AN ECONOMIC ANALYSIS OF RAISING FUEL PRICE IN INDONESIA

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ABSTRACT

This paper outlines economic frameworks for analyzing the impact of increasing Juel price on the Indonesian economy. The discussions focus on the analysis of inter-fuels substitution, impact of raising fuel price on cost of productions and on the air quality, and the potential benefits-costs from the mentioned policy. The responsiveness of emission with respect to fuel prices makes fuel prices a powerful tool in the kit of indirect policy instruments available to the policy maker.

Several empirical researches show that Juel price can be formulated to induce inter-fuel substitution to reduce the pollution and not necessarily induce high inflation. However, increase in prices for pollution-laden fuels will generally lead to demand reduction, and the net effect on emission will depend on: whether other fuels will produce lesser pollutant, their cross price elasticities are positive, and which fuel share in the total input used are high (the higher the share of fuel the lesser the price elasticity - need higher percentage change in price to decrease the use of such fuel).

The impacts of fuel price policy on the Indonesian government budget is examined through change in the government revenue, both from the direct revenue of oils and natural gas sectors and taxation. Lastly, the fuel price policy could be directed to increase the air quality which beneficial for human being.

Key words: fuel pricing, inter-fuel substitution, emission elasticity, dose-response, pollution.

1. INTRODUCTION

Problem of air quality is becoming severe in many big cities in Indonesia. In Jakarta, the Indonesian capital city, death due to respiratory illness already are twice the national average, and annual air pollution costs estimated to be about $0.5 billion per year in 1995 (World Bank 1996). Without strong public action, this problem is likely to escalate in the near future. This is because of high rate of urbanization, increase concentration of industrial activities in the urban area, and the increase use of old cars and motor vehicles for commuter purposes.

As the World Bank (1996) reported, the main health threatening air pollutants in Indonesia's cities are suspended particulate matter (SPM), lead, carbon monoxide, sulfur and nitrogen oxides, and carcinogenic hydrocarbons (HC). Motor vehicles emissions are the biggest sources of this threat, contributing some 40-60% of SPM, 90-100% of lead, 89% of HC and 30-90% of remaining air pollutants. Moreover, rapid growth in the number of motor vehicles (over 20% per year), increasingly congested traffic, and longer commutes and rising daily exposure are all leading to sharply accelerating health costs.

In its country Department Report 1996, the World Bank suggested practical options to manage and reduce the air pollution problem applicable to Indonesia. These policies are: phasing-out leaded gasoline, setting higher standards, and/or phasing-out two-stroke motorcycles, and reducing diesel emissions. The World Bank also introduced additional measures to manage both the demand and supply of urban transport through setting higher fuel prices, improving public transport, congestion pricing, and better traffic management.

Many pros and cons come up regarding the cost and benefit of setting higher fuel prices policy. Setting high fuel price will increase cost of production. As a result, the Indonesian economy may experience high inflation (cost-push inflation). Such inflation may slow down the Indonesian economic growth. On the other hand, pricing mechanism is potentially attractive to the policy maker because the use of fuel provide a good proxy for the rate of use of polluting equipment. Thus, if individuals and firms are induced to economize with fuel use, or to switch to cleaner fuels then their emissions will be reduced (Eslceland et. al. 1994).

This paper is intended to provide an economic framework for analyzing the impact of increasing fuel price on the Indonesian economy. The discussion will focus on the analysis of the inter-fuels substitution, the impact of raising fuel price on cost of productions and on the air quality, and the potential benefits-costs from the mentioned policy. The next section will resume theoretical background of the analysis, namely the model of fuel elasticity of substitution and the emission elasticities. Section 3 presents the objectives and principles of the Indonesian oil policy. Section 4 reports estimated inter-fuel elasticities of substitution and emissions elasticities. Section 5 discusses the impacts of raising fuel prices on the Indonesian government budget and the social benefits. Summary and conclusion are presented in section 6.

2. PRICING POLICY, INTER-FUELS ELASTICITIES OF SUBSTITUTION, AND EMISSIONS ELASTICITIES

A fundamental principle of public policy to deal with the above air pollution problem is to address the pollution (externality) directly. An instrument that can be used is a tax levied on the individual emission. If we can set a (Pigouvian) tax equal to the marginal social damages, then we can assure that the polluters will operate at the social optimum level (Baumol and Oates 1988). However, the cost of implementation of this tax policy is very high. It would be very costly to monitor the flow of emission from each and every polluter. This is because there is a large number of motor vehicles and manufacturing firms. Other alternative instruments available are setting standards for emission rates by type of activity or equipment, and subsidy for reducing emission.

A pricing policy that sound environment will accord with the global trend to protect our environment is a second best policy. This is because controlling emission points will be too costly. With the second best policy, we focus on input used as a target policy as opposed to the amount of smog (emission control). Basically, fuel substitution and energy conservation are the two main transmission mechanisms by which changes in energy pricing policies affect emissions.

The analytical approach is to combine estimates of how fuel demand respond to prices, through econometric analysis, with engineering estimates of the technical link between input used and emission. The responsiveness of emission makes energy prices a powerful tool in the kit of indirect policy instruments available to the policy maker. Changes in industrial energy use can be thought of as coming from one of the three sources: changes in the inter-industry mix of goods produced, changes in the intra-industry output shares of the products, or changes in the intra-firm energy intensity of individual producers (Moss and Tybout (1996)).

The set of price defined in this paper is the efficiency price, namely prices that strictly matches economic costs, including depletion allowances, risk premiums, environmental abatement costs and user costs. Moreover, such efficiency prices should, accommodate financial, fiscal, social, and environmental objectives described in the objectives and principles of oil polices.

The framework of modeling inter-fuel elasticities of substitutions and emission elasticities are as follows. Let the production function be written as in equation (I).[1]

$$y = f\,(x_1, x_2, \ldots x_m) \qquad (1)$$

where y is the quantity of output and X; is the quantity of input i used, for m input types. Let assume the emission of air pollutants be determined by the firm's use of inputs, as equation (2).

$$e = e\,(x_1, x_2, \ldots x_m) \qquad (2)$$

Next, assume we have a production function that is weakly separable and homothetic in inputs, such as energy (E), capital (K), labor (L), and material (M). This means that for the subset of inputs designated as m types of fuels i.e. $x_1, \ldots, x_m$, the effect of fuel used on output can be summarized by its effects on the value of an aggregate energy function $E=E(x_1, \ldots, xm)$. Thus the marginal rates of substitution between fuel depend only on the use of fuel, and marginal rates of substitution between aggregate inputs depend on E, and not on the use of individual fuels. It is assumed that the aggregate energy function is homothetic with respect to its respective components and the cost function associated with the energy sub model is linearly homogeneous in aggregate E.

By these assumptions, the production function of equation (1) can be rewritten as follows:

$$y = f\,(K, L, M, E\,(X_1, X_2 \ldots X_m)) \qquad (3)$$

By assuming that K is constant, the short term cost function is

$$C = C\,(Y, K, p_L, p_M, p_E\,(p_1, p_2, \ldots, p_m)) \qquad (4)$$

[1] The procedure and modelling framework in this paper was pioneered by Jorgenson, Christensen, and Lau, JCL (1971), see Eskeland (1994), Pitt (1985).

where P represents prices of inputs used and P's with numerical subscripts are fuel prices. Using Sheppard's lemma, we can write the demand for fuel X_i in the form of share cost equation:

$$xi = xi\ [\ E\ (Y, K, p_L, p_M, p_E \ldots\ldots$$

$$(p_1,p_2,...,p_m),\ p_1,p_2,...,p_m)]\ \ldots\ldots = \frac{\partial C}{\partial p_i} \qquad (4)$$

There are two concepts of demand elasticities with respect to individual prices of fuel j, P_j. First, consider the substitutability of one fuel for another, while aggregate energy is held constant. Second, the substitutability between inputs (and among them, between individual fuels) when output is held constant, but the aggregate energy and the other aggregate inputs change. The relationships between the two demand elasticities are as follows:

$$-ij = {}_{-EE}{}^{*}Sj + {}_{-ij\ -E\ constant} \qquad (6)$$

where $\varepsilon_{ij\ (Econstant)}$ reflects the price elasticity under the assumption that aggregate energy use, E, remains constant, and ε_{EE} is the elasticity of aggregate energy with respect to P_E.

Both these elasticities would be used in analyzing the effect of price changes on emission. The above elasticity equation allows us to focus on inter-fuel substitution in isolation. One also could allow compensatory price changes for the energy aggregate, so that P_E is held constant while the relative prices between fuels are changing (keeping the aggregate energy used constant).

We can substitute input demand function into the emission function to determine the effect of price of fuel j on emission. This effect measures the elasticity of emissions with respect to P_j

$$\frac{\partial e}{\partial P_j} \cdot \frac{P_j}{e} - E\ constant = \frac{1}{e} \sum e_i\ x_i\ {}_{-ij\ -\ E\ constant} \qquad (7)$$

where e_i is the partial derivative of emissions with respect to x_i

Similarly allowing for adjustment of the price of aggregate energy, P_E, and thereby adjustment of the overall energy used, the elasticity of emissions holding the output constant can be obtained.

$$\frac{\partial e}{\partial P_j} \cdot \frac{P_j}{e} = \frac{1}{e} \sum e_i\ x_i$$

$$= \frac{1}{e}\sum\left(esubi\ \ x_i\left(-EE\,S_j + _{\text{-ij - E constant}}\right)\right) \qquad ......(8)$$

Equation (8) shows that the effect of a price change on emission depends on the sum of demand elasticities weighted by each fuel's role in emission, eiXi/e.

3. OBJECTIVES AND PRINCIPLES OF INDONESIAN OIL POLICY[2]

At its peak in 1980-1981, the oil industry of Indonesia provided for more than 70% of the government domestic budgetary revenue and almost 82% of export earnings. The high dependence on oil proved to be a major

weakness in the following years when international oil prices began a steady decline after 1982 and eventually collapsed in 1986. Even so, it remains the single most important source of foreign exchange and fiscal revenue. Crude oil and refined petroleum products accounted for 15% of total export earnings in 1994, while budgetary revenue from oil companies provided 16.1% of domestic government revenue during fiscal year 1994/1995. In view of this, the Indonesian government's strategies and objec^ tives for this sector are as follows:

a. The economic (efficiency) objective: to meet the country's energy requirements in the very least cost way, and conserve exportable petroleum reserves, principally by encouraging the domestic market to substitute oil consumption by alternative fuels for which there is non-exportable surplus (e.g. gas and coal) or which are non tradable (e.g. hydropower and geothermal).
b. The resource mobilization (financial and fiscal) objective: to maximize the country's foreign exchange earnings and budgetary revenues, and enable producers to recover their costs and obtain sufficient resources to finance their growth and development. This requires that the enterprises be able to earn a reasonable rate of return on their assets and self-finance part of their investment.
c. The social (equity and fairness) objective: to promote the regionally balanced development of the country and enable most of the people to afford the basic services provided by energy (for lightening, cooking, transportation). The government has been keen to make kerosene, diesel oil and electricity available in

[2] This section refers to Bank Indonesia (1994), Indonesia-Country Profile (1990-1995), World Bank (1990)

all parts of the country in a uniform manner and to keep their prices at subsidized levels.

d. The environmental objective: to promote the production and utilization of energy resources in a manner that will conserve the environment for future generation.

In addition to the above policy oriented objectives, there are also some practical objectives of pricing design that relate to inadequacy and uncertainty of the underlying data frequency of adjustment simplicity in price structures, ease of administration and conformity with contrac-ual agreements and country's legal framework. In short, there is the possibility to adjust the current fuel price to the desired economic level provided the above considerations are met.

4. ESTIMATE OF INTER-FUELS SUBSTITUTION

Increasing the fuel price to their economic price levels seems to be in line with the objective of conserving the fuel reserve for export purposes, inducing the use of alternative sources of energy (gas, coal, hydropower and geo-thermal), and supporting the environment conservation. But, the increase will be in contrast with the objective to support economic growth by providing low price in the domestic market, to increase the distribution of income and support of low level income activities to meet their basic needs. However, combination of or a package of regulation may be implemented to reduce negative impacts of the adjustment of fuel price toward the economic price.

Table 1. Partial Fuel Price Elasticities

Sector 311

Price / Quantity	Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
Electricity	-1.3388 (0.1149)	-0.0166 (0.3440)	0.3813 (0.2030)	0.6138 (0.1974)	0.3487 (0.2383)
Gasoline	0.1088 (0.1558)	-2.3020 (0.4168)	-.1602 (0.2592)	0.8987 (0.2442)	0.9502 (0.2962)
Fuel Oil	0.6944 (0.0671)	0.3694 (0.1840)	-0.8084 (0.1096)	0.3345 (0.1056)	0.7517 (0.1284)
Diesel	-0.1922 (0.2468)	3.4725 (0.6739)	-0.3696 (0.4130)	-4.0597 (0.3604)	0.5228 (0.4746)
Kerosene	0.1896 (0.1554)	0.9904 (0.4256)	1.1603 (0.2561)	0.8318 (0.2457)	-3.5536 (0.2747)

Sector 381

Price / Quantity	Electricity	Gasoline.	Fuel Oil	Diesel	Kerosene
Electricity	-2.8214 (0.1569)	0.9196 (0.3265)	0.4613 (0.2038)	0.9761 (0.2675)	0.8649 (0.2866)
Gasoline	0.2181 (0.1806)	-1.3492 (0.3670)	-0.2028 (0.2387)	-0.3002 (0.3176)	1.3016 (0.3307)
Fuel Oil	1.6326 (0.1152)	0.0739 (0.2399)	-0.7477 (0.-1420)	-0.0637 (0.1965)	0.1763 (0.1085)
Diesel	1.2988 (0.1802)	0.8543 (0.3849)	-0.0260 (0.2318)	-1.4636 (0.5452)	-1.3779 (0.3533)
Kerosene	0.3023 (0.2420)	0.6443 (0.5011)	1.0906 (0.3061)	1.0295 (0.4139)	-3.7509 (0.4150)

Figures in the brackets are standard errors.
Source: Mark M. Pitt (1985)

Pitt (1985) examined the industrial energy demand with firm level data for the case of Indonesia. He modeled the variable cost function of the food processing (ISIC 311) and fabricated metal product (ISIC 381) as a non homothetic translog second-order approximation. The elasticity of substitutions are calculated from the estimated share cost function. He found that most fuels in most sectors are substitutes. The statistically significant cross-price elasticities of all fuels for all sectors with respect to the price of electricity are positive. Among pair-wise patterns of substitutability, fuel oil and electricity seems to be one of the strongest. In addition the elasticity of kerosene demand with respect to the price of fuel oil is large (exceeds 1). Thus, decrease in the price of kerosene (clean fuel) relative to fuel oil may induce substantial substitution of kerosene for fuel oil in many manufacturing sectors.[3]

In addition, Pitt estimated the elasticities of average total cost with respect to the price of aggregate energy and each of the five fuels (electricity, gasoline, fuel oil, diesel, and kerosene). These results are reported in table 2.

These elasticities shows the effect of energy price increases on the total cost of output, assuming constant level of output and capital. Pitt noted that fuel's oil price would appear to be the most important of the five in influencing cost of production. The increase of price of fuel oil will reduce its use and decrease production cost And,

[3] Dirty fuels are: coal, fuel oil, gasoline, HSDO (High Speed Diesel). Clean Fuels are: Diesel, Kerosene, and Natural Gas.

overall doubling of energy prices will only result in a 3% increase in the total cost. Increase of cost of production due to increase in the energy price will not worsen the inflation rates.

Table 3 reports Eskeland's et. al (1994) research on the elasticity of fuel prices in the manufacturing sector while holding the aggregate energy constant. It is shown that the own price elasticities are generally large in absolute value, ranging from -.83 for groups fuel to -1.5 for coal. The cross price elasticity takes both signs, but most of them are positive and thus reflect the substitutability between fuels. Substitution effect will induce the increase of demand for clean fuel in response to increase in the price of dirty fuel. Therefore, the government may induce increase in consumption of clean fuel by increasing the relative price of the dirty fuel without any major impact on the increase in the cost of production.

Table 2 Energy and Total Cost Elasticities[1]

Sector	$\eta_{EE}^a = -\eta_{EL}$		$\eta_{LL}^a = -\eta_{LE}$		$\eta_{TC,E}$	$\eta_{TC,1}^b$	$\eta_{TC,2}^b$	$\eta_{TC,3}^b$	$\eta_{TC,4}^b$	$\eta_{TC,5}^b$
311	−0.7053	(0.0244)	−0.1704	(0.0059)	0.0184	0.0038	0.0019	0.0090	0.0013	0.0024
312	−0.6777	(0.0196)	−0.2160	(0.0063)	0.0296	0.0032	0.0044	0.0173	0.0010	0.0036
313	−0.7207	(0.0349)	−0.1132	(0.0055)	0.0136	0.0050	0.0030	0.0037	0.0002	0.0017
314	−0.6899	(0.0542)	−0.0662	(0.0052)	0.0028	0.0011	0.0008	0.0006	0.0001	0.0002
3211	−0.6214	(0.0239)	−0.1619	(0.0062)	0.0300	0.0185	0.0015	0.0064	0.0015	0.0021
321	−0.6045	(0.0358)	−0.0968	(0.0057)	0.0213	0.0113	0.0016	0.0063	0.0006	0.0015
322	−0.4641	(0.0637)	−0.0390	(0.0054)	0.0099	0.0076	0.0012	0.0009	0.0001	0.0001
323	−0.5184	(0.0306)	−0.1191	(0.0059)	0.0078	0.0036	0.0007	0.0029	0.0003	0.0002
324	−0.4749	(0.0619)	−0.0412	(0.0054)	0.0141	0.0071	0.0023	0.0039	0.0004	0.0005
331	−0.4168	(0.0440)	−0.0775	(0.0082)	0.0222	0.0015	0.0041	0.0159	0.0004	0.0002
332	−0.0742	(0.0873)	−0.0064	(0.0075)	0.0220	0.0079	0.0039	0.0101	0.0000	0.0001
341	−0.4923	(0.0416)	−0.1107	(0.0093)	0.0235	0.0041	0.0027	0.0125	0.0025	0.0016
342	−0.3724	(0.0656)	−0.0491	(0.0086)	0.0240	0.0142	0.0040	0.0038	0.0004	0.0016
351	−0.5747	(0.0331)	−0.1637	(0.0094)	0.0377	0.0047	0.0030	0.0246	0.0038	0.0016
352	−0.5013	(0.0618)	−0.0676	(0.0083)	0.0134	0.0039	0.0030	0.0049	0.0003	0.0013
355	−0.5679	(0.0288)	−0.1947	(0.0099)	0.0141	0.0032	0.0014	0.0069	0.0016	0.0009
356	−0.5749	(0.0357)	−0.1437	(0.0092)	0.0289	0.0069	0.0022	0.0165	0.0023	0.0009
361	−0.5252	(0.0228)	−0.4489	(0.0195)	0.1567	0.0274	0.0109	0.0482	0.0565	0.0136
362	−0.6400	(0.0308)	−0.3314	(0.0159)	0.0799	0.0154	0.0045	0.0196	0.0351	0.0053
363	−0.3295	(0.0918)	−0.1071	(0.0118)	0.0293	0.0099	0.0037	0.0142	0.0008	0.0007
364	−0.7356	(0.0588)	−0.1706	(0.0128)	0.0752	0.0032	0.0054	0.0480	0.0123	0.0062
369	−0.7528	(0.0482)	−0.2095	(0.0134)	0.0486	0.0004	0.0044	0.0402	0.0023	0.0013
381	−0.5795	(0.0349)	−0.1016	(0.0061)	0.0166	0.0049	0.0023	0.0072	0.0010	0.0011
382	−0.5173	(0.0483)	−0.0626	(0.0058)	0.0210	0.0107	0.0026	0.0058	0.0005	0.0013
383	−0.5567	(0.0405)	−0.0821	(0.0060)	0.0117	0.0035	0.0020	0.0047	0.0007	0.0008
384	−0.5030	(0.0508)	−0.0575	(0.0058)	0.0093	0.0030	0.0017	0.0038	0.0002	0.0005
385	−0.4114	(0.0656)	−0.0355	(0.0057)	0.0097	0.0053	0.0011	0.0015	0.0000	0.0018

[a] Elasticities are followed by approximate standard errors in parentheses.
[b] 1 = electricity, 2 = gasoline, 3 = fuel oil, 4 = diesel, 5 = kerosene.

Table 3: Price Elasticities: Aggregate Energy Held Constant

Price / Quantity	Electricity Price	Others'	Coal Price	Diesel Price	Grouped Fuel Price	Natural Gas Price
Electricity	-1.02 **(.11)	.17 *(.09)	.09 **(.04)	.04 (-03)	.80 ** (.15)	-.08 **(.02)
Fuel Oil	.23 *(.12)	-1.26 ** (.29)	.04 (.06)	-.16 *(.09)	1.1 ** (.31)	.14 ** (.05)
Coal	.27 ** (.12)	-.09 (.33)	-1.51 ** (.12)	-.20 *(.12)	-1.06 ** (.24)	.06 (.04)
Diesel	.06 (.04)	.23 (.18)	.09 *(.05)	-1.37 ** (.10)	1.40 ** (.1-8)	-.00 (.11)
Grouped Fuels	.22 **(.04)	.39 **(.18)	-.09 ** (.02)	.28 ** (.04)	-.83 ** (.10)	.01 (.01)
Natural Gas	-1.11 **(.26)	-.09 (.43)	.27 (.17)	-.02 (1.04)	.59 (.69)	-1.21 *(86)

** means significant under 5%, * significant under 10%.
Source: Eskeland et. al. (1994)

The impacts of changing energy price on the emission is reported in table 4. In this report, it assumed that emission depend only on the amounts of energy used. By using the demand for energy and its price elasticities we can calculate the elasticity of emission with respect to energy prices. The pollutants include TSP: Total Suspended Particles or Dust, Sulfur Oxide, SO_X or smog, Nitrogin Oxide, NO_X, VOC: Volatile Organic Compounds and Carbon Monoxide, CO. It is observed that, price increase for electricity and coal would help to control TSP, whereas price reductions to grouped fuels (diesel and gasoline) would also help. For SO_X control, price increase for fuel oil and coal or reductions for gasoline and diesel would help.

Table 4 Emission Elasticities, Energy Constant

Price / Quantity	Electricity	Other Fuels	Coal	Diesel	Group Fuels	Natural Gas
TSP	-.21	-.03	-.83	.12	.94	.01
SOx	.02	-.44	-.37	-.09	.83	.05
NO_X	.12	-.55	-.14	-.17	.67	.07
VOC	.12	.15	-.07	.23	-.47	.01
CO	.13	.15	-.09	.22	-.42	.01

Source: Eskeland et. al. (1994)

The above researches show that energy price can be formulated to induce inter-fuel substitution to reduce the pollution. However, increase in prices for pollution-laden fuels will generally lead to demand reduction, and as expected, the net effect on emission will depend on: whether other fuels will produce lesser pollutant, their cross price elasticity are positive, and which fuel share in the total input used are high (the higher the share of fuel the lesser the price elasticity - need higher percentage change in price to decrease the use of such fuel).

5. IMPACTS OF RAISING FUEL PRICES ON THE INDONESIAN GOVERNMENT BUDGET AND SOCIAL BENEFITS

There are two different set of linkages between the energy sector and the Indonesian government budget (see for example Lewis 1993, Bank Indonesia 1994). The most obvious is the revenue flow from the oil and Liquified Natural Gas (LNG) sectors to the government budget. As mentioned earlier, revenues from oil and gas exports still represent a large source of revenue. An additional linkage occurs through the system of indirect taxes and controlled prices that the government regulates. Fuel products are subject to the value added tax, and the tax component is included in the retail prices set by the government. Pertamina, the state-owned company, accounting for its fuels operation (selling and procuring oil for domestic market) requires it to sell fuel products at controlled prices; however it also receives the world price for the oil used in producing the refined fuel products. With revenues largely fixed, and cost varying in the movement of world oil prices or Indonesia's exchange rates, the Pertamina's fuel systems can either produce net revenue for the government (when world oil prices are low) or require a net subsidy (when prices are high).

The impact of raising domestic fuel prices on the government budget are complicated by the variations in the world oil prices and the fluctuations of the exchange rates. Since the current domestic fuels market are set below the economic prices, due to subsidy, increasing set price of domestic fuel will increase the government revenues. As illustrated in the following table, setting the fuel prices equal to their economic prices and imposing value added tax will generate additional government revenue.

Table 5: Economic Subsidies and Taxes on Petroleum Product

	Official Price (Rp/Liter)a)	Economic Cost (Rp/Liter)b)	Price/Cost Ratio	Tax/Subsidy (Rp/Liter)	Incremental Revenue (Rp Billion)c)
Aviation gas	330	291	1.13	39	0
Aviation Turbo	330	324	1.02	6	20.4
Gasoline	450	335	1.34	115	0
Kerosene	190	314	0.61	(124)	225.7
Automotive Diesel	245	372	0.66	(127)	415
Industrial Diesel	235	294	0.80	(59)	44.9
Fuel Oil	220	192	1.15	28	0

a. Official Price at the depot or gas station pump, per May 1990
b. Including 20% road user charge for gasoline and automotive diesel
c. Incremental revenue from adding 10% VAT to efficiency prices, for products whose prices are below that leve and multiplied by estimated consumption level.

Source: World Bank (1990)

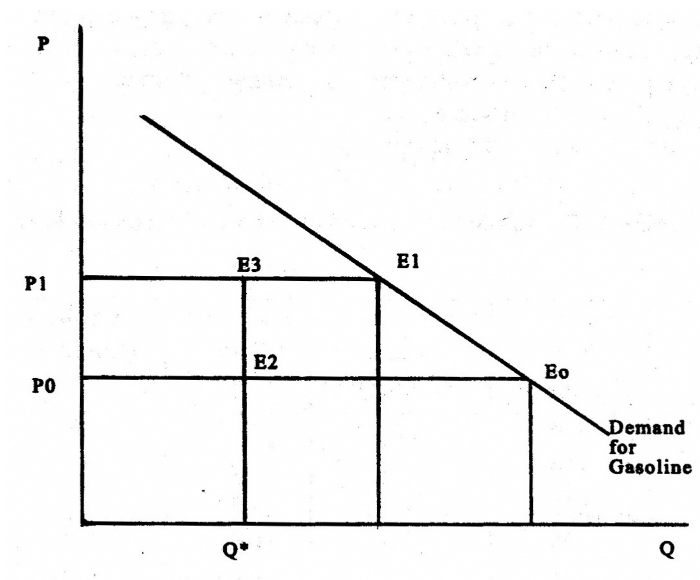
The analysis of the impacts of raising domestic fuel prices on the social welfare in this paper will be focused on the welfare loss due to the decrease in the consumers surplus and welfare gain due to a better air quality. There is no doubt that increase in the domestic fuel prices will reduce the consumers surplus. But, the burden may be different amongst households whose share of fuel consumption with respect to their total expenditures are different. In general, the higher the share of fuel consumption in the total expenditures, the larger the welfare loss.

Many compensation schemes may be implemented to reduce the above loss, mainly to the poor. The schemes should be intended to support the social (equity and fairness) objective of oil policy. Alternative scheme may be in the

form of lifelines rates, vouchers, increasing social assistance payments, and general adjustments to wages and pensions (Freund and Wallich 1996). The lifelines rates basically set the price for small volumes of consumption at low levels. This is administered by the utilities which provide discounted prices to consumer for a single needed block of energy while charging full price for any consumption of excess energy over the limited lifeline block.

Graphical illustration:

Raising fuel price from P_0 to P_1 will reduce the consumer surplus $P_0E_0E_1P_1$. Under the lifeline price, the first block OQ* is set at the original price P_0, and consumption above Q* will be charged at P_1. Thus the consumer surplus loss reduced to $E_2E_3E_1E_0$.



There is no question that a better quality of air will be beneficial to human being. These benefits are dependent on the expected health effects of the pollutant, the magnitude of the effect in response to air pollution (dose-response), the economic valuation of the adverse effect, and the existence of sub-populations particularly sensitive to air pollution. Information about health and economic effects of air pollution need to be categorized for pollutants commonly discharged by mobile and stationary sources. Five pollutants are considered in this paper: paniculate matter (TSP), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone, and lead.

The benefit of a better air quality developed by Ostro (1990) are calculated using the following steps. First, the dose-response function, the relationship between the change in the prevalence of a given health effect associated with a change in outdoor air quality (A) is estimated. Then, multiply this estimate by the number of population at risk of health effect i and the change of air pollution under consideration result the change in population risk of health effect i. The change of air pollution is calculated as the change from current air pollution levels to some standard (in this case Indonesian standard), to simplify the threshold effect. The Indonesian ambient air quality standards for annual average used is 90 micrograms/m^3 (μ/m^3) for Total Suspended Particles (TSP), 0.5 (μ/m^3) for lead, 100 (μ/m^3) nitrogen dioxide, 60 (μ/m^3) sulfur dioxide, and 200 (μ/m^3) ozone. The value of the health effects then is calculated based on the willingness to pay (WTP) for reducing risk or modify cost of illness approach. Ostro reported that decreasing the current ambient level to the standard will result in the following benefits.

Table 6 Health Benefit of Reducing Particulate Matter to Indonesian Standard

Health Effect	Low	Medium	High
Premature Mortality	750	1,200	1,600
Hospital Admissions	1,100	2,000	2,700
Emergency Room Visit	22,100	40,600	59,100
Restricted Activity Days	4,460,000	6,330,000	9,905,000
Lower Respiratory Illness (Children)	49,300	104,000	146,600
Asthma Attacks	232,000	464,000	3,885,000
Respiratory Symptoms	15,705,000	31,000,000	47,100,000
Chronic Bronchitis	4,800	9,600	14,300

Health Benefit of Reducing Ambient Lead

Standard			
Effect	Indonesian	WHO	90% Reduction
Hypertension Non-fatal	62,350	135,660	241,000
Heart Attacks	68	190	559
Premature Mortality IQ	57	1588	461
Loss (point)	1,091,860	2,073,205	3,130,918

Source: Ostro (1994)

6. SUMMARY AND CONCLUSION

This paper provides empirical application of pricing policy to address environment quality improvement. The economic framework for analyzing the impact of increasing fuel price on the Indonesian economy is examined. The discussion focuses on the analysis of the inter-fuel substitution, the impact of raising fuel price on the cost of productions and on the emission reduction (improvement of the air quality). The welfare effects of pricing policy are focused on the health effects and the consumer surplus effects.

Using sub-sectors: food processing (ISIC 311) and fabricated metal product (ISIC 381), Pitt (1985) showed evidences of substitutability pattern amongst the fuel used in these sub sectors. Thus, we can exercise fuel price policies to induce the use of clean fuel in place of dirty fuel. Moreover, the increase of fuel prices will not worsen the inflation rates. This is because doubling fuel prices will result in only 3% increase in total cost. These results were confirmed by Eskeland et. al. (1994) using the manufacturing sector. He further examined the elasticity of emission in response to increase in fuel prices.

The above researches showed that we can formulate energy price to induce inter-fuel substitution to reduce the pollution. What we have to be careful is that increased prices for pollution-laden fuel will generally lead to demand reduction, and as expected, the net effect on emission will depend on: whether other fuel will produce lesser pollutant, their cross price elasticity are positive, and which fuel share of the total input used are high: the higher the share of fuel the lesser the price elasticity (need higher percentage change in price to decrease the use of such fuel).

The improvement of air quality will be beneficial to human beings. Ostro (1990) showed that the decrease in the ambient level down to the standard will improve the human health status such as Premature Mortality, Hospital Admissions, Emergency Room Visit, Restricted Activity Days, Lower Respiratory Illness (Children), Asthma Attacks, Respiratory Symptoms, Chronic Bronchitis, Hypertension, Non-fatal Heart Attacks, Premature Mortality, and IQ Loss (point). The value of the above health improvement may be calculated by using cost saving method or willingness to pay method.

The increase in fuel prices will also affect the consumers surplus. However, there exist alternative policies such as lifeline pricing, vouchers, increasing social assistance payments, and general adjustments to wages and pensions to provide compensation for the needy.

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APPENDIX

The Three-Digit ISIC CODES

ISIC CODES-Sectors	ISIC CODES - Sectors	ISIC CODES- Sectors
311 Food Processing	3211 Spinning and Weaving	331 Wood and Wood Products
312 Other food products	321 Textiles except 3211	332 Wood Furniture

313 beverages 314 Tobacco Products	322 Wearing apparel 323 leather and leather Substitutes 324 Leather footwear	341 paper and Paper products 342 printing and Publishing

ISIC CODES-Sectors	ISIC CODES-Sectors	ISIC CODES-Sectors
351 basic Chemicals 352 Other Chemical product 355 Rubber Products 356 Plastic wares	361 Ceramic and Porcelain 362 Glass and Glass Products 363 Cement and Cement Products 364 Structural Clay Product 369 Other non Metallic product	381 Fabricated metal products 382 machinery except electrical 383 Electrical Machinery 384 Transport Equipment 385 Measuring and Optical Equipment

Emission factors (kg/TOE) and Each Fuel's Role in Emission

Emission Factors Role, (%)	Electri-city	Others incl. Oil	Coal	Diesel	Grouped Fuel	Natural Gas	Weighted Average	TOE/ BNS Output
TSP	34.8 (37%)	.8 (4%)	23.2 (57%)	.3 (1%)	.2 (1%)	0 (0%)	6.2 (100%)	1598
SOX	65.4 (16%)	36.3 (37%)	43.6 (26%)	12.8 (9%)	12.8 (12%)	0 (0%)	26.2 (100%)	6711
NOX	3.6 (6%)	6.2 (46%)	2.4 (10%)	2.6 (13%)	2.6 (23%)	0 (0%)	3.6 (100%)	9910
VOC	.3 (6%)	.0 (2%)	.2 (10%)	.0 (1%)	.9 (80%)	0 (0%)	0.3 (100%)	80
CO	9.6 (7%)	.7 (2%)	6.4 (12%)	.6 (1%)	25.1 (77%)	0.05 (0%)	8.6 (100%)	2201

TSP: Total Suspended Particles or Dust, TOE: Ton Oil Equivalent. VOC: Volatile Organic Compounds. Others Fuel: Fuel Oil, Kerosene, Wood etc. Grouped Fuel: Gasoline and HSDO.