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Energy intensities and the impact of high energy prices on producing and consuming sectors in Malaysia

An input–output assessment of the Malaysian economy and the vulnerability to energy price changes

Henrik Klinge Jacobsen

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Abstract The increase in oil prices has put pressure on the global economy. Even economies that have a high degree of self-sufficiency concerning oil products are experiencing rising production costs and price increases for households energy use. Therefore, changes in energy policies are under consideration for countries highly dependent on imported energy as well as countries with a high degree of self-sufficiency. Examination of dependence on cheap energy sources for economic growth in different economic sectors is becoming more important as countries are trying to promote activities that are less energy intense. Among the policy changes under consideration, the adjustment of domestic energy subsidies is of particular interest. The effect of high energy prices on a fast growing economy, such as in Malaysia, is considerable, as the country will shift from being a net exporter of energy to a net importer in less than 10 years. Malaysia until recently has experienced increasing overall energy intensity and the growth up to 2,000 was quite high, especially for electricity intensity. A continued rise in energy intensity will be quite problematic in this new high oil price regime. This paper investigates the impact of rising energy prices on production costs for the different sectors of the Malaysian economy. Input–output (I–O) calculations demonstrate that the impact on the exporting component of the manufacturing sectors is less than for the average production. Therefore the production cost increase caused by, for example, an adjustment in electricity prices of 25% will result in less than 1/2% increase. As the competing countries in world markets are experiencing the same rise in energy costs, including electricity based on fossil fuels, there is no vital argument for not allowing domestic energy prices to adjust to the international price changes.

Keywords Energy use · Energy prices · Input–output

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H. K. Jacobsen (✉)
Risø National Laboratory, Technical University of Denmark,
P.O. Box 49, Roskilde 4000, Denmark
e-mail: henrik.jacobsen@risoe.dk

1 Introduction

The Malaysian economy has experienced remarkable growth during the last decades. This growth has been accompanied by a corresponding rise in energy consumption, which has drawn upon the rich energy resources of Malaysia. The energy intensity of the economy has increased due to growth in energy intense manufacturing sectors as well as due to growth in income that has increased the use of private transport in particular.

Malaysia's energy policy has two major goals. The first goal is to ensure a cheap and reliable supply of energy for all productive uses to promote development and contribute to the attraction of foreign investments. Second, a social aspect of the policy aims to supply cheap energy to the entire population, including those people not so well off and the population in isolated rural areas. These policy objectives will be maintained, but some policy adjustments will have to be considered in light of the new global energy price regime and the fast growing energy demand that cannot be supplied from domestic fossil fuel resources.

The energy dependence of the entire economy is still not extremely high with an average cost share of only 4–5%. This figure is however low based on the in international comparison relatively low domestic energy prices in Malaysia. Transport fuel (petrol and to a greater degree diesel) in particular has been subsidised. Further, natural gas prices, and through this the electricity price is below what can be argued based on marginal gas import cost comparisons. Some adjustments to world market prices have taken place, but the economy is still subsidising energy use. In 2006, some further price adjustments for transport fuels and electricity were implemented. These policy changes must be seen in relation to the changes occurring in other Southeast Asian countries with regard to a possible 'greening' of industries (Oosterveer et al. 2006).

With the possibility of continued growth, or more likely a stabilisation of energy intensity, the economy will be relatively vulnerable to energy price changes in the future. Within a few years the economy will become a net importer of oil products and in less than 10 years a net importer of energy, at which time the impact will be felt on both public finances and the current account. The new Malaysian Input–Output (I–O) tables for (2000) can be used to examine in more detail the short-term sectoral impact and to some degree also the cost effects on sectors competing in export markets. The data for the 94 Malaysian economic sectors and commodities however do not provide sufficient detail on energy data for analyses covering specific energy types. Therefore additional information from the manufacturing survey supplied by the Department of Statistics has been transformed to formats that can be combined with the I–O National Accounts based statistics. From this, a number of multiplicators can be calculated using I–O techniques. These results provide important information about which sectors will be affected by specific energy price changes.

2 Structure of the Malaysian industrial sectors and energy intensity

The Malaysian economy has been developing fast and at the same time has shifted from a partly agriculturally based economy to an economy with much higher dependence on the electronics and semiconductor industries, along with domestically-oriented consumer and construction related industries.

The energy intensities however have continued to increase as the electrification of all production processes is just beginning to fade out. Recently the increase in energy intensity has been attributable more to transport than to industrial structural development.

Final energy demand relative to total GDP has been rising, up to 2003, which is the last actual observation in Fig. 1. From then on the development is based on a projection constructed in the spring 2005 as part of the IRP 2 (Integrated Resource Planning) Danish-Malaysian cooperation project on renewable energy and energy efficiency (2004–2006). Based on detailed sectoral information, the projection assumes that the latest tendency towards a stabilisation of energy intensity will continue. For electricity, the time span of 15 years from now is only able to reduce intensity marginally, relative to 2003. The stronger tendency for increased electricity consumption to some extent is attributable to development within the manufacturing sector, which is responsible for a large part of electricity consumption in Malaysia (48% in 2003). However, some additional energy consumption could be directly associated with the manufacturing sector, since transport fuel (mainly diesel) is not referred to the manufacturing sector, but to a transport sector in the National Energy Balance for Malaysia (Ministry of Energy, Water and Communications 2004). This means that from a driving point of view, the energy consumption associated with manufacturing GDP will be higher than the share used for total energy in calculations in this paper.

Energy intensities in manufacturing are at a higher level than they are for overall GDP. Especially for electricity, the intensity is much higher in manufacturing. However, this intensity varies a great deal among the manufacturing subsectors, as will be seen in a later figure (Fig. 2).

As growth rates for the manufacturing sector are expected to remain high (6–7% annually) and electricity intensity is quite high (Fig. 3), the growth of total electricity demand will also remain high. If electricity demand growth has to be reduced, it will have to involve reducing electricity intensity in the manufacturing sector.

Reducing electricity intensity in the manufacturing subsectors would also influence the degree to which these sectors are exposed to rising electricity prices.

The manufacturing sector's share of GDP is only 31% (Fig. 4) , but its share of electricity consumption is as high as 48%. Combined with manufacturing's high growth rate and the importance for Malaysia's export performance, the manufacturing sector must be examined in more detail.

As seen in Table 1, the manufacturing subsectoral structure includes both basic heavy industries and a very large machinery sector that is diversified and includes electronics and semi-conductors that are very export oriented subsectors.

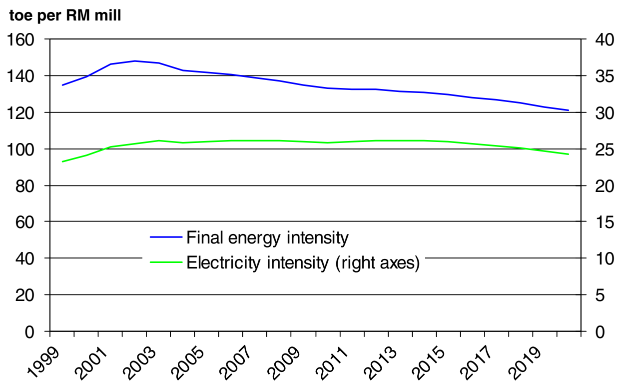

Fig. 1 Fuel intensities for Malaysia (National Energy Balance and author's projections)

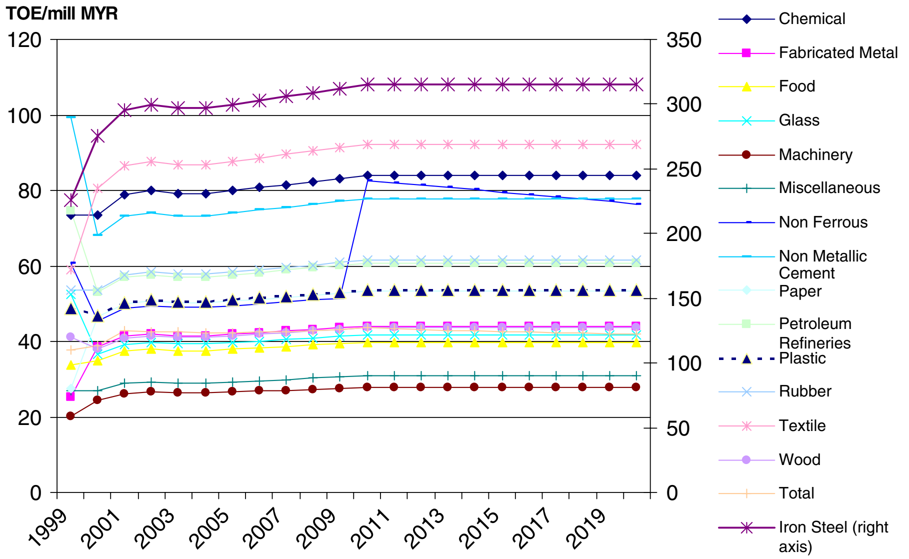

Fig. 2 Manufacturing subsectors electricity intensities (Department of Statistics and author's calculations)

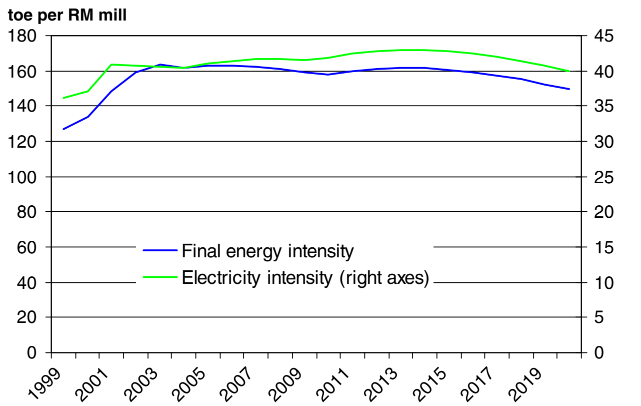

Fig. 3 Manufacturing fuel intensities (Department Of Statistics and author's calculations)

Regarding electricity intensities of subsectors, it appears that iron and steel have considerably higher intensity than do the rest. The machinery sector, which is the largest and most export oriented, has the lowest electricity intensity. The increase in intensity for non-ferrous metals is associated with a planned introduction of an aluminium smelter in Sarawak around 2010. The electricity intensity for that specific plant is assumed to be around four times that of the rest of the non-ferrous metals sector.(Fig. 2)

Table 1 shows the composition of energy consumption in the manufacturing sector. The largest sector measured by GDP is the machinery subsector, approximately five times the size of the second largest (food). The relatively low energy intensity results in this sector

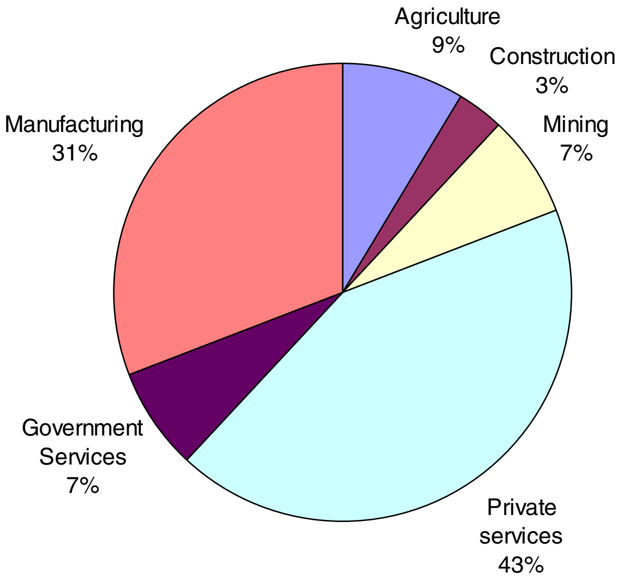

Fig. 4 The structure of Malaysian GDP in 2003

Table 1 Distribution of fuel demand on manufacturing sectors and distribution of GDP within manufacturing in 2003 (source: DOS manufacturing survey 2000, 2002 and author's calculations)

2003	GDP in manufacturing (%)	Electricity (%)	Natural gas (%)	Other fuels (%)	Total energy (electricity gross) (%)
Chemical	6	12	12	8	11
Fabricated metal	4	4	3	2	3
Food	11	10	1	13	9
Glass	2	2	24	3	7
Iron steel	1	7	4	6	6
Machinery	49	30	9	4	19
Miscellaneous	1	1	0	0	1
Non ferrous	1	2	2	1	2
Non metallic cement	4	7	20	38	18
Paper	3	4	0	6	4
Petroleum refineries	1	1	20	0	5
Plastic	6	7	0	1	4
Rubber	3	4	3	11	6
Textile	3	6	0	5	5
Wood	4	4	1	2	3
Total manufacturing	100	100	100	100	100

consuming only 30% of total electricity consumed within manufacturing. For natural gas and other fuels, this share is even lower resulting in a total share of energy at only 19%.

For natural gas there is much more variation. Seventy-five percent of natural gas consumption is concentrated in four subsectors, of which machinery is not even included.

The most outstanding here is glass manufacturing, which consumes 24% of natural gas and only accounts for 2% of the GDP.

The category ''Other Fuels'' is a combination of fuel oil, diesel, LPG, coal and biomass. Here the sector ''Non-metallic Minerals incl. Cement'' stands out with 38% of the energy consumption. The majority of this is coal, which for the largest part is consumed within the cement industry.

When adding up the total energy use, including electricity with its gross amount (electricity conversion efficiency of 30%), machinery and non-metallic minerals consume about the same share of energy. This emphasises the very large differences in vulnerability to energy price changes among the different manufacturing subsectors.

As a result of different growth rates in manufacturing subsectors, the energy shares will change. For example, it appears that the share for machinery of total manufacturing electricity consumption will grow from 30% in 2003 (Table 1) to 40% in 2020 because of the higher projected growth for machinery compared to other manufacturing subsectors.

3 Energy price changes and input–output data for Malaysia

This section describes the method and data used for the calculations of price impacts. The origin of the data is the Malaysian I–O tables for (2000) combined with energy data from the Department Of Statistics and the National Energy Balance for Malaysia. I–O calculations are used to construct short-term cost effects under a given set of assumptions that are further discussed below.

The main advantage and motivation for using the I–O tables is to include the intermediate inputs' content of energy in the calculation of cost impacts on different sectors. For example, in this way the impact of higher energy prices for fuels used in the production of industrial machinery is added together with the energy used in the production of transport services used in the production of industrial machinery. The transport part is the first element in the chain of indirect impacts.

3.1 Energy price change and the Input–Output (I–O) related assumptions

The energy price changes that can be evaluated using I–O statistics can be of different types. Several examples are relevant.

- International oil price change, for example 50%, fully passed to all domestic energy prices (less effect on electricity etc.) and assuming the same cost/price change for all imported goods as for those domestically produced
- A change in domestic prices for natural gas only and full pass through to electricity prices
- A change in transport fuel prices domestically

The I–O analyses could address several price change exercises, but here we concentrate on international oil prices, and domestic electricity and gas prices in a following section of the paper. Section 4 presents the results for international oil price changes with assumed full effect on domestic energy prices.

The price change has to be interpreted as a short-term change as it makes less sense to use static input–output to calculate long-term effects. Therefore the calculation will be the direct effect from the sector's own energy use plus the additional elements from other sectors' input of energy used to produce intermediate input in the first sector. Increased wages and increased capital costs will not be taken into account. The effect from changed input mix in the producing sectors due to changes in relative input prices is also excluded by this kind of analyses.

Additionally, the calculation has to be a sum of the domestic inputs' effect and the effect of the content of energy in imported intermediate goods. This last element involves some assumptions concerning technology, because no data on energy technology used for production of imported goods to Malaysia are available.

The Input–Output methodology makes the option of using all the available information in the detailed tables the most natural choice. Therefore, calculations are done at the most detailed level and results are only aggregated after calculation. All calculations are thus performed with the 94 × 94 I–O matrices for Malaysia. Results for total manufacturing etc. are reported after aggregation of results. The basic I–O calculation assumptions include:

- All cost change is assumed to be fully passed to the following chain in the production and supply process (the only exception could be with the energy products: electricity and gas, see next section)
- The prices for all uses of a given commodity are identical (no price discrimination)
- Endogenous import (import share of final demand unchanged by price change)
- No behavioural effects or income effects are considered (static I–O calculations)
- For calculations on final demand level, the import part is assumed to have the same energy content as domestic production

These assumptions are used for our calculations even though they are not fully realistic. In particular, the assumption concerning energy imports in imported goods is a rough assumption. Furthermore, since we are considering quite large price changes regarding energy, it is unrealistic to assume that there is no substitution between factors of production in the medium term. Final demand composition most likely will also be affected by the energy price changes. These kinds of effects would need an economic model for evaluation and that is not within the scope of this paper.

3.2 Input–Output tables for Malaysia in (2000) and the energy goods domestically supplied as well as imported

The newly available Input–Output tables for Malaysia for the year (2000) are based on the activity X commodity structure and derived tables from that. Activities comprise 94 sectors and 94 commodities are included. The tables allow for detailed I–O calculations, but unfortunately no energy matrices exist that are comparable to the national account statistics included in Malaysian I–O tables.

Calculations are performed based on the make matrix M (Table 2), the use matrix (Table 10) and the import matrix (Table 14). Table 18 is the inverted activity by activity matrix that can be derived from Table 17 and from Table 14 using Table 2. The make matrix M (Table 2) transfers the commodity output to sectoral output and is used for transforming calculation results from commodity based to activity based or vice versa.

The import matrix is used for the calculation of global energy content and construction of the alternative inverted matrix. The import of intermediate inputs are added to the domestically supplied intermediate inputs to derive the total inputs of commodities in the

Table 2 Energy sectors and main composition of output in 2000 (mill RM)

	Production	Supplied for intermediate use	Supplied for private consumption	Other final demand (inventory, fixed capital formation)	Export	Import
Crude petrol, natural gas & coal	41,320	12,661	–	3,452	25,207	5,001
Petrol & coal products	32,478	14,668	9,582	−659	8,887	9,301
Electricity & gas	15,454	12,052	3,399	0	3	1

production of each commodity. This is needed for all the calculations of energy content in domestic productions and the possible cost impact of changing international energy prices.

There are three energy commodities/sectors in the Malaysian I–O tables.

- Crude petrol, natural gas & coal (commodity 9)
- Petrol & coal products (commodity 42)
- Electricity & gas (commodity 66)

Crude includes the raw extracted oil, natural gas and coal. It is assumed that LNG is treated as crude and exported directly as commodity 9, as gas is not included in commodity 42 and there is no export of commodity 66.

The table shows that crude production is the largest sector by output of the three. This sector supplies some energy for domestic intermediate use (refining 11,600 mill. and a small share for industrial chemicals etc.), although the largest share is exported. There is no private or government consumption of this commodity.

''Petroleum & coal products'' is the second largest energy commodity and nearly half the production is supplied for intermediate use. This commodity is also supplied for private consumption (30%) and exports (27%). As the commodity consists of a large number of energy products (diesel, fuel oil, petrol, LPG, coal products and other refinery by-products), the use in the different demand components can have very different compositions concerning energy types. For further detailed studies of energy use and separate price changes, this commodity/sector will have to be expanded.

Finally, electricity and gas is the smallest sector regarding output (for value added, however, the sector is 40% larger than petrol and coal (refineries)). Production is mainly supplied for intermediate use with private consumption using only 22%. There is practically no export or import of this commodity. The sector can be expanded only into commodities of electricity and natural gas, which is done for the studies of gas and electricity prices below.

By adding the domestically supplied intermediate inputs and the imported intermediate coefficients, the total direct input of energy commodities in production can be calculated.

The result for energy input is represented in Fig. 5, which presents the 10 commodities with the highest energy input. As is apparent, there are a number of food processing industries among the top 10. This stresses the importance in Malaysia of reducing energy use in these sectors, similar to the Vietnamese case (Dieu 2006). The measure of energy input is obtained by adding energy commodities in value terms. This is not equivalent to adding in net energy terms. Electricity is counted as energy for all of its value, of which some in reality is created by capital and labour input. If the changes in all three energy type prices were the same (electricity and petroleum products, imported or domestically

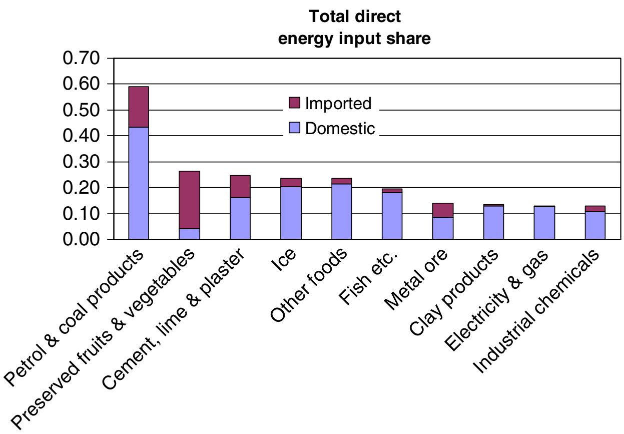

Fig. 5 Domestic and imported direct energy input. This is a total value input share for energy-related commodities and for electricity in particular this involves capital and labour content. The shares are not purely energy and they can be higher than the global energy shares reported below, which are based on the primary energy inputs.

produced), the total numbers in the figure would indicate that preserved fruit and vegetable production costs would increase by 26% if all the energy prices increased by 100% at the same time.[1] This measure just calculates the direct energy input and excludes the effect from other sectors using energy to produce their output. For this purpose we need to calculate the indirect energy content using the inverse I–O matrix.

4 Full and partial impact of World price changes

This section focus on the direct cost impact on the Malaysian subsectors and final demand components from rising energy prices. The analyses in this section examine the impact of increasing all energy prices based on a change in the crude price.

For the calculation of consequences from international energy price changes, several changes in the data setup have to be addressed. For the I–O energy component, it is assumed that commodity number 44, ‘‘petroleum and coal products’’, can be treated as one energy type with the same price impact. That means it is hereby assumed that the effect on coal prices is the same as the effect on diesel, fuel oil and petrol. An increase in oil prices will thus result in a proportional increase in coal and petroleum products prices. This is more correct in the longer term than in the short term as coal prices fluctuate less than do oil prices and probably the effect on coal prices is less than on petroleum products. As coal in Malaysia is used in only two industrial sectors (cement and partly iron), along with the considerable amount used in power, there is not a large problem with this assumption.

Apart from this assumption, we need to make an assumption regarding imported energy as compared to domestically supplied energy. It is assumed that the two are similar. This means that imported petroleum products and coal are similar to what is supplied domestically (Table 3).

[1] Because electricity has a higher weight than the direct fuel costs associated with electricity production, these results overestimate the impact of an increase in global energy (fuel) costs. The calculation in the next section is more representative of such a situation.

Table 3 Energy input domestically supplied and imported in 2000

(1000 RM)	Imported intermediate use	Imported final demand	Total import	Domestic intermediate	Domestic final	Total domestically supplied	Total use including export
Crude petrol, natural gas & coal	4,875,477	125,144	5,000,621	12,660,572	28,659,788	41,320,360	46,320,981
Petrol & coal products	9,016,995	283,860	9,300,855	14,668,060	17,809,985	32,478,045	41,778,900
Electricity & gas	1,174	0	1,174	12,051,610	3,402,012	15,453,622	15,454,796

As with any I–O relation, it is not possible to add the columns and then the rows to get total energy consumption. In energy terms that would be double counting the crude processed and used as input in other production processes.

What can be seen here is that the electricity and gas imported is a small amount, which is assumed to be natural gas imported for use in the power sector. Crude and coal import is 5 billion RM, mainly for intermediate input and the component in final demand as inventory changes (could be crude or coal). For the domesticly supplied 41 billion RM of crude petrol etc. the 25 billion RM is for exports (how much is crude oil and how much is LNG is not clear, but the LNG is included here).

For petrol and coal products, the import is 9 billion RM compared to 32 billion RM domestically supplied, of which 8.9 billion RM is exported. Only a small fraction of the import is used in the electricity and gas sector (54 mill. RM). For the domestically supplied component the electricity and gas production use is 1.3 billion RM petrol and coal products.

To calculate price dependence, the domestic and the international components are added. For both, there is a direct impact and an indirect impact. As the first energy commodity is used mainly as input in the refineries (petroleum and coal products), the cost effects will be transmitted this way.

Basically, it is possible to just examine the crude oil, gas and coal products. This simple alternative has been chosen for the present study.[2] For this, the total domestic + import intermediate table is constructed first and an alternative inverse table from that. Then the direct and indirect global content of crude in domestic production can be identified. This results in the cost impacts shown in Fig. 6 for the 10 commodities, with the highest cost impact out of 94 commodities.

If the results are interpreted as the effect on cost in these sectors, the effect of a 100% increase of crude oil prices would be a 17% increase in the production cost of preserved fruits and vegetables. Transport is showing an impact of around 10% due to diesel and petrol use, whereas industrial chemicals would experience a 12% increase due to its use of natural gas and oil substances as a raw material. Cement is energy intensive production and this is the result of a combination of fuel oil and coal use, and the cost impact is also around 12%.

These numbers are very much in contrast to the ones calculated for the domestic electricity and gas prices in the next section, where the effect of just changing domestic

[2] An alternative could involve using a series of assumptions concerning the crude price impact on petroleum products prices and on electricity and gas prices.

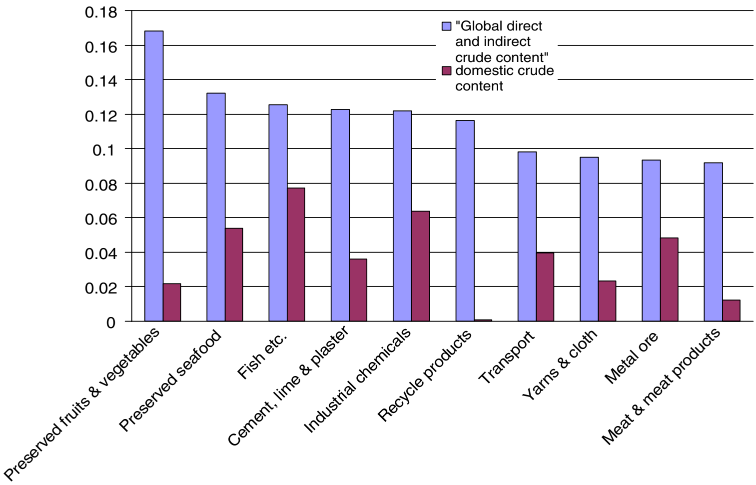

Fig. 6 The direct and indirect content of crude oil, gas and coal: The 10 commodities with the highest total shares

natural gas prices is moderate. The main reason is due to transport fuels, but this is not the only reason. For preserved fruits and vegetables, the reason is the large direct input of petroleum products imported in contrast to other sectors using petroleum products. The petroleum products use crude with the same high share also when imported, which creates the high effect on this specific sector contrary to the calculation taking only gas and electricity into consideration. In this global energy content, some of the sectors with high electricity intensity does not end up among the commodities with highest energy content, which is because the crude content in electricity is not that high (only around 6%) which is an underestimation when using the I–O table data for the electricity and gas sector.

5 Change in domestic natural gas and electricity prices and the resulting cost effects

This section addresses the cost impacts of changes in natural gas and electricity prices specifically. First, the necessary modification and expansion of the electricity and gas commodity in the I–O table is described.

Because the I–O matrices only have three energy commodities, it is necessary to expand some of these energy commodities. This can be done by using energy information available for certain sectors (manufacturing) and combining this with a number of assumptions. Therefore, some energy coefficients (or energy cost shares) have been constructed based on the Manufacturing survey data (a combination of 2000 or 2002 data). These data provide seven energy types for each manufacturing subsector in energy terms and in value terms. In addition to that, assumptions were made for other sectors (agriculture, service etc.) based on the National Energy Balance.

To make the I–O table consistent, the expansion of one commodity to two involves expanding with one row and one column. Thereby the square intermediate matrix *Ad*will become 95 by 95 instead of the 94 by 94 reported in the publication of the Malaysian I–O tables. Securing a high degree of consistency involves putting a number of restrictions on the new commodities relative to the original totals.[3] For example, all column totals (input factors) will still have to add up to one to make the construction of an inverse table possible. The steps in this simple procedure are further described in Appendix B.

Table 4 shows the resulting coefficients for electricity and gas inputs, respectively. Only a few commodities have more than marginal natural gas input, namely: china glass and pottery, cement, other chemical products, clay products industrial chemicals and iron. For electricity, the input shares are much higher and nearly all sectors have electricity inputs.

5.1 Impact on domestic sectors and final demand from changes in natural gas and electricity prices

An electricity price change could be initiated by international fuel price changes in general or it could be related to a change of price for specific domestic fuels. This will only be the case if this price change is passed on as assumed in these input-output calculations. First, the change in price for fuel used only in electricity production is illustrated and next the combined effect of adjusting both the power sector and the industrial sector natural gas tariff. An increase of 50% followed by an increase of 200% for all gas sold at wholesale level is also examined.

For practical calculations using the I–O tables and our energy sector information there are a few options. With such an increase, either the I–O passing of price effect could be used or an indication on the effect in electricity prices. This example assumes 40% fuel cost in total electricity production cost. This is combined with 40% gas costs out of total fuel costs. With this, the 50% increase in gas price corresponds to $0.40 \times 0.40 \times 0.50 = 0.08$ increase in electricity production costs. If this cost increase is assumed passed to the electricity price—the price will go up by 8%. This electricity price increase is used because the I–O table does not have the input elements in the electricity sector separately.

If this way of passing the increased cost to output price is assumed followed in all sectors of the economy, I–O calculation could be used to show the effect for all the output prices and the prices for final demand (Table 5).

The cost implications for the final demand components show that private consumption is the most exposed to electricity price increases. However, an 8% increase will have only a direct and indirect effect on the price of private consumption of around 0.36%. In other words, the effect on CPI will be only 0.36%.[4] The large increase of 200% for gas price will increase the electricity price by around 32%[5] and CPI by 1.44%. There is not assumed to be any effect on inflation (annual price increases). The argument for this is that expectations of consumers and businesses concerning long-term energy price increases will not be affected by this one-time government adjustment of subsidies to gas prices.

On the other hand, it is shown that the consequences for exports is less, in that the electricity price increase of up to 32% will lead to a cost increase of only 0.57%. Such a large increase in electricity prices thus will only have a minor impact on the overall export competitiveness. As it is most likely that competing countries have experienced the same

[3] With the available information, the adjustments of the I–O table do not exactly respect the restrictions, but the effect on the matrix for our purpose is considered marginal.

[4] The possible effects through changes in labour costs are excluded from this type of I–O calculation, which also assumes price reaction patterns to cost increases to be identical for all commodity markets independent of the competitive characteristics of this market.

[5] Here it is again assumed that no fuel substitution takes place in electricity production, which is most unlikely in the present situation of some excess capacity.

Table 4 Input coefficients for electricity and gas input in all sectors/commodities

Commodity	Electricity (%)	Natural gas (%)
Agricultural products other	0.0	0.0
Rubber primary products	1.3	0.0
Oil Palm primary products	0.2	0.0
Coconut	0.1	0.0
Tea	0.9	0.0
Livestock etc.	0.3	0.0
Forestry & logging products	0.0	0.0
Fish etc.	0.8	0.0
Crude petrol, natural gas & coal	0.0	0.0
Metal ore	2.6	0.0
Stone, clay & sand quarrying	1.7	0.0
Meat & meat products	1.1	0.0
Dairy products	1.4	0.0
Preserved fruits & vegetables	1.8	0.1
Preserved seafood	0.9	0.0
Oils and fats	2.1	0.1
Grain mill products	2.0	0.0
Bakery products	1.6	0.0
Confectionery	1.8	0.0
Ice	12.0	0.0
Other foods	10.0	0.0
Animal feeds	0.8	0.0
Wine and spirits	0.7	0.0
Soft drinks	1.3	0.0
Tobacco	0.8	0.1
Yarns & cloth	5.1	0.0
Knitted fabrics	2.8	0.0
Other textiles	2.8	0.0
Wearing apparel	0.9	0.0
Leather products	2.2	0.0
Footwear	3.4	0.0
Sawmill products	1.8	0.0
Other wood products	1.9	0.0
Furniture	1.3	0.0
Paper & board	3.3	0.1
Printed products	1.8	0.0
Industrial chemicals	5.0	0.8
Paints & lacquers	1.0	0.2
Drugs & medicines	0.0	0.0
Soap & cleaning preparations	0.0	0.0
Other chemical products	4.2	1.1
Petrol & coal products	3.2	3.2
Processed rubber	2.2	0.0

Table 4 continued

Commodity	Electricity (%)	Natural gas (%)
Rubber products	2.4	0.1
Plastic products	3.4	0.0
China, glass & pottery	4.7	2.9
Clay products	5.7	0.9
Cement, lime & plaster	7.2	1.1
Other non-metal products	1.4	0.2
Iron & steel	3.0	0.7
Non-ferrous metal	1.6	0.1
Other fabricated metal and fixtures	1.6	0.1
Structural metal products	1.8	0.0
Other metal products	2.0	0.1
Industrial machinery	1.0	0.1
Household machinery	0.4	0.0
Radio, TV & com. equipment	0.9	0.0
Elect. appliances & houseware	1.2	0.0
Other electrical machinery	1.8	0.0
Ships & boats	0.9	0.0
Motor vehicles	0.9	0.0
Cycles & motorcycles	1.3	0.0
Other transport equipment	1.9	0.0
Instruments & clocks	1.9	0.0
Other products	1.2	0.0
Electricity	1.1	3.3
Natural gas	2.5	0.0
Water	7.9	0.0
Buildings & construction	0.3	0.0
Wholesale & retail trade	1.2	0.0
Hotels & restaurants	3.2	0.0
Transport	0.7	0.0
Communication	1.3	0.0
Banking services	1.0	0.0
Other financial services	2.0	0.0
Insurance	0.7	0.0
Real estate	2.4	0.0
Ownership of dwellings	0.0	0.0
Business services	0.8	0.0
Education - Private	1.4	0.0
Education - Public	1.2	0.0
Health - Private	1.9	0.0
Health - Public	1.9	0.0
Private non-profit services	1.7	0.0
Entertainment	5.9	0.0
Radio & TV broadcasting	3.0	0.0

Table 4 continued

Commodity	Electricity (%)	Natural gas (%)
Recreation	0.7	0.0
Repair motor vehicles	2.4	0.0
Other repair	2.4	0.0
Recycle products	2.3	0.0
Other private services	2.2	0.0
Public administration	2.4	0.0
Public order	1.4	0.0
Defence	1.2	0.0
Other public administration	1.9	0.0
Private consumption	2.4	0.0

Table 5 Cost impact of electricity price increases on final demand components

Gas price change	50%	200%
Private consumption	0.36%	1.44%
Government consumption Federal	0.17%	0.67%
Government consumption State	0.21%	0.86%
Government consumption Local	0.22%	0.88%
Changes in inventory	−0.06%	−0.24%
Gross fixed capital formation	0.08%	0.32%
Exports	0.14%	0.57%

developments in gas prices and therefore in many cases also electricity prices, there is most likely no effect on export competitiveness for Malaysian industries.

For the large increase in gas prices, it is however not enough to examine only the impact on electricity prices. This will also involve an increase of the retail price to industrial gas consumers. The gas consumption in manufacturing has increased greatly in recent years and 2003 levels for that are used in the calculation.

The gas price is assumed to be adjusted to the same level for power sector and industrial use at the wholesale level. The difference from wholesale level to industrial average price level is assumed to remain unchanged based on unaffected distribution costs for natural gas. This in reality would depend on the price setting behaviour of the sector and existing agreements/contracts.

The cost increase for natural gas at wholesale level thus is assumed passed on to industrial (retail) gas customers. There is not a constant mark up on costs. The gas retail price will thus increase with the gas input share of total costs in the retail gas sector. This share is estimated to be 73%.[6] The retail gas price (industrial gas price) will only increase by 73% of the price increase at the wholesale level. Table 6 shows the combined cost effect for the producing sectors.

The results in Table 7 show that the cost of private consumption will be affected the most with an increase in the price level of 1.8%. Export is less exposed to these electricity

[6] Gas Malaysia buying at 9.4 RM per mm BTU versus industrial tariffs of 12.9 RM per mm BTU (approx. 2005)

Table 6 Cost impact of combined increase of electricity price and industrial gas price (200% increases in both gas prices)

Commodity	Direct electricity + natural gas (%)	Indirect electricity + natural gas (%)	Total electricity + natural gas (%)	Direct relative to total columns 1/3 (%)
Ice	3.9	1.2	5.1	75.9
Other foods	3.2	1.4	4.6	70.1
China, glass & pottery	3.7	0.9	4.6	79.9
Cement, lime & plaster	3.2	1.4	4.6	69.2
Petrol & coal products	3.5	0.3	3.8	91.9
Clay products	2.5	1.0	3.5	71.5
Industrial chemicals	2.2	1.1	3.3	66.7
Water	2.5	0.7	3.2	78.0
Other chemical products	2.2	0.5	2.7	81.1
Yarns & cloth	1.6	1.0	2.6	62.8
Entertainment	1.9	0.6	2.5	75.4
Iron & steel	1.5	0.7	2.2	68.9
Oils & fats	0.7	1.3	2.1	34.5
Other non-metal products	0.6	1.4	2.0	29.7
Footwear	1.1	0.8	1.9	58.5
Hotels & restaurants	1.0	0.7	1.8	57.5
Paper & board	1.1	0.6	1.7	64.9
Paints & lacquers	0.4	1.3	1.7	25.1
Plastic products	1.1	0.5	1.6	66.5
Leather products	0.7	0.8	1.5	46.4
Other textiles	0.9	0.6	1.5	59.3
Knitted fabrics	0.9	0.6	1.5	60.7
Metal ore	0.8	0.6	1.5	56.9
Radio & TV broadcasting	1.0	0.5	1.5	64.5
Preserved fruits & vegetables	0.6	0.8	1.4	43.5
Rubber products	0.9	0.6	1.4	60.9
Processed rubber	0.7	0.7	1.4	50.4
Soft drinks	0.4	0.9	1.4	31.7
Recycle products	0.7	0.6	1.4	53.4
Dairy products	0.4	0.9	1.3	33.1
Fish etc.	0.3	1.0	1.2	20.8
Confectionery	0.6	0.6	1.2	48.4
Real estate	0.8	0.5	1.2	61.1
Preserved seafood	0.3	0.9	1.2	26.1
Other private services	0.7	0.5	1.2	59.4
Other repair	0.8	0.4	1.2	64.7
Repair motor vehicles	0.8	0.4	1.2	63.6

Table 6 continued

Commodity	Direct electricity + natural gas (%)	Indirect electricity + natural gas (%)	Total electricity + natural gas (%)	Direct relative to total columns 1/3 (%)
Other metal products	0.7	0.5	1.2	57.3
Public administration	0.8	0.4	1.2	65.4
Printed products	0.6	0.6	1.1	49.1
Bakery products	0.5	0.6	1.1	45.2
Other wood products	0.6	0.5	1.1	55.9
Grain mill products	0.6	0.5	1.1	57.5
Meat & meat products	0.4	0.7	1.1	33.6
Structural metal products	0.6	0.5	1.0	55.4
Cycles & motorcycles	0.4	0.6	1.0	39.7
Other financial services	0.6	0.3	1.0	65.4
Stone, clay & sand quarrying	0.6	0.4	1.0	56.4
Non-ferrous metal	0.6	0.4	1.0	59.8
Private non-profit services	0.5	0.4	1.0	56.3
Other fabricated metals and fixtures	0.6	0.4	1.0	57.0
Other transport equip.	0.6	0.4	1.0	61.3
Instruments & clocks	0.6	0.4	1.0	63.1
Other public administ.	0.6	0.3	0.9	63.4
Sawmill products	0.6	0.4	0.9	59.8
Other products	0.4	0.5	0.9	41.8
Other electrical machinery	0.6	0.3	0.9	64.2
Wine and spirits	0.2	0.7	0.9	24.2
Furniture	0.4	0.5	0.9	45.1
Buildings & construction	0.1	0.8	0.9	12.7
Wearing apparel	0.3	0.6	0.9	34.2
Soap & cleaning preparations	0.0	0.9	0.9	0.0
Health – Private	0.6	0.3	0.8	70.2
Health – Public	0.6	0.2	0.8	71.4
Transport	0.2	0.6	0.8	27.6
Rubber primary products	0.4	0.4	0.8	52.3
Defence	0.4	0.4	0.8	47.2
Public order	0.5	0.3	0.7	61.7
Elect. appliances & houseware	0.4	0.3	0.7	54.7
Drugs & medicines	0.0	0.7	0.7	0.0
Communication	0.4	0.2	0.7	63.7
Motor vehicles	0.3	0.4	0.7	45.6
Education - Private	0.5	0.2	0.6	71.4
Animal feeds	0.3	0.4	0.6	42.3
Wholesale & retail trade	0.4	0.2	0.6	62.6

Table 6 continued

Commodity	Direct electricity + natural gas (%)	Indirect electricity + natural gas (%)	Total electricity + natural gas (%)	Direct relative to total columns 1/3 (%)
Livestock etc.	0.1	0.5	0.6	18.3
Ships & boats	0.3	0.3	0.6	50.6
Industrial machinery	0.4	0.2	0.6	63.6
Education - Public	0.4	0.2	0.5	71.9
Tea	0.3	0.2	0.5	56.3
Radio, TV & com. equip	0.3	0.2	0.5	56.0
Recreation	0.2	0.3	0.5	45.3
Oil Palm primary prod.	0.1	0.5	0.5	12.5
Insurance	0.2	0.3	0.5	46.8
Business services	0.2	0.3	0.5	48.4
Tobacco	0.3	0.2	0.5	61.7
Banking services	0.3	0.1	0.5	70.8
Agricultural prod. other	0.0	0.3	0.3	5.0
Forestry & logging products	0.0	0.3	0.3	0.0
Household machinery	0.1	0.1	0.3	44.7
Coconut	0.0	0.1	0.1	41.0
Crude petrol, natural gas & coal	0.0	0.1	0.1	0.0
Ownership of dwellings	0.0	0.0	0.0	0.0

Table 7 Cost impact of gas price increase for power by 200% and industrial use by 75%

	Direct and indirect effect from electricity price change (%)	Direct and indirect effect from wholesale gas price change (%)	Direct and indirect effect from electricity and wholesale gas price change (%)
Private consumption	1.44	0.35	1.80
Government consumption			
Federal	0.67	0.10	0.77
State	0.86	0.11	0.97
Local	0.88	0.11	1.00
Changes in inventory	−0.24	−0.31	−0.55
Gross fixed capital formation	0.32	0.13	0.45
Exports	0.57	0.25	0.82

and gas price changes with a cost impact of only 0.82%. Compared to the weighted average production cost effect of 0.94%, export is less exposed than is the average, reflecting the fact that export is less intense in electricity and gas use than is average production.

The reason that private consumption experiences a higher impact is that this is purely consumption and cannot be compared to production costs, of which 38% on average is value added that has no direct nor indirect energy content with this input-output methodology.

6 Concluding remarks

The figures on energy use show that Malaysia is exposed to international energy price increases due to its relatively high energy intensity of GDP. The differences among the industries are large and the traditionally highly energy intense iron and steal sector also is at the top of the electricity intensity graph in Fig. 4. Even though the projection assumes a minor reduction of energy intensities up to 2020, the economy will remain energy intense and with the shift from being a net energy exporter at present to a net import status around 2015, continued high energy prices will have a greater impact on the economy.

The findings from the I–O calculations indicate which industries and final demand components will experience the highest immediate cost increases. The I–O methodology however does not tell to what degree the industries will be able to adjust their input mix or how final demand will react to the price changes. Therefore, we have only identified the industries that most likely will have to adjust either inputs or output levels.

For the final demand components, the calculation reveals Malaysian export is less exposed to energy price changes than is the average production and much less than is private consumption. Therefore, the export-oriented industries which are competing in international markets should be able to deal with energy price increases in line with those their competitors on foreign markets will have to face. The more domestic-oriented industries will be exposed to less competition and have longer time to adjust along with possible future trade liberalisation.

At the detailed level, there are sectors that are much more exposed than the average and at the top of the 95 sectors are, for example, some food industries/products (preserved fruit, ice etc.) as well as cement. For the calculation of global energy content, the questionable technology assumptions produce energy cost content of 9–17% for the 10 most energy dependent products, with an average of 5.5%.

Natural gas is not a fully internationally traded energy good, but the processed LNG product makes it closely linked to world market energy price changes. Analysing the immediate cost effect of adjusting domestic natural gas prices to a level that is closer to levels in other regions involves adjusting also the electricity price based on the natural gas fuel share in the electricity production. For this, the natural gas and electricity sector in the I–O table was split and this revised I–O table was used for the calculation of specific price change impacts.

With an increase of the gas price for electricity production by 200%, the results show that on average input costs would be increased by 0.94%, but exports would only be affected by 0.82%. For private consumption the effect is much higher (1.82%) due to a combination of direct energy use in households and the energy content in all the other goods consumed. The economy is not exposed to a great degree to such a change in natural gas prices even though it is a large change. As there will be some substitution taking place, reducing the production cost impact and the adjustment of prices could be implemented gradually; there need not be any negative impact on the economy. This will be reinforced with the possible effect of reducing other production costs based on the increased natural gas revenue from domestic extraction.

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Appendix A: Construction of the import matrix and the global inverse matrix

The import matrix corresponds to the intermediate matrix in size (94×94) for the part used for adding up domestic and imported input. The import matrix used is Table 10 in the DOS 2000 I–O tables. The first step is transforming Table 10 to a coefficient matrix by dividing Table 10 with total inputs/output. Hereafter the two tables are added. This is what the domestic + imported direct energy figures in graphs (Fig. 5) and tables reflect. This is the global input matrix for the Malaysian sectors used for the calculation of inverse matrix.

Next a visual basic routine in EXCEL is used to construct $(I-(Am + Ad))^{-1}$ the new inverse matrix. As usual, all diagonal elements in this inverse are greater than or equal to 1 etc. It is not possible to check the consistency of the new inverse using the production calculation

$$g = (I - Ag)f,$$

where g is now the global production associated with fulfilling Malaysian final demand, since there are no records of this global production. For the calculation of global energy content and derived cost calculation, this global production has to be calculated as a first step in the calculation of energy input in final demand.

It must be stressed that any of these calculations involving global effects involve further ''rude'' assumptions. The basic assumption is that all imports are produced using the same technology as used domestically. That means the input structure is similar to that of $Am + Ad$. for all final demand (f), regardless of whether domestically produced or imported.

This is problematic, but there is no practical alternative if we want to address the total requirements for specific products (for example energy products) to fulfill the final demands. This is required for an analyses of how global energy price changes might affect final demand (for example private consumption) prices.

To calculate this global production requirement, we have to define the final demand for domestic production in Table 14 and final demand for imports from Table 10. (The Table 14 figures are actually based on coefficients and multiplied by the total final demand figure). These two demand components are then added for the 94 products and the final demand components. After this, the newly constructed global inverse matrix is used to construct the global production distributed on the 94 products by using matrix multiplication. From this the total global (crude and natural gas) input needed for Malaysian production can be extracted.

Appendix B: Expansion/split of I–O commodity electricity and gas

Here the procedure undertaken is reported in a number of steps:

- The extension exemplified by the sector (commodity) electricity and gas: (row, column 66).
- First step is the extension of row dimension by one: The new row 67 is natural gas and row 66 is now electricity. Then we need the input composition on electricity and natural gas for each sector. For that purpose we use data from the energy part of the DOS Manufacturing survey etc. We need cost comparable figures for electricity and

gas and not the physical units. Cost for both electricity and gas are reported in the survey.

- Construction of the input coefficient for the two new rows is done by splitting the former row 66 coefficient into two using the electricity share of (electricity + natural gas) from the manufacturing survey and then multiplying by the I–O coefficient for commodity electricity and gas. But the two sectoral/commodity definitions are not similar so additional assumptions have to be made for linking the manufacturing survey definition with the I–O coefficient.
- Consistency of this row expansion is conducted by checking that total inputs in columns still add up to 1.
- Adding a new column poses a different problem as now there is no restriction on the total coefficient, but on the total production generated in the two sectors/commodities. The simple solution used here as the first step is to assume similar input structure in the production of the two commodities.
- The intra square new 2 by 2 elements pose a specific problem and this was solved by assuming that electricity is using a distribution of total electricity and gas input of (25% electricity and 75% natural gas). For natural gas the corresponding distribution is 100% natural gas. This is complicated because it seems that natural gas input to electricity and gas are only supplied via petrol and coal products. Other assumptions would require that these shares be redefined.
- Finally, there is the problem that the manufacturing survey 2002 reflects some changes in total electricity and gas input not reflected in the 2000 I–O matrix. The problem is that gas use has increased considerably in industries and declined a bit in electricity. For every of the 95 commodities, the input of petroleum products (42) has been revised correspondingly. That means that the sum of the two (three) input coefficients of (42 and 66, now expanded to 66 and 67) corresponds to the previous sum of the two, but composition between these two has changed according to the development in the 2002 manufacturing survey. For the rest of the sectors no change is made.

Appendix C Electricity price increase and cost impact

Commodity	Direct Electricity 50%	Indirect Electricity 50%	Total 50%	Total 200%
Ice	1.0%	0.1%	1.1%	4.4%
Other foods	0.8%	0.2%	1.0%	3.9%
Cement, lime & plaster	0.6%	0.2%	0.8%	3.0%
Water	0.6%	0.1%	0.7%	2.9%
Clay products	0.5%	0.1%	0.6%	2.3%
Industrial chemicals	0.5%	0.1%	0.6%	2.3%
Entertainment	0.4%	0.2%	0.6%	2.3%
Yarns & cloth	0.4%	0.2%	0.6%	2.2%
China, glass & pottery	0.4%	0.1%	0.5%	1.9%
Other chemical products	0.3%	0.1%	0.4%	1.6%
Footwear	0.2%	0.2%	0.4%	1.6%
Oils and fats	0.3%	0.1%	0.4%	1.6%

Appendix C continued

Commodity	Direct Electricity 50%	Indirect Electricity 50%	Total 50%	Total 200%
Hotels & restaurants	0.3%	0.1%	0.4%	1.5%
Paper & board	0.3%	0.1%	0.4%	1.4%
Plastic products	0.3%	0.1%	0.4%	1.4%
Iron & steel	0.2%	0.1%	0.3%	1.4%
Other non-metal products	0.1%	0.2%	0.3%	1.3%
Radio & TV broadcasting	0.2%	0.1%	0.3%	1.3%
Knitted fabrics	0.2%	0.1%	0.3%	1.3%
Leather products	0.2%	0.2%	0.3%	1.3%
Other textiles	0.2%	0.1%	0.3%	1.3%
Petrol & coal products	0.2%	0.1%	0.3%	1.2%
Processed rubber	0.2%	0.1%	0.3%	1.2%
Metal ore	0.1%	0.2%	0.3%	1.2%
Paints & lacquers	0.3%	0.0%	0.3%	1.2%
Preserved fruits & vegetab.	0.1%	0.1%	0.3%	1.1%
Recycle products	0.2%	0.1%	0.3%	1.1%
Dairy products	0.1%	0.2%	0.3%	1.1%
Rubber products	0.2%	0.1%	0.3%	1.1%
Soft drinks	0.1%	0.2%	0.3%	1.1%
Real estate	0.2%	0.1%	0.3%	1.1%
Other private services	0.2%	0.1%	0.3%	1.1%
Other repair	0.2%	0.1%	0.3%	1.1%
Confectionery	0.2%	0.1%	0.3%	1.0%
Public administration	0.1%	0.1%	0.3%	1.0%
Repair motor vehicles	0.2%	0.1%	0.3%	1.0%
Printed products	0.2%	0.1%	0.3%	1.0%
Bakery products	0.1%	0.1%	0.2%	1.0%
Other metal products	0.1%	0.1%	0.2%	1.0%
Grain mill products	0.2%	0.1%	0.2%	0.9%
Cycles & motorcycles	0.2%	0.1%	0.2%	0.9%
Other financial services	0.1%	0.1%	0.2%	0.9%
Other wood products	0.2%	0.1%	0.2%	0.9%
Structural metal products	0.2%	0.1%	0.2%	0.9%
Meat & meat products	0.1%	0.1%	0.2%	0.9%
Private non-profit services	0.1%	0.1%	0.2%	0.9%
Instruments & clocks	0.1%	0.1%	0.2%	0.8%
Other public administration	0.2%	0.1%	0.2%	0.8%
Preserved seafood	0.2%	0.1%	0.2%	0.8%
Other transport equipment	0.1%	0.1%	0.2%	0.8%
Other electrical machinery	0.1%	0.1%	0.2%	0.8%
Stone, clay & sand quarrying	0.1%	0.1%	0.2%	0.8%
Other fabricated metals	0.1%	0.1%	0.2%	0.8%
Furniture	0.1%	0.1%	0.2%	0.8%

Appendix C continued

Commodity	Direct Electricity 50%	Indirect Electricity 50%	Total 50%	Total 200%
Wearing apparel	0.1%	0.1%	0.2%	0.8%
Other products	0.1%	0.1%	0.2%	0.8%
Non-ferrous metal	0.1%	0.1%	0.2%	0.8%
Sawmill products	0.1%	0.0%	0.2%	0.8%
Health – Private	0.1%	0.0%	0.2%	0.7%
Health – Public	0.1%	0.1%	0.2%	0.7%
Fish etc.	0.1%	0.0%	0.2%	0.7%
Wine and spirits	0.1%	0.1%	0.2%	0.7%
Rubber primary products	0.1%	0.1%	0.2%	0.7%
Public order	0.1%	0.1%	0.2%	0.7%
Defence	0.1%	0.0%	0.2%	0.6%
Buildings & construction	0.1%	0.1%	0.2%	0.6%
Elect. appliances & houseware	0.1%	0.1%	0.2%	0.6%
Communication	0.0%	0.1%	0.2%	0.6%
Education – Private	0.1%	0.0%	0.1%	0.6%
Motor vehicles	0.1%	0.0%	0.1%	0.6%
Transport	0.1%	0.1%	0.1%	0.6%
Soap & cleaning preparat.	0.1%	0.0%	0.1%	0.5%
Wholesale & retail trade	0.1%	0.1%	0.1%	0.5%
Animal feeds	0.0%	0.1%	0.1%	0.5%
Education – Public	0.1%	0.1%	0.1%	0.5%
Ships & boats	0.1%	0.0%	0.1%	0.5%
Livestock etc.	0.1%	0.0%	0.1%	0.5%
Insurance	0.0%	0.1%	0.1%	0.5%
Radio, TV & com. Equipm.	0.1%	0.1%	0.1%	0.5%
Recreation	0.1%	0.0%	0.1%	0.5%
Industrial machinery	0.1%	0.1%	0.1%	0.4%
Tea	0.1%	0.0%	0.1%	0.4%
Business services	0.1%	0.0%	0.1%	0.4%
Banking services	0.1%	0.0%	0.1%	0.4%
Drugs & medicines	0.1%	0.0%	0.1%	0.4%
Tobacco	0.0%	0.1%	0.1%	0.4%
Oil Palm primary products	0.1%	0.0%	0.1%	0.4%
Household machinery	0.0%	0.1%	0.1%	0.3%
Agricultural products other	0.0%	0.0%	0.1%	0.2%
Forestry & logging product	0.0%	0.0%	0.1%	0.2%
Coconut	0.0%	0.0%	0.0%	0.1%
Crude petrol, natural gas & coal	0.0%	0.0%	0.0%	0.1%
Ownership of dwellings	0.0%	0.0%	0.0%	0.0%

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