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Evaluation of Impacts of the Rise in Energy Prices on Costs of Production and Living Expenses in Malaysia

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Abstract: This paper examines the impacts of increasing energy prices on cost of production and living expenses of households in Malaysia. Analysis was done using an input-output price model that allows for the decomposition of the impacts into direct and indirect effects. An increase in electricity price was found to have minimal impacts on costs of production and living expenses of households. However, if both electricity and petroleum prices increased simultaneously, energy prices would have a considerable impact on production sectors and households. The indirect effect which captures the interdependencies among production sectors is most responsible for the increase in cost of production and living expenses.

Keywords: Costs of production, energy prices, input-output, living costs
JEL classification: C67, D30, D57

1. Introduction

A policy of subsidising petroleum products has been pursued in developing countries to keep the prices well below the international levels. For example, the estimated explicit petroleum subsidies for 16 different countries shows that the allocation of subsidies in 2006 ranges from 0.1 per cent of gross domestic products (GDP) in Lebanon to 8.5 per cent of GDP in Yemen (see Baig *et al*. 2007).[1] When the prices of these traded commodities are policy variable, a large increase in world prices raises a basic question: should the domestic prices be adjusted? For the record, world crude oil prices have increased drastically, particularly in 2011 when prices hit an average of USD 106.40 per barrel (see Figure 1).

The recent crude oil price hike has compelled governments of developing countries, including the Malaysian government to review the allocation of the petroleum subsidy as part of ongoing economic and market reforms to rebalance fiscal priorities.[2] In addition to

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[1] Explicit subsidies mainly reflect compensation to the national energy company for the increased difference between the wholesale domestic price and the world price of energy.

[2] Price of petroleum products in Malaysia is subsidised under an automatic pricing formula where the sales tax on petroleum products is reduced to offset the differences between reference prices and government-set final retail prices. When the difference between the reference prices and final retail prices exceed the sales tax, the tax is completely eliminated and the products are explicitly subsidised.

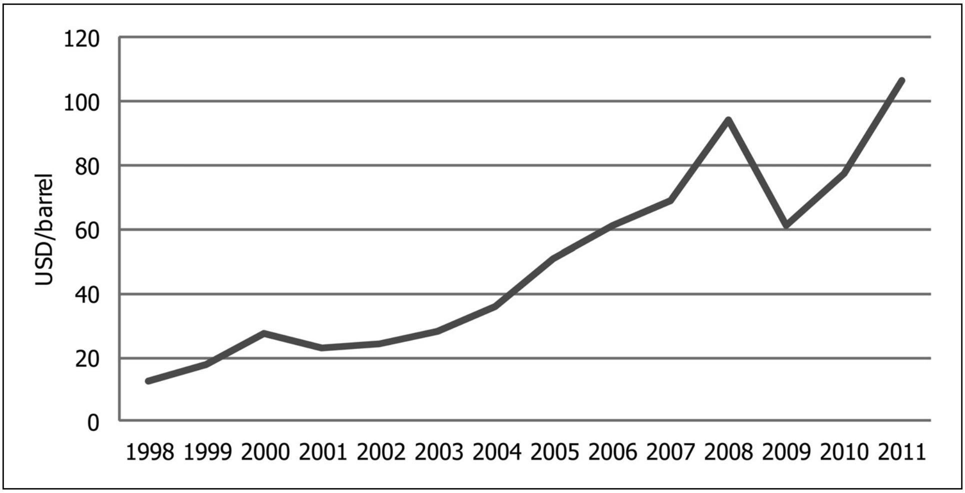

Figure 1. OPEC Basket price
Source: Organization of the Petroleum Exporting Countries (2011)

the subsidy reforms, the government claims that the petroleum subsidy not only undermines fiscal budgets but also distorts economic efficiency and allocation of resources. As a result of a reduction in subsidy, the average price of petrol has increased from MYR (Malaysian Ringgit) 1.90/litre in 2007 to MYR 2.18/litre in 2008 (15% higher) and that of diesel from MYR 1.58/litre to MYR 2.13/litre (45% higher).

The policy of deregulation of petroleum prices may have significant impacts on costs of production of the electricity sector given that petroleum products are essential inputs for the electricity sector. Specifically, production of electricity requires about 45 per cent of inputs from petroleum products (Department of Statistics Malaysia, 2000). As a response to this, the Malaysian government recently increased between 0.1 per cent and 10 per cent of electricity retail tariff for the consumption of electricity between 301 kWh (kilowatt per hour) to 1,000 kWh.

An increase in electricity retail tariff would have the effect of driving up prices of other products given that electricity is the main input for production. For example, of MYR 13.2 billion expenditure on energy inputs by the manufacturing sector in 2005, 58 per cent was represented by electricity input (Department of Statistics Malaysia, various years). In turn, the increase in price of electricity and other products would lead to an increase in the household budget allocation so as to maintain the same level of utility. There is a broad agreement warning against the unfavorable effects of deregulation of energy prices on household standard of living (Silva *et al*. 2009; Saboohi 2001; Behrens 1984; Berndt and Morrison 1979). The fact is that households in the lowest quintile may bear a heavier burden of higher energy prices because they are inclined to spend more of their budget on energy expenditure than households in the highest quintile.

The purpose of this paper is to analyse the extent to which an increase in recent petroleum and electricity prices will have an implication on costs of production and living costs of households. Since these two types of energy products are being used to produce most goods and services, higher energy prices could affect prices of other products and household through direct and indirect increases in input prices and expenditure. Producers and consumers could be affected directly through consumption of energy products. In addition, producers and consumers could also be affected indirectly through consumption of non-energy products whose prices have to be increased to offset the increase in energy costs. To capture these two effects, we applied an input-output price model which allows for the separation of direct and indirect effects of higher energy prices in a single analytical framework.

In this article, we do not seek to explain the reasons underlying the increase in the petroleum and electricity prices.[3] Our focus is on the consequences of a rise in price on costs of production and living costs of households. We performed two scenario analyses. For the first scenario, we only simulated an increase in electricity price on cost of production and living costs of household. We are aware that an analysis of higher electricity price alone may not give a complete overview of the impacts on the economy, given that the price of petroleum has been increased recently. Producers and consumers are likely to be affected seriously if the impacts of higher petroleum and electricity prices are simultaneously taken into consideration. For this reason, we simulate impacts of an increase in the prices of these two energy products in the second scenario.

This article is structured as follows. Section 2 reviews the current petroleum subsidy allocation and new electricity tariff announced by the Malaysian government, and links these subsidy and tariff rates to the consumption of petroleum and electricity by producers and consumers. Section 3 outlines the input-output price model and data associated with this study. Section 4 presents the empirical findings of our price simulations based on the two scenarios. Concluding remarks follow in Section 5.

2. Overview of Energy Consumption

Let us first discuss energy requirements for the production sectors. Energy remains the most important input for the production sector. More importantly, requirement of energy as an intermediate input for production has increased from 9.8 per cent in 2000 to 10.2 per cent in 2005 (Department of Statistics Malaysia 2005; 2010). In Table 1, direct expenditure of the manufacturing sectors (i.e. sectors classified according to Malaysia Standard Industrial Classification (MSIC)) on energy inputs for 2005 is disaggregated broadly into petroleum and electricity products.[4] Overall, it can be seen that most of the manufacturing sectors are highly dependent on electricity, on an average accounting for 58%. Input of petroleum constitutes a major proportion of total energy consumption only for foods and beverages (MSIC-15), paper and paper products (MSIC-21), petroleum refinery (MSIC-23) and non-metallic products (MSIC-26).

The direct consumption of petroleum input may be low but if indirect consumption is taken into consideration, consumption of petroleum is likely to be larger. The fact is that

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[3] See Wirl (2008) for an overview of theories that explain oil price fluctuations in general and in particular the recent price shocks.

[4] We are unable to compile the expenditure of energy inputs for agriculture, construction and building, and services sectors, given the lack of data.

Table 1. Direct expenditure of energy products by manufacturing sectors in 2005

		Diesel, petrol and other fuels		LPG and other energy types		Electricity		% share of expenditure on energy	
MSIC 2-digit	No. of establishments	Quantity ('000 Litre)	Value (RM'000)	Quantity ('000 kg)	Value (RM'000)	Quantity ('000 kWh)	Value (RM'000)	Petroleum	Electricity
15	4372	588,809	560,164	17,216,900	182,859	2,245,192	599,178	55.4	44.6
16	170	1,497	1,392	100,100	4,462	47,951	11,243	34.2	65.8
17	761	90,792	89,131	438,500	22,250	1,213,384	336,002	24.9	75.1
18	5556	12,207	13,008	163,600	1,669	190,947	51,813	22.1	77.9
19	379	1,866	1,682	100	142	41,600	11,605	13.6	86.4
20	1536	271,786	267,764	167,900	7,811	1,390,095	361,777	43.2	56.8
21	537	198,491	153,779	3,006,400	46,639	688,073	170,943	54.0	46.0
22	1497	10,346	12,433	48,800	1,991	345,004	92,517	13.5	86.5
23	32	307,753	337,210	177,700	181,684	597,095	175,579	74.7	25.3
24	893	271,511	248,306	87,425,200	620,743	4,165,773	991,308	46.7	53.3
25	1815	367,690	313,604	8,554,600	156,839	3,170,464	838,137	36.0	64.0
26	1260	363,560	332,171	74,231,800	801,623	3,028,336	728,508	60.9	39.1
27	931	344,740	283,092	26,967,600	294,765	3,333,197	867,778	40.0	60.0
28	3025	71,953	70,837	539,300	36,800	849,444	221,455	32.7	67.3
29	1164	23,278	24,340	1,648,300	22,629	555,305	145,353	24.4	75.6
30	67	8,431	8,318	8,422,400	188,400	1,339,760	339,101	36.7	63.3
31-32	900	58,628	52,484	70,550,900	96,968	5,216,603	1,245,011	10.7	89.3
34-35	575	53,915	55,721	927,600	25,350	742,934	203,295	28.5	71.5
33,36-37	2787	38,694	39,807	4,897,700	14,831	863,522	231,577	19.1	80.9
Total	28257	3,085,946	2,865,244	305,485,400	2,708,454	30,024,679	7,622,178	42.2	57.8

Source: Department of Statistics Malaysia (various years)

Table 2. Energy products share of budget in 2005 (%)

	Urban	Rural	Total
Petrol	4.24	4.61	4.32
Diesel	0.04	0.12	0.06
LPG for cooking	0.19	0.25	0.20
LPG for vehicles	0.01	0.01	0.01
Electricity	0.49	0.43	0.48
Kerosene	0.01	0.03	0.01
Firewood	0.00	0.01	0.00
Charcoal	0.01	0.01	0.01
Other fuels	0.00	0.01	0.00
Non-energy commodities			
Agriculture	4.10	7.22	4.76
Manufacturing	31.81	44.71	34.56
Services	59.11	42.59	55.59
Mean monthly income (MYR)	2,818	1,040	2,265

Source: Department of Statistics Malaysia (2006)

although the input of electricity for the manufacturing sectors is larger than the input of petroleum, almost half of the production of electricity requires input from the petroleum sector. Specifically, in producing that output of electricity, the electricity sector required about 45 per cent of petroleum input in 2005 (Department of Statistics Malaysia 2010). This indicates that among energy types, petroleum input is most important for the production of output.

Next, we discuss consumption of energy by households at different geographical locations, that is, across rural and urban areas. According to official estimates, about 65 per cent of Malaysian households reside in urban areas with the other 35% reside in rural areas (Economic Planning Unit 2006). The rural households are on average poorer than the urban households, with their income being equivalent to 37 per cent of urban income (setting income of urban households at 100), as indicated in Table 2. In addition to the differences in population density and income, there is also a considerable difference in the consumption of energy products across rural and urban households.

Table 2 presents the percentage share of direct expenditure on detailed energy types for both rural and urban households. In Malaysia, on average, the petrol expenses form a considerable portion of the total expenditure, accounting for 4.32 per cent. This share is comparable to the consumption of agricultural products. If the share of other petroleum products (i.e. diesel and liquid petroleum gas (LPG)) is taken into account, the expenditure share of petroleum products would be equal to 4.59 per cent. In contrast to production products, the consumption of electricity does not constitute a large share of the household budget as it accounts for only 0.48 per cent.

Rural households spend more of their budget on petroleum than urban households (9% higher for petrol, 200% higher for diesel and 30% higher for LPG). However, for electricity consumption, the expenditure share of urban households is 14 per cent higher than the rural households. A number of factors are responsible for the difference in consumption patterns between these two groups of households; differing levels of development and standard of living are the main drivers. For example, urban households may spend less on petrol because they may largely depend on public transport as the main commuting mode. Similarly, urban households may allocate a greater share of their budget on electricity given that their houses are equipped with the most modern electric and electronic appliances.

Based on data in Tables 1 and 2, one may argue that an increase in electricity price for example, may have a minimal impact on household consumption. The reason behind this argument is that expenditure on electricity constitutes only about 0.5 per cent of household budget share. However, it should be mentioned here that data in Table 2 record only the direct consumption of energy while ignoring the indirect effect of higher energy prices. For example, an increase in electricity price would directly affect the household through consumption of electricity (this is a direct effect). Subsequently there will be the indirect effect on consumption of other products as prices of these products would have been increased to offset the increase in electricity cost. This indirect effect can be clearly justified where 35 per cent of total expenditure is attributed to manufacturing products (Table 2) and production of manufacturing products requires 58 per cent of inputs from electricity (Table 1). In the next section, the direct and indirect effects of higher energy prices are separated in our analysis and this will be discussed in greater detail.

3. Methodology and Data

3.1 Input-Output Price Model

An input-output model analyses interdependencies in the production and consumption of output in an economy. Specifically, it shows the interrelations among different production sectors which purchase goods and services from other sectors as production inputs and which in turn produce goods and services which are sold to other sectors. Input-output model formulations can be classified into two types of analyses, that is, quantity and price models. In a standard quantity model, x output of sector j, can be obtained by simply post-multiplying a Leontief inverse matrix $(I-A)^{-1}$, with a vector of domestic final demands, f and foreign (exports) final demands, e. This can be illustrated by the following well-known expressions;

$$
\begin{aligned}
x &= Ax + (f + e) \\
&= (I - A)^{-1}(f + e) = (f + e)
\end{aligned}
\tag{1}
$$

where I is the identity matrix, A $(A = Z\hat{x}^{-1})$ is the domestic input coefficient matrix and $(I - A)^{-1}$ is the Leontief inverse matrix. Each element of the Leontief inverse matrix shows total output effects (both the direct and indirect effects) for any sector j to satisfy each unit of final demand. In this model formulation, quantity levels are assumed to be varied while prices are fixed. To keep the prices fixed, assumptions of an excess capacity and unused resources exist, and linear relationships (fixed input coefficients) are presumed throughout the framework.

The dual for the quantity model is a price model (also known as a cost-push model). The model is useful for analysis of price shocks given prices may vary while quantities are assumed to be fixed. In the standard price model version, frequently the Leontief inverse matrix is transposed and the vector of exogenous cost is expressed in terms of column vectors instead of row vectors (Miller and Blair 2009). In such a case:

$$p = A'p + vp_v + mp_m + tp_t$$
$$= (I - A')^{-1} (vpv + mp_m + tp_t) = L'(vp_v + mp_m + tp_t) = L'(v + m + t) \quad (2)$$

where, p is the vector of normalised prices for the particular sector, A' is a transposition of the matrix of domestic input coefficient, p_v, p_m and p_t are the vector of normalised prices for the value added, imports and indirect tax (prices per category) and v, m and t are termed as the vector of value added coefficient (value added per unit of output), import coefficient (import per unit of output) and indirect tax coefficient (tax per unit of output). For the base-year equilibrium, $L'(vp_v + mp_m + tp_t)$ is simply equivalent to $L'(v + m + t)$ as p_v, p_m and p_t are set at unity. Although the same coefficients of the inverse matrix $(I - A)^{-1}$) are applied in equations (1) and (2), both models are independent. Quantities and prices move independently – x is determined by and is influenced by $(f + e)$ and p is influenced by $(v + m + t)$. In Equation (1), supply is perfectly price elastic whereas in equation (2), demand is perfectly price inelastic.[5]

Concerning the price model, equation (2) reflects the sum of both direct and indirect effects. To decompose the total effects into direct and indirect effects, we basically can further expand $(I - A)^{-1}$ through a power series approximation approach (see Miller and Blair 2009), as indicated below. For simplicity, we may define w as a total exogenous cost $(w = v + m + t)$.

$$p = (I + A' + A'^2 + A'^3 + \dots)\, w \quad (3)$$

Removing the parentheses, this is equivalent to

$$p = w + A'w + A'^2w + A'^3w + \dots = w + A'w + A'(A'w) + A'(A'^2w) + \dots \quad (4)$$

Notice that each term after the first can be obtained as the preceding term pre-multiplied by A' and this continues until final results are achieved, that is, equal to the element of $(I - A')^{-1}$. This iterative approach is a detailed approach of obtaining the total effects of exogenous cost increases upon the price of the different sectors. For simplicity, we attempted to decompose the input-output price effect into direct and indirect effects. Direct effect is represented by the effects of $(w + A'w)$, showing how a one-unit increase in the exogenous cost for a sector has first-order effects on costs of the sector itself and of other sectors. The indirect effect is represented by the effects of $(A'(A'w) + A'(A'^2w) + \dots)$, measuring how the first order effects give rise to second- and higher-order effects because the first-order increases in costs generate further pressure on the costs of whole sectors whose prices of output have been increased to offset the increase in their costs of input.

A price shock in an input-output model can be imposed in two ways: (i) an increase in a unit price of exogenous components (p_v, p_m and p_t), e.g., a unit price of import; or (ii) an increase in a unit price of a particular sector (p). We adopted the second approach, where price of energy sectors were rendered exogenously by dropping them from the system. This implies that in our simulation, the prices of petroleum and electricity are assumed to be entirely exogenous whereas prices of other sectors $(n - 2)$ are endogenous. This assumption can be justified given that the prices of petroleum and electricity in Malaysia are determined by the government.

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[5] For an extensive discussion between price and quantity models, refer to Oosterhaven (1996).

Treating prices of petroleum and electricity as exogenous implies that we are now working with mixed endogenous-exogenous price model (see Saari *et al.* 2010).[6] This approach is applied to discover the impacts of changes on the prices of petroleum and electricity sectors on prices of other sectors by considering prices of petroleum and electricity determined exogenously in the model. This is in contrast to the standard modeling formulation where prices of petroleum and electricity sectors are determined endogenously. To illustrate this approach, let us consider an analysis of an increase in electricity price as an example. We define this as Scenario 1 analysis.

We re-arranged the price model as in equation (2) by partitioning the production sectors into the electricity sector and a group of other sectors.

$$\left[\frac{\mathbf{p}_N}{\mathbf{p}_E}\right] = \left[\begin{array}{cc}\mathbf{A'}_N & \mathbf{S'} \\ \hline \mathbf{R'} & \mathbf{A'}_E\end{array}\right]\left[\frac{\mathbf{p}_N}{\mathbf{p}_E}\right] + \left[\frac{\mathbf{p}_{WN}}{\mathbf{p}_{WE}}\right]\left[\frac{\mathbf{w}_N}{\mathbf{w}_E}\right] \quad (5)$$

where p_N and p_E are the unit price vectors for the non-electricity sectors $(n-1)$ and electricity sector. Matrix $\left[\begin{array}{cc}\mathbf{A'}_N & \mathbf{S'} \\ \hline \mathbf{R'} & \mathbf{A'}_E\end{array}\right]$ is the transposition element of domestic input coefficient matrix where A'_N and A'_E represent domestic input coefficient among the non-electricity sectors and electricity sector. Matrix R' is the domestic input coefficient of non-electricity sectors on electricity sector and S' is the matrix of domestic input coefficient of the electricity sector on non-electricity sectors. Setting all prices indices at unity and treating p_E as exogenously determined, we re-arranged the preceding equation as follows:

$$\left[\frac{\mathbf{p}_N}{\mathbf{w}_E}\right] = \left[\begin{array}{c|c}(\mathbf{I}-\mathbf{A'}_N) & 0 \\ \hline -\mathbf{R'} & -\mathbf{I}\end{array}\right]^{-1}\left[\begin{array}{c|c}\mathbf{I} & \mathbf{S'} \\ \hline 0 & -(\mathbf{I}-\mathbf{A'}_E)\end{array}\right]\left[\frac{\mathbf{w}_N}{\mathbf{p}_E}\right] \quad (6)$$

This matrix reflects the impacts of exogenous cost component of other sectors, w_N, and of price of electricity sector, p_E, on the prices of other sectors, p_N, and exogenous cost for the electricity sector, w_E.

In our analyses, w_N is constant and p_E is the only variable. It should be borne in mind that when $p_N = 1$, there is no deviation in the price of electricity from its baseline value. However, when, for example, the price of electricity is double, the shock is introduced in the system as $p_N = 2$. Solving equation(6) for p_E and expressing the resulting price deviations from unity in percentage form, one can determine the impacts of this price shock on the price of rest of the sectors, p_N. It should be mentioned here is that if we introduce a new level of w_E (after the shock) together with w_N into equation (2), the same results of price changes as Equation (6) can be obtained. This is one way to check the consistency of the model.

For analysis of Scenario 2, we simulated the increase in prices of electricity and petroleum products simultaneously in the model. Modeling approaches for Scenario 2 analysis are similar to the above approaches as in equations (5) and (6). The only difference is that there are two prices that are exogenously determined: petroleum and electricity. Thus, we may define now p_E and w_E as representatives of the prices and exogenous costs for the petroleum

[6] Hartono and Resosudarmo (2008), Resosudarmo and Thorbecke (1996) and Lewis and Thorbecke (1992), for instance, applied the mixed endogenous-exogenous model within a context of quantity model.

and electricity sectors. Further, p_N and w_N are the unit price vectors and exogenous cost for the non-energy sectors (n – 2).

The next issue is to determine the extent to which increases in prices of output affect living costs of households by looking at their 'consumption loss.' Consumption loss can be defined as the reduction in the budget share when energy prices are raised. To calculate consumption loss associated with higher energy prices, we can just simply derive an index that measures the real consumption effect. This can be done by deflating the current level of consumption by the new price level (after the shock). That is

$$\Delta c_{jm} = {C_{jm}}/{\Delta p_j} \tag{7}$$

where subscript m represents consumption by categories of households.

One may argue the superiority of the input-output model for price shock analyses given that the model is linear in nature. Linearity of the input-output model implies that composition of commodities (or products) used for production inputs are fixed and analyses are run with an absence of substitution possibilities among inputs. In the context of perfectly priced inelastic demand (i.e. price model), linearity implies that the increase in energy costs would result in the producers transmiting the higher costs of production to the final users (e.g. consumers) by increasing price of output. This however, may not be realistic because in response to the increase in energy prices, producers may tend to reduce the use of energy inputs and substitute with other relatively inexpensive inputs in order to minimise the total costs without affecting the current level of production.

This may lead to the open criticism of the linearity assumption in the sense that it is unable to incorporate market mechanisms and policy instruments that work through price incentives. However, the use of input-output models can be justified on the notion that short- and long-run production cost functions exist. In the short-run (during one period) it might be a constraint for producers to adjust capital endowments and thus the use of current production technique is likely to be observed. This fixed production technique is implicitly represented by the fixed input-output coefficient. Moreover, even if the substitution does occurs, it may reflect only at disaggregated levels (or at firm levels) while at aggregated levels (or at industry levels) the composition of inputs is likely to be stable.

3.2 Data

Two sets of data were used in this study. First, we utilised the latest input-output table for 2005 published by the Department of Statistics Malaysia (2010). This input-output table consists of 120 sectors and is classified according to the Malaysia Standard Industrial Classification (MSIC)(see Department of Statistics Malaysia 2000). The input-output table is applied to measure the price effects of higher electricity and petroleum prices. It is worth noting that output of the electricity sector is classified together with gas in a sector called 'electricity and gas.' This sectoral classification constraint may not affect our results because 98 per cent of flows of output for this sector are dominated mostly by the output of electricity whereas gas flows only account for 2 per cent. Therefore, our concentration on this sector for a simulation of electricity price shock is well represented. For the petroleum sector, we do not encounter a classification constraint because the 'petroleum refinery' sector in the input-output table only comprises the products of the petroleum sector.

We are also interested in the consumption consequences of the simulated energy price increase as a measure for the changes in living costs. The household consumption data are represented by a vector of private consumption in the input-output table but there is no disaggregation of the household. To disaggregate household consumption into several categories, the second data set that is required is the latest household expenditure survey (HES) for 2004/05 carried out by the Department of Statistics Malaysia (2006). The HES is a multi-purpose household survey conducted to gather detailed information on expenditure of households, taking demographic characteristics across socio-economic groups into account. We have classified the households according to two geographical locations; Peninsular Malaysia (termed as West Malaysia) and, Sabah and Sarawak (termed as East Malaysia). Each geographical location is further disaggregated into two strata, that is, distinguishing between rural and urban areas. All in all, this leads to four household groups (2 geographical locations x 2 strata). As a consequent of this, we are able to quantify the extent to which households under different geographical locations which are characterised by different income levels (rural is essentially the lowest income earner while urban is essentially the highest income earner) are affected by energy price hikes.

It is important to note here is that classification of commodities in the HES are compiled based on classification of individual consumptions by purposes (COICOP). This classification is inconsistent with the production classification (which applies to MSIC). Therefore reclassification of the commodities from COICOP to MSIC classification was made and this can be easily achieved as the Department of Statistics Malaysia provides correspondence classification between these two classification schemes.

4. Results and Discussion

4.1 Imposing Price Shocks

Two scenarios of price shocks are analysed: increase in electricity price (or tariff) on one hand and a simultaneous increase in petroleum and electricity prices on the other hand. For this purpose, we have to set how much the electricity and petroleum prices should be imposed in our model. The question of how much electricity and petroleum prices should be imposed in the model is a policy variable. We basically can impose any price shocks, for example, 10 per cent, 20 per cent and so on but there must be explanations behind the imposed price shocks.

For Scenario 1, we ran the analyses by simulating if price of electricity had been 8.76% per cent above the actual level. The simulation of an increase of 8.76% of electricity price is made based on two sources of information: the current consumption of electricity by industries and the new tariff rates announced by the government (see Appendix 1). First, we used information available in Table 1 to calculate the average monthly consumption of electricity by industries. It is observed that all industries use more than 1,000 kWh on an average, with leather and footwear sector (MSIC-19) indicating the lowest at 2,864 kWh per month and office, accounting and computing machinery sector (MSIC-30) recording the highest at 1,666,368 kWh per month. Next, the average consumption of electricity was matched with the new electricity tariff available in Appendix 1. According to the new electricity tariff, there would be an increase of 8.76 per cent (or MYR 30.30) from MYR 345.95 to MYR 376.25 for the consumption of more than 1,000 kWh. Based on this, we consider 8.76 per cent of increase in the new electricity tariff as the exogenous price shock for the electricity sector in our first simulation.

For Scenario 2, we need to specify exogenously in our model the percentage increase in the petroleum price when subsidies have been reduced. For this purpose, we compiled the amount of subsidy allocation and consumption of petroleum products, and based on such information we estimated the amount of subsidy content in each litre and kilogram (kg) consumption of petroleum products. This information is available in Appendix 2. Given the fact that the latest statistics for subsidy allocation and consumption of petroleum products is only available for 2009, we therefore considered subsidy in 2008 as a baseline for the price simulation shock.

It can be observed in Appendix 2 that between 2008 and 2009, subsidy for petrol was reduced by 57 per cent (from MYR 0.311/litre to MYR 0.133/litre), that of diesel declined by 79 per cent (from MYR 1.304/litre to MYR 0.275/litre) and that of LPG was reduced by 20 per cent (from MYR 1.71/kg to MYR 1.38/kg). Then, we need to specify exogenously in our model, the percentage increase in the petroleum price when the subsidy has been eliminated. We could measure this, for example, by estimating price elasticity of petroleum but insufficient subsidy data limited our analysis. As an alternative, we assumed that reduction of this subsidy allocation for petroleum products would lead to an immediate increase in the price of petroleum products.

Accordingly, we could claim that there would be 57 per cent increase in the price of petrol, 79 per cent increase in the price of diesel and 20 per cent increase in the price of LPG. We, however, could not impose these three price shocks separately in our model because output of the petroleum refinery sector in input-output classification combines all of these three products. Alternatively, we calculated an average increase for these three products, weighted by the amount of subsidy. This would give an average of 45.93 per cent increase in the price of petroleum products. We aware that a one-off 45.93 per cent increase in the price of petroleum products are extremely high and unlikely to be imposed by the government. In fact, between 2008 and 2009, the government gradually increased the price of petroleum products in small percentages. We, however, considered a 45.93 per cent shock in the price of petroleum products as the 'maximum' level that can be imposed by the government. The choice of 'reasonable' price adjustment is beyond the scope of this paper and depends on the definition of 'reasonable' and thus on political considerations. Therefore, in Scenario 2, we simulated an increase of 8.76 per cent in the electricity tariff and of 45.93 per cent in the petroleum price as exogenous price shock in our model.

4.2 Increase in Costs of Production

Impacts on costs of production estimated for Scenario 1 and 2 are presented in Tables 3 and 4. Recall that for Scenario 1, we simulated the price of electricity 8.76 per cent above its actual level. For Scenario 2, the simulated increase in electricity price was combined with an analysis of 45.93 per cent increase in petroleum price. Given the limited length of this paper, we only report the top 30 sectors that are mostly affected by the higher energy prices.[7] Recall that in the input-output price analysis, a percentage increase in price of output

[7] The full results for the 120 sectors are available on request from authors.

Table 3. Results for Scenario 1(%)

Sectors	Total effect	Contribution of Direct	Contribution of Indirect
1. Accommodation	0.69	66.6	33.4
2. Restaurants	0.59	54.5	45.5
3. Yarn and cloth	0.53	73.1	26.9
4. Port and airport operation services	0.51	72.5	27.5
5. Waterworks	0.49	68.8	31.2
6. Finishing of textiles	0.38	44.0	56.0
7. Cement, lime and plaster	0.36	55.0	45.0
8. Amusement and recreational services	0.34	38.3	61.7
9. Sheet glass and glass products	0.32	64.7	35.3
10. Paddy	0.32	75.1	24.9
11. Other transport equipment	0.32	68.7	31.3
12. Clay and ceramic	0.32	69.9	30.1
13. Iron and steel products	0.31	58.2	41.8
14. Watches and clocks	0.31	64.2	35.8
15. Other textiles	0.29	51.7	48.3
16. Rubber gloves	0.27	35.7	64.3
17. Tyres	0.27	55.1	44.9
18. Plastics products	0.27	61.2	38.8
19. Veneer sheets, plywood, laminated & particle board	0.26	68.8	31.2
20. Flower plants	0.26	53.7	46.3
21. Public administration	0.25	56.5	43.5
22. Other private services	0.25	59.6	40.4
23. Publishing	0.24	53.4	46.6
24. Pharmaceuticals, chemicals & botanical products	0.24	47.9	52.1
25. Real estate	0.24	61.1	38.9
26. Other fabricated metal products	0.24	44.5	55.5
27. Motorcycles	0.23	39.0	61.0
28. Builders' carpentry and joinery	0.23	59.4	40.6
29. Casting of metals	0.23	42.8	57.2
30. Rubber processing	0.22	43.3	56.7
Weighted average of sectoral price impact	0.27	29.0	71.0

Source: Computed from Equation (6)

implies an increase in cost of production. An increase in input costs are transmitted throughout the economy as they are passed on (completely) by producers in the prices of their products that are purchased by final users. For example, a 10 per cent increase in price of output for a particular sector indicates that there is a 10 per cent increase in costs of production for that sector.

For Scenario 1, results show that the impacts on the individual sector are considerably small. The largest price increase occurs in the accommodation sector, which accounts for 0.69 per cent. The aggregate price increase is just 0.27 per cent[8]. Our results suggest that

[8] The aggregate price increase is calculated as the average of sectoral price impact taking into consideration total output for each sector.

Table 4. Results for Scenario 2 (%)

Sectors	Total effect	Contribution of Direct	Contribution of Indirect
Air transport	19.53	56.45	43.55
Cement, lime and plaster	15.75	60.76	39.24
Clay and ceramic	11.14	75.26	24.74
Basic chemicals	10.37	69.69	30.31
Restaurants	8.53	52.13	47.87
Water transport	7.98	39.63	60.37
Metal ore mining	7.05	61.88	38.12
Rubber gloves	6.97	48.86	51.14
Land transport	6.95	75.07	24.93
Sheet glass and glass products	6.83	65.85	34.15
Other chemicals products	6.76	70.14	29.86
Concrete & other non-metallic mineral products	5.89	46.11	53.89
Rental and leasing	5.27	52.00	48.00
Other private services	5.22	56.03	43.97
Stone clay and sand quarrying	5.10	62.91	37.09
Finishing of textiles	4.98	36.91	63.09
Fertilizers	4.86	34.31	65.69
Veneer sheets, plywood, laminated & particle board	4.69	50.38	49.62
Iron and steel products	4.67	53.34	46.66
Insurance	4.33	42.33	57.67
Accommodation	4.33	42.75	57.25
Tyres	4.33	47.58	52.42
Other textiles	4.15	46.14	53.86
Non residential	4.11	31.11	68.89
Civil engineering	3.93	47.63	52.37
Rubber processing	3.86	40.07	59.93
Builders' carpentry and joinery	3.53	39.05	60.95
Casting of metals	3.30	26.21	73.79
Residential	3.28	21.13	78.87
Waterworks	3.21	37.36	62.64
Weighted average of sectoral price impact	5.11	29.0	71.0

Source: Computed from Equation (6)

imposing an increase in the electricity sector in the developing countries would have small effects on the prices of other sectors. This can be supported, for example, by Nguyen (2008) who shows that the impacts of a 36 per cent increase in the Vietnamese electricity price affected only 0.56 per cent of the aggregate price increase. However, when the prices of electricity and petroleum are simulated simultaneously in Scenario 2, the impacts on prices of other sectors are considerably large. The average price increases by 5.11 per cent compared to 0.27 per cent for Scenario 1. Looking at the individual sectors, four sectors experienced a price increase of more than 10 per cent. These include the sectors of air transport (19.53%), cement, lime and plaster (15.75%), clay and ceramic (11.14%) and basic chemical (10.37%).

Disaggregating the impacts into direct and indirect effects, we observed that the former explains the most for the increase in the prices of other sectors in Scenario 1. For example, the direct effect is responsible for 75.1 per cent of the increase in the price of the paddy sector. This provides an indication that sectors that are heavily affected are relatively more reliant on electricity products and therefore an increase in the price of electricity immediately impacts their costs of production. The contribution of direct and indirect effects for Scenario 2 was rather mixed. It was observed that the direct effect contributed largely to the price increase for the sectors that had been affected more than 5 per cent. In contrast, the indirect effect explains the most for the price increase of sectors below the 5 per cent level.

Interdependencies among the production sectors can be put forward to explain why some sectors experience a smaller increase in costs of production. These sectors may not use petroleum and electricity significantly as their intermediate inputs, but they need to buy intermediate inputs from other sectors in which petroleum and electricity constitutes a higher proportion of total intermediate cost. For example, the fertiliser sector purchases only a negligible percentage of its intermediate inputs from petroleum and electricity sectors (with a direct consumption for both energy inputs being approximately 5%). But the wholesale and retail trade sector, the sector that contributes the main input to the fertiliser sector (with a direct consumption of 2.0%), is affected more directly from the increase in energy prices.

4.3 Increase in Living Costs of Households

In this sub-section, we attempt to assess the impacts of price rises estimated in sub-section 4.2 on living costs of households. For this purpose, we classified the input-output sectoral classifications into 12 consumption categories, following closely the classifications of individual consumptions by purposes (COICOP), produced by the United Nations (2011).[9] This would provide a better understanding for the implication of higher energy prices on household consumption.

Table 5 presents the results of the increase in living costs associated with higher energy prices. In this analysis, we compared the current budget share (before price shocks) and the associated consumption loss when energy prices were raised. This is given in columns (1) and (2) of Table 5. In columns (3) and (4), the consumption loss was decomposed into the effects that are determined by direct and indirect effects. In estimating the consumption loss associated with the higher energy prices, we assumed no substitution among consumption of commodities takes place (i.e. zero price elasticity of demand for all commodities).[10] This is a reasonable approximation for the short-run analysis where households are likely to be consuming the minimum amount of the most affected commodities given the current level of income. Over time, households may adjust their budget allocation and possibly their stock of household goods (for example, switching to more energy efficient goods) which in turn minimises the consumption loss.

[9] There are 14 consumption categories classified by the United Nations (2011). In this study, however, some consumption categories have been consolidated because classifications that are available in the HES and input-output table could not support all classification categories of United Nations (2011).

[10] Silva *et al.* (2009) and Saboohi (2001), for example, also use this assumption for the estimation of consumption loss associated with higher energy prices.

Results suggest that consumption loss due to higher electricity price (Scenario 1) is minimal, accounting for a reduction of only 0.32 per cent. However, by taking into consideration the shock in the petroleum price (Scenario 2), the consumption loss is estimated to increase by 4.01 per cent. This consumption loss can also be interpreted as the increase in consumer expenditure by 4.01 per cent that would be required to purchase the same quantities of commodities, as before the price shocks, in order to maintain the same level of utility.

For the analyses of both scenarios, consumption of housing, water, electricity, gas and other fuels explains approximately half the consumption loss (0.17% for Scenario 1 and 2.00% for Scenario 2). The indirect effect contributes more than two-thirds for the consumption loss on expenditure on housing, water, electricity, gas and other fuels. This provides an indication that the increase in costs of production of other sectors that consume a large proportion of energy inputs further pushes the energy prices, which in turn passes the final increase to the households. In our detailed results, we observed that the indirect effect of petroleum sector is responsible the most for the total indirect effect. In addition to housing, water, electricity, gas and other fuels, other consumption items that have been affected the most are miscellaneous goods and services, and food and non-alcoholic beverages. This holds for the analyses of both scenarios.

Detailed results for different household groups are found in Table 6. For Scenario 1, consumption loss associated with higher electricity price for rural and urban households in West Malaysia is comparable at 0.32 per cent. In fact, the reduction in consumption share across commodities more or less shows a similar pattern between these two household groups. In East Malaysia, however, consumption loss of urban households is marginally (or 0.04%) higher than the rural households. The higher consumption loss for the urban East Malaysias households can be explained by the consumption loss in the expenditure on housing, water, electricity, gas and other fuels, and miscellaneous goods and services. Therefore, results for Scenario 1 analysis suggest that living costs of the urban households in East Malaysia are affected mostly from the higher electricity price.

Results for Scenario 2 indicate that the increase in living expenses of households in West and East Malaysia is comparable. The consumption loss of the urban households in West and East Malaysia is marginally higher than the rural households. In comparison to the rural households, consumption loss of urban households is 0.03 per cent higher for West Malaysia and 0.07 per cent higher for East Malaysia. It is important to note that although the living costs of the urban households are marginally higher, the average income of the urban households is more than double the income of the rural households (see Table 2). Therefore, taking into consideration the average income level of the rural and urban households, our results suggest that households with a low level of living standard in general, and the population in rural areas particularly, could be affected seriously from higher energy prices. Similar outcomes are found for similar types of studies in different countries which show that rural households have been most affected by higher energy prices (see Silva *et al.* 2009 for Montenegro; Gangopadhyay *et al.* 2005 for India; Saboohi 2001 for Iran).

Table 5. Impacts on consumption of aggregate household (%)

	Budget share (1)	Change in budget share (2)	Cont. of direct effect (3)	Cont. of indirect effect (4)
A. Scenario 1				
Food and non-alcoholic beverages	20.37	0.03	41.60	58.40
Alcoholic beverages and tobacco	1.07	0.00	25.44	74.56
Clothing and footwear	2.06	0.00	38.69	61.31
Housing, water, electricity, gas and other fuels	8.08	0.17	17.35	82.65
Furnishings, household equipment and routine household maintenance	3.43	0.00	45.51	54.49
Transport	4.60	0.01	43.40	56.60
Communication	3.23	0.01	58.46	41.54
Recreation and culture	7.22	0.02	50.31	49.69
Restaurants and hotels	0.74	0.00	59.59	40.41
Miscellaneous goods and services	41.66	0.06	53.01	46.99
Expenditure on non-profit institutions	0.71	0.00	11.56	88.44
Expenditure on general government	6.83	0.01	38.14	61.86
Total	100.00	0.32	32.22	67.78
B. Scenario 2				
Food and non-alcoholic beverages	20.37	0.45	40.58	59.42
Alcoholic beverages and tobacco	1.07	0.01	25.43	74.57
Clothing and footwear	2.06	0.03	20.80	79.20
Housing, water, electricity, gas and other fuels	8.08	2.00	20.71	79.29
Furnishings, household equipment and routine household maintenance	3.43	0.07	35.25	64.75
Transport	4.60	0.17	50.82	49.18
Communication	3.23	0.04	35.91	64.09
Recreation and culture	7.22	0.14	20.00	80.00
Restaurants and hotels	0.74	0.05	51.67	48.33
Miscellaneous goods and services	41.66	0.86	40.04	59.96
Expenditure on non-profit institutions	0.71	0.01	30.39	69.61
Expenditure on general government	6.83	0.17	21.28	78.72
Total	100.00	4.01	53.03	46.90

Source: Computed from equation (7)

Table 6. Impacts on consumption of disaggregated household groups (%)

	Scenario 1				Scenario 2			
	West Malaysia		East Malaysia		West Malaysia		East Malaysia	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Food and non-alcoholic beverages	0.04	0.03	0.04	0.03	0.54	0.42	0.64	0.43
Alcoholic beverages and tobacco	0.00	0.00	0.00	0.00	0.02	0.01	0.02	0.01
Clothing and footwear	0.00	0.00	0.00	0.00	0.04	0.03	0.04	0.03
Water, electricity, gas and other fuels	0.17	0.18	0.15	0.18	2.08	1.99	1.86	2.00
Furnishings, household equipment and routine household maintenance	0.01	0.00	0.01	0.00	0.16	0.04	0.07	0.07
Transport	0.01	0.01	0.01	0.01	0.14	0.17	0.32	0.19
Communication	0.01	0.01	0.00	0.00	0.04	0.04	0.02	0.03
Recreation and culture	0.02	0.02	0.02	0.02	0.16	0.12	0.19	0.16
Restaurants and hotels	0.00	0.00	0.01	0.01	0.04	0.04	0.07	0.08
Miscellaneous goods and services	0.05	0.07	0.05	0.07	0.63	0.93	0.61	0.84
Expenditure on non-profit institutions	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
Expenditure on general government	0.01	0.01	0.01	0.01	0.13	0.19	0.08	0.13
Total	0.32	0.32	0.30	0.34	3.99	4.02	3.92	3.99

Source: Computed from equation (7)

5. Conclusion

This paper examines the extent to which deregulation of energy prices affects costs of production and living costs of households. Results show that an increase in electricity price would have a minimal impact on producers and consumers. However, when both electricity and petroleum prices are allowed to increase simultaneously, results show that the energy prices have a considerable impact on costs of production and living costs of households. Generally, rural households, and particularly lower income groups could be largely affected by rising energy prices.

On the government side, our model estimates that about 65 per cent (which is equivalent to MYR 175 million) of additional revenue in the forms of indirect taxes (i.e. domestic and imported taxes) are expected to be collected as a result of rising energy prices (both electricity and petroleum prices). Therefore, as a counter policy, it would be a necessary for the government to compensate the consumption loss of households. The mitigating policies of energy price shocks can be designed for short-run and long-run perspectives. For short-run, mitigating actions such as direct cash transfers and unprecedented cash transfer programmes (i.e. printed subsidy coupons for selected commodities) to the lower income households might be considered. For the long-run, 'indirect' policies such as modernisation of public transportation and greater networks, and investment in other productive sectors could be considered as options. The 'best' policy options, however, are beyond the scope of this paper and depend largely on political considerations and the definition of the 'best' policy.

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Appendix 1. New electricity tariff effective 1 June 2011

Volume consumption	Current tariff (MYR)	Increment (MYR)
0 - 200 kWh	0 - 43.60	No changes
201 - 300 kWh	43.93 - 77.00	No changes
301 - 400 kWh	77.33 - 110.40	0.07 - 6.60
401 - 600 kWh	114.69 - 180.80	2.72 - 18.00
601 - 800 kWh	181.19 - 259.20	18.04 - 25.90
801 - 1000 kWh	259.62 - 345.50	25.93 - 30.30
More than 1000 kWh	Above 345.95	Above 30.30

Source: Ministry of Energy, Green Technology and Water (2011)
Note: kWh is kilowatt per hour.

Appendix 2. Subsidy and consumption of fuels, 2004-2009

	Gasoline	Diesel	LPG
A. Subsidy of fuels (MYR million)			
2004	641	3,344	803
2005	2,674	4,399	1,091
2006	1,859	4,287	1,135
2007	2,825	4,427	1,518
2008	5,250	7,873	2,255
2009	2,340	1,533	1,720
B. Consumption of fuels (million litter/KG)			
2004	14,646	5,563	
2005	15,235	5,622	
2006	15,363	5,467	1,770
2007	15,293	5,027	1,173
2008	16,875	6,039	1,317
2009	17,543	5,566	1,250
C. Proportion of subsidy (MYR per litter/kg of fuels)			
2004	0.044	0.601	
2005	0.176	0.782	
2006	0.121	0.784	0.64
2007	0.185	0.881	1.29
2008	0.311	1.304	1.71
2009	0.133	0.275	1.38

Source: Ministry of Domestic Trade, Co-operative and Consumerism (2011)