Jurnal Ekonomi Malaysia 28 (1994) 39 – 55

Economic Impact of Oil Trade in a Developing Country: An Empirical Investigation of Consequences of Recent Gulf Crisis in Malaysia

Zakariah Abdul Rashid
Mohd. Shahwahid Haji Othman

ABSTRACT

Petroleum-based industry has become significant to the Malaysian economy since the early seventies. It is now one of the key industries in the economy. The economy's export ratio of oil quadrupled to 16 percent in 1988 from 4 percent in 1974. The country is now a net exporter of oil and gas but a net importer of petroleum products. This paper attempts to present the results of our empirical inquiry into the impact of an increase in oil price to the economy. Using the inter-industry input-output model, the paper found that the net effect of an increase in oil surplus and a deficit in petroleum products trade provides strong potential for expanding output and employment.

ABSTRAK

Industri berasaskan petroleum sangat penting kepada ekonomi Malaysia semenjak awal tujuhpuluhan lagi. Ia kini merupakan salah satu daripada industri utama dalam ekonomi. Nisbah eksport minyak ekonomi ini meningkat empat kali ganda kepada 16 peratus dalam tahun 1988 daripada 4 peratus dalam tahun 1974. Negara ini kini merupakan pengeksport bersih minyak dan gas tetapi pengimport bersih barangan petroleum. Kertas kajian ini cuba membentangkan hasil kajian empirik tentang kesan peningkatan harga minyak ke atas ekonomi negara ini. Dengan menggunakan model input-output, kertas kajian ini mendapati bahawa kesan bersih peningkatan dalam lebihan dagangan minyak dan deficit dagangan barangan petroleum menawarkan potensi yang kukuh kepada pengembangan output dan gunatenaga.

INTRODUCTION: OIL AND GAS SCENE

Malaysia is fortunate to be blessed with generous energy resources such as oil, gas, coal and hydro power; of which oil is the most important. The total proven reserves of oil as of December 1988 was about 3.05 billion barrels, one-half of which is found in Peninsular Malaysia and the remaining, is mostly found in Sarawak. With a production rate of 500,000 barrels per day (b/d), the reserve can last, if no new reserve is discovered, up to the year 2005.

In 1988, exports of crude petroleum, refined petroleum and other petroleum products were valued at $6128.7 million, $680.6 million and $11.3 million whereas in 1981, they were at $6921.4 million, $225.0 million and $0.4 million respectively. The decline in the export value of crude petroleum is followed by an increase in the volume of its export, reflecting a fall in the world price of crude in this period (Table 1). On the other hand, the rapid growth of export in terms of both value and volume in those of refined petroleum and other petroleum products is due to a strong domestic demand.

TABLE 1. Export of crude petroleum and petroleum products in 1981 and 1988*

	1988		1981	
	RM mil	tonne	RM mil	tonne
Crude Petroleum	6,128.7	19,927,221	6,921.4	10,143,173
Refined Petroleum Product	680.6	(b)	225.0	(b)
Residual Petroleum Products	11.3	22,260	0.4	474
Total	6,820.6	23,635,037	7,146.8	23,168,883

Source: External Trade Statistic, 1981 & 1988, Department of Statistics, Malaysia.
Note: *Producer Price Index for SITC 33 (Petroleum, petroleum products & related materials) dropped from 170.4 in 1981 to 118 in 1988.

The economy's production of crude oil is mainly for export, accounting for more than 70 percent of total production. The attraction for export is due to the fact that the country's crude which is superior in quality with low sulphur content (i.e. sweet and light variety) fetches premium price compared to the world crude. Furthermore, 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 crudes. For example, in 1986, only 68 percent of refining activities used local crude whereas in 1990 the proportion of local crude refined has increased to more than 88 percent (Figure 1).

While the national petroleum company, Petronas, imports heavier crudes to run its refineries, Shell is completing the upgrading of its Port Dickson refinery to enable it to run entirely on domestic crudes. Petronas has refinery capacity of 300,000 b/d (Terengganu) and Esso and Shell have capacities of 47,300 and 90,000 b/d (Port Dickson) respectively (Table 2). Shell has also another 45,000 b/d refinery capacity at Lutong in Sarawak. Petronas is planning to have another refinery plant (located in Melaka) which is expected to begin operations in 1994. Initially, the Melaka plant will have a processing capacity of 100,000 b/d, which will be expanded to 230,000 b/d at the end of the country. The plant will process both local sweet and Gulf sour crudes. By the turn of the century, the country would be having a total processing capacity of nearly one-half billion b/d.

Natural gas is the main alternative source of energy to oil and has a proven reserve three times than that of oil. Natural gas reserve is estimated at about 1,500 billion cubic meters or 9.5 billion of oil equivalent (boe).[1] Oil has become the major source of foreign exchange and it exports contributed 11 percent to GDP during the first-half of 1980s but fell to 7 percent during the 1986-88 period. Fluctuation in oil prices has caused significant changes in earnings from export of oil which contributed one-quarter to total export earnings in 1982. The earnings, however, fell to one-tenth in 1988 because of the 60 percent fall in oil prices.

Malaysia is the Far East's fifth largest crude oil producer, after China, Indonesia, India and Australia. While new discoveries are likely to be made, the current proven oil reserves in the country are still worrying for a nation so dependent on export revenues of oil

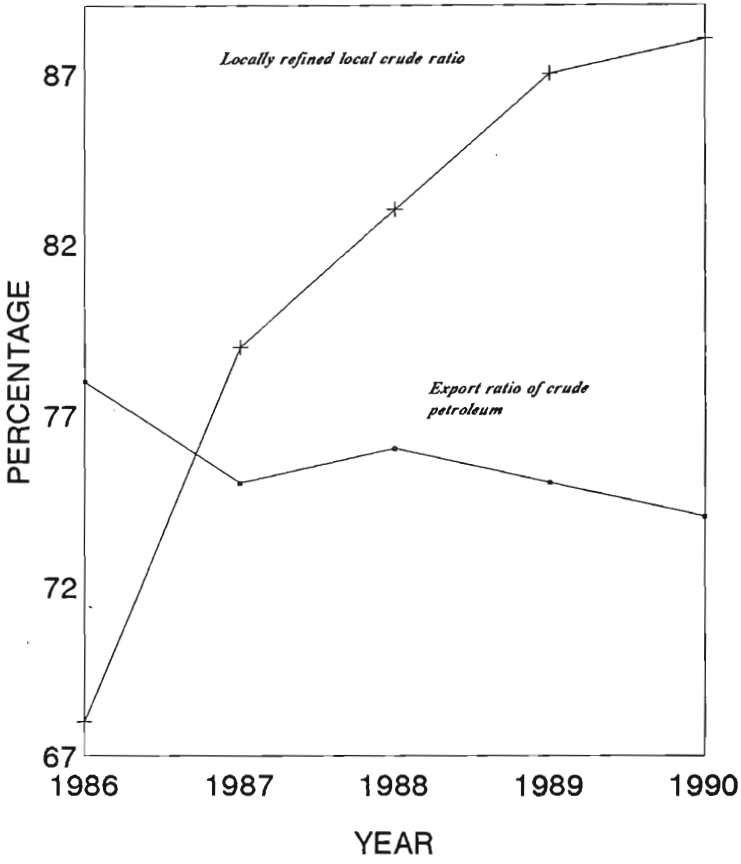

FIGURE 1.
Export ratio of crude petroleum and locally refined local crude ratio

TABLE 2. Refinery Plants in Malaysia

Operator	Location	Capacity	Start operation	Crude type
Shell	Lutong	45,000	1917	local
ESSO	Port Dickson	49,000	1960	local and Mid. East
Shell	Port Dickson	90,000	1963	local and Mid. East
Petronas	Kertih	30,000	1983	local

Source: Petronas, Malaysia's Petroleum Industry, 1991.

and consuming about 170,000 b/d to meet the bulk of its domestic energy requirements. The first estimate of current proven oil reserve which was reported by Petronas was put at 3.1 billion barrels was revised to 2.9 billion barrels (Hough 1988). The decline in oil and commodity prices which domestically reduced the national revenue has made the natural gas as a cheap and competitive fuel and also brought the launching of the Peninsular Gas Utilization (PGU) project in late 1984. The policy behind the project was to maximize the use of indigenous gas which has reserves of 9.5 billion boe and sufficient to last over 100 years at current production rate.

Production of natural gas comes from 34 oil and gas fields offshore Terengganu, Sarawak and Sabah; some 88 percent being associated gas. The second stage of the Peninsular Gas Utilization project (PGU II) requires the construction of 726 km. of pipeline to bring natural gas from Terengganu in the east coast of peninsular Malaysia to power stations, industries and homes on the west coast, then continuing to Johor and Singapore.

OIL AND PETROLEUM PRODUCTS TRADES

The petroleum-based industries have become significant to the Malaysian economy since early Seventies. It is now one of the key industries in the economy. The export ratio of crude petroleum quadrupled to 16 percent in 1988 from a mere 4 percent in 1974. In 1988, RM 6128 million and RM 408 million of crude petroleum

and other crude oils obtained from bituminous minerals were exported and imported respectively. The corresponding value of export and import of refined petroleum products were RM 680 million and RM 1651 million. In addition, RM 1836 million of natural gas (whether or not liquefied) were exported and RM 158 million of liquefied propane and butane and petroleum gases and other hydrocarbon gases were imported. These figures show that the country is the net exporter of crude petroleum and natural gas and the net importer of petroleum products.

Economic forecasts of growth in industrialized countries are influenced by changes in the world prices of oil. According to the World Economic Outlook (1990), the real growth rates of those countries have to be adjusted downwardly by 0.3 percent for every US$7 increase in the oil price. As an open small economy which exports its commodities to the industrialized countries, Malaysia's growth performance will certainly be influenced by that of the industrialized countries. Furthermore, oil and gas exports contribute significantly to the GDP and foreign exchange and petroleum products imports provide all the necessary industrial inputs of the economy.

This paper attempts to present the results of our empirical inquiry into the economic impact of production, export and import of petroleum products (crude petroleum and petroleum products industries) to the Malaysian economy. Based on the 1983 inter-industry table of Malaysia, it is found that crude petroleum is mainly exported (more than one-half) and another one-third of its production is consumed locally by petroleum product and basic metal industries. Products of petroleum, on the other hand, is mainly consumed locally by electricity, transportation and household sectors which as a group absorbs nearly one-half of the total production.

Similarly, while the production of crude petroleum depends on the output of petroleum products and transportation industries as its main intermediate inputs (respectively represent 16 percent and 31 percent of the total intermediate inputs), the production of petroleum products appear to be too dependent on the output of crude petroleum which comprises nearly 90 percent of the total intermediate input. The above inter-industry relationship sets out that both the crude petroleum and the petroleum products sectors

are linked technologically (directly and indirectly) to the rest of the economy.

MODELS AND RESULTS

Linkage Effects The expansion of an industry not only generates demand for its inputs, but also induces the expansion of industries which use the commodities produced as inputs. The connection with supplier industries is called backward linkage and that with user industries is called forward linkage. The column sum of elements of the Leontief inverse matrix for any industry, say industry *j*, is given by:

$$\sum_{i=1}^{40} b_{ij} \qquad j = 1, 2, 3....., 40 \tag{1}$$

which measures the total input requirements for a unit increase in the final demand for the j^{th} industry. The elements of the jth column of the Leontief inverse matrix $(I–A)^{-1}$, measure the total, direct and indirect, production from all industries generated by one unit of final demand for the output of the jth industry. For comparative purposes, it is the relative magnitude of the above measure which is important, and the measure can be normalised as:

$$\frac{\frac{1}{n}\sum_{i=1}^{40} b_{ij}}{\frac{1}{n^2}\sum_{ij}^{40} b_{ij}} \tag{2}$$

This measure, which is independent of the unit of measurement is called an index of backward linkage and would indicate high backward linkage, in the sense of generating above-average response in other sectors if its value is greater than one.

Similarly, the row sum of the elements of the matrix for, say industry i, is given by:

$$\sum_{j=1}^{40} b_{ij} \qquad i = 1, 2, 3, ..., 40 \tag{3}$$

which measures the increase in the output of the i^{th} industry required to satisfy a unit increase in the final demand of all the industries. The elements of the i^{th} row of the Leontief inverse matrix measure the total output of the i^{th} industry generated by one unit of final demand in each of the industry, including the i^{th} industry. Again, this measure can be normalised as:

$$\frac{\frac{1}{n}\sum_{i=1}^{40} b_{ij}}{\frac{1}{n^2}\sum_{ij}^{40} b_{ij}} \tag{4}$$

and this is called an index of forward linkage. This index with a value of greater than one indicates high forward linkage, in the sense that these sectors display above-average dependence on the output of other sectors.

By using the 1983 inter-industry table of Malaysia, (Table 3) although the petroleum mining industry does not have a strong backward linkage, it has a strong forward linkage with the rest of the economy. From a forty-sector economy of Malaysia, the petroleum mining and manufacture of petroleum products respectively ranked at 37 and 15 in the descending scale of backward linkage. Meat and dairy products, other food production, bakery and confectionery, food canning and leather product industries ranked first five where backward linkages are concerned, with food and beverage manufacturing industry scoring the highest index, indicating its close connection with its supplier industries. Even though Malaysia has had a long history of petroleum development and exploration which commenced at the turn of the century, it was only in the mid-1970s that the large scale offshore crude oil production starts to find its effect.

Petroleum mining and refining activities involve highly specialized and capital intensive machinery (UNIDO 1992) which are imported from industrialized countries. The industries rely heavily and employ a relatively large number of expatriates who are trained specially to operate the machines (*Nada Petronas* 1989). Such a phenomenon contributes to the lack of technological linkage from domestic supply industries.

The petroleum-based industries, however, appear to have strong forward linkage which may induce expansionary activities in the

TABLE 3. Sectoral linkage indices of the Malaysian economy, 1983

Sector	Backward Linkage		Forward Linkage	
	Index	Rank	Index	Rank
Agr. & livestock	1.032	16	1.583	5
Plant. crops	0.750	38	1.205	8
Forestry & Log' g	0.821	35	0.955	15
Fishing	0.724	40	1.083	11
Mining, inc. oil	0.763	37	1.699	4
Meat & Diary prd.	1.474	1	0.840	22
Food canning	1.282	4	0.647	39
Bakery & conf.	1.295	3	0.654	35
Other food prd.	1.423	2	2.058	2
Beverages	1.077	11	0.679	33
Tobacco Prd.	0.891	29	0.654	38
Textiles	1.154	7	0.994	13
Wearing apparel	0.949	23	0.667	34
Leather prd.	1.218	5	0.654	36
Wood prd.	1.147	8	0.846	21
Paper & publish.	0.917	25	0.968	14
Chemicals	0.981	19	1.179	9
Petroleum prd.	1.038	15	1.538	6
Rubber prd.	1.064	12	0.769	26
Glass & clay prd.	1.019	17	0.731	28
Other non-metals	1.006	18	0.897	19
Metal prd.	1.083	10	1.122	10
Non-electric mech.	0.949	22	0.833	23
Electric mech.	0.859	31	0.763	27
Transport equip.	0.827	34	0.904	17
Other manuf. prd.	0.929	24	0.705	31
Water, gas & elec.	1.058	14	1.359	7
Construction	1.109	9	0.872	20
Wholesale & retail	0.891	30	2.333	1
Hotel & restaurant	1.199	6	0.904	18
Land transport.	1.058	13	1.032	12
Water transport.	0.904	26	0.910	16
Air transport.	0.904	27	0.788	25
Communication	0.744	39	0.827	24
Buss. services	0.795	36	1.827	3
Pte. services	0.904	28	0.641	40
Cultural services	0.955	21	0.712	30
Motor repair	0.981	20	0.731	29
Personal services	0.846	33	0.654	37
Govern. services	0.846	32	0.679	32

Source: Computed from the models

refining of crudes, energy generation, transportation and manufacture of petrochemical products. The table shows that, respectively, petroleum mining and petroleum products industries ranked at fourth after wholesale and retail trade, other food products and business services and sixth after agriculture and livestock in the descending scale of forward linkage. The direct backward and forward linkages of petroleum mining and petroleum product industries - suppliers of their inputs and purchasers of their outputs - are discussed in Section II. The direct backward linkage is obtained by looking at the amount of output from supplier industries required for one unit of its total intermediate input; whereas the direct forward linkage is obtained by looking at the amount of its output purchased by other industries for one unit of its total intermediate output.

The Peninsular Gas Utilization II project, launched in the late 1984 to pipe natural gas from Terengganu in the east coast of Peninsula Malaysia to power stations, industries and homes on the west coast and continuing to Johor and Singapore, provides a good potential of forward linkages between petroleum-based industries with the rest of the economy. Petronas' plans of establishing the LPG-based petrochemical complex producing propylene, polypropylene, methyl tertiary butyl ether (MTBE) and ethane-based petrochemical complex producing ethylene and polyethylene is an few example of potential forward linkages.

OUTPUT AND EMPLOYMENT GENERATION

The potential contribution of the expansion in net export of crude oil and gas and in net import of petroleum products to the sectoral gross output and employment can be delineated by the following expression: If we let be the change in the net export of crude oil and gas and be the change in the net import of petroleum products, the potential contribution of those changes to the sectoral output can be shown as:

$$(X_i) = (I - A)^{-1}(\triangle X) \tag{5}$$

where (x_i) is the column vector of sectoral output. $(I - A)^{-1}$ is the Leontief inverse matrix and $(\triangle x)$ is the column vector whose elements are δ, λ and zero elsewhere.

The potential contribution of changes in net export of oil and gas and in net import of petroleum products to employment creation for sector i can be calculated by the following expression:

$$(6) \qquad \eta_i(\delta b_{m,i} + \lambda b_{p,i}), \qquad i = 1, 2, 3, ..., 40$$

where η is the employment coefficient, b is the element in the Leontief inverse matrix which can interpreted as the employment partial multiplier and the subscripts m and p represent the petroleum mining and petroleum products sectors respectively. Such a comparative-static analysis of input-output model seems to be quite useful as a tool of indicating the direct and indirect output and labour requirements as a result of a change in the world price of oil. It is worth reemphasising that the above model is based on the static input-output framework, in the sense that the sectoral output and employment required to support the exogenuous change in trades are exclusive flow requirements. Apart from these requirements each sector has to carry stocks which consist of buildings, machinery and other fixed assets, as well as stocks of raw materials, goods in process and finished goods, in order to carry on production. Furthermore, the change in trades has to be permenant before any new investment in stocks can be justified and the impact on sectoral output and employment requires some time lapse.

We have compiled 1990 monthly figures for exports and imports of Malaysia's crude oil and gas and petroleum products; and calculated average net exports of crude oil and gas and average net imports of petroleum products due to the Gulf crisis (The crisis started in the 2nd day of August, 1990).[2] Table 4 shows that average monthly net export of crude oil and gas in the first seven months of the year was RM 634 thousand while that of the last five months was RM 1.129 million, giving an increase in the net export of crude oils and gas due to the crisis of RM 495 thousand, (δ) or equivalent to 78 percent. Similarly, an average monthly net import of petroleum products in the first seven months was RM 123 thousand while that of the last five months was RM 166 thousand, giving an increase in the net import of petroleum products due to the crisis of RM 43 thousand, (λ) or equivalent to 35 percent.

The impact of change in oil price on the economy is working through the economy's export and import of crude oils and petroleum products. The above trade figures show how the increase in world price of oils following the Gulf Crisis has resulted in an

TABLE 4. Average monthly net exports and imports of crude oils and petroleum products, 1990

($ '000)

	Before Gulf Crisis	After Gulf Crisis	Difference Values	Difference %
Net exports of crude oils	633.89	1129.44	495.55	78.18
Net imports of petroleum products	123.16	166.19	43.03	34.94

Sources: External Trade Statistics (Monthly), 1990.

increase in not only export of crude oils and gas (because the country is the net exporter of the commodity) but also import of petroleum products (because the country is the net importer of the commodity). As a small open economy, as part of the final demand, export and import would certainly have significant influence on the economy's sectoral output and employment. Our model for estimating the potential effects of change in oil trade on output (equation (5)) and employment (equation (6)) is based on the Leontief inverse matrix's coefficient which can be interpreted as the partial multiplier with respect to output and employment.

That the economy experienced an increase in both net export of crude oil and gas and in net import of petroleum products has certainly brought, directly and indirectly, mixed effects to the economy. While the increase in net export of oil and gas yields a favourable increase in sectoral output, as a leakage, the increase in net import in petroleum products, on the other hand, gives a negative impact to the changes in sectoral output. As indicated by the above figures, since the surplus of oil and gas trade is larger than the deficit in the petroleum products trade, except for the petroleum product industry itself, the overall impact to the rest of the sectors shows good potential for output expansion. Certainly, across the sectors of the economy the biggest share of potential output expansion comes from oil and gas output itself which may contribute more than 90 percent, while slightly more than 3 percent comes from 'output' of water transportation services, possibly through the services of tankers and barges bringing oil and gas in shore (Table 5).

TABLE 5. Effect of crude oil and petroleum products trades on sectoral output and employment due to 1990 Gulf crisis

Sector	Total Effect on	
	Output ($)	Employment
Agr. & livestock	4448	711.6
Plant. crops	4499	1407.3
Forestry & Log' g	3904	40.6
Fishing	3361	155.6
Mining, inc. oil	5825893	41946.4
Meat & Diary prd.	2224	15.8
Food canning	0	0
Bakery & conf.	0	0
Other food prd.	4939	152.1
Beverages	0543	0.9
Tobacco Prd.	0	0
Textiles	543	7.5
Wearing apparel	543	8.5
Leather prd.	0	0
Wood prd.	7369	215.9
Paper & publish.	8145	17.9
Chemicals	17275	32.9
Petroleum prd.	-368231	-220.9
Rubber prd.	9102	135.6
Glass & clay prd.	1681	2.0
Other non-metals	5870	58.7
Metal prd.	32248	354.7
Non-electric mech.	36588	80.5
Electric mech.	5094	130.4
Transport equip.	8947	38.5
Other manuf. prd.	543	9.2
Water, gas & elec.	83650	1020.5
Construction	36639	2707.7
Wholesale & retail	88364	9189.8
Hotel & restaurant	19083	719.4
Land transport.	29892	1392.9
Water transport.	214793	257.8
Air transport.	47189	51.9
Communication	9438	27.4
Buss. services	122461	24.5
Pte. services	0	0
Cultural services	543	0.4
Motor repair	12360	325.1
Personal services	543	13.7
Govern. services	1681	301.0
	6282200	61334

Source: Computed from the models

Our results also show that changes in the trade patterns of petroleum-based industries do not affect, directly and indirectly, food canning, bakery and confectionery, tobacco products, leather products and private services industries. Separating the indirect from direct effects of the changes in trades on the petroleum mining and petroleum products industries, the indirect effect contributes more than 90 percent of the total output expansion.[3] On the labour market, as shown in the table, the increase in both net export of oil and gas and net import of petroleum products have the potential of creating new employment not only in the petroleum mining sector (about 42 000 jobs), but also in the industries such as wholesale and retail trades (about 9000 jobs), construction (about 2700 jobs), land transportation (about 1400 jobs), gas and .pn19 electricity (about 1000 jobs) and plantation crops (about 1400 jobs). These figures represent the potential job created due to the Gulf crisis of 1990, or additional requirements of output and employment to support the increase in trade. Whether the labour market will respond to the requirements depend on whether the surplus in oil trade is going to be permanent or otherwise. As we know, the Gulf crisis was temporary and thus the above figures can best serve as output and employment multipliers of any autonomous in change the Final Demand of Mining (petroleum) and petroleum products industries (The 1983 Input-Output Table is used to derived the multipliers and does not explain anything about current labour market).

CONCLUSIONS

Even though Malaysia enjoys a favourable balance of trade in oil, it also experiences a deficit in petroleum products trade; reflecting the peculiar structure of the country's petroleum-based industries. This phenomenon gives an important bearing on the whole economy whenever a small change in the world price of oil occurs. Through the linkage effects, as the surplus outweighs the deficit, potential gains also outweigh the potential losses both in terms of output and employment expansion.

In the 1990s, however, uncertainties linger around the world oil market. Industrialized countries are formulating energy-security measures to ensure an adequate and reliable supply of energy at reasonable prices. These measures imply a security margin that can absorb 'shocks' on price of oil and among other things will take the

forms of conserving consumption and establishing emergency stock. Considering the prevailing low price of oil and perception of surplus, the question of conservation now become uncertain. But the technological change and innovation as well as pressure from environmental concerns are expected to continue to play an important role in pursuing conservation. According to the developing countries' economic projections of the late 1970s and 1980s, oil demand was expected to increase substantially. This did not happen, in large part, because of the poor economic performance in many of these countries - the result of weak industrial-world markets for commodities, balance-of-payment problems and debt-related austerity. The potential for growth in oil consumption in these countries remains enormous (Yergin 1989).

Considering these uncertainties, will Malaysia be able to achieve the potential expansion in output and employment? And the next question is to what extent the resources should be mobilised in the petroleum mining and petroleum products industries? These questions should be addressed together with the problems of uncertainties that linger upon the world market of oil in the 1990s.

ACKNOWLEDGEMENT

The research has been supported by University Grant No: 50206-91-04.

NOTES

1. Malaysia has proven gas reserves three times that of oil and now is shifting to greater utilization of natural gas not only as an alternative source of energy and fuel, but also as a feedstock in fertilizers and other petrochemicals manufacturing. Two large gas projects in Bintulu are producing LNG and ammonia-urea fertilizers. In Sabah, there is another huge gas offshore project producing associated gas from two oil fields. The gas is piped to Labuan where plants producing methanol, iron and steel and a power station use LNG.
2. Crude oils included in SITC 333 Petroleum oils and oils from bituminous minerals, crude; and Petroleum products include in SITC 334 Petroleum products, refined and SITC 335 Residual petroleum products, n.e.s. and related materials.
3. Let the balance equations of the two-sector economy be,

(1) $$X_1 = a_{11}X_1 + a_{12}X_2 + F_1$$

$$X_2 = a_{21}X_1 + a_{22}X_2 + F_2$$

Change in trade in either petroleum mining or petroleum products industries can be shown as:

(2) $$\begin{bmatrix} 0 \\ \lambda \end{bmatrix}$$

Total (direct and indirect) import on change in output can be shown as:

(3) $$X_2^* - X_2 = a_{22}(X_2^* - X_2) + \lambda$$

(4) $$= \frac{\lambda}{(1 - a_{22})}$$

Where X_2^* is the new output level of the second sector. The direct impact on the change in output is:

(5) $$\lambda(a_{12} + a_{22})$$

From equation (4) and (5), the indirect impact on the change in output can be expressed as:

(6) $$\lambda\{b_{22} - (a_{12} + 9_{22})\}$$

The general case can easily be shown in matrix notation. Equation (A) can be rewritten as

$$\triangle X^T = (I - A)^{-1} \triangle F$$

Where $\triangle X^T$ represents the vector of direct and indirect impact on change in sectoral output and $\triangle F$ represents the change in trade.

REFERENCES

Abdul Rahman A.Z., Ahmad S., Zakariah A.R. & Shahwahid H.O. 1990. The Economic Impact of Tourism in Malaysia. A report submitted to the Ecoic and Social Commission for Asia and the Pasific (ESCAP), October.

Brittan, S. 1990. "Economic Veiwpoint: Fiddling before Armageddon". *Financial Times*, Sept. 27.

Hough, V.G. 1988. Dependence changing from oil to gas. *Petroleum Economists*, June: 197-98.

Kamal S. & Chua C.P. 1990. Energy for Sustainable Development: The Case of Malaysia. *Malaysia Institute of Economic Research (MIER) discussion paper*, No. 35.

Malaysia. 1990. *External Trade Statistics (monthly)*. Department of Statistics.

Malaysia. 1987. *Input-output table of Malaysia, 1983*. Department of Statistics.

McGilvary, J.W. 1977. Linkages, Key Sectors and Development Strategy. In *Structure, System and Economic Policy*, Leontief, W. (ed.) Cambridge University Press.

Petronas. 1989. Petroleum Development in Malaysia. *Nada Petronas*, June 1989, p. 9.

UNDP/UNIDO. 1991. *Final report on dynamic input-output analysis and sectoral projection of the manufacturing sector*. Government of Malaysia.

International Monetary Fund. 1990. *World Economic Outlook, 1990*. A survey by the staff of International Monetary Fund, Washington, D.C. April.

Yergin, D. 1989. Energy Issues for the 1990s. *Dialogue*: 17-23.

Zakariah A.R. & Shahwahid H.O. 1991. Implications of increase in oil price to the Malaysian Economy (in Malay). *Option* 6(1).

Fakulti Ekonomi & Pengurusan
Universiti Pertanian Malaysia
43400 UPM Serdang
Selangor D.E.