed from equation (2)

The table also demonstrates cost structure for different industries in the economy. Overall, the domestic material inputs represent the largest amount of input used in the production for each ringgit worth of output

produced. However, looking for individual industries, most of the industries have required larger amounts of domestic inputs than imported materials, except for the plastic products, metal products, non-electrical machinery, electrical machinery, and other manufacturing products. These five industries tend to consume large amounts of imported materials as inputs in its production process. On the other hand, among the industries which have experienced large proportion of domestic costs are the preserved food, water, cement, lime and plaster, meat and dairy products, and grain mill products. Meanwhile, the results also point to the fact that the labour costs do not represent the largest proportion of the industrial total costs.

Under the assumption that increases in petroleum prices do not affect labour requirements, Table 4 and Table 5 presents the results of changes in cost of production resulted from domestic and imported petroleum price level shocks. The total impact on the cost of production in these tables was obtained from three different price shock simulations with three different scenarios. In all simulations, the study allowed 30 percent, 60 percent and 90 percent increase in petroleum price in the first scenario as described earlier.

Assuming that the import and labour prices remain unchanged, the result of the domestic petroleum price shocks in the first simulation shows that the industries have to pay 59 percent, 118 percent and 177 percent higher than the current level cost of production as a result of 30 percent, 60 percent and 90 percent increases in the domestic petroleum price, respectively. This implies that high impact on the cost of production in industries is due to the domestic petroleum price shocks. The simulation results indicate that the fishing, electricity and gas, forestry and logging products, china, glass and clay products, and oil palm primary products are among the top five industries which are mostly affected by increase in the domestic petroleum price. If the price of petroleum shock increases to 90 percent higher than current price level, the cost of production of these sectors will increase up to 34 percent for fishing; 21 percent for electricity and gas; 20 percent for forestry and logging; 11 percent for both china, glass and clay products, and oil palm primary products.

In the second simulation on imported petroleum price, we assumed that the rest of the sectoral input prices were constant. The results in Table 5 reveals that the effect of imported petroleum price shocks on costs of production is less than the domestic petroleum price shock which was shown in the simulation 1. By allowing 30 percent, 60 percent and 90 percent increases in the imported petroleum price, the result shows that the industrial costs of production will increase up to

**Table 4**
Index of Costs of Production as a Result of Changes in the Petroleum Price

| Industries | Simulation I | | | Simulation II | | | Simulation III | | |
|---|---|---|---|---|---|---|---|---|---|
| | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 1 | Scenario 2 | Scenario 3 |
| 1. Agriculture primary prod. | 0.0526 | 0.0530 | 0.0534 | 0.0525 | 0.0529 | 0.0533 | 0.0530 | 0.0538 | 0.0545 |
| 2. Rubber primary products | 0.1163 | 0.1171 | 0.1179 | 0.1167 | 0.1179 | 0.1190 | 0.1175 | 0.1194 | 0.1214 |
| 3. Oil palm primary products | 0.1057 | 0.1094 | 0.1132 | 0.1029 | 0.1039 | 0.1049 | 0.1067 | 0.1114 | 0.1161 |
| 4. Livestock, etc. | 0.1196 | 0.1201 | 0.1206 | 0.1194 | 0.1196 | 0.1199 | 0.1199 | 0.1206 | 0.1213 |
| 5. Forestry and logging prod. | 0.0252 | 0.0267 | 0.0282 | 0.0246 | 0.0255 | 0.0264 | 0.0261 | 0.0285 | 0.0310 |
| 6. Fishing | 0.0924 | 0.1019 | 0.1114 | 0.0838 | 0.0846 | 0.0854 | 0.0932 | 0.1035 | 0.1138 |
| 7. Crude petrol, natural gas | 0.0065 | 0.0065 | 0.0065 | 0.0065 | 0.0065 | 0.0065 | 0.0065 | 0.0065 | 0.0066 |
| 8. Other mining | 0.1851 | 0.1905 | 0.1958 | 0.1825 | 0.1853 | 0.1881 | 0.1879 | 0.1960 | 0.2041 |
| 9. Meat and dairy products | 0.2222 | 0.2228 | 0.2233 | 0.2256 | 0.2296 | 0.2335 | 0.2262 | 0.2307 | 0.2352 |
| 10. Preserved food | 0.5151 | 0.5162 | 0.5173 | 0.5360 | 0.5579 | 0.5798 | 0.5371 | 0.5601 | 0.5830 |
| 11. Oils and fats | 0.0228 | 0.0231 | 0.0235 | 0.0225 | 0.0226 | 0.0227 | 0.0229 | 0.0233 | 0.0237 |
| 12. Grain mills products | 0.3957 | 0.3972 | 0.3987 | 0.3949 | 0.3957 | 0.3965 | 0.3964 | 0.3987 | 0.4010 |
| 13. Bakery and confectionary | 0.2681 | 0.2689 | 0.2698 | 0.2729 | 0.2786 | 0.2842 | 0.2737 | 0.2802 | 0.2867 |
| 14. Other foods | 0.1099 | 0.1105 | 0.1111 | 0.1100 | 0.1106 | 0.1113 | 0.1106 | 0.1118 | 0.1131 |
| 15. Beverages | 0.2833 | 0.2839 | 0.2845 | 0.2838 | 0.2850 | 0.2861 | 0.2844 | 0.2862 | 0.2880 |
| 16. Textile products | 0.0792 | 0.0796 | 0.0799 | 0.0802 | 0.0815 | 0.0828 | 0.0805 | 0.0821 | 0.0838 |
| 17. Wearing apparels | 0.0943 | 0.0944 | 0.0944 | 0.0950 | 0.0957 | 0.0965 | 0.0950 | 0.0958 | 0.0966 |
| 18. Wooden products | 0.0476 | 0.0479 | 0.0483 | 0.0476 | 0.0479 | 0.0483 | 0.0479 | 0.0486 | 0.0494 |
| 19. Furniture | 0.1192 | 0.1194 | 0.1196 | 0.1193 | 0.1196 | 0.1199 | 0.1195 | 0.1201 | 0.1206 |
| 20. Paper and printing prod. | 0.0531 | 0.0535 | 0.0539 | 0.0531 | 0.0536 | 0.0540 | 0.0535 | 0.0544 | 0.0552 |
| 21. Chemical products | 0.0285 | 0.0291 | 0.0297 | 0.0280 | 0.0282 | 0.0284 | 0.0287 | 0.0295 | 0.0303 |
| 22. Petrol products | 0.0244 | 0.0250 | 0.0257 | 0.0239 | 0.0240 | 0.0241 | 0.0245 | 0.0252 | 0.0259 |
| 23. Rubber products | 0.0846 | 0.0853 | 0.0860 | 0.0849 | 0.0859 | 0.0869 | 0.0856 | 0.0873 | 0.0891 |
| 24. Plastic products | 0.0719 | 0.0721 | 0.0722 | 0.0729 | 0.0741 | 0.0752 | 0.0731 | 0.0744 | 0.0757 |
| 25. China, glass and clay prod. | 0.1100 | 0.1140 | 0.1180 | 0.1065 | 0.1070 | 0.1075 | 0.1105 | 0.1150 | 0.1195 |
| 26. Cement, lime and plaster | 0.2945 | 0.3009 | 0.3074 | 0.2983 | 0.3086 | 0.3189 | 0.3048 | 0.3215 | 0.3383 |
| 27. Other non-metal products | 0.2273 | 0.2287 | 0.2301 | 0.2302 | 0.2344 | 0.2387 | 0.2315 | 0.2372 | 0.2428 |
| 28. Metal products | 0.0271 | 0.0271 | 0.0272 | 0.0272 | 0.0274 | 0.0276 | 0.0273 | 0.0275 | 0.0278 |
| 29. Non-electrical machinery | 0.0095 | 0.0095 | 0.0095 | 0.0095 | 0.0096 | 0.0096 | 0.0095 | 0.0096 | 0.0096 |
| 30. Electrical machinery | 0.0052 | 0.0052 | 0.0052 | 0.0052 | 0.0052 | 0.0052 | 0.0052 | 0.0052 | 0.0052 |
| 31. Transport equipment | 0.0421 | 0.0421 | 0.0422 | 0.0421 | 0.0421 | 0.0422 | 0.0421 | 0.0422 | 0.0423 |
| 32. Other manufacturing prod. | 0.0538 | 0.0539 | 0.0540 | 0.0541 | 0.0544 | 0.0548 | 0.0542 | 0.0546 | 0.0550 |
| 33. Electricity and gas | 0.0251 | 0.0267 | 0.0283 | 0.0235 | 0.0236 | 0.0237 | 0.0251 | 0.0268 | 0.0285 |
| 34. Water | 0.2603 | 0.2614 | 0.2625 | 0.2592 | 0.2592 | 0.2592 | 0.2603 | 0.2614 | 0.2625 |
| 35. Buildings and construction | 0.0154 | 0.0154 | 0.0155 | 0.0154 | 0.0154 | 0.0154 | 0.0154 | 0.0155 | 0.0156 |
| 36. Wholesale and retail trade | 0.0055 | 0.0055 | 0.0055 | 0.0055 | 0.0056 | 0.0057 | 0.0056 | 0.0057 | 0.0057 |
| 37. Hotels and restaurants | 0.0319 | 0.0320 | 0.0322 | 0.0318 | 0.0318 | 0.0318 | 0.0319 | 0.0321 | 0.0322 |
| 38. Transport | 0.0195 | 0.0201 | 0.0208 | 0.0192 | 0.0195 | 0.0198 | 0.0198 | 0.0207 | 0.0216 |
| 39. Communication | 0.0209 | 0.0209 | 0.0210 | 0.0209 | 0.0209 | 0.0209 | 0.0209 | 0.0210 | 0.0210 |
| 40. Financial services | 0.0074 | 0.0074 | 0.0074 | 0.0074 | 0.0074 | 0.0074 | 0.0074 | 0.0074 | 0.0074 |
| 41. Private services | 0.0070 | 0.0070 | 0.0070 | 0.0069 | 0.0070 | 0.0070 | 0.0070 | 0.0070 | 0.0071 |
| 42. Public services | 0.0080 | 0.0080 | 0.0081 | 0.0080 | 0.0080 | 0.0080 | 0.0080 | 0.0080 | 0.0081 |
| 43. Private non-profit services | 0.6869 | 0.6889 | 0.6909 | 0.6855 | 0.6861 | 0.6867 | 0.6875 | 0.6901 | 0.6927 |
| Total | 4.9805 | 5.0290 | 5.0775 | 4.9959 | 5.0598 | 5.1237 | 5.0444 | 5.1568 | 5.2692 |

Source: Computed from equation (3), (4) and (5)

40 percent, 79 percent and 118 percent, respectively. The preserved food, forestry and logging, and cement, lime and plaster are among the industries which are largely affected as a result of an increase in the imported petroleum price.

**Table 5**
Changes in Index of Costs of Production due to Changes in the Petroleum Price (%)

| Industries | Simulation I | | | Simulation II | | | Simulation III | | |
|---|---|---|---|---|---|---|---|---|---|
| | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 1 | Scenario 2 | Scenario 3 |
| 1. Agriculture primary prod. | 0.80 | 1.59 | 2.39 | 0.72 | 1.43 | 2.15 | 1.51 | 3.03 | 4.54 |
| 2. Rubber primary products | 0.68 | 1.36 | 2.04 | 1.01 | 2.02 | 3.04 | 1.69 | 3.38 | 5.08 |
| 3. Oil palm primary products | 3.67 | 7.34 | 11.01 | 0.96 | 1.93 | 2.89 | 4.64 | 9.27 | 13.91 |
| 4. Livestock, etc. | 0.39 | 0.78 | 1.17 | 0.19 | 0.39 | 0.58 | 0.59 | 1.17 | 1.76 |
| 5. Forestry and logging prod. | 6.36 | 12.73 | 19.09 | 3.89 | 7.79 | 11.68 | 10.26 | 20.51 | 30.77 |
| 6. Fishing | 11.45 | 22.90 | 34.34 | 0.97 | 1.94 | 2.91 | 12.42 | 24.83 | 37.25 |
| 7. Crude petrol, natural gas | 0.42 | 0.85 | 1.27 | 0.16 | 0.31 | 0.47 | 0.58 | 1.16 | 1.74 |
| 8. Other mining | 2.97 | 5.95 | 8.92 | 1.53 | 3.06 | 4.59 | 4.50 | 9.01 | 13.51 |
| 9. Meat and dairy products | 0.25 | 0.50 | 0.75 | 1.78 | 3.56 | 5.34 | 2.03 | 4.06 | 6.09 |
| 10. Preserved food | 0.21 | 0.41 | 0.62 | 4.26 | 8.53 | 12.79 | 4.47 | 8.94 | 13.42 |
| 11. Oils and fats | 1.56 | 3.12 | 4.68 | 0.37 | 0.75 | 1.12 | 1.93 | 3.87 | 5.80 |
| 12. Grain mills products | 0.38 | 0.77 | 1.15 | 0.19 | 0.39 | 0.58 | 0.58 | 1.15 | 1.73 |
| 13. Bakery and confectionary | 0.32 | 0.63 | 0.95 | 2.12 | 4.23 | 6.35 | 2.43 | 4.86 | 7.30 |
| 14. Other foods | 0.54 | 1.09 | 1.63 | 0.62 | 1.23 | 1.85 | 1.16 | 2.32 | 3.49 |
| 15. Beverages | 0.22 | 0.44 | 0.66 | 0.41 | 0.82 | 1.23 | 0.63 | 1.26 | 1.89 |
| 16. Textile products | 0.42 | 0.83 | 1.25 | 1.63 | 3.27 | 4.90 | 2.05 | 4.10 | 6.15 |
| 17. Wearing apparels | 0.06 | 0.13 | 0.19 | 0.78 | 1.56 | 2.34 | 0.84 | 1.68 | 2.53 |
| 18. Wooden products | 0.74 | 1.49 | 2.23 | 0.78 | 1.56 | 2.34 | 1.52 | 3.04 | 4.57 |
| 19. Furniture | 0.18 | 0.36 | 0.54 | 0.26 | 0.53 | 0.79 | 0.44 | 0.88 | 1.33 |
| 20. Paper and printing product | 0.74 | 1.47 | 2.21 | 0.82 | 1.64 | 2.46 | 1.56 | 3.11 | 4.67 |
| 21. Chemical products | 2.25 | 4.50 | 6.74 | 0.70 | 1.41 | 2.11 | 2.95 | 5.90 | 8.85 |
| 22. Petrol products | 2.66 | 5.32 | 7.98 | 0.39 | 0.78 | 1.17 | 3.05 | 6.11 | 9.16 |
| 23. Rubber products | 0.84 | 1.68 | 2.53 | 1.23 | 2.45 | 3.68 | 2.07 | 4.14 | 6.20 |
| 24. Plastic products | 0.22 | 0.43 | 0.65 | 1.61 | 3.23 | 4.84 | 1.83 | 3.66 | 5.49 |
| 25. China, glass and clay prod. | 3.79 | 7.58 | 11.36 | 0.49 | 0.98 | 1.46 | 4.28 | 8.55 | 12.83 |
| 26. Cement, lime and plaster | 2.25 | 4.49 | 6.74 | 3.58 | 7.16 | 10.74 | 5.83 | 11.66 | 17.48 |
| 27. Other non-metal products | 0.61 | 1.23 | 1.84 | 1.88 | 3.76 | 5.64 | 2.49 | 4.99 | 7.48 |
| 28. Metal products | 0.29 | 0.59 | 0.88 | 0.74 | 1.48 | 2.22 | 1.04 | 2.07 | 3.11 |
| 29. Non-electrical machinery | 0.06 | 0.13 | 0.19 | 0.23 | 0.47 | 0.70 | 0.30 | 0.59 | 0.89 |
| 30. Electrical machinery | 0.06 | 0.12 | 0.19 | 0.11 | 0.23 | 0.34 | 0.18 | 0.35 | 0.53 |
| 31. Transport equipment | 0.10 | 0.20 | 0.31 | 0.10 | 0.20 | 0.30 | 0.20 | 0.41 | 0.61 |
| 32. Other manufacturing prod. | 0.14 | 0.28 | 0.42 | 0.67 | 1.33 | 2.00 | 0.81 | 1.61 | 2.42 |
| 33. Electricity and gas | 6.92 | 13.85 | 20.77 | 0.29 | 0.58 | 0.87 | 7.22 | 14.43 | 21.65 |
| 34. Water | 0.42 | 0.84 | 1.27 | 0.00 | 0.01 | 0.01 | 0.43 | 0.85 | 1.28 |
| 35. Buildings and construction | 0.32 | 0.65 | 0.97 | 0.29 | 0.59 | 0.88 | 0.62 | 1.24 | 1.85 |
| 36. Wholesale and retail trade | 0.34 | 0.69 | 1.03 | 1.40 | 2.80 | 4.20 | 1.74 | 3.49 | 5.23 |
| 37. Hotels and restaurants | 0.39 | 0.78 | 1.16 | 0.02 | 0.05 | 0.07 | 0.41 | 0.82 | 1.23 |
| 38. Transport | 3.31 | 6.63 | 9.94 | 1.56 | 3.12 | 4.67 | 4.87 | 9.74 | 14.61 |
| 39. Communication | 0.08 | 0.16 | 0.24 | 0.06 | 0.12 | 0.18 | 0.14 | 0.28 | 0.43 |
| 40. Financial services | 0.01 | 0.02 | 0.03 | 0.01 | 0.02 | 0.03 | 0.02 | 0.04 | 0.07 |
| 41. Private services | 0.52 | 1.04 | 1.57 | 0.33 | 0.65 | 0.98 | 0.85 | 1.70 | 2.55 |
| 42. Public services | 0.59 | 1.18 | 1.77 | 0.04 | 0.07 | 0.11 | 0.63 | 1.26 | 1.88 |
| 43. Private non-profit services | 0.29 | 0.58 | 0.87 | 0.09 | 0.18 | 0.26 | 0.38 | 0.75 | 1.13 |
| Total | 58.85 | 117.70 | 176.55 | 39.30 | 78.60 | 117.89 | 98.15 | 196.30 | 294.45 |

Source: Computed from Table 3 and 4.

On the other hand, the result of simulations show that the industrial costs of production increase drastically if we allow for increasing in both domestic and imported petroleum prices in the third simulation. If the prices of petroleum (both domestic and imported) increase up to 90 percent higher than the current level, the industrial costs of

production in the economy will increase up to 295 percent. The fishing, forestry and logging products, electricity and gas, cement, lime and plaster, and transport are among the top five industries most affected by the increase in the domestic petroleum price.

The industries which have experienced large effect as a result of an increase in the cost of production are mainly due to interdependencies among industries. These sectors use petroleum products substantially as an intermediate input that is bought from the petroleum product sector, which constitutes higher proportion of total intermediate cost. Since these sectors are relatively more reliant on petroleum products, therefore an increase in petroleum price would cause an immediate impact on their production costs. On the other hand, some of the industries are not much affected by the price shock because they relatively use less petroleum products as an intermediate input in their production process such as the livestock, furniture, and water industries.

## CONCLUSIONS

This paper has analysed the impact of an increase in the domestic and imported petroleum prices on the costs of production in the Malaysian production sector. Since it employs the input-output model as its basic framework, the study takes into account the inter-industry relationships in calculating the sectoral costs of production. The results indicated that without the government interventions, fishing, forestry and logging products, electricity and gas, cement, lime and plaster, and transport will mostly be affected by the increase in the petroleum price. These sectors are known to rely heavily on petroleum products as an intermediate input.

The results also show that impact due to petroleum price shocks on agricultural sub-sectors of fishing and logging products is high. Since this sector is given special emphasis under the Ninth Malaysia Plan (2006-2010), a special programme or strategy needs to be formulated to ensure its success. Given the challenging economic conditions, the government needs appropriate information to evaluate their programme or policy that can realise its aspiration to modernise the agricultural sector.

The paper also found that the effect on costs of production is largely attributed to the increase in domestic petroleum price rather than imported petroleum price. Therefore, the sector which highly depends on the domestic material inputs in the production cost structure will

mostly be affected by the increase in petroleum price. In addition, this study also can provide the information to the policy makers or the government in identifying the industries which would be hit hardest by the domestic petroleum price rise.

## END NOTE

[1] Joule is the unit of energy to establish the equivalent physical heat content of each energy form. One metajoule = $10^6$ joules, one gigajoule (GJ) = $10^9$ joules and one petajoules (PJ) = $10^{15}$ joules and one PJ = 0.0239 million tones of oil equivalent (mtoe).

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## APPENDIX 1

### Cost of Domestic Materials

Let $A$ be the Malaysian 2000 43rd order square coefficient matrix whose elements $a_{ij}$ being the amounts of output of sector $i$ used by sector $j$ in order to produce one unit of sector $j$ output. Let us further suppose that $P$ is the column vector of producer price indices of domestic materials of whose elements $p_{tj}$ being the price index domestic material of base year in sector $j$.

The per unit cost of each sector of the economy can then be represented as:

$$P.\ A \tag{A1}$$

The elements of $P.A$ matrix show the annual costs of production for each of the $n$ sectors. By multiplying the column vector of $P$, we get the cost of sector $j$ per unit of its output in base year , this is expressed as;

$$\sum_j P_j a_{ij} \tag{A2}$$

Cost of Imported Inputs

The import coefficient ${}^{m}a_{ij}$ represents the amount of imported input of sector $i$ purchased by sector $j$ in order to produce one unit of output. When multiplied by the import price of sector $j$ would give the value of imported output of sector $i$ purchased by sector $j$ for each unit of sector $j$ output. Therefore the total cost of imported inputs in year $t$ for producing one unit of $j$ output is the column sum of all the value of imported inputs for each unit sector $j$ output.

$$\sum_j {}^{m}P_j {}^{m}a_{ij} \tag{A3}$$

### Cost of Labour

The costs of labour input is treated separately because the labour coefficient, unlike other two cost items, is represented as a vector because labour cannot be distinguished by sectors. $L_j$ is the labour coefficient representing the amount of salaries and wages paid to produce one unit of sector $j$ output. The annual wage rate $w_j$ gives us the value of labour used in order to produce one unit of sector $j$. When sectoral wage rate is multiplied by the labour coefficients, it will give

the value of labour used in order to produce one unit of the sectoral output, or simply called labour costs.

$$w_j L_j \tag{A4}$$

In matrix notation, the annual cost of labour for each the $n$ sector for the entire period by multiplying the column vector of the labour coefficient by the matrix of indices of wage rate, that is:

$$L.W \tag{A5}$$

Where L = column vector $[L_{ij}]$ and

$W = [w_{ij}]$