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Indonesia
Selected Issues of Energy Pricing Policies

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CURRENCY EQUIVALENTS

Before November 15, 1978	US$1.00 = Rp 415
Annual Averages 1979-82	
1979	US$1.00 = Rp 623
1980	US$1.00 = Rp 627
1981	US$1.00 = Rp 632
1982	US$1.00 = Rp 661
After March 30, 1983	US$1.00 = Rp 970

FISCAL YEAR

Government	-	April 1 to March 31
Bank Indonesia	-	April 1 to March 31
State Banks	-	January 1 to December 31

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INDONESIA

SELECTED ISSUES OF ENERGY PRICING POLICIES

This report is based on the findings of two missions to Indonesia; one in November 1981 and the second in February 1982. The missions consisted of the following:

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SUMMARY AND CONCLUSIONS

Introduction

Indonesia is a country richly endowed with an energy resource base. In addition to oil, this base includes coal, natural gas, hydroelectric power and geothermal energy. As a result of the changing international environment and the events of the last decade, Indonesia has had to undergo a structural transformation process which, among other things, has necessitated a change in the economic policy environment, particularly with respect to the efficient use and allocation of the vast energy resources. Consequently, a much closer attention is now being paid in Indonesia to energy policy formulation and on the role of energy in the economic development process.

Needless to say, Indonesia is not unique in having to address these energy policy issues. The two oil price shocks of the seventies, which affected all capital-importing oil exporters through the large and sudden increase in oil revenues, brought to the fore the problems of short- and medium-run economic management and the related questions associated with the exploitation and allocation of the countries' energy resources. The recent instability in the world oil market has placed an even greater urgency on these issues and the Government of Indonesia, fully recognizing the enormity of the task, has begun the process of developing a consensus on national energy policy.

This report is designed to aid in the formulation of that policy. Its specific focus is on the pricing of energy products and the implications of increasing energy prices on the industrial, household, and transport sectors and on the macroeconomic environment. As can be seen from the past actions of the Government, it is committed to a gradual increase in the price of energy until the domestic price reflects its scarcity value to the economy. Understandably, a major concern of the Government reflects the effects of such a significant policy change on the three major energy-consuming sectors mentioned above and on the important macroeconomic variables. Consequently, this report--which was completed prior to the latest increase in the price of energy (in January 1983) and the devaluation of the rupiah in March 1983--is designed to outline to policy makers in the Government the extent to which the demand for energy in Indonesia is responsive to price changes, the possibilities of interfuel substitution, the substitutability of energy with labor and capital, the welfare effects on the poor, the implications for deforestation in rural Java and the impact on macroeconomic variables such as output and the price level.

To provide a quantitative basis for the conclusions of this report, the techniques of analysis used in addressing the issues referred to above involve econometric modelling. The models developed and used in this report involve as close a representation of reality as the state of the art permits today. The advantages of this approach are that the many restrictive assumptions that are explicitly or implicitly made in traditional analytical techniques such as the use of energy balances or energy shares in total costs or even simple regression analysis are not made here. The resulting solutions are, thus, more accurate representation of (household and industrial) economic behaviour than those that are derived from using more limited analytical techniques. Nevertheless, it should also be recognized that all models are at best only approximations of reality and, thus the numbers presented in this report are intended to be illustrative only. Also the data used in this analysis have been obtained from the BPS (Central Bureau of Statistics), Surveys of Industry (various years), and SUSENAS household surveys. Though questions always arise about the quality of data in developing countries, it should be pointed out that in Indonesia, significant strides have been made, since the mid-seventies, in improving the quality of data. Also, there is no evidence to indicate a systematic under- or over-reporting of information by firms or households. Any errors in the data are assumed to be random in nature and statistical tests have been performed to determine the level of confidence one might have in the resulting estimates; these are presented in the main report. The results obtained correspond with one's prior notion of substitution possibilities. The estimates are not consistent with extremely poor data. There is, therefore, no reason to believe that the major conclusions that emerge from this analysis are affected by models used or by the quality of data so long as the emphasis of the results is placed on orders of magnitude, rather than absolute values, and on the direction of change.

Recognizing this and the fact that differences in energy use cannot be explained in the aggregate, this report conducts the analysis at a fairly disaggregated level. The three sectors -- which together account for almost 92% of total energy consumption in Indonesia -- are, therefore, disaggregated into their component parts. Thus, the industrial sector is disaggregated into 27 subsectors and within each subsector the structure of demand is analyzed by decomposing energy into the five major energy sources and by differentiating this demand by geographical location; the household sector is characterized by various attributes such as income levels, regional and urban/rural location; and the transport sector is broken down into the road, rail and maritime subsectors. By so doing, it is hoped that this report will contribute to an improved understanding of the disaggregated nature of energy demand in these three sectors and on the resulting implications of changing energy prices. At the macroeconomic level, the report focuses on the possible effects of rising energy prices on nominal wages, the consumer price index, output, employment and profits. And, finally, the report attempts a brief discussion on the approaches to eliminating energy subsidies; viz., it outlines the pros and cons of sudden and gradual price increases to aid policy makers in formulating a strategy to increasing energy prices that would be most suitable in the Indonesian context.

The Background

Over the past decade, oil and LNG exports have dominated non-oil exports in Indonesia. In 1980-81, they accounted for almost 75% of total exports, whereas in 1973-74 they accounted for only 37%. Thus, over the recent past, the structure of exports has shifted dramatically in favor of the oil sector. This has naturally been reflected in the budget of the Central

Government. In 1980/81, revenues from this source accounted for almost 60% of total budgetary revenues.

However, small shifts in the world price of oil can have a significant effect on Indonesia's external resource balance and on revenues in the budget. For example, a $1 per barrel change in the international price of oil can lead to a change of $300 million in the external resource balance. The recent glut of oil on the world markets -- which led to a reduction of oil production in Indonesia from a planned 1.64 million barrels per day to 1.3 million barrels per day -- resulted in a net reduction of almost $5 billion in Indonesia's current account; in 1980/81 the current account surplus stood at $2.2 billion and in 1981/82 it is estimated to show a deficit of $2.8 billion. Fortunately for Indonesia, its rich energy resource endowments can, at least in part, mitigate the uncertainties introduced by the vagaries of the international oil market, but only if these resources are carefully husbanded. This necessitates both the development of alternate energy resources -- which are expected to require large investments (almost 2% to 4% of GDP or about $10 billion) -- and an improved allocation of these resources through proper pricing policies; the growth in the primary consumption of energy as high as 16% per annum between 1977-79 highlights the need to reduce the domestic demand for energy which has resulted mainly from the subsidized domestic pricing structure of oil products.

The domestic prices of energy fuels in Indonesia remain below their international levels. As of December 1981, the weighted average price of energy amounted to 35% of the international price. Except for premium gasoline, all forms of commercial energy were subsidized, with the kerosene price at one extreme (18% of the international price) and regular gasoline at the other (79% of the world price). This, of course, resulted in large budgetary and economic subsidies to oil products. In 1981/82, the total budgetary subsidies amounted to Rp 1.4 trillion ($2.3 billion) -- an increase of 40% over 1980/81 -- and the economic subsidy was even larger (Rp 2.8 trillion). The costs associated with the economic subsidy arise from the diversion of budgetary resources away from other more economically beneficial uses into the oil sector, the misallocation of the country's resources arising from subsidized energy prices, and the administrative and bureaucratic mechanisms necessary to ensure the operation, maintenance and monitoring of the price control regime and the associated subsidies.

To reduce these costs and the associated budgetary and economic subsidies, the Government, in January 1982, increased domestic oil prices by about 60%. This contributed an additional Rp 1.2 trillion to the budget and reduced the economic subsidy to oil products from almost 5.5% of GDP to 3.8% of GDP. Furthermore, on January 1983, the Government again increased the domestic prices of energy which further reduced the economic subsidy given to kerosene, diesel and fuel oil. Subsequently, the decrease in the world price of oil and the devaluation of the Rupiah in March 1983 has lowered the dollar equivalent of the domestic energy prices.

As a result of these policy measures, over the period December 1982 to April 1983, the weighted average price of energy, as a percent of international energy prices, changed dramatically from 55% to 83% (in January 1983) and to 70% in April 1983; the latest figure reflects the devaluation of the Rupiah which took place in March 1983. This increase in the domestic price of energy is much more significant when compared to the level prevailing in December 1981 when the weighted average price was only 35% of the international price. Thus, over a fairly short period of time (December 1981 to April 1983) the Government has halved the economic subsidy to energy. As of April 1983, kerosene, motor diesel, industrial diesel and fuel oil were still subsidized, but at a much lower rate than in December 1981 (and December 1982) whereas aviation gas, super gasoline and regular gasoline are now taxed so that their domestic prices are higher than their respective international prices.

The Government is clearly aware of the costs of energy price controls, but it has been reluctant to use prices as a tool of demand management primarily for three reasons. First, the Government is concerned that an increase in the price of energy, and particularly of kerosene, to its international level would adversely affect the welfare of the poor. Second, there is also concern that kerosene and firewood may be close fuel substitutes for the poor, and thus, a rise in the price of kerosene, particularly in rural Java, would contribute to severe deforestation problems with undesirable ecological effects. Third, the Government is concerned that raising energy prices would be inflationary and this, in turn, would have an adverse effect on economic growth; thus, subsidized energy prices are perceived as a tool for inflation control. The concerns of the Government are understandable, but the economic costs of eliminating energy subsidies may have been overestimated and the benefits underestimated; this is the underlying theme of this report.

The Structure of Energy Demand

Indonesia's commercial energy consumption on a per capita basis is not very high. In 1979, it amounted to only 237 kilograms of coal equivalent (kce) and in 1980, this figure approached 266 kce. This indicates that Indonesia's per capita consumption of energy was moderately higher than that of India (210 kce in 1980) but substantially below that of other middle-income countries. However, the growth rate of energy consumption in Indonesia is rather high -- an average of 10.1% per annum over the period 1974-79 -- partly due to the pricing policies mentioned earlier. This growth rate is significantly higher than the average for low-income countries (8.1%) and middle-income countries (6.3%). Only the capital-surplus oil-exporting countries exceed the Indonesian average, primarily because of subsidized energy prices.

The major consumer of primary (commercial and non-commercial) energy in Indonesia is the household sector; in 1978, its share amounted to almost 65% of the total. This is followed by the industrial sector (21%) and the transport sector (12%). In terms of commercial energy, oil is the major energy fuel which is consumed primarily by the industrial and the transport sectors; this product remains of overwhelming importance to the Indonesian economy. Over the period 1969-79, the annual consumption of oil tripled, increasing from around 40 million barrels to about 122 million barrels. Of these oil products, kerosene, in 1979, accounted for the largest share (37%) followed by diesel fuel (28%), gasoline (18%), and fuel oil (9%).

The structure of energy demand in the three major energy-consuming sectors, under the existing price structure, is characterized by a wide variation in energy use and fuel mix. The industrial sector, which has been one of the fastest growing sectors in the past decade, is also the one in which commercial energy consumption growth rate is the highest; in the period 1968-78, it grew at an average annual rate of 12.9%. This has also been, in part, due to the subsidies provided to many fuels and this, in turn, has made the sector increasingly energy-intensive in its choice of production technologies. As should be expected, the variation in energy use in this sector is very wide; the average value of energy consumed by firms varies from Rp 0.3 million in the wearing apparel sector to Rp 53.8 million in the glass and glass products sector -- a ratio of more than 100 to 1. Energy intensities, measured as the ratio of the value of energy inputs to value-added (in 1978) show similar wide variations -- from 3.65% in leather footware to 74.31% in the structural clay products subsector. The average value for all firms in Indonesia is 6.5% and, interestingly, this value is much higher in rural industries (13.9%) than in urban ones (4.4%). In general, it appears that structural clay products, glass and glass products, ceramics and porcelain, cement and cement products, and paper and paper products are the relatively more energy-intensive subsectors. Furthermore, the share of energy costs in the total costs of production varies significantly across subsectors -- from a high of almost 16% in the ceramics and porcelain subsector to a low of 0.26% in the tobacco subsector; in general, the non-metallic mineral sectors, have higher energy costs shares than the other sectors.

It should be noted that this structure of energy demand in the industrial sector reflects the existing energy prices. As the Government policy changes to reflect higher domestic energy prices, not only will the demand for ènergy in the industrial sector change, but so will the structure of the industrial sector and this, in turn, will also be reflected in a shifting comparative advantage within the industrial sector. As energy prices rise, some firms will adjust towards more energy-efficient capital equipment (where a choice of technology exists) and others (where such a choice does not exist) will have to absorb the increased costs and, thus, may lose their comparative advantage. Consequently, in the aggregate, some industries may even expand whereas others may shrink resulting in an entirely different industrial structure.

Of all the petroleum products, two -- fuel oil and diesel oil -- dominate energy consumption in the industrial sector. Fuel oil accounted for 43% and diesel oil for 29% of the total industrial energy consumption in 1976, and these shares had not changed significantly in 1978. Electricity is the third most important source of energy, its relative share increasing from 13.4% in 1976 to 16.5% in 1978, followed by kerosene (around 9% - 10%). As might be expected, kerosene's relative share for rural Indonesia is about three times that in the urban areas.

The major forms of energy consumed by the household sector are kerosene, firewood, and charcoal. Household energy expenditures constituted about 5% of the total household expenditures in 1978. While this is relatively modest compared to the expenditure share of food, it is one of the largest non-food items. In addition, there is significant variation in household energy consumption by geographical location. For example, an average household consumes 40% more kerosene in Java than in the outer islands and the urban household consumes, on the average, twice as much kerosene as the rural one. The consumption of electricity, as might be expected, is also very much an urban phenomenon and restricted mainly to Java. Similarly, charcoal is consumed more by urban households than rural ones, but there is very little difference in the household average between Java and the outer islands.

Depending on their geographical location, Indonesian households allocate, on the average, 3% to 7% of their incomes to energy (kerosene, charcoal, firewood, and electricity), and though rural households spend less in absolute amounts on energy, their energy expenditure share is slightly higher than that of the urban households. However, Javanese households spend more on energy, both in absolute amounts and in terms of relative income shares, than do non-Javanese households. Furthermore, for Indonesia as a whole, the shares of energy expenditures decline secularly as income levels rise, and the data on charcoal and firewood suggest that they are inferior goods.

In the transport sector, virtually all the energy consumed is derived from petroleum products. This sector accounts for almost all of the consumption of aviation fuel and gasoline, about one-third and one-tenth of diesel and fuel oil consumption, respectively, and none of kerosene. Disaggregating the transport sector indicates that the road subsector accounts for over two-thirds of total fuel consumed in transport; this subsector accounts for virtually all gasoline consumption and for more than two-thirds of diesel consumed in the transport sector. The maritime subsectors account for about one-third of diesel consumption and all of the fuel oil consumption. The railways subsector accounts for only 1% of the transport sector's fuel consumption; this rather minor role in energy use is not expected to change in the near future.

The dominant role of the road subsector in energy consumption is explained, in part, by the very rapid growth in the vehicle population in Indonesia. For the period 1977-80, passenger vehicles increased at an average annual rate of 15.4%, buses at 22.5%, trucks at 19.4%, and motorcycles at 16.3%. For all vehicles, except motorcycles, the growth rates have been accelerating since 1970. The percentage of vehicles using diesel engines has also been increasing with trucks accounting for 80% of diesel consumption in the sector. Furthermore, trucks and buses together account for two-thirds of the total fuel consumption in the road subsector and half of total consumption in the entire transport sector.

The Effects of Changing Energy Prices on the Industrial Sector

The structure of energy demand in the industrial sector depends on the extent to which capital, labor and energy can be used in different proportions in response to changes in their prices and on the characteristics of production. The industrial structure and the substitutability of capital, labor and energy are critical determinants of energy demand, and the characteristics of production determine the extent to which fuels can be substituted for each other in the different subsectors. Energy demand relationships are derived for 27 industrial subsectors at the three-digit level for electricity, gasoline, fuel oil, diesel and kerosene. A distinction is also made between energy demand in Java and the outer islands and by urban/rural location of industry.

The analysis indicates that there is a price elastic demand for energy in most industrial subsectors. This suggests that increasing energy prices can lead to a significant reduction in energy demand and that prices can be an effective tool to achieve increased energy conservation. In particular, the demand for kerosene and diesel appear to be very elastic; for example, the largest price elasticity for kerosene is -4.54 and for diesel it is -6.68, both in the wearing apparel subsector. On the other hand, most of the inelastic price response is for fuel oil and electricity. The mean value and variance for the price elasticities for each fuel source across the 27 subsectors are respectively: electricity: -3.36, 0.59; gasoline: -1.55, 0.79; fuel oil: -1.17, 0.66; diesel oil: -2.75, 4.55; and kerosene: -3.20, 1.37. These measures indicate the relative price responsiveness of demand for different forms of energy and the substantial variation that exists across subsectors and fuels.

An important consideration for energy policy formulation is the extent to which individual fuels can be substituted for each other. As energy prices increase or as reserves of energy decline in Indonesia, the ability of industrial users of energy to substitute away from more expensive forms of energy towards less expensive ones will affect the costs of manufacturing. For example, in the short term, the impact on the demand for say, fuel oil as a result of increases in electricity prices, will depend on the extent to which these two fuels are substitutes for each other in the different industrial subsectors. These interfuel substitution possibilities in the manufacturing sector are indicated by the various cross-price elasticities. The analysis shows that most cross-price elasticities are positive indicating that most fuels in most subsectors are substitutes. The analysis also reveals that electricity is never a complement with any fuel in any industrial subsector and one of the strongest patterns of interfuel substitution appears to be between diesel and electricity. This is not a surprising result as diesel is an important energy input and is used primarily to drive prime-movers and in-plant electrical generating equipment. Electrical motors driven by purchased electricity can substitute well for prime-movers and in-plant power generation.

Gasoline and kerosene also seem to offer possibilities for interfuel substitution in the industrial sector as do kerosene and fuel oil. Thus, increases in the price of fuel oil may induce substantial substitution of kerosene for fuel oil, and increases in the price of kerosene may induce a substitution of gasoline for kerosene in many manufacturing subsectors. Consequently, the potential for interfuel substitution is quite large in the industrial sector.

The analysis indicates that the price elasticities of demand differ significantly by industrial subsector and fuel source suggesting a differential impact of a price change on the demand for energy across subsectors. Thus, not only will different industrial subsectors adjust their demand for energy sources differentially in response to a price change in that energy product, but also that the possibilities for interfuel substitution vary considerably. This suggests that any strategy for eliminating energy subsidies which involves a significant change in the relative prices of different forms of energy may have unintended and perhaps undesirable consequences as a result of interfuel substitution. But it should also be reiterated that the current domestic relative prices of different fuels are not the same as the international relative prices; thus in the long-run, domestic relative prices will have to change to reflect the proper scarcity values of the different fuels.

As far as the demand for aggregate energy and labor are concerned, all of the own-price elasticities are negative and statistically significant. For energy, they range from -0.8 for cement and cement products to -0.4 for printing, and for labor the range is from -0.4 in the ceramics and porcelain subsector to -0.04 in the measuring and optical equipment one. Moreover, in every subsector, the own-price elasticities of labor are less than that of energy; similar results have been obtained in studies of developed countries. These price elasticities, therefore, clearly demonstrate the inappropriateness of analytical procedures which use fixed coefficients input-output tables as the basis for projecting energy demand. The analysis also shows that subsectors in which energy demand is very responsive to changes in energy prices are precisely those subsectors in which energy demand is responsive to changes in the wage rate. Furthermore, as the cross-price elasticities for the different subsectors indicate, energy and labor are substitutes; for example, the cross-price elasticity in the ceramics and porcelain subsector is 0.5 and in the glass and glass products subsector it is 0.3. Thus, increases in energy prices would lead to increases in employment. Moreover, in all subsectors, except the leather footware one, the energy-output ratio declines with increasing scale of operations. This implies that, with the one exception cited above, larger scale plants are more energy-efficient than smaller ones with the greatest savings found in the food processing subsectors.

A crucial question, however, is the impact of increasing energy prices on the costs of production. The elasticities of total costs with respect to the price of energy tell us by what proportion the price of manufactured output would rise, or profit rates decline (in an open economy) in response to an increase in the price of energy. The non-metallic mineral products subsectors, as expected, are those whose total costs are most sensitive to the price of energy; but the sensitivity is not very large. For example, a 10% increase in energy price would result in a 1.6% increase in the cost of producing ceramics and porcelain. Moreover, for 18 out of the 27 subsectors analyzed, a 10% increase in energy prices would result in only a 0.3% increase or less in total costs. These figures indicate that increases in energy prices are not likely to lead to a significant increase in the costs of production in the industrial sector. Furthermore, the price of fuel oil appears to be the most important of the five energy sources in influencing the costs of production, with kerosene being the least important. Thus, increases in kerosene prices are likely to have the least impact on the costs of manufacturing while an increase in fuel oil prices is likely to have the most. This is not surprising since fuel oil accounts for 42% of total energy consumption in the industrial sector while kerosene accounts for only 9%.

Four different price regimes were analyzed to determine the effects of large changes in energy prices on the costs of manufacturing. In all four cases, the results indicate that increasing energy prices would lead to declines in energy consumption and increases in the total costs of manufacturing; the variance in these changes across subsectors is, however, quite large. Nevertheless, this analysis demonstrates the ability of firms to substitute away from energy in response to an increase in its price and, for most subsectors, results in a relatively small increase in the total costs of production. This is most vividly portrayed by simulating an increase in energy prices from their current levels to international ones. In all but five subsectors, the demand for energy would fall by more than 20% and only in wood furniture manufacturing is the fall less than 10%. The resulting increases in total cost are, however, rather modest. In only six sectors would total costs rise by more than 2%. The highest cost increase is registered by the ceramics and porcelain subsector (361) -- 14.7% -- and the lowest by the tobacco subsector -- 0.1%. This relatively small effect on total costs of substantial increases in energy prices indicates that fears about a significant loss of international competitiveness of the manufacturing sector are misplaced. Consequently, the arguments presented to provide subsidized energy to the industrial sector on the grounds of encouraging industrial development are not well-founded. On the contrary, the provision of subsidized energy fosters energy- (and thus capital-) intensive industries, some of which show low social rates of return. What is essential, of course, is the adequate supply of energy (rather than cheap energy) that is priced to reflect its scarcity value to Indonesia. Moreover, the cost increases described above seem particularly small when compared to the effect on total costs of manufacturing of such government interventions as import tariffs, sales taxes, export disincentives (through negative rates of effective protection), subsidized borrowing, industrial licensing, and investment regulations. Alterations in these programs will have a much greater impact on the competitiveness and prices of most manufacturing subsectors than large energy price adjustments.

The only subsector which might be seriously disadvantaged by a large energy price rise appears to be the ceramics and porcelain one. However, the economic (as opposed to the financial) profitability of this sector is, in fact, quite low and, thus, an increase in energy prices may well be a blessing in disguise. Furthermore, an often overlooked positive effect of an energy price rise is the increased labor-intensity of production that would result. Subsectors which will increase employment in the greatest proportion in response to an energy price rise -- those with the highest cross-price elasticities of labor with respect to the price of energy -- are ceramics and porcelain (elasticity = 0.45), glass and glass products (0.33), other non-metallic metal products (0.21), other food products (0.22), and rubber (0.19). These are the subsectors in which employment will increase most significantly, in the short run, due to increases in energy prices. Analysis undertaken in other countries shows that, in the long run also, energy and labor are substitutes and, thus, increases in energy prices would also lead to long-run increases in employment. Thus, the long-run impact of increased energy prices on employment generation are substantial and should not be ignored.

Moreover, evidence in many developed and developing countries indicates that, as a result of increases in energy prices, a change in the capital stock takes place over time; as opposed to improvement in the energy efficiency of older plants, new capital equipment which is, in general, more energy-efficient than older equipment, is installed. One study indicates that as a result of pricing policy changes in Korea, the energy-intensity of the industrial sector declined over the period 1973-77. In Brazil, over the period 1973-76, the decline in industrial energy consumption was even greater than in Korea as a result of proper energy pricing and conservation policies. This has been explained, in part, by the shift to new energy-efficient capital equipment and a substitution away from traditional fuels towards modern fuels which are more efficient in end use. India, however, is an example of a country in which energy conservation policies have not had the same impact on energy demand as in Korea or Brazil, partly because of the Government's industrial policy environment that has discouraged modernization which could have resulted in an adjustment towards more energy-efficient capital equipment. Thus, improper industrial policies can, at least partly, negate the beneficial effects of proper energy pricing policies. This is an important related issue and needs to be given consideration by policy makers when formulating and implementing energy policies in Indonesia.

Natural gas is also used in small quantities by the industrial sector; the major consumers are fertilizer, steel and cement plants. The current gas price, however, does not reflect its scarcity value and a study conducted by Gaffney, Cline and Associates for MIGAS under IDA Credit No. 451-IND indicates that the optimal pricing policy for gas, which would ensure its efficient utilization, would range around $3.08/MMSCFD for West Java and $2.68/MMSCFD for Sumatra. These prices would, however, vary by customer depending on location to reflect the pipeline costs involved.

The Demand for Energy by Households

The structure of energy demand by the household sector depends in large measure on the preferences of the consumers. The substitution away from energy as energy prices increase depends on the willingness of consumers to substitute between energy and other goods in the consumption basket as well as on the extent to which there would be reduction in the purchases of energy consuming appliances, such as kerosene stoves or petromax lamps, and the replacement of existing appliances with those that use energy more efficiently. Income growth is also an important characteristic of energy demand; the increase in the demand for energy and the extent of substitution from one source of energy to another as household incomes rise are important considerations here. Finally, the extent to which fuels are substitutes for one another as their relative prices change is likely to be dependent on the urban/rural nature of the household and its geographical location in the country. These characteristics fundamentally determine the nature of household energy demand.

In Indonesia, the relative allocation of expenditure among the various fuels varies significantly according to household location. In urban areas of both Java and the outer islands, kerosene expenditure exceeds that of the two wood fuels, charcoal and firewood, combined. Rural households outside of Java spend only slightly more on kerosene than on the wood fuels, but rural Javanese households spend twice as much on firewood than on kerosene. The prices of these energy fuels also vary substantially by location. The greatest level of kerosene consumption occurs in urban Java where average prices are the lowest. In contrast, kerosene prices are highest in rural areas outside Java and where household monthly consumptions are the least.

The analysis indicates that the price elasticity of demand for kerosene is close to unity and does not vary significantly by either the income level of households or their georgraphical location. This suggests that an increase in kerosene price will lead to a proportional decrease in its consumption by households. However, the impact of a kerosene price increase on the absolute level of kerosene consumption would be the largest in urban areas -- as urban households consume about twice as much kerosene as rural ones -- and on the higher income groups, particularly in rural Java. Since the highest income group spends 50% of its energy expenditures on kerosene compared to 27% for the lowest, the latter group would suffer relatively less than the former assuming no changes in the price of firewood. Survey data also indicate that the poorest 40% of the population consume only 20% of the kerosene. Thus, the kerosene subsidy, though it helps the poor, is very strongly biased towards the rich. As far as the other fuels are concerned, the own-price elasticities of firewood are greater than unity for households across all characteristic groupings; those for charcoal are somewhat smaller and, interestingly, the cross-price elasticity of charcoal and kerosene indicates that they are, in fact, complements; this reflects the limited, but specialized use of charcoal by households.

From the policy point of view, however, of greatest importance is the elasticity of demand for firewood with respect to the price of kerosene. This cross-price elasticity, particularly for rural Java, is at the heart of one justification for the kerosene subsidy; viz., that higher domestic kerosene prices would encourage a shift to firewood and, thereby, aggravate an already serious deforestation problem. The analysis, however, demonstrates that the demand for firewood is rather inelastic with respect to the price of kerosene; viz., an increase in kerosene prices will not significantly alter the demand for firewood. For Indonesia, a 10% increase in the price of kerosene will result in almost no change in the demand for firewood. The same result emerges for rural Java where the problems of deforestation are the most severe. This finding would argue that an often noted rationale for kerosene subsidy, viz., that it prevents further deforestation in rural Java, is not supported by the data. However, in the other geographic regions of the country, this cross-price elasticity is positive and statistically significant. It is particularly high in urban Java where it exceeds unity, but since urban households account only for 2% of firewood consumption in Java, this is not an issue of major policy concern. In both rural and urban areas outside Java, this cross-price elasticity is positive and significant; for all of outside Java it is 0.30. However, increased levels of wood consumption outside Java have not been a serious matter of concern since the problems of deforestation and erosion resulting from household wood gathering outside Java are much less severe than in Java. This would indicate that rural households, which account for a significant consumption of the total demand for firewood (65% in 1978) do not perceive kerosene as an important substitute; thus, raising the price of kerosene, over the long run, is not likely to have a significant effect on the demand for firewood, at least in rural Java.

The income elasticities for all three fuels vary substantially across households with different characteristics or in different geographical locations. For example, kerosene demand elasticities with respect to household expenditure levels are twice as high in rural Indonesia than in urban Indonesia. This same relationship holds for rural and urban Java. Consequently, as income levels rise in Indonesia, there will be increased demand for kerosene and the distribution of this incremental demand will be skewed towards the rural areas. This suggests that unless a proper pricing structure is established, economic growth in Indonesia will necessitate continuing and increasing economic and budgetary subsidies for kerosene, and these, over the long run, would begin to have a detrimental effect on resource allocation and the growth process itself. In addition, the different income elasticties of demand for kerosene by rural and urban households indicate that as long as kerosene prices remain subsidized and income levels rise, the larger incremental demand for kerosene by rural households will increase their welfare loss, if energy prices are eventually increased. This, in turn may make it more difficult for the Government to adjust kerosene price to a higher level to reflect its scarcity value.

Regarding firewood, most of the income elasticities are negative indicating that firewood is an inferior good; viz., as income levels rise, the demand for firewood declines. As expected, these elasticities are higher (in absolute value) for households with higher expenditure levels. Moreover, for Java as a whole, the elasticity is -0.42, and for rural Java it is -0.38. These values suggest that continued income growth will aid substantially in alleviating the deforestation and soil erosion problem, particularly in rural Java where the problem is the most serious.

Simulating the impact of large increases in kerosene prices indicates that rural households will reduce their consumption of kerosene proportionately more than urban ones; a 60% price increase will result in a 40% reduction of kerosene consumption by rural households and 30% by urban ones. However, in absolute amounts, urban households would reduce their kerosene consumption more than rural ones -- by 12.4 litres/month compared to 5.3 litres/month. For Indonesia as a whole, a 60% increase in the price of kerosene, *ceteris paribus*, would reduce its demand by households by 38%.

There is almost no effect of this large kerosene price increase on firewood consumption in rural Java. This substantiates the earlier result on the cross-price elasticities for rural Java. Thus, a large increase in kerosene prices will not have the adverse long-run consequences of deforestation in rural Java as feared by the Government.

An increase in the price of kerosene would also lead to a decline in the economic subsidy. For Indonesia as a whole, the net kerosene subsidies provided to households would fall by nearly 80% as a result of a 60% price increase. The urban bias would remain, but urban, and to a lesser extent Javanese, households would bear the greatest absolute loss in subsidy. The subsidy provided to urban households would drop by Rp 612/month compared to Rp 241/month for rural households. Households in urban Java would have their subsidies reduced by an even larger amount, Rp 719 per month compared to Rp 253 per month for rural Java. The analysis also indicates that a small proportional change in the price of kerosene can have a significant effect on reducing the economic subsidy and that the effect on the economic subsidy is greater the higher the absolute level of kerosene prices. Furthermore, the available evidence demonstrates that, despite periodic increases in the domestic price levels of oil products in Indonesia, the economic subsidy will continue to rise if the changes in the domestic prices are less than those in the international prices.

Naturally, an important aspect of any change in energy pricing policy is its distributional effect. As might be expected, any increase in energy prices will lead to a loss in welfare of all household consumers. But the analysis undertaken indicates that this loss will be greater for urban households than for rural ones -- about two-and-half times as much -- for energy prices increases of 25%, 50%, and 100%. For both urban and rural areas, the welfare loss also varies significantly across the various provinces of Indonesia. For example, for urban households, the welfare loss due to a 25% increase in energy prices ranges from Rp 2,096 in Kalimantan Timur to Rp 691 in Sulawesi Selatan -- a ratio of about three to one. Similar variations are observed for rural households. This suggests that any policy designed to compensate for the increase in energy prices should take these regional differences into account. The welfare loss, as expected, also varies by the size of household; it increases with the size. These conclusions have obvious policy implications if the Government chooses to compensate the losers; and this, of course, has administrative implications. But, to the extent that richer households live in urban areas and poorer ones in rural areas, this welfare analysis substantiates what was stated earlier, that the current subsidized pricing structure benefits the richer households, not the poorer ones, and thus worsens, not improves, the distribution of income in Indonesia.

LPG consumption in Indonesia is currently very low, about 0.85 million barrels in 1981/82. A primary cause of this low consumption is the high price of LPG relative to that of kerosene. In Indonesia, this price ratio is about 3.0 compared to Mexico and the Philippines, where it is 1.0, and Brazil, where it is 0.35. The domestic price of LPG is around $43/bbl compared to total production costs of $20 - $25/bbl. This high price acts as a disincentive to LPG consumption, and since kerosene and LPG are substitutes for urban household cooking, there are strong incentives to use kerosene.

Equalizing the domestic price of these two fuels would significantly alter the current biases in consumption. Preliminary analysis indicates that 20% - 40% of the kerosene used in urban areas would be replaced by LPG with benefits accruing to Indonesia in the order of $100 - $150 million per year by 1990. The costs of bottling LPG could also be reduced by permitting increased imports of bottles, and access to poorer households could be increased by increased production and imports of cheaper one-burner LPG stoves.

The Effects of Energy Pricing Policies on the Transport Sector

Another area of concern to the Indonesian Government is the impact of higher energy prices on the transport sector. The available evidence indicates that this is likely to be quite limited; the across-the-board 60% energy price increase of January 1982 were estimated to lead to about 12% - 18% increase in total transport costs, and the January 1983 increases are estimated to have about the same impact. Furthermore, the impact of increased transport costs on final commodity prices is also not likely to be large because transport costs do not make up a large share of the total costs of marketing and production.

Although the demand for transport services is inelastic with respect to fuel prices, the fuel efficiency with which a given level of transport services can be provided can be increased and this gives rise to some short-run price responsiveness of fuel consumption in the transport sector. This can come about through diverse means such as improved maintenance, reduction of discretionary driving and substitution of buses for cars or bicycles for motorcycles, and substitution of rail or sea for road transport as the relative prices of the services change to reflect their true costs. Over the longer term, various other adjustments and substitutions can take place -- and this would include a change in the capital stock which reflects a less energy-intensive structure -- as energy prices are raised to reflect their opportunity costs. The longer the delay in making such changes, the more the economy will be locked into a pattern of location and capital stock which is less energy efficient than it could be as the myriad of adjustments and substitutions that could have taken place are prevented.

The weak data base on fuel consumption in the transport sector does not permit quantification of either the short-run or the long-run impact of higher fuel prices. However, most studies of demand for fuel in the transport sector in developed countries indicate short-run price elasticities of about 0.1 to 0.2. Studies of developed countries also indicate that long-run price elasticities are much greater than short-run and are likely to exceed 1.0 over a 10-year period. Nevertheless, despite the low short-run elasticities, the potential magnitude of fuel price adjustments in Indonesia could lead to immediate and noticeable reductions in the rate of energy consumption growth. Assuming elasticities of only 0.1 for all products used in transport, the 60% price increases in January 1982 would induce, other things being equal, about 6% decrease in the consumption of fuel. Much more importantly, the conservation of fuel in the long run would be quite significant.

However, the most important issue facing the Government today is the price of diesel oil relative to its world market price and to the domestic prices of other petroleum products; aviation fuel and gasoline are now priced above their import prices while diesel and fuel oil are well below their respective world prices. For more than a decade, the Government has maintained the domestic ratio of automotive diesel price to gasoline price well below that which exists in the world market (0.35 compared to about 1.0 in 1982). This price distortion in favor of diesel has encouraged the more rapid growth in consumption of that product and a rapid increase in the percentage of vehicles using diesel. In addition, it has encouraged a rate of dieselization that is greater than economically desirable. In order to reduce this distortion and, thereby, reduce the aggregate budget and economic subsidies, the nominal price of diesel should be increased more rapidly than that of gasoline during the coming years. In fact, given that the gasoline price is already above world price levels and assuming no significant increases in the world price in the next few years, it may be argued that the real gasoline price need not be increased at all.

This, however, raises the issue of whether or not the diesel price can be increased more rapidly than the kerosene price given that kerosene can, at least in part, be substituted for diesel in the industrial sector, and to a lesser extent, in transport. There are, however, technical limits to the use of kerosene in diesel engines. Available information suggests that when kerosene approaches 20% of the fuel mixture, engine performance deteriorates and maintenance costs increase. Thus, substitution will be limited. The Government could dissuade substitution of kerosene for diesel by disseminating information to truck and bus companies about the extra maintenance and repair costs associated with blending kerosene with diesel and by taxing bulk transport and bulk sale of kerosene in the industrial sector.

The Government has recognized the problem of the rapid growth in diesel consumption and has considered measures for "selective dieselization" intended to limit the consequences of the existing price distortion in favor of diesel through a regulatory approach. If enforceable, such an approach may help, but priority should be given to improving the efficiency in the use of diesel engines rather than mandating a substitution of gasoline for diesel engines. Although nonprice measures may contribute to this objective, an increase in the diesel price will be the most effective means to limit diesel consumption growth, and any necessary substitutions to gasoline engines will be made by the public reflecting the relative costs of owning and operating diesel and gasoline powered vehicles.

The Macroeconomic Implications

The macroeconomic analysis conducted in this report focuses on supply relationships with the key aspect being the possibility of a wage response. If an increase in energy prices does not induce a rise in nominal wages, then it can be treated essentially as a change in relative prices with no escalation effect on the overall price level. The alternative would be to assume that an energy price increase raises the nominal wage through its effect on consumer prices. As energy prices rise, prices of consumer goods rise, and this raises wage demands. The increase in wages then spreads the effect of the energy price increase through the economy and which results in a general escalation of prices.

Estimates of the sensitivity of the consumer price index, the price level of the industrial sector and the demand for labor and energy to an increase in the price of energy are discussed in the report under different assumptions about relative factor shares, the responsiveness of prices in the agricultural sector and different monetary policies. A range of results under these varying assumptions are presented. The purpose of this analysis is to point out the key parameters or channels of effects of energy price increases that might be missed by the usual microeconomic analysis and point the way for further lines of study.

The results show that if agriculture prices are assumed to respond to energy prices in the same way as do industrial prices and that there is no change in the rate of growth of money supply, then a 10% increase in energy prices would lead to about 1.5% - 2% increase in the CPI with industrial prices rising by about 0.5% to 1.5%. If the other extreme assumption is made about the growth in the money supply; viz., that monetary policy fully accommodates any cost increase by expanding the stock of money to hold output in industry constant, then full price escalation emerges as a possibility. All prices and the money stock rise by the same proportion as the price of energy leaving no relative price effects. If it is further assumed that there would be no change in agricultural prices, then a 10% increase in energy price would lead to a 3.73% increase in the CPI with full monetary accommodation. This result shows the danger of demand accommodation if one is not certain about the stickiness of the price of agricultural output. Consequently, an important aspect for policy makers is to recognize that removing the energy subsidy and then expanding demand to maintain output in the previously subsidized sector can mean undoing the originally intended relative price effects. This analysis also shows that, with demand accommodation, the importance of the relative shares of labor and capital is diminished, since both "pass on" the energy price increase and this, therefore, highlights the key question; viz., whether there is a sector of significant size in the economy, such as agriculture, whose price is not sensitive to the price of energy. If there is none, then full wage escalation emerges as a possibility.

The analysis and the results obtained under the varying assumptions mentioned above indicate that there are four crucial factors that determine the macroeconomic implications of any energy price change. They are: (a) the degree of nominal wage response to a change in the CPI; (b) the shares of capital, energy, and labor in the industrial sector; (c) the existence of a significant sector such as agriculture whose price does or does not respond to an increase in energy price; and (d) whether demand management policy attempts to prevent the reduction in industrial sector output following the energy price increase.

As far as the balance of payments is concerned, a removal of the energy subsidy is also likely to improve the trade outlook substantially. By 1990/91, the increase in the exportable surplus would be approximately $5 billion. This would be nearly sufficient to eliminate a projected $7 billion payment deficit. With such an increase in exports as the subsidy is removed, there are three main lines of response for balance-of-payments policy. The exchange rate can be appreciated in a general attempt to reduce non-oil exports and increase imports. An alternative would be to maintain the exchange rate and direct the additional foreign exchange earnings toward imports that are important in the development plan. A third alternative would be to invest abroad or add to reserves. Each of these alternatives is considered, in turn, in the report.

Alternate Pricing Policy Options

Most of the analysis conducted in this report focuses on the economic implications of increasing energy prices. The recommendations made in previous Bank reports to let energy prices reflect their true scarcity value of energy is also reinforced. However, the transition process or the adjustment from the current pricing structure to the desired one is of major concern to policy makers; the basic question they face is, how should Indonesia adjust its domestic energy prices to levels that reflect their opportunity costs? Three options are considered in this report. It should be emphasized here that given the amount of data and information available, it was not possible to arrive at any conclusion regarding the superiority of one option over another; this report remains deliberately agnostic on that issue. That is a determination that can only be made by the Government after a careful analysis and taking into account the specifics of the situation in Indonesia. The intention here is to outline the analytics (the pros and cons) that may need to be considered in the process of reaching a final judgement.

The instinctive answer to the transition process seems to be to do it gradually. This is based on concerns about the effects of a sudden price increase on producers and consumers who have difficulty in adjusting to rapid price changes. The basic rationale for gradual price increases is the idea that this will minimize adjustment costs. If the path of the energy price is announced in advance, producers and consumers can adjust their stocks of energy-using durable goods gradually. This, in turn, would eliminate the sudden losses to consumers and bankruptcy among producers.

These are the benefits, but there are also costs to such an approach. A program of gradual removal of energy subsidies thus, allowing the domestic price to rise to the world market price faces two main economic problems. First, the domestic price must rise relative to world price increases during the adjustment period. This places a strong restriction on the rate of increase of the domestic price; it must exceed the domestic rate of interest. This program, therefore, presents a strong incentive for hoarding in the private sector. Second, investment undertaken while energy prices are still below world market prices will still be energy-inefficient. The inefficiency will end only after a full generation of the replacement of capital equipment and consumer durables after the domestic price reaches the world level. This could prolong the life of the capital equipment using excessive energy for several years after the adjustment program is finished.

An alternate policy option that would seem to reduce the potential hoarding problem would be to remove the energy subsidy in unannounced discrete jumps in the price; over the last decade, this has been the approach of the Indonesian Government. This would seem to reduce the certainty attached to the margin between the energy price increase and the domestic interest rate thus, reducing the incentive to hoard. The gains of this policy are mainly illusory, however, as the fundamental incentive to hoard is not removed. In addition, the policy would create speculative bubbles around times when the private sector expects a discrete price increase; and this expectation would be based on past official behavior regarding energy price increases.

In addition to speculative problems associated with energy as a storable durable asset, a program of discrete unannounced jumps makes the path of energy prices to capital investors uncertain. This makes the marginal productivity of waiting until the price situation becomes clear before investing very high and thus leading to delays in investment. Therefore, an implicit policy of occasional discrete price jumps could create a disruption of investment in the private sector by maximizing uncertainty and the return from waiting. The non-economic gains of this adjustment policy would have to be substantial to outweigh these economic losses to the development program.

A third policy option would be to move domestic prices suddenly to world market levels, <u>and</u> simultaneously to recycle the revenues to energy consumers in the form of a temporary subsidy to income proportional to the initial energy consumption. The income subsidy could then be phased out gradually along a path keyed to the ability of producers and consumers to adjust capital and durable inputs. The gains from this policy package include the fact that the jump to world market levels would provide an <u>immediate</u> incentive to replace capital stock and durables with energy efficient units. So the move to energy efficiency would be completed after one turnover of the capital stock beginning from the time when the policy is implemented. Also, the immediate jump would forestall any further speculation on energy prices and release any existing energy hoards into productive use. Furthermore, the initial losses to "locked in" consumers and producers will be proportional to their existing energy consumption. So an initial subsidy to income also proportional to the initial consumption level could eliminate the initial capital losses. A gradual phasing out of the subsidy as consumers and producers are able to replace existing capital into energy efficient units would serve <u>exactly</u> the same purpose as a gradual price adjustment, permitting a smooth transition from the short run to the long run. The final result would be the same without the incentives to hoard energy or delay adjustments to energy efficiency. A basic question, however, is the administrative feasibility and costs associated with such a program. But, if it were feasible to administer efficiently, this policy package would have the same benefits as a gradual removal of the energy price subsidy without incurring the costs. Furthermore, some realistic assessment also needs to be made about the speed at which the industrial structure would be permitted to adjust by the prevailing industrial policy environment. If the latter remains a constraint, then a strategy of gradual price increases may dominate one of sudden price changes.

The Government also has the option of either announcing or not announcing future price increases. The behavior of the firms and households would depend upon their expectations of the timing and level of future price. Given past price increases, it is likely that there will be expectations of future prices rises. If the Government follows a policy of announcing the trajectory of future prices, and actually implements that strategy, firms and households will undertake their adjustments and new investments with full certainty of future prices. So will individuals and firms with a capacity to hoard; they will now have the incentive to buy and store energy while the prices are low and release these stocks when prices are high. The extent to which this will actually take place will depend on the investments required to store alternate forms of energy. If, however, price changes are unannounced, an element of uncertainty will enter into the decision-making of firms and households regarding their investment behavior. Firms investing in new capital equipment will now not do so in capital that reflects the long-term price level; rather, they will make some judgement about the timing and level of future energy prices, compare them to the useful life of different forms of capital and after weighing the costs and benefits in this uncertain environment reach some judgement. If future prices are correctly anticipated, then socially efficient investment decisions will be made. If the anticipations are, however, incorrect, then socially inefficient decisions will be made; the extent of this inefficiency will depend upon the error in anticipation. This element of uncertainty will also enter the "hoarding decision" and less hoarding, than under conditions of certainty, will take place.

Whatever strategy is undertaken, the conclusion that energy prices must eventually reflect their opportunity costs remains valid. For non-tradeable forms of energy, such as electricity, the opportunity costs would be the long-run marginal cost of production and distribution; for tradeable forms the relevant opportunity cost would be the world price. The crucial question that policy makers will face once domestic prices approximate international prices, is whether to continue administering prices and make periodic adjustments to reflect a changing world environment or to decontrol prices and permit the market to adjust these prices. The answer to this issue would depend very much on expectations of future energy prices. If the expectations are that international prices will be essentially stable over the long run (though there may be short-term fluctuations) then decontrolling prices eventually may be the better solution. If, on the other hand, international energy prices are expected to have very wide fluctuations over the long run, then administered prices to stabilize them domestically and insulate the economy from the large international gyrations, but still letting them reflect the long-run opportunity cost, may be the answer.

1. INTRODUCTION

1.01 Over the last decade, the world economy has undergone a major structural change as a result of the two oil price shocks of 1973-74 and 1978-80. Since then, the world economy has had to adjust; from an era of cheap and abundant energy to one of higher prices and relative scarcity. Within this changing international environment, the capital-importing oil exporters -- which includes a rather heterogeneous group of countries such as Algeria, Ecuador, Indonesia, Nigeria, Trinidad and Venezuela -- faced severe problems of short- and medium-run economic management brought about by the large and sudden increases in oil revenues and brought to the fore the urgency of energy policy formulation

1.02 Prior to the first oil shock in 1973-74, however, very few countries paid much attention to energy policy and there was very little reason to do so; the real price of energy had been falling till then, supplies were reasonably secure, and OPEC had not as yet become a major force to be reckoned with. Subsequently to that period, when oil supplies were temporarily cut off and there was a quantum leap in the real price of oil, the situation changed significantly enough for all countries -- developing and developed, oil exporters and importers -- to pay much closer attention to energy policy issues. The importance and the impact of higher energy prices was in large measure determined by the characteristics of energy demand; viz., the ability of manufacturers to produce goods using less energy and that of consumers to consume less energy directly and, indirectly, shift their purchases of goods to those produced with less energy-intensive techniques. Consequently, many countries have begun to focus on issues of energy demand management, increasing domestic energy supplies, on the efficiency of energy use and, particularly for developing countries, on the appropriate role of energy in the economic development process.

1.03 Indonesia is one of those capital-importing oil exporters that has had to undergo a major structural adjustment process as a result of the events of the last decade. This has been exacerbated by the recent instability in the world oil market. Indonesia, however, is also fortunate enough to have vast natural energy resources in addition to oil and this includes coal, natural gas, hydroelectric power and geothermal energy. The efficient exploitation of this natural resource endowment necessitates a careful consideration of an energy development strategy and policy formulation. The Government has fully recognized the importance and the enormity of the task and this is reflected in its Third Five Year Plan, Repelita III (1978/80-1983/84). The Government has begun the process of formulating a national energy policy and one of the many steps taken has been the commissioning of several studies designed to provide a comprehensive perspective of the energy sector. Some of these studies have taken the broad overview of the entire energy sector discussing the supply and demand for energy sources, energy pricing, technology assessments, alternative energy supply strategies, projections of energy demand, and the organizational and institutional framework. 1/

1.04 Within the framework of these studies, the importance of developing the rich energy resource base in Indonesia has been adequately stressed and warrants re-emphasis here. The policy instruments at the disposal of the Indonesian Government to develop and conserve these energy resources are many. They include direct investment allocations made by the Government, physical controls and regulations, education, pricing and fiscal instruments to affect consumption and investment decisions made by the public at large, and research and development undertaken by the Government itself or encouraged through grants and subsidies to educational and research institutions. The specific focus of this report is on one of the central issues in Indonesia's energy policy, and that is the issue of the pricing of energy products and the implications of different pricing strategies on the industrial, household and the transport sectors, and on the macroeconomic environment.

1.05 The issue of pricing is important because prices in many countries have been demonstrated to be an effective tool to reduce energy demand and allocate energy resources reasonably efficiently. Moreover, the pervasive use of energy and the high consumption growth rate in Indonesia would more than likely overwhelm most non-price mechanisms designed to allocate energy; however, selective and careful use of some non-price mechanisms may be effective. Furthermore, energy consists of a number of fuels that are often close substitutes for one another and proper relative prices are essential to provide the right signals for fuel substitution possibilities; incorrect signals can distort the use of specific fuels and can even worsen the situation. Also, the investment requirements in the energy sector in Indonesia are so large that it has become crucial that the energy sector be able to finance its own investments through proper pricing of its output; this is rapidly becoming an important issue in the power sector. Finally, the focus on pricing has been mandated by the large subsidies to petroleum products -- in 1980/81, the economic subsidy amounted to Rp 2.3 trillion or 5.3% of the GDP ($3.4 billion) 2/--and by the resulting drain on the public budget and the misallocation of energy resources in the economy. The three sectors mentioned above were chosen because they, together, account for almost 92% of total commercial energy consumption. Moreover, it is essential to recognize that differences in energy use cannot be explained in the aggregate, but must be explained on a sector-by-sector basis. Aggregate

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1/ Three major studies commissioned by the Government are: Indonesia: Issues and Options in the Energy Sector, The World Bank, Report No. 3543-IND, November 1981, (henceforth, Energy Assessment Report, 1981); Energy Planning for Development in Indonesia, Director General for Power, Ministry of Mines and Energy and Energy/Development International, August 1981 (supported by USAID), (henceforth, MME/USAID Energy Report, 1981); and, Alternative Strategies for Energy Supply in Indonesia, 1979-2003, BPPT and Bechtel National Inc., December 1980 (henceforth, BPPT/Bechtel Energy Report, 1980).

2/ Indonesia: Financial Resources and Human Development in the Eighties. The World Bank, Report No. 3785--IND, May 3, 1982. Henceforth, referred to as CEM, 1982.

ratios, such as the energy/GNP ratios, provide very little useful information as the demand for energy by the industrial sector would be very different from that of the households. Beyond that, the demand for a specific fuel source, such as kerosene, may depend on the very different characteristics of the industrial and household sectors. Furthermore, just as investigating the demand for aggregate energy is inadequate, looking at the industrial sector or the household sector also limits our understanding. Consequently, in this study we investigate energy demand at a disaggregated level for all three sectors; the industrial sector is disaggregated into 27 subsectors, the household sector is differentiated by various characteristics such as income levels, regional location and urban/rural households, and the transport sector is disaggregated into its composite subsectors such as road, rail and sea.

1.06 The report does not provide any new policy prescriptions regarding energy pricing; the recommendations made in previous Bank reports in the recent past--the eventual elimination of energy subsidies--still hold. [1/] Rather, the intention now is to delve deeper into the analysis of pricing issues, including the pros and cons of gradual and sudden price increases, because there are several economic (and political) ramifications associated with any strategy of eliminating energy subsidies. The objective of this report, therefore, is to outline to decision-makers in the Government alternative paths for increasing energy prices and their <u>economic</u> implications for the three major energy-consuming sectors mentioned earlier and for the economy as a whole. The intention is to contribute to an improved understanding of the nature of energy demand in Indonesia and shed some additional light on issues such as the extent to which the demand for energy is responsive to price changes, the possibilities of interfuel substitution, the substitutability of energy with labor and capital, the impact of energy price changes on the costs of manufacturing, the economic subsidy and macroeconomic variables such as output and inflation. These issues have been of concern to policy makers in Indonesia and continue to remain of importance in the design of appropriate energy policy. The analytical framework and the various models used in conducting the analyses have, like all models, their limitations. Consequently, the resulting numbers provided in the analytical chapters are not to be treated as definitive, but rather as suggestive. They are intended to demonstrate the orders of magnitude and directions of change involved as a result of policy changes rather than absolute values.

1.07 This report is divided into eight chapters. Chapter 2 briefly outlines the importance of the energy sector in Indonesia, the current pricing policies, their justifications and implications, the Bank's recommendations made in the past, and recent price policy changes of the Governmnent. This chapter also briefly discusses the experience of other countries with regard to pricing issues. Chapter 3, a descriptive chapter, gives a fairly detailed breakdown of the structure of energy demand, both at the macro level and at the micro level by industrial, household and transport sectors; these two

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1/ See, for example, <u>Indonesia: Long Run Development and Short-Run Adjustment</u>, The World Bank, Report No. 2788-IND, February 20, 1980 (henceforth <u>CEM</u>, 1980); <u>Indonesia: Development Prospects and Policy Options</u>. The World Bank, Report No. 3307-IND, April 6, 1981 (henceforth, <u>CEM</u>, 1981); and <u>CEM</u>, 1982.

chapters set the scene for the subsequent parts of the report which deal explicitly with issues of pricing.

1.08 The implications of energy pricing policies for the industrial sector are outlined in Chapter 4. The chapter analyzes the effects of increasing energy prices on the various industrial subsectors, investigates the possibilities of interfuel substitution within specific subsectors, and the impact of energy price changes on the international competitiveness of the industrial sector. Chapter 5 discusses the demand for energy by the household sector. It investigates the extent to which higher energy prices will reduce the household demand for energy, the implications of kerosene price increases for the problems of deforestation in rural Java, the subsidy effects of such price changes and the impact of income growth on the household demand for energy. It also attempts to answer questions such as which groups of households are likely to benefit the most from a particular price policy change? Which groups are likely to benefit the least? And, how do the distributions of welfare among different groups of households compare before and after the implementation of a particular policy change? Chapter 6 discusses the effects of energy policies on the transport sector. It discusses the subsidies provided to energy use in the transport sector, the short- and long-run impact of higher fuel prices on the demand for energy and the demand for transport services and the implications of relative energy price adjustments for the transport sector. Chapter 7, outlines the macroeconomic implications of increasing energy price in Indonesia. It focuses on the possible effects of rising energy prices on nominal wages and the resulting implications for industrial prices and the consumer price index, output, employment and profits in industry. The intention here is to highlight the key parameters associated with the effects of increased energy prices that may be overlooked within a microeconomic framework. The crucial aspects here are the degree of wage sensitivity to increasing energy prices and the degree of monetary accommodation to the resulting inflation. Finally, the last stage of the pricing analysis focuses, in Chapter 8, on the analytics of alternate policy options faced by Indonesian policy makers to adjust domestic energy prices to levels that reflect their true scarcity value. These policy options for increasing energy prices are discussed and the pros and cons of each approach are outlined to aid policy makers in formulating the most suitable strategy for Indonesian conditions. It is hoped that this report will contribute to an improved understanding of the economic implications of raising energy prices in Indonesia. The detailed technical analyses are excluded from the main body of this report; they are, however, presented in the appendices (Volume III of this report). The models presented in these appendices can also be used by the Government in simulating pricing strategies not considered in this report. Used in this way, they can be powerful tools in the process of policy formulation.

2. THE SETTING

Introduction

2.01 This chapter sets the scene for the main body of the report. It puts Indonesia's energy sector into perspective with the rest of the economy; its importance to Indonesia's economic development is, therefore, outlined here. Subsequently, the chapter briefly discusses the nature of the energy pricing policies followed since the early 1970s, the concerns of the Government and the resulting justifications for these policies, and the economic and budgetary costs associated with them. This chapter also outlines the most recent price measures undertaken by the Government and closes with a brief description of energy pricing policies followed by other countries.

The Importance of the Energy Sector

2.02 The importance of the energy sector to Indonesia's economic development cannot be underestimated. Within the energy sector, oil and, to a lesser extent, LNG dominate. Their exports have been a significant contributing factor to Indonesia's relatively high GDP growth rates achieved during the seventies; over the period 1970-79, Indonesia's GDP grew at an average annual rate of 7.6% compared to 4.6% for all low-income countries, 5.5% for all middle-income countries and 3.2% for the industrial market economies. 1/ Oil and LNG exports over the past decade have accounted for a significant share of total exports; for example in 1980-81, oil and LNG exports (on a gross basis) amounted to over $16.7 billion--accounting for about 75% of total exports--compared to only $5.6 billion of total non-oil exports. This is a complete reversal of the structure of exports in the early seventies; in 1973-74, total oil and LNG exports amounted to only $1.1 billion--accounting for about 37% of total exports--while total non-oil exports amounted to about $1.8 billion or 63% of total exports. 2/

2.03 In the Central Government budget, revenues from oil and LNG amounted to over Rp 7 trillion in 1980/81 and accounted for almost 60% of the total budgetary revenues. In 1981/82, these revenues are estimated to increase to over Rp 8.5 trillion, representing a real increase of 11.0%. If the average price of oil exports remains unchanged through 1982/83, rises at the same rate as international inflation through 1985/86 and then, until the end of the decade, rises at a real rate of 3% per annum, then, by 1990/91, budgetary revenues from oil and gas could amount to almost Rp 22 trillion or almost $35 billion at current exchange rates. 3/ These figures clearly indicate that the oil and LNG sectors are very important to contributing to the government's budget and, therefore, to Indonesia's development program. But a word of caution needs to be introduced here. Over the coming decade, the exportable oil surplus is expected to decline (from 443 million barrels in 1980/81 to 335 million barrels by 1990/91) and the receipts from the sales of LNG are

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1/ World Development Report, 1981. The World Bank, Washington, D.C.

2/ CEM, 1982, Annex I, Table 1.

3/ CEM, 1982, p. 42.

expected to increase, but not sufficiently to offset the decline in the exportable oil surplus. Consequently, despite the large absolute amounts of revenue expected to be generated by the oil and LNG sectors, the maintenance of continued growth in government revenues in the presence of a declining oil surplus requires not only increased efforts to mobilize domestic resources from non-oil income, but also a reduction in oil subsidies.

2.04 Moreover, a major area of concern remains the world price of oil and the extreme sensitivity of the budget and the balance of payments to this parameter. There is little doubt that small shifts in the international price of oil can have a significant effect on Indonesia's external resource prospects and on revenues in the budget. For example, a $1 per barrel change in the international price of oil can lead to a change of $300 million in the external resource balance. Consequently, the recent glut of oil on the international market--as a result of which Indonesian oil production was reduced from a planned 1.64 million barrels per day to 1.3 million barrels per day--contributed to the worsened balance of payments picture in 1981/82. Indonesia's current account surplus of $2.2 billion, in 1980/81, are estimated to have turned into a deficit of about $2.8 billion in 1981/82 -- a change of almost $5 billion. To prevent the decline in budget revenues that would have also occurred as a result of the glut, the Government, in January 1982, made the important policy change of increasing domestic oil prices across the board by about 60%. This contributed an additional Rp 1.2 trillion in revenues to the Government's budget -- equivalent to 14% of the development budget -- and reduced the economic oil subsidy from almost 5.5% of GDP to 3.8% of GDP (see also para. 2.08). [1]

2.05 The vagaries of the international oil market have clearly introduced uncertainties in Indonesian economic policy-making and to the country's prospects for continued high economic growth rates, particularly those achieved in the recent past; viz., 9.6% per annum of GDP growth in 1980 and 7.8% per annum in 1981. [2] These uncertainties can, in part, be mitigated by the nation's diverse energy endowments, but only if they are carefully nurtured and husbanded. However, the mere presence of these resources makes Indonesia more fortunate than most developing countries. For example, proven oil reserves, as of December 1980, amounted to 9.5 billion barrels which is equivalent to 16 years of production at the current annual rate of production of 575 million barrels; undiscovered reserves are estimated to vary from 10 to 40 billion barrels. The reserves of natural gas are estimated to be around 69 trillion cubic feet (8220 MBOE) which is about as much as the current proven oil reserves. Coal reserves are placed at between 10 and 15 trillion tonnes, and the Ministry of Mines and Energy has estimated "measurable" coal reserves at 2.6 billion tonnes. If the estimated coal reserves are proven, they could exceed oil and gas in terms of energy content. Identified resources of geothermal energy are estimated to be about 1500 MW while potential resources

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1/ CEM, 1982, pp. 25 and 44.

2/ These GDP growth rates are measured at 1973 market prices. GDP growth in 1981 (a tentative estimate) declined, in part, as a result of the world recession and to the glut of oil in the world markets. See CEM, 1982, p. 21.

are placed at 10,000 MW. The potential of hydro power has been estimated to be around 31,000 MW of capacity and 155,000 gwh of annual energy. 1/ Nuclear power is another source of potential energy depending upon the final determination of a very rich uranium deposit first identified in 1976 in Central Kalimantan. In addition, Indonesia's equatorial rainforests and tropical semi-deciduous forests offer a relatively large potential for biomass regeneration and agricultural residues form a large but as yet untapped source of energy for Indonesia.

2.06 The uncertainties associated with these estimates clearly need to be reduced and actions are currently being taken by the Government to obtain firmer estimates of its energy base. Nevertheless, these figures, however uncertain, still indicate the diverse and promising energy potential of Indonesia, particularly when compared with many energy-poor countries such as Turkey, South Korea or Chile. But to maintain energy exports at current levels and to meet the expected increases in domestic energy demand over the next two decades would necessitate the development of alternate energy resources in Indonesia which, in turn, would require very large investments; one estimate suggests increases from a current level of about 2% of GDP to almost 4% of GDP; this could amount to over $10 trillion. 2/ Moreover, the estimated 1980 population of 147 million, a population growth rate of 2.3% per annum (over the period 1971-80), 3/ and the growth in primary energy consumption of as high as 16% per annum between 1977 and 1979, 4/ highlight the need to reduce the domestic demand for energy if Indonesia is to continue, over the longer run, to be a net exporter of energy.

2.07 Consequently, even though Indonesia has an abundant endowment of primary energy sources in an absolute sense, over the long term, only careful pricing and investment policies will ensure a reduction in domestic demand and the efficient utilization of these resources and thus, the continued, high economic growth experienced in the past. It should, however, be mentioned that appropriate energy policies are necessary, but not sufficient for economic growth in Indonesia. The economic transformation process also requires several other structural adjustment policies, particularly in the industrial and financial sectors, and these have been discussed in detail elsewhere. 5/

1/ Energy Assessment Report, 1981.

2/ The priority investments are likely to be in the development of coal, hydro and geothermal power. See the Energy Assessment Report, 1981, p. 86.

3/ CEM, 1982, p. 188.

4/ MME/USAID Energy Report, p. 14.

5/ For details see Indonesia: Selected Issues of Industrial Development and Trade Strategy, The World Bank, Report No. 3182-IND, July 15, 1981; CEM, 1981; and CEM, 1982.

Domestic Energy Pricing Policies

2.08 The domestic prices of many energy fuels in Indonesia remain well below their international levels. Figures 2.1 and 2.2 show the trends in domestic prices and in the ratios of domestic to international prices for the years 1972 to 1982. As of December 1981, the weighted average price of energy in Indonesia amounted to 35% of the equivalent international price. As of that date, all forms of commercial energy, except for premium gasoline, were subsidized; the domestic prices ranged from 18% (for kerosene) to 79% (for regular gasoline) of the relevant international prices (see Table 2.1). Subsidies on the domestic sale of refined oil products have been large only since the late 1970s. In the early 1970s, surpluses were recorded in the Government's budget under "other oil receipts" as domestic prices covered the costs of production. By the mid-1970s, rapidly increasing domestic consumption exceeded domestic supply, particularly for kerosene, requiring increased imports at international prices. The budgetary costs of these oil subsidies, and their movements over time, are shown in Figure 2.3. As can be seen, the turning point (from budgetary tax to subsidy) occurred after FY 73-74. Beginning in FY 74-75, tax collections -- based on PERTAMINA'S excess of sales receipts over reported costs -- began to decline as did the real (controlled) prices of domestic oil products. Apart from FY 76-77, when there was a domestic price increase in April 1976, the budgetary subsidy continued to grow as the increases in the controlled domestic oil prices did not keep pace with PERTAMINA's refining and distribution costs. In 1981/82, total budgetary subsidies on oil amounted to Rp 1.4 trillion ($2.3 billion), an increase of 40% over 1980/81. [1/]

2.09 The economic cost of the oil subsidy is, however, even larger. The economic subsidy of the Indonesian pricing policy is the difference between the controlled price of domestically-consumed refined oil products and what Indonesia would receive if these products were sold/bought on the world market. When viewed in this light, the economic subsidy of the oil products amounts to a multiple of the budgetary subsidy. In 1980/81, the economic subsidy amounted to Rp $2.3 trillion -- or almost 2.5 times the budgetary subsidy -- and in 1981/82, this amount increased to Rp 2.8 trillion or almost double the budgetary cost. Furthermore, when taken as a share of the GDP, the economic subsidy amounted to 5.3% of the GDP in 1980/81 and to 5.4% in

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1/ CEM 1982, p. 45. Under production sharing agreements with foreign producers and from PERTAMINA'S own production, domestic oil refineries are able to obtain indigenous crude at below world market prices. It should, therefore, be noted that the calculation of the subsidy in the national budget is based on the difference between PERTAMINA's sales receipts and its actual outlays. PERTAMINA, through its "pro-rata" crude contracts with foreign oil companies, is able to secure a large portion of the crude it refines for the domestic market at a price below the export price for Indonesian crude. For example, in 1978, when Indonesia crude export prices were around $13.50 per barrel, PERTAMINA, through this feature of the contract, obtained crude for at most $3.50 per barrel. This, in turn, tends to lower the budgetary cost as taxes not collected on pro-rata crude do not show up in the budget.

FIGURE 2.1
DOMESTIC PRICE OF PETROLEUM PRODUCTS, 1972-82
(RP/LITER)

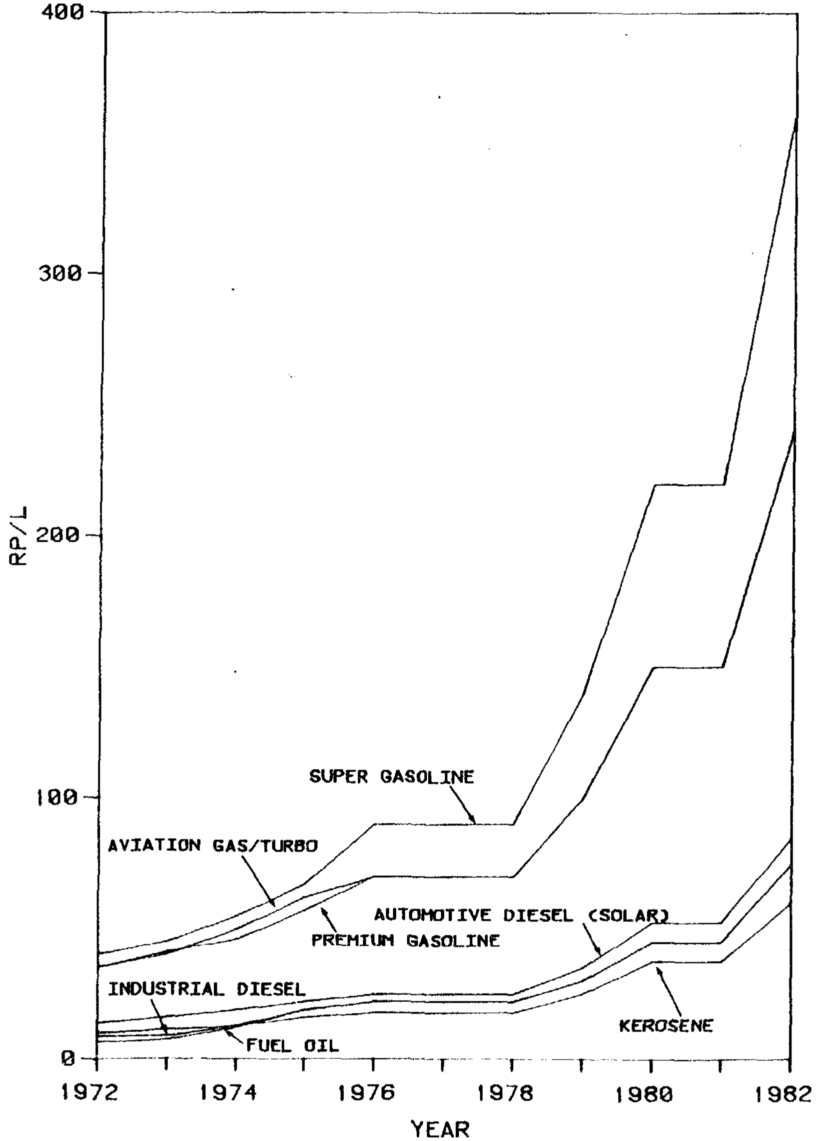


FIGURE 2.2
RATIO OF DOMESTIC PRICES TO INTERNATIONAL PRICES,
1972-1982

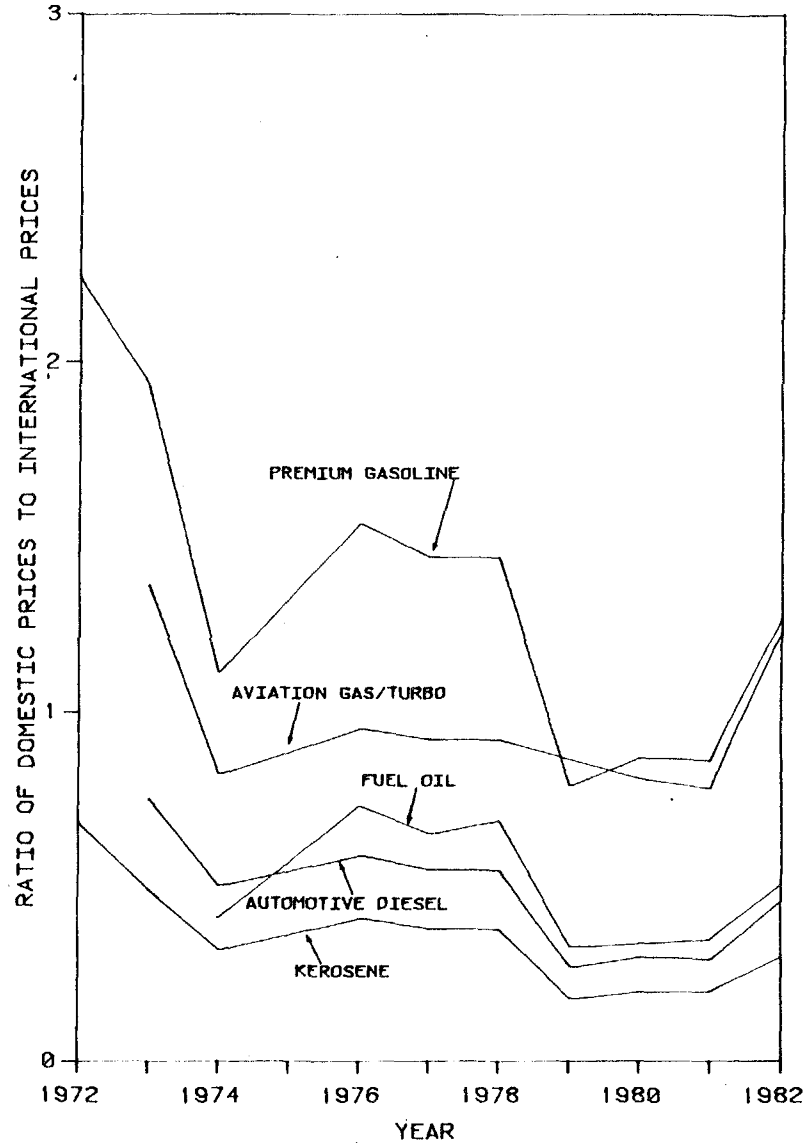


Table 2.1: Domestic Oil Prices and Subsidies
(December 1981, January 1982)

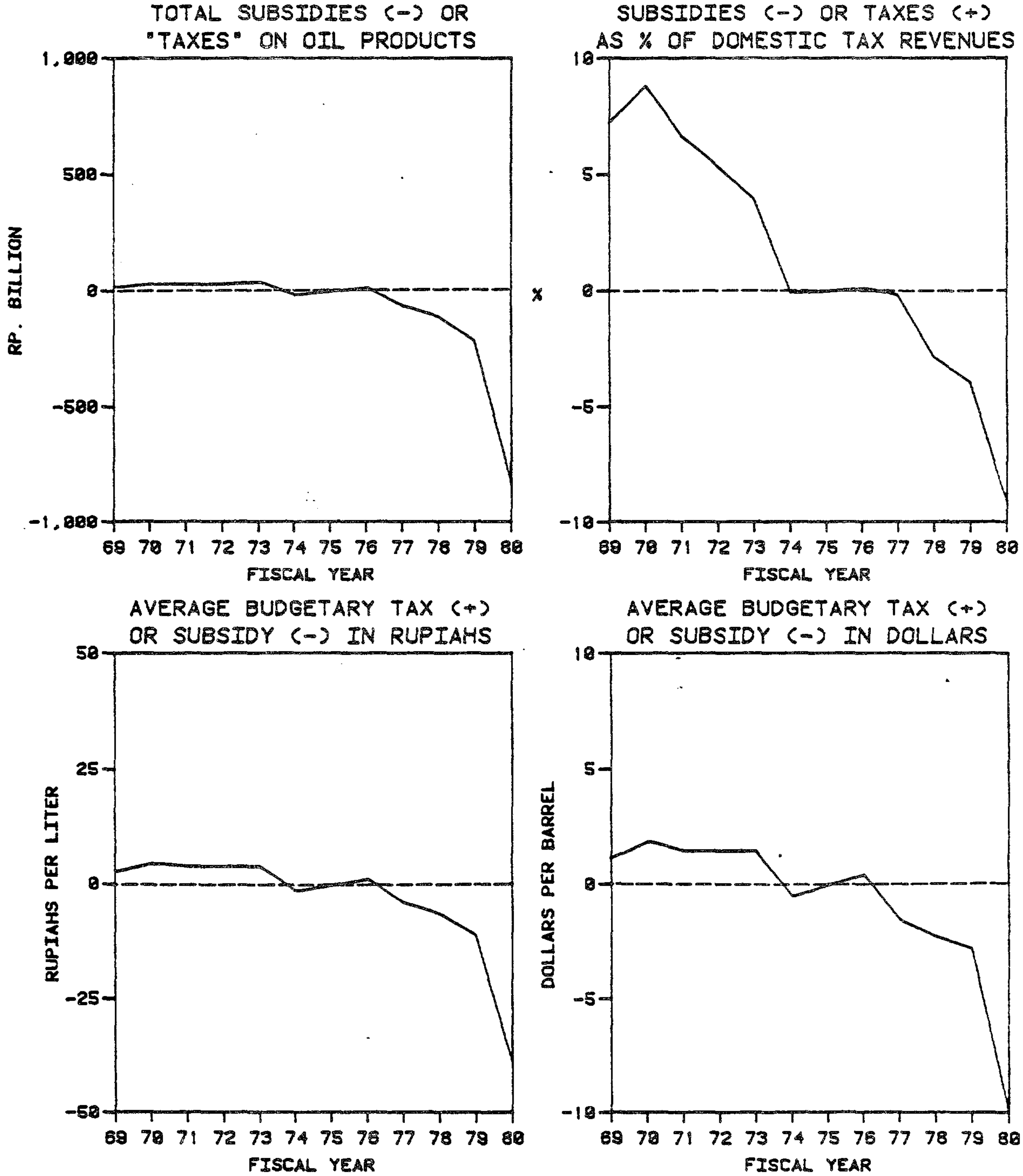
Product	Market Share 1980 (%)	(Rp/ltr) Dec. 1981	(Rp/ltr) Jan. 1982	International price a/	Domestic Price as Proportion of International Price b/ Dec. 1981	Domestic Price as Proportion of International Price b/ Jan. 1982
Aviation turbo/gas	3.2	150.0	240.0	195.0	0.77	1.23
Premium gasoline	0.3	220.0	360.0	202.0	1.09	1.78
Regular gasoline	16.5	150.0	240.0	189.0	0.79	1.27
Kerosene	34.8	37.5	60.0	203.0	0.18	0.30
Motor diesel	28.5	52.5	85.0	185.0	0.28	0.46
Industrial diesel	5.6	45.0	75.0	185.0	0.24	0.41
Fuel oil	11.2	45.0	75.0	146.0	0.31	0.51
Total Average	100.0	66.0	106.0	188.0	0.35	0.56

a/ Based on 1981 Singapore ex-refinery prices, increased by 5% to allow for distribution costs.

b/ A fraction higher than unity indicates a tax. A fraction lower than unity indicates an economic subsidy.

Source: Department of Mines and Energy and Bank staff estimates, as cited in CEM, 1982.

FIGURE 2.3
BUGETARY SUBSIDIES/TAXES ON OIL PRODUCTS
1969-70 THROUGH 1980-81.



SOURCE: REPUBLIK INDONESIA, NOTA KEUANGAN, 1978-79 AND NOTA KEUANGAN, 1980-81, AS CITED IN GILLIS (1980), OP. CIT.

1981/82. These costs are large relative to the Indonesian economy. To reduce and eventually eliminate the budgetary subsidies, the Government plans a large expansion of domestic refining capacity; investments are expected to be around Rp 2 trillion (about $3 billion). The achievement of self-sufficiency in oil products through these investments may eliminate the budgetary subsidies, but it will not reduce the economic subsidy involved in selling oil domestically at less than world market prices. Summers has estimated that the economic waste (deadweight loss) associated with these economic subsidies may range from 0.25% to 0.5% of GDP depending on whether the price elasticity of demand is assumed to be 0.25 or 0.5. 1/ These losses are large, but not unusual for oil-exporting developing countries that have imposed price controls and subsidized domestic energy consumption. For example, the economic waste in Bolivia, in the mid-seventies, due to energy subsidies ranged from 0.6% to 0.8% of GDP. 2/ On the other hand, Arrow and Kalt have estimated the deadweight loss from oil price controls in the United States in 1978 to be about only 0.1% of GNP. 3/

The Government's Concerns

2.10 Though aware that price controls on oil products impose an economic cost to the society, the Government has been reluctant to use prices as a tool of demand management for a variety of reasons; the three most important ones are those related to income distribution, environmental and inflationary concerns. Since these issues are addressed in much greater depth in the subsequent chapters, only the essence of the problem is outlined here.

2.11 The Government's concern with poverty alleviation, environmental protection and inflation control have had the effect of decreasing the real price of energy by an average of 25% over the period 1973 to 1978; the real price of automotive diesel and kerosene have decreased by 32% and 29%, respectively. 4/ This situation was ameliorated somewhat by the increase in energy prices in 1980 (Figure 2.2). However, the oil product that remains central to the Government's three major concerns mentioned above is kerosene. In 1978, it accounted for 37% of the domestic oil consumption and

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1/ Summers, L. "Oil Subsidies in Indonesia" in M. Gillis and P. Timmer, Public Policy in Indonesia: Issues and Methodology [Oegelslager, Hain and Gunn (forthcoming)].

2/ Gillis, M. (1978). "Allocative and X-Efficiency in State-Owned Enterprises: Some Asian and Latin American Cases," Technical Paper Series #13, Institute of Latin American Studies, University of Texas, Austin; as cited in M. Gillis (1980), "Energy Demand in Indonesia: Projections and Policies," Development Discussion Paper No. 82. Harvard Institute for International Development, Harvard University, Cambridge, Massachusetts.

3/ Arrow, K.J. and J.R. Kalt (1978). "Why Oil Prices Should be Decontrolled," Regulation. Sept./Oct., pp. 16-17; as cited in Gillis (1980), op. cit.

4/ MME/USAID Energy Report, p. 17.

32% of all consumption of commercial energy. Consequently, the Government's concern is that a rise in kerosene prices, which would also necessitate price increases in other fuels, would be inflationary. Moreover, household consumption of kerosene is estimated to be about 80% of total kerosene sales.[1/] In addition, expenditure survey data for 1976 and 1978 indicates that about 20% of total kerosene consumption is consumed by the poorest 40%. The Government, therefore, feels that an increase in the kerosene price to its international level would adversely affect the welfare of the poor. There is also concern within the Government that kerosene and firewood may be close fuel substitutes for the poor; thus, a rise in the price of kerosene, particularly in rural Java, would provide an incentive to increased use of firewood and, therefore, contribute to severe deforestation problems with undesirable ecological effects. Consequently, one justification for the kerosene subsidy is that it is believed to help slow the pace of soil erosion which would result from the cutting of forests on mountain slopes. Hence, the Government's concern with environmental deterioration if kerosene prices are raised.

2.12 It is, therefore, not surprising that the controlled price of kerosene departs furthest from its opportunity cost. For example, until December 1981, the domestic price of kerosene was set at Rp 37.5 per litre, whereas its international price was close to Rp 203 per litre. Thus, the unit economic subsidy on kerosene amounted to 82% (see Table 2.1) and the subsidy on kerosene accounted for about 53% of the total economic subsidy. Since automotive diesel and kerosene are partial substitutes, automotive diesel was also subsidized; it accounted for another 32% of the total economic subsidy. These two products, therefore, accounted for almost 85% of the total economic subsidy.[2/]

2.13 The concerns of the Government appear to be legitimate, but the economic costs of eliminating the subsidies may have been overestimated and the benefits underestimated. This has been articulated in previous reports where three major reasons have been advanced as to why oil subsidies should be gradually reduced. The first relates to foreign exchange savings through reduced consumption which could amount to almost $7 billion annually; the second relates to the annual budget savings which could amount to Rp 9 trillion; and the third, to improved resource allocation.[3/]

2.14 Most importantly, the existing price system tends to encourage the development of energy-intensive industries, which are also very capital-intensive, such as cement, smelting and ceramics/pottery. Thus, large amounts

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1/ Salyawati Hadi, et al. (1978). "Utilization of Firewood and Agricultural Waste in Indonesia," LPPH, April. This figure has never been confirmed. There is very little reliable information on energy use in households. Consequently, it is not even known with certainty whether the figure given above is increasing or decreasing.

2/ Industrial diesel and fuel oil accounted for about 6.7% each and regular gasoline for 1.7% of the total economic subsidy.

3/ See, for example, CEM, 1981, p. 25 for a more detailed discussion.

of investment funds may have been allocated to activities, some of which may, in fact, have low social rates of return. For example, the social profit ratios for energy-intensive industries such as cement, ceramics and pottery, and glassware, are well below one, indicating their low social profitability. 1/ Moreover, these low prices tend to encourage an inefficient use of the transport system, which is reinforced by large direct subsidies received by certain transport sectors. Finally, the existing structure of prices tends to favor the relatively well-off households. For example, one study shows that, on the average, in 1976, urban households received an economic subsidy via their consumption of kerosene amounting to Rp 203 per person per month, while the figure for rural households was only Rp 83. Moreover, within each group, the subsidy was distributed roughly in proportion to the household income, so that the bulk of the subsidy accrued to households with above average incomes. 2/ Such a pricing structure, therefore, not only misallocates scarce resources, but also tends to worsen the distribution of income.

Recent Price Policy Changes

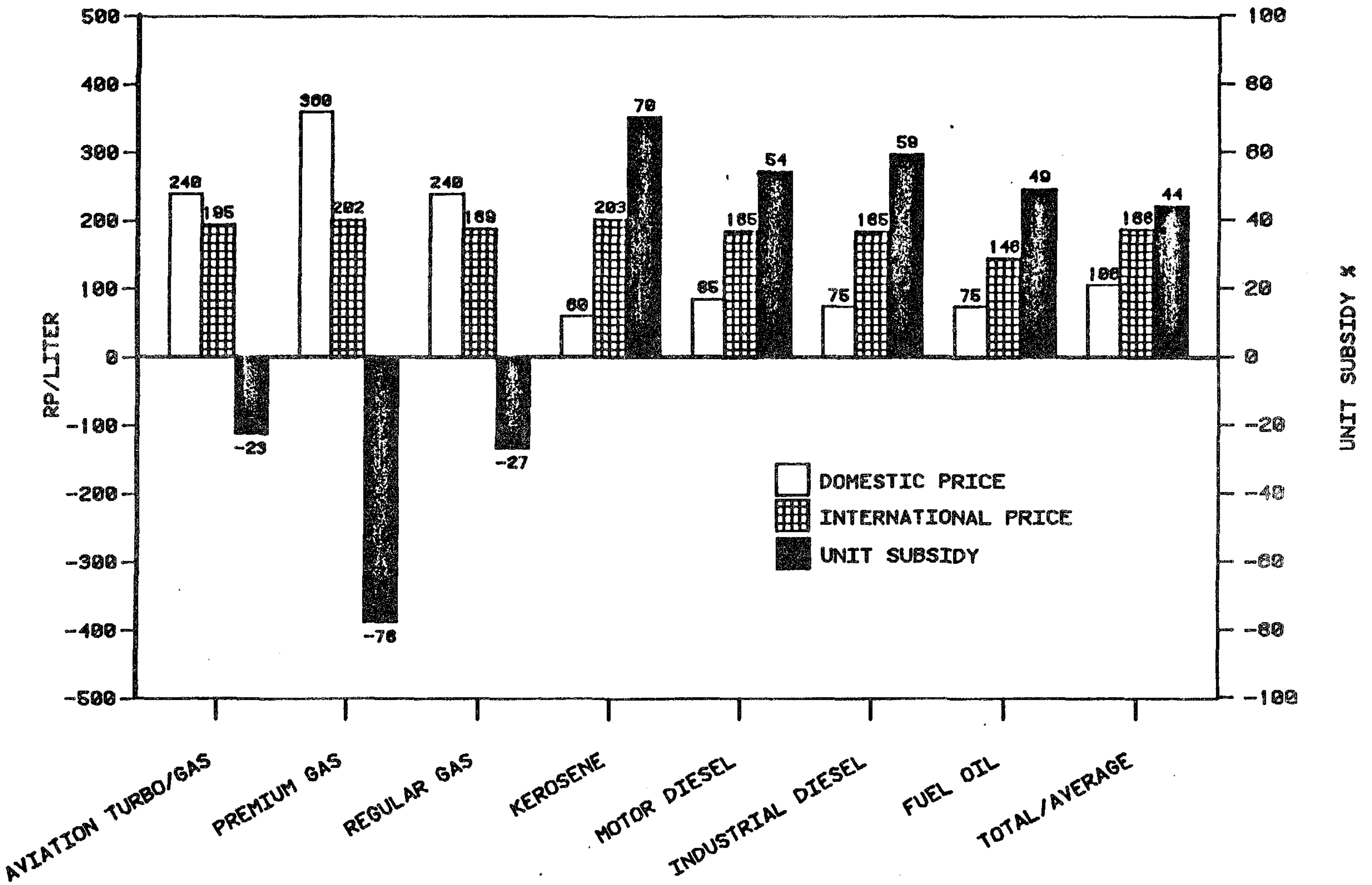
2.15 Temporary subsidies on energy may protect the economy in the short run from disruptive international oil price shocks, but the long-term consequences can be quite severe. Some of the positive effects of even a partial price increase can be seen by the 60% increase announced in January 1982; this represented a major step by the Government in reducing the economic distortions referred to earlier. Though the full impact on the economy is yet to be ascertained as the price increases work their way through the system, the effects on the budget are expected to be quite beneficial; as mentioned earlier, Rp 1.2 trillion will be generated as additional revenues, and the economic subsidy, though still high, will now be reduced to 3.8% of GDP.

2.16 As a result of this price change, aviation turbo/gas and premium and regular gasoline are now all taxed, i.e., their domestic prices are now above their international prices. The tax is 23%, 78% and 27% for the three fuels, respectively. Prior to this price change, aviation turbo/gas and regular gasoline were subsidized while premium gasoline was not; the unit economic subsidy was 23% on aviation turbo/gas and 21% on regular gasoline, while the tax on premium gasoline was 9%. However, kerosene, motor diesel, industrial diesel and fuel oil continue to be subsidized even after the price increases; the economic subsidy ranges from 70% for kerosene to 49% for fuel oil (see Figure 2.4). In other words, the domestic prices of these fuels remain substantially below their respective international prices; the domestic price of kerosene is 30% of the international price, whereas that of fuel oil is 51%.

1/ Hughes, G. (forthcoming), "Shadow Prices and Economic Policy in Indonesia," Oxford University Press. The social profit ratios using traditional efficiency prices are for cement: 0.90; ceramics and pottery: 0.78; and glassware: 0.26.

2/ Hughes, G. (forthcoming), op. cit. This issue is discussed more fully in Chapter 5.

FIGURE 2.4
DOMESTIC AND INTERNATIONAL PRICES AND UNIT SUBSIDIES, 1982



SOURCE: CEM, 1982

2.17 However, as a consequence of the January 1982 price increase, the international price, and the average economic subsidy has declined from 65% to 44%. Moreover, on January 7, 1983, the Government of Indonesia substsantially increased domestic prices for petroleum products and thus significantly reduced the economic subsidy given to kerosene, diesel, and fuel oil. However, subsequent to that change, the decrease in the official OPEC price has reduced the import parity price of refined products, and the devaluation of the rupiah effective on March 30, 1983, has lowered the dollar equivalent of the January 1983 domestic prices. Table 2.2 shows the net effect of these changes on the ratios of domestic to international prices and on the economic subsidies for each product. Despite the OPEC price decline and the devaluation, the ratios of domestic to international prices are still significantly higher than they were before the January 1983 domestic price increases. In terms of the weighted average for all products, the economic subsidy decreased by 17.6% between December 1982 and April 1983. These price increases are clearly steps in the right direction. What effects will these price changes have on the total demand for energy? What will be the new distribution of demand by sectors? Will there be profit-squeezes in certain industries? Which income groups are likely to suffer the most/least? What are the implications for the balance of payments? These and many other similar questions must be of concern to the Indonesian policymakers, not only because of the recent measures taken, but also because of similar measures contemplated for the future. This report (Chapters 4-7) attempts to provide answers to some of these questions.

Some International Experience

2.18 Prior to 1973, the real domestic price of commercial fuels in most countries had been declining. Since 1973, however, many developing countries have taken steps to price energy at international levels. But these countries have differed in the way in which energy for direct consumption (e.g., motor gasoline and kerosene) and that for intermediate use (e.g., fuel oil) have been priced. In general, products for direct consumption have been taxed more heavily than those for intermediate use; a pattern followed very much by the industrial countries. Also, in general, oil-producing countries have tended to price energy at well below the international price. In some case, however, and specifically for kerosene, the domestic price in many developing countries, as in Indonesia, is heavily subsidized in the belief that higher prices would affect the incomes of the rural and urban poor. Consequently, kerosene, natural gas, and to some extent LPG have been subsidized as have been diesel oil -- largely used by the industrial, transport and power sectors -- and electricity for certain low-income classes of customers. This structure of prices has introduced distortions in the energy demand pattern in these countries.

2.19 If one makes the distinctions between oil-importing and oil-exporting developing countries, then it can be seen that in oil-importing countries, the nominal and the real price of petroleum products has risen, whereas the opposite holds true in the oil-exporting group (see

Table 2.2: DOMESTIC OIL PRICES AND SUBSIDIES
(Rp/liter)
(December 1982, January 1983, April 1983)

	Market share (1980,%)	Domestic prices		International prices /a			Domestic price/ international price			Economic subsidies		
		Dec 1982	Jan-Apr 1983	Dec 1982	Jan 1983	Apr 1983	Dec 1982	Jan 1983	Apr 1983	Dec 1982	Jan 1983	Apr 1983
Aviation turbo/gas	3.2	240	300	207	210	253	1.16	1.43	1.19	(33)	(90)	(47)
Super gasoline	0.3	360	400	202	205	251	1.78	1.95	1.59	(158)	(195)	(149)
Regular gasoline	16.5	240	320	181	183	222	1.33	1.75	1.44	(59)	(137)	(98)
Kerosene	34.8	60	100	206	209	250	0.29	0.48	0.40	146	109	150
Motor diesel	28.5	85	145	198	201	234	0.43	0.72	0.62	113	56	89
Industrial diesel	5.6	75	125	194	197	229	0.39	0.63	0.55	119	72	104
Fuel oil	11.2	75	125	132	134	167	0.57	0.93	0.75	57	9	42
Total/Average	100.0	106	161	191	194	231	0.55	0.83	0.70	85	33	70

/a Based on Singapore (Pulau Bulcom) prices for refined products, increased by 5% to allow for distribution costs.

Table 2.3). 1/ For example, in Brazil, over the period 1973 to 1977, the retail price of kerosene increased by 196% and that of gasoline by 334%. Similarly, in India, the increase was 156% and 182%. On the other hand, the figures for Mexico, an oil-exporter, show a decline of 33% for kerosene, but an increase of 42% for gasoline, and for Egypt, another oil-exporter, a decline of 17% for fuel and light oil. 2/ As of 1980, Egypt has continued to price its energy products at substantially below international prices (see Table 2.4) and the economic subsidy varies from 96% on naphtha, to 93% on fuel oil, to 84% on kerosene and 15% on aviation fuel. It has been estimated that if the real international price of fuel oil increases at 3% per year, real domestic prices would have to be doubled each year for four years in order to eliminate the economic subsidy. 3/

2.20 As far as gasoline is concerned, most countries have tended to raise its price after 1973, but as of 1977, Bolivia, Burma and Colombia were the very few countries which continued to subsidize regular gasoline by pricing it domestically below its world price. Many other developing countries, such as Ethiopia, Ghana, Lebanon, Sri Lanka and Turkey, though not selling gasoline below its world price, had reduced their gasoline taxes permanently to ease the burden on the consumers by absorbing part of the international price increase. Burma and Tunisia, however, were the only two countries selling regular gasoline below the 1973 pre-embargo prices. 4/ Also in many countries, the real price of electricity has either declined or not changed very much since 1973 because much of it is produced from coal or hydro where prices have not reflected the changes in international petroleum prices.

2.21 The effects of increased energy prices on energy demand in the short term are not very large, particularly in developing countries. This is because the full adjustment process requires a change in the utilization of capital stock, an adaptation and modification of the energy efficiency of existing capital stock and the replacement of the existing capital stock. Adjustment of the capital utilization rate can be made in the short run, but the replacement of capital stock is a long-run phenomenon, whereas modification of the capital stock (retrofitting) can probably be accomplished in the medium run. Nevertheless, the oil price increases of 1973-74 have had a significant effect, albeit over quite a few years, particularly in the industrial countries. The rise in prices plus other non-price conservation measures have reduced the intensity of energy use in these countries; the ratio of total energy use per thousand dollars of GDP has declined by 2% per year for each year from 1973 to 1980. This has resulted in a savings of 10

1/ Domestic petroleum product prices have also been kept below world prices in countries self-sufficient in oil such as Argentina, Colombia, and Peru.

2/ The figure for Egypt covers the period 1973-76.

3/ See Ridker, R. (1981). "The Management of Energy Use in Developing Countries," Background Report for the World Development Report, 1981.

4/ Energy Options and Policy Issues in Developing Countries (1979); Background Paper for the World Development Report, 1979.

Table 2.3: CHANGES IN DOMESTIC RETAIL PRICES OF ENERGY IN SELECTED COUNTRIES, 1973 = 100 [1/]

	1968	1970	1973	1974	1975	1976	1977	1978	1979
Brazil									
Kerosene	174	--	100	137	215	211	215	196	--
Gasoline	183	--	100	183	310	393	359	334	--
Egypt									
Fuel & Light	134	124	100	92	87	83	--	--	--
India									
Fuel & Light	99	106	100	105	109	124	--	--	--
Kerosene	--	113	100	150	141	169	150	156	--
Gasoline	--	95	100	203	181	188	169	182	--
Korea									
Fuel & Light	114	103	100	112	--	101	92	--	--
Mexico									
Kerosene	122	--	100	122	50	89	78	67	--
Gasoline	123	--	100	142	188	202	163	142	--
Turkey									
Fuel & Light	--	91	100	113	101	99	--	--	--
Kerosene	--	130	100	147	122	101	82	105	--
Gasoline	--	140	100	142	117	97	75	164	--
Unweighted Mean									
Fuel & Light	112.5	106	100	104	98	92	--	--	--
Kerosene	148	133	100	127	122	128	118	118	--
Gasoline	--	118	100	150	176	192	169	180	--

1/ Corrected for changes in other domestic prices.

Source: Ridker (1981), op.cit.

Table 2.4: RATIO OF DOMESTIC TO BORDER PRICES AND ECONOMIC SUBSIDY FOR OIL PRODUCTS AND GAS, EGYPT, 1980

	Domestic Price as Percentage of Border Price	Economic Subsidy (%)
LPG	19	81
Kerosene	16	84
Diesel	15	85
Gas Oil	16	84
Fuel Oil	7	93
Natural Gas a/	6	94
Naptha	4	96
Supergas	72	28
Regular Gas	63	37
Aviation Fuel	85	15

a/ For the industrial sector; delivered to the power sector, the appropriate figures on 8 and 92%.

Source: Report by Pierce-Whiteman-Peida Consortium to Egyptian Petroleum Corporation, Petroleum Products Pricing (First Interim Report), p. 7, as cited in Ridker (1981), op.cit.

million barrels of oil equivalent per day, or almost 15% reduction in demand than what would have been the case in the absence of the price change. 1/

2.22 The growth of income in developing countries, of course, contributes towards increased energy consumption and this tends to mitigate the effects of increased prices on demand. In developing countries, long-term income elasticities tend to the higher than in the industrial ones -- 1.3 compared to 1.0 -- whereas the reverse is true for long-term price elasticities -- 0.3 compared to 0.4. Thus each 10% increase in price results in a long-run reduction of energy demand by 4% in industrial countries and by 3% in developing ones.

2.23 In developing countries, there is some preliminary evidence indicating that the energy intensity of industries may be declining. Also in Brazil, an increase in real gasoline prices by 116% has led to a reduction of gasoline consumption from 3,700 litres in 1973 to 2,020 litres in 1978. 2/ Relative price changes may have also led to undesirable inter-fuel substitution. Subsidized prices of kerosene have, in many developing countries, led to the substitution of kerosene for diesel oil, and in some cases to modifications of gasoline engines. Furthermore, black market sales of kerosene in the urban centers have, in some countries, led to increased use of firewood and accelerated soil erosion and deforestation. To what extent these effects are also present in Indonesia is not known, but the potential for undesirable interfuel substitution exists within the existing relative price structure.

1/ World Development Report, 1981. The World Bank, Washington, D.C.

2/ Other fuels such as alcohol, LPG, kerosene, and diesel may have been substituted for gasoline as a result of this price increase. The extent of this interfuel substitution is not known.

3. THE STRUCTURE OF ENERGY DEMAND

Introduction

3.01 The focus of this report is on the implications of altering energy prices on the industrial, household and transport sectors, and on the macroeconomic environment. To place the forthcoming analysis into proper perspective, this chapter provides a discussion of the structure of energy demand in Indonesia under the existing pricing structure. It is essentially a descriptive chapter. It begins with an overview picture which places Indonesia in the international context; it then discusses the energy demand patterns by the three major sectors discussed above; and, finally, it outlines the structure of energy demand within each of these three sectors at a fairly disaggregated level.

An Overview

3.02 Indonesia, with a current population of about 147 million, ranks as the fifth most populous nation in the world. Its consumption of primary energy in 1979 amounted to almost 34 thousand tonnes of coal equivalent (TCE or 163 MBOE). Yet, on a per capita basis, Indonesia's commercial energy consumption amounted to only 237 kilograms of coal equivalent (kce) compared to a mean value of 463 kce for all low-income countries and 1,225 kce for all middle- income countries (Table 3.1). Indonesia's growth rate of energy consumption, however, is rather high, in part due to its pricing policies discussed earlier. Over the period 1974-79, Indonesia's average annual growth rate of energy amounted to 10.1% -- higher than its average annual GDP growth over that period of 7.5%, 1/ implying an average GDP elasticity of about 1.35; this growth rate of energy consumption is significantly above the average for low-income countries (8.1%) and middle-income countries (6.3%). Only the capital-surplus oil exporters exceed the Indonesian average, primarily because of similar energy pricing policies.

3.03 Furthermore, compared to other Asian nations, Indonesia's energy sector (as measured by consumption per capita) is considerably smaller, yet energy consumption is growing much faster. For example, in 1979, energy consumption per capita and the average annual growth rate of energy (1974-79) in the Philippines was 356 kce and 5.6% respectively; in Malaysia it was 767 kce and 4.1%; in Thailand, 376 kce and 7.6%; in India, 242 kce and 8.3%; and in Turkey, 807 kce and 7.0% (Figures 3.1 and 3.2). Countries where energy consumption growth rate exceeds that of Indonesia are either those that have a rapidly growing economy and industrial sector, such as Hong Kong (16.7%), Korea (11.4%) and Singapore (17.1%) or the oil-exporting countries such as Saudi Arabia (14.3%), Algeria (12.3%) and Egypt (10.3%) where domestic energy prices remain heavily subsidized.

3.04 Despite the relatively low per capita consumption of energy, the rehabilitation of the economy, following the transfer of power from President

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1/ At constant 1973 prices.

Table 3.1: GROWTH RATES OF ENERGY PRODUCTION AND CONSUMPTION AND PER CAPITA ENERGY CONSUMPTION, 1960 - 79

	Energy Production (Average Annual Growth Rate, %)		Energy Consumption (Average Annual Growth Rate, %)		Energy Consumption Per Capita (Kilograms of Coal Equivalent)	
	1960-74	1974-79	1960-74	1974-79	1960	1979
Indonesia a/	8.5	6.5	3.8	10.1	130	237
Low Income Countries	5.2	8.4	4.4	8.1	356	463
Middle Income Countries	12.7	-0.5	8.4	6.3	509	1,225
Industrial Market Econs.	4.1	2.3	5.3	2.5	4,486	7,892
Capital Surplus Oil Exporters	12.7	4.0	7.6	10.4	771	1,458
Non-Market Industrial Economies	5.3	4.7	5.2	3.9	2,980	6,164

a/ Indonesia, at a per capita GNP of US $370 in 1979 is classified as a low income country in the World Development Report, 1981.

Source: World Development Report, 1981.

FIGURE 3.1 GROWTH RATE OF ENERGY CONSUMPTION, 1974-79

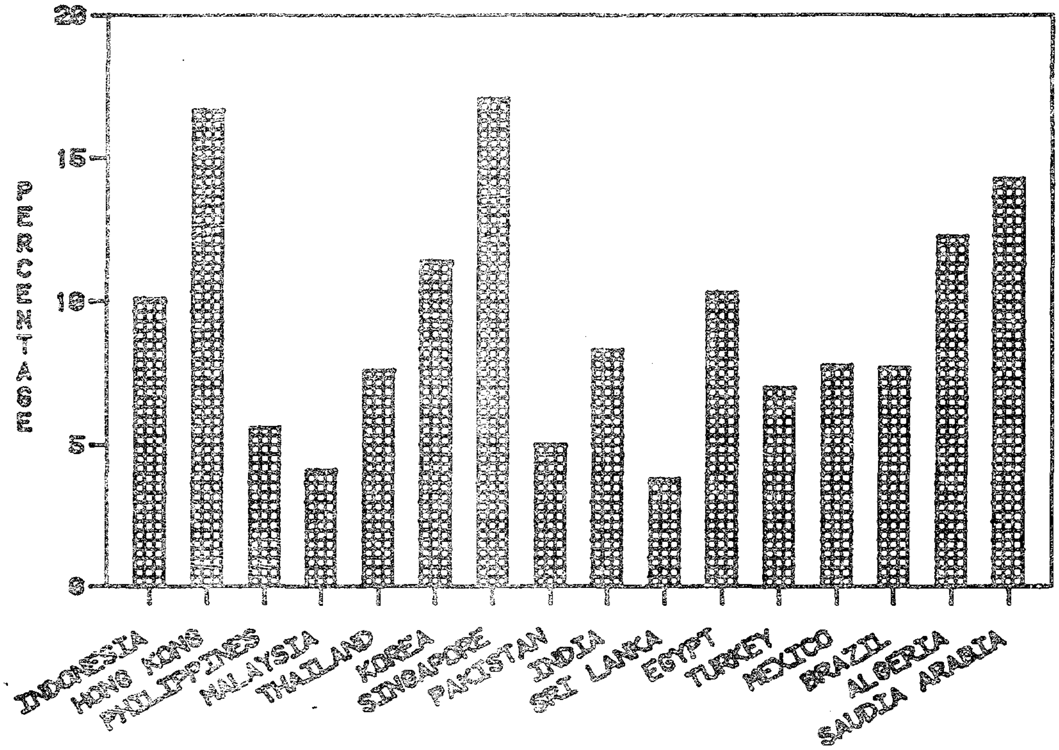
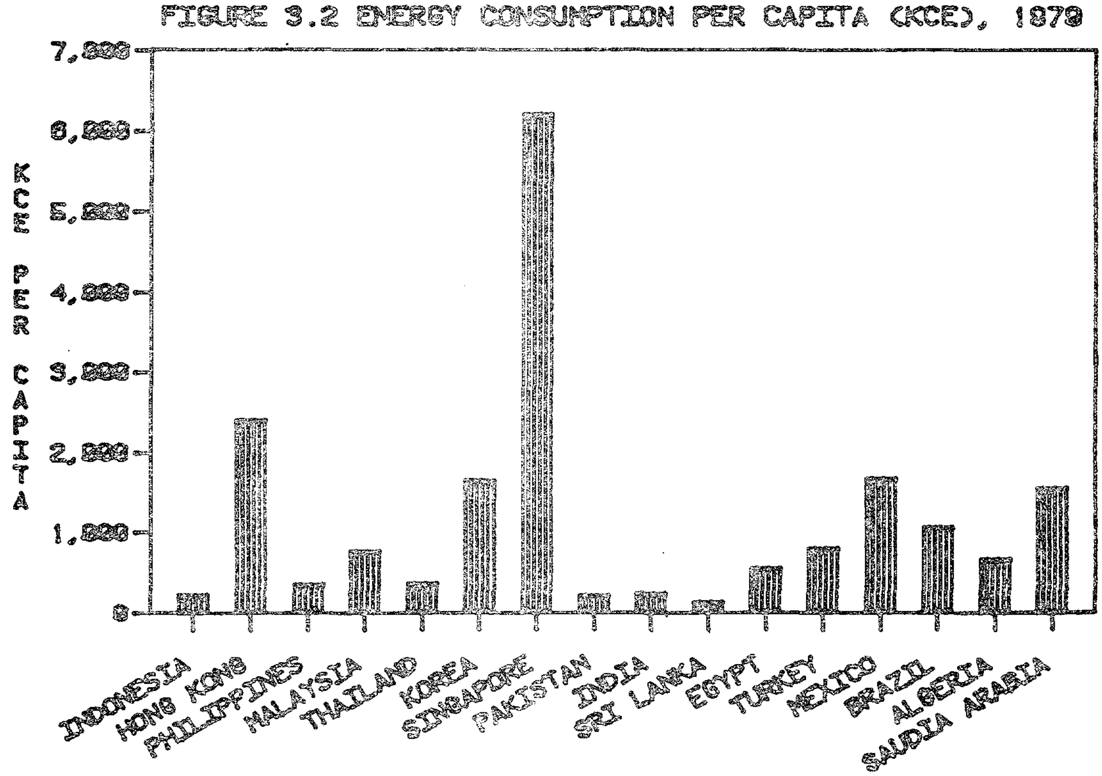


FIGURE 3.2 ENERGY CONSUMPTION PER CAPITA (KCE), 1979



Sukarno to the "New Order" government now headed by President Suharto, led to substantial growth in energy consumption. From 1968 through 1978, domestic consumption of commercial and non-commercial energy grew from 24.60 millions TCE to 66.85 millions TCE, implying an average annual growth rate of 10.5%. Over the same period, per capita consumption grew by 8.4% (Table 3.2). However, as of 1977, commercial energy consumption -- i.e., that of oil, kerosene, gas, charcoal, and hydro -- accounted for only 39.7% of all energy consumption; non-commercial energy, wood and agricultural wastes, accounted for the rest (61.3%); and refined products from petroleum comprised 88.3% of all commercial energy.

3.05 These figures, however, do not reveal an important aspect of the pattern of energy use. The completion of the rehabilitation of the economic infrastructure led to a much higher growth of energy consumption after 1972. From that time until 1977, commercial energy consumption grew at 14.7% per annum - compared to a GDP growth rate of 7.6% per annum - implying an average income elasticity of almost 2.0. 1/ Natural gas growth, from a small base (9.4% commercial energy), was the most rapid at 24.8% per annum, and oil products consumption grew at 14.1% per annum over that period.

Sectoral Patterns

3.06 As of 1978, the household sector was the major consumer of primary energy consumption, accounting for almost 65% of the total. The industrial sector consumed almost 21% followed by the transportation sector at about 12%. There is very little reason to believe that these shares have changed significantly since then. While the electric power sector used only 2.9% of total primary energy consumption, it is the fastest growing energy consumer (Table 3.3) and its growth will represent the largest single need for capital investment in the energy sector in the future.

3.07 In terms of commercial energy, Table 3.4 presents a breakdown by major sectors. It can be seen that oil is consumed primarily by the industrial and electricity sectors; kerosene, by the industrial and household sectors; and coal, by the industrial and transportation sectors. Note that coal is not shown in Table 3.4 as being consumed by the electricity sector because, as of 1978, there were no coal fired power plants; they were mostly oil-based. With the exploitation of the coal fields in Kalimantan and South Sumatra, this pattern of consumption will certainly be changed as most new power plants are expected to be multifired ones capable of using coal, oil, and/or natural gas.

The Demand Pattern of Refined Petroleum Products

3.08 As discussed earlier, oil is of overwhelming importance to the energy sector and to the Indonesian economy. Over the period 1969-1979, consumption of oil tripled, increasing from 40.26 million barrels to 122.47 million barrels. In 1979, kerosene consumption accounted for the largest share, 37.0%, followed by automotive diesel fuel (27.6%), gasoline (17.6%) and fuel oil (9.4%). (See Table 3.5.)

1/ *Gillis (1980), op. cit.*

Table 3.2: PRIMARY ENERGY CONSUMPTION, 1978
(Millions of TCE)

	Commercial a/	Non-Commercial b/	Total
Consumption	26.55	40.30	66.85
Percent of Total	40	60	100
Average Annual Growth Rate (68 -78); %	11.6	9.9	10.5
Per Capita Consumption	195	296	491
Average Annual Growth Rate (68 - 78); %	9.5	7.8	8.4

a/ Commercial energy refers to oil, kerosene, gas, charcoal, and hydro.

b/ Non-commercial energy refers to wood and agricultural sectors.

Source: BPPT/Bechtel Energy Report, 1980. Various tables.

Table 3.3: PRIMARY ENERGY CONSUMPTION BY MAJOR SECTORS, 1978

Energy / Sector	Commercial Energy			Non-Commercial Energy			Total	
	Consumption Millions TCE	% of Total	Growth Rate (68 - 78) % p.a.	Consumption Millions TCE	% of Total	Growth Rate (68 - 78) % p.a.	Consumption Millions TCE	% of Total
Industry	10.23	38.53	12.9	3.77	9.35	1.8	14.0	20.94
Household	6.72	25.31	9.1	36.50	90.57	11.3	43.22	64.65
Transportation	7.69	28.96	11.8	0.03	0.07	-7.2	7.72	11.55
Electricity	1.91	7.19	13.9	--	--	--	1.91	2.86
Total	26.55	100.0	11.6	40.30	100.0	9.9	66.85	100.0

Source: BPPT/Bechtel Energy Report, 1980. Various tables.

Table 3.4: CONSUMPTION AND GROWTH RATE OF COMMERCIAL PRIMARY ENERGY BY MAJOR SECTORS, 1978

	Industry		Household		Transportation		Electricity a/	
	Consumption (millions TCE)	Growth Rate 1968-78 (%)	Consumption (millions TCE)	Growth Rate 1968-78 (%)	Consumption (millions TCE)	Growth Rate 1968-78 (%)	Consumption (millions TCE)	Growth Rate 1968-78 (%)
Oil	5.59	10.9	--	--	7.66	12.1	1.67	16.2
Kerosene	1.91	11.0	6.6	9.2	--	--	--	--
Natural Gas	2.49	24.8	--	--	--	--	--	--
City Gas	0.07	19.2	0.02	1.7	--	--	--	--
Coal	0.17	6.6	--	--	6.03	-7.2	--	--
LPG	--	--	0.06	65.7	--	--	--	--
Charcoal	--	--	0.04	-4.2	--	--	--	--
Hydro	--	--	--	--	--	--	0.23	5.1
Total	10.23	12.9	6.72	9.1	7.69	11.8	1.91	13.9

a/ Consumption of primary energy and to generate electricity by oil.

Source: BPPT/Bechtel Energy Report, 1980. Various tables.

Table 3.5: CONSUMPTION AND GROWTH RATE OF REFINED PETROLEUM PRODUCTS, 1979

	Consumption (millions of barrels)	Percent of Total	Average Annual Growth Rate (%) (1969-1979)	GDP Elasticity
Aviation Fuel	2.52	2.2	16.0	2.09
Gasoline	21.64	17.6	8.9	1.14
Kerosene	45.48	37.0	10.4	1.33
Automotive Diesel Fuel	33.84	27.6	21.5	2.76
High Speed Diesel Fuel	7.42	6.1	14.3	1.83
Fuel Oil	11.57	9.4	5.3	0.68
Total	122.47	100.0	11.8	1.51

Source: Gillis (1980), op. cit.

3.09 Table 3.5 also shows the growth rate for each of the petroleum products over the period 1969-79, and the elasticity of demand with respect to GDP. The income elasticity for kerosene is shown to be 1.33; but if it is recognized that much of kerosene growth occurred after 1973 -- an average of 12.3% per annum from 1973-79 -- when GDP grew at an average of 7.8% per annum, then the income elasticity rises to 1.57, a very high figure. 1/ Another characteristic of the growth of petroleum products is the very high growth of diesel fuel which is almost double the growth rate of kerosene. This is the fastest growing product, used mostly by vehicles and in private electricity generation. It reflects, in part, the improved infrastructure and transport facilities, i.e. urban and intra-urban bus services, and the substitution of gasoline powered trucks by diesel motors. But, as discussed in Chapter 2, the heavy subsidy afforded to diesel fuel and kerosene remain the basic underlying cause for the high growth in demand for both these fuels.

The Structure of Energy Demand in the Industrial Sector

3.10 The industrial sector has been one of the fastest growing sectors over the last decade. 2/ Over the period 1970 to 1978, it averaged 12.4% per annum compared to 7.9% per annum for GDP. As this sector has grown, so has its consumption of commercial energy (see Table 3.4). Partly, in response to the subsidies provided to many fuels, the manufacturing sector has become increasingly energy-intensive. The sector is also characterized by a wide variation in energy use and fuel mix as demonstrated by Table 3.6. The average value of energy consumed by firms in the three-digit sectors listed varies from Rp 0.3 million in the weaving apparel sector to Rp 53.8 million in the glass and glass products sector -- a ratio of more than 100 to 1.

1/ It should, however, be noted that the income elasticities, as determined above, are biased upwards; i.e., they are overestimates of the "true" (BLUE) elasticity because the implicit demand function omits price as a relevant variable. Inclusion of price will lower the income elasticity. One study for Indonesia obtains an income elasticity of 1 when price is included, and another study shows that it is 0.78. See Gillis (1980) op.cit. Moreover, growth in demand for kerosene is likely to be more highly correlated to income growth in the household sector than to overall GDP, and the price effect of substitute fuels must also be incorporated. Thus, cross-price elasticities between kerosene and firewood -- guessed at in some studies to be between 0.2 and 0.4 -- if correct, are large enough to be important. See A. Strout (1978), "The Demand for Kerosene in Indonesia," (mimeo). Consequently, projecting demand for fuel products based on the "naive" model of income elasticities must be used with great caution. Chapter 5 estimates demand functions for kerosene and other fuels consumed by the household sector and presents estimates of own- and cross-price elasticities and income elasticities that are not subject to the limitations mentioned above.

2/ In this section, industry refers to the medium and large scale manufacturing sector. The analysis described here is based on the annual manufacturing surveys conducted by BPS for 1976, 1977 and 1978, and covers in 1978, 7,770 firms.

Table 3.6: ENERGY CONSUMPTION IN INDONESIAN MANUFACTURING, 1978

Sector	Electricity (Kwh Million)	Gasoline (Litres Thousands)	Fuel Oil (Litres Thousands)	Diesel (Litres Thousands)	Kerosene (Litres Thousands)	Value Energy (Rp. Millions)	Energy as Share of Value-Added (Percent)
311 Food Processing	88.8	8.3	102.6	74.2	24.4	7.8	17.48
312 Other Food Products	14.3	2.5	78.8	69.3	9.6	5.5	22.67
313 Beverages	45.6	24.2	57.4	85.2	3.2	6.3	8.33
314 Tobacco	12.9	4.2	17.0	1.5	6.9	1.5	27.10
321 Textiles	100.7	3.4	137.4	68.8	7.7	7.1	6.79
322 Wearing Apparel	6.2	1.7	5.0	0.0	0.5	0.3	1.37
323 Leather and Leather Substitutes	27.2	3.5	34.9	4.8	1.2	1.8	7.02
324 Leather Footwear	26.4	53.2	43.1	4.7	3.8	6.3	3.65
331 Wood and Wood Products	35.1	6.8	78.8	4.2	1.2	4.2	14.93
332 Wood Furniture	5.6	2.5	6.6	0.7	0.1	0.5	4.80
341 Paper and Paper Products	402.0	13.7	232.5	327.8	5.9	34.0	40.06
342 Printing and Publishing	36.3	7.2	18.9	0.5	1.0	1.6	7.21
351 Basic Chemicals	216.6	40.7	133.9	114.4	44.9	14.6	14.41
352 Other Chemical Products	69.3	14.3	55.4	26.3	21.1	4.7	19.50
355 Rubber	36.5	21.0	418.9	143.2	13.4	19.4	21.29
356 Plastic Wares	50.3	4.6	86.7	7.5	1.6	3.4	33.51
361 Ceramic and Porcelain	85.2	5.0	516.0	519.8	303.1	36.0	48.98
362 Glass and Glass Products	430.0	3.5	247.2	1085.4	94.2	53.8	65.89
363 Cement and Cement Products	687.7	6.5	275.2	320.7	414.3	26.8	41.24
364 Structural Clay Products	1.2	0.2	8.8	21.9	2.2	2.4	74.31
369 Other Non-Metallic Metal Products	2.4	3.1	45.8	32.4	0.1	3.9	31.24
381 Fabricated Metal Products	57.7	7.7	107.7	34.1	10.3	5.9	10.86
382 Machinery	55.8	6.8	18.4	4.7	1.2	3.8	15.56
383 Electrical Machinery	127.1	21.2	161.3	35.8	9.6	10.5	7.85
384 Transport Equipment	107.8	17.8	150.8	8.8	5.4	8.9	5.36
385 Measuring and Optical Equipment	6.9	1.6	1.5	0.0	1.4	1.1	9.98

3.11 Differences in energy's share in value-added and the mix of fuel are similarly striking. Energy as a share of value added ranges from 3.65% in leather footware to 65.89% in the glass and glass products sector; the average value for all firms in Indonesia being 6.5%. It is interesting to note that energy's share in value-added is significantly higher in rural industries than in urban ones; for rural industries the share is 13.9% compared to only 4.4% in urban areas. With respect to regional characteristics, no major differences between Java and non-Java can be detected (Table 3.7).

3.12 Energy intensities, measured as the ratios of value of energy inputs to value added, are presented in Table 3.8 for selected subsectors. In general, the relatively energy-intensive subsectors are not those which consume the most energy. Textile and food processing, the major (total) energy consuming subsectors, are not as energy-intensive as structural clay products (364), glass and glass products (362), ceramic and porcelain (361), and cement and cement products (363). A geographical disaggregation of subsectors into Java/outer islands (non-Java) and urban/rural does not change the basic characteristics of energy intensities by subsector, except for the outer islands. The rankings, however, do change by regional location. In general, structural clay products (364), glass and glass products (362), ceramic and porcelain (361), cement and cement products (363), paper and paper products (341), plastic products (356), and iron and steel (371) are the relatively energy-intensive subsectors. This, in turn, implies that these sectors are likely to be relatively sensitive to changes in energy costs and vulnerable to rising energy prices. 1/

3.13 In Table 3.9, the consumption of commercial energy is disaggregated into eight separate sources of energy; it also lists the major consuming subsectors of each energy source. The table indicates those manufacturing subsectors that account for a relatively large share (greater than 70%) of the consumption of these eight fuels in the industrial sector. The feature to note here is the high degree of concentration of kerosene, coal, cokes and gas consumption on a few subsectors. More than 50% of kerosene, cokes, coal and gas are consumed by cement and cement products, food processing, and glass and glass products respectively. The consumption of the rest -- namely, gasoline, fuel, oil, diesel oil and electricity -- are distributed over various subsectors. However, textile, food processing, and cement and cement products are the most important consumers of almost all petroleum products and electricity.

3.14 The relative importance of different forms of commercial energy used in the manufacturing sector are summarized in Table 3.10 for 1976 and 1978. Two petroleum products -- fuel oil and diesel oil -- dominate. Fuel oil accounted for 43% and diesel oil for 29% of the total energy consumption by the manufacturing sector in 1976; their shares do not change significantly in 1978, except for regions outside Java (non-Java in the table). There, for example, the share of diesel in total energy consumption (in non-Java) declined drastically from 20% in 1976 to 6.5% in 1978, while the relative importance of fuel oil increased from 49.0% in 1976 to 63% in 1978.

1/ See Chapter 4 for a detailed discussion of the elasticity of total cost with respect to the price of various fuels for each sector.

Table 3.7: PROFILE OF THE MANUFACTURING SECTOR, 1976-78

	1976	1977	1978
I. Total No. of Establishments (No.)	7,219.0	7,606.0	7,770.0
Urban (%)	45.5	44.8	44.7
Rural (%)	54.5	55.2	55.3
Java (%)	85.6	85.4	84.1
Non-Java (%)	14.4	14.6	15.9
II. Total Value-Added (Rp Million)	579.4	681.0	940.1
Urban (%)	58.9	55.8	53.5
Rural (%)	41.1	44.2	46.5
Java (%)	85.9	88.4	82.2
Non-Java (%)	14.1	11.6	17.8
III. Total Value of all Energy Inputs (RP Million)	46.8	52.8	60.8
Urban (%)	37.6	35.4	36.7
Rural (%)	62.4	64.6	63.3
Java (%)	87.6	88.4	86.1
Non-Java (%)	12.4	11.6	13.9
IV. Energy Input/Value-Added (%)			
All Indonesia	8.1	7.8	6.5
Urban	5.1	4.9	4.4
Rural	12.3	11.4	13.9
Java	8.2	7.8	6.8
Non-Java	7.1	7.8	5.0

Table 3.8: ENERGY INTENSITY OF MANUFACTURING, 1978 [a]

I. All Indonesia

364	Structural Clay Products	0.7431
362	Glass and Glass Products	0.6589
361	Ceramic and Porcelain	0.4898
363	Cement and Cement Products	0.4124
341	Paper and Paper Products	0.3351
356	Plastic Products	0.3351
371	Iron and Steel	0.3274
369	Other Non-Metallic Mineral Products	0.3124

II. Java

364	Structural Clay Products	0.8720
362	Glass and Glass Products	0.6759
361	Ceramic and Porcelain	0.5458
363	Cement and Cement Products	0.4590
341	Paper and Paper Products	0.4116
356	Plastic Products	0.3633
371	Iron and Steel	0.3453
314	Tobacco	0.2818

III. Non-Java

369	Other Non-Metallic Mineral Products	0.8155
362	Glass and Glass Products	0.5060
312	Other Food Products	0.3122
371	Iron and Steel	0.2438
355	Rubber	0.2236
364	Structural Clay Products	0.2126
385	Measuring and Optical Equipment	0.1970
341	Paper and Paper Products	0.1828

IV. Urban

362	Glass and Glass Products	0.6871
361	Ceramic and Porcelain	0.5885
364	Structural Clay Products	0.4653
356	Plastic Products	0.3753
371	Iron and Steel	0.2619
312	Other Food Products	0.2413
355	Rubber	0.2220
352	Other Chemical Products	0.2010

V. Rural

364	Structural Clay Products	0.7591
363	Cement and Cement Products	0.7297
341	Paper and Paper Products	0.5573
362	Glass and Glass Products	0.5111
371	Iron and Steel	0.4209
361	Ceramic and Porcelain	0.3911
369	Other Non-Metallic Mineral Products	0.3214
314	Tobacco	0.3016

[a] Means of samples; measured as the value of energy as a share of value-added.

Table 3.9: SHARE OF ENERGY CONSUMPTION IN INDUSTRIAL SUB-SECTORS, 1978
(%)

	Sub-Sector	Gasoline	Fuel Oil	Diesel	Kerosene	Coal	Cokes	Gas	Electricity
311	Food Processing	28.4	8.9	20.2	3.2	4.3	57.5	2.9	10.9
312	Other Food Products	--	6.2	7.5	3.2	--	--	--	4.4
314	Tobacco	4.6	--	--	2.5	--	--	--	--
321	Textiles	10.4	34.2	23.7	8.0	--	--	5.3	33.9
331	Wood and Wood Products	4.7	4.5	--	--	--	--	--	--
341	Paper and Paper Products	--	--	4.7	--	--	--	--	4.4
351	Basic Chemicals	5.8	--	--	--	13.3	--	6.9	5.3
352	Other Chemical Products	6.5	--	--	3.3	--	--	--	--
355	Rubber	6.6	10.6	5.0	--	2.4	--	1.6	5.8
361	Ceramics and Porcelain	--	--	--	2.2	--	--	--	--
362	Glass and Glass Products	--	--	9.4	2.5	--	--	54.9	--
363	Cement and Cement Products	--	10.6	17.1	67.1	54.8	--	6.7	13.0
371	Iron and Steel	--	--	--	--	22.5	23.1	--	--
381	Fabricated Metal Products	4.0	4.5	2.0	--	1.7	4.8	.9	3.8
382	Machinery	--	--	--	--	.8	13.0	--	--
383	Electrical Equipment	--	--	--	--	--	.3	19.0	--
384	Transport Equipment	--	3.1	--	--	--	--	--	--
385	Measuring and Optical Equipment	--	--	--	--	--	1.2	--	--
	Sub-Total	71.0	82.6	89.6	92.0	99.8	99.9	98.2	81.5
	Other Sub-Sectors	29.0	17.4	10.4	8.0	0.2	0.1	0.8	18.5
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 3.10: STRUCTURE OF ENERGY USE BY KIND OF ENERGY IN THE MANUFACTURING SECTOR
(% Based on BOE)

	1976					1978				
	All Indonesia	Java	Non-Java	Urban	Rural	All Indonesia	Java	Non-Java	Urban	Rural
Gasoline	4.0	3.6	6.2	5.0	3.3	2.9	2.8	4.0	3.9	2.3
Fuel oil	42.8	41.9	48.7	47.3	40.0	41.7	38.4	62.7	44.6	40.0
Diesel	28.7	29.8	20.2	28.6	28.7	28.7	32.2	6.5	30.7	27.6
Kerosene	10.2	9.9	12.6	4.8	13.6	9.1	9.0	9.8	4.8	11.7
Coal	0.5	0.3	2.0	0.1	0.7	0.3	0.1	1.3	0.1	0.4
Gas	0.5	0.6	0	1.0	0.2	0.6	0.7	01.5	0.2	
Electricity	13.4	13.8	10.3	13.3	13.4	16.5	16.7	15.7	14.4	17.8
Produced in plant a/	(76.3)	(76.0)	(77.9)	(77.6)	(75.3)	(79.6)	(79.2)	(82.0)	(79.7)	(79.5)
Bought from PLN	(23.0)	(23.2)	(21.9)	(21.5)	(24.1)	(19.9)	(20.2)	(17.8)	(19.8)	(19.9)
Bought from non-PLN	(0.7)	(0.8)	(0.2)	(0.9)	(0.6)	(0.5)	(0.6)	(0.2)	(0.5)	(0.6)
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

a/ It is assumed that electricity is sold out of that produced in plant.

3.15 Electricity is the third most important source of energy -- afterfuel oil and diesel -- and its relative share increased from 1976 to 1978. Kerosene accounts for 9-10% of the total energy use in the industrial sector for all of Indonesia. However, its relative share for rural Indonesia is about three times that in the urban areas. The shares of coal and gas are negligible, less than 1%; moreover, the former appears to be declining, both in terms of absolute quantity and relative shares.

3.16 The structure of energy use by three-digit industrial subsector is shown in Table 3.11. As can be seen the textile industry relies heavily on fuel oil; more than 50% of its energy requirements are met by fuel oil, as compared with the average industrial sector share of 42%. The cement and cement products industry, on the other hand, indicates a very high dependence on kerosene; the kerosene share is 40% in this subsector compared to the industry average of 10%. The glass and glass products subsector is heavily dependent on diesel (72% in 1976 and 65% in 1978) and natural gas as compared to the other subsectors. The share of electricity has increased in almost all the subsectors over the three-year period. [1/]

3.17 Table 3.12 presents the share of energy costs in the total costs of production. As can be seen, the shares range from as high as almost 16% in the ceramics and porcelain subsector (361) to a low of 0.26% in the tobacco subsector (314). The non-metallic minerals sectors (36) have relatively higher energy costs shares than other sectors; for glass and glass products (362) the share is 8%; for structural clay products (364) it is 7.5%; for other non-metallic mineral products (369) it is 4.9%; and for cement and cement products (363) it is 3%. This low energy cost share for the cement and cement products subsector may appear to be low, on the face of it, but as explained later (Chapter 4) this subsector consists of very few large cement manufacturing firms, which are relatively energy-intensive, and a large number of smaller cement products firms. Aggregation of this subsector to the three-digit ISIC level rather than the five-digit level is the reason for this relatively low figure. [2/]

3.18 The discussion so far has been restricted to the three-digit level sectors, and this will be the practice in most of the discussion on the industrial sector in this report. However, disaggregation to the five-digit sectors does throw some additional light on the structure of energy demand. Unpublished BPS data give the quantities and values of fuel and lubricant

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1/ The average growth rates of each of these sectors are also given in Table 3.12. It can be seen that the average income elasticity for manufacturing over the three-year period is 1.11. But see footnote 1 on page 29.

2/ Aggregation to the three-digit level, rather than disaggregation to five-digits explains many other unexpected numbers for the cement and cement products subsector (363) in this report. This is also discussed in Chapter 4 later.

Table 3.11: STRUCTURE OF ENERGY USE BY SELECTED SUBSECTORS
(%)

SITC Code		Gasoline	Fuel Oil	Diesel	Kerosene	Coal	Gas	Electricity	Total	Share in Total Manufacturing Consumption of Energy	Average Growth Rates 1976-1978: Total Energy	Average Growth Rates 1976-1978: Real Output a/
	1976											
361	Textile	1.4	52.0	27.2	2.5	--	0.1	16.8	100.0	30.7	--	--
363	Cement	0.5	25.9	24.7	39.8	1.2	0.1	7.7	100.0	18.3	--	--
311	Food Processing	9.3	35.1	38.5	3.9	1.0	0.7	11.5	100.0	11.6	--	--
312	Other Food Products	1.7	50.0	35.2	4.2	0	0	8.9	100.0	4.3	--	--
362	Glass and Glass Products	0.2	13.7	71.8	4.2	0	4.9	5.2	100.0	3.9	--	--
355	Rubber	3.2	45.6	35.4	0.7	0.3	0	14.8	100.0	3.4	--	--
381	Fabricated Metal Products	10.0	45.3	20.5	4.3	0.1	0.3	19.5	100.0	3.7	--	--
341	Paper and Paper Products	3.3	45.7	31.8	0.4	0	0	18.7	100.0	3.3	--	--
	All Manufacturing	4.0	42.8	28.7	10.2	0.5	0.5	13.4	100.0	100.0		
	1978											
321	Textile	1.1	51.4	24.5	2.6	--	0.1	20.2	100.0	27.7	12.2	4.9
363	Cement and Cement Products	0.5	24.7	27.4	34.2	0.9	0.2	12.0	100.0	17.9	16.9	17.9
311	Food Processing	6.7	29.7	46.6	2.4	0.1	0.1	14.5	100.0	12.5	22.3	16.5
312	Other Food Products	1.2	44.2	37.0	4.9	--	--	12.6	100.0	5.8	37.2	16.6
362	Glass and Glass Products	0.2	15.6	65.2	5.5	--	8.5	5.1	100.0	4.2	21.2	48.7
355	Rubber	2.7	61.8	20.1	1.8	0.1	0.1	13.3	100.0	7.2	72.3	116.3
381	Fabricated Metal Products	3.5	55.6	16.8	4.9	0.1	0.2	18.9	100.0	3.4	13.0	9.8
341	Paper and Paper Products	1.6	31.8	42.7	0.7	--	--	23.2	100.0	3.2	16.0	8.8
	All Manufacturing	2.9	41.7	28.7	9.1	0.3	0.6	16.5	100.0	100.0	18.1	16.3

a/ Outputs deflated by implicit GDP deflator for manufacturing.

Table 3.12: SHARE OF ENERGY IN TOTAL COSTS

	Sector	Energy Costs as a Share of Total Costs
311	Food Processing	1.823
312	Other Food Products	2.967
313	Beverages	1.370
314	Tobacco	0.259
3211	Spinning and Weaving	3.001
321	Textiles Except 3211	2.132
322	Wearing Apparel	1.000
323	Leather and Leather Substitutes	0.776
324	Leather Footware	1.414
331	Wood and Wood Products	2.207
332	Wood Furniture	2.057
341	Paper and Paper Products	2.312
342	Printing and Publishing	2.326
351	Basic Chemicals	3.710
352	Other Chemical Products	1.247
355	Rubber	1.408
356	Plastic Wares	2.767
361	Ceramic and Porcelain	15.665
362	Glass and Glass Products	7.993
363	Cement and Cement Products	2.931
364	Structural Clay Products	7.518
369	Other Non-Metallic Metal Products	4.859
381	Fabricated Metal Products	1.657
382	Machinery	2.098
383	Electrical Machinery	1.169
384	Transport Equipment	0.927
385	Measuring and Optical Equipment	0.972

inputs for 1979 at the five-digit level. 1/ The breakdown is as follows: gasoline, fuel oil, diesel oil, kerosene, coal, cokes, gas, other fuel, lubricating oil, total. The data are slightly unwieldy, since they are not, as yet, available in tape form. But a careful perusal of the tables suggests concentration on the first four categories, which are the main subsidized fuels plus lubricating oil. These data on fuel inputs can be compared with the published BPS Industrial Statistics 1979 data on gross output and value-added at the five-digit level to obtain a detailed picture of energy intensities. Since the data are not on tape, it has not been possible follow the obvious procedure of arranging all sectors by total energy use and by a measure of energy output intensity. As an alternative, the focus is placed on the five-digit sectors within the three-digit sectors identified in Chapter 4 as most sensitive to the total energy price. The objective here is to identify five-digit sectors that have particularly high energy shares.

3.19 The results of this preliminary investigation are summarized in Table 3.13. The sectors in the table are those with a ratio of total value of fuel and lubricant input to value added greater than 0.10. In addition, the table shows the gross output of each sector as a measure of its size, and the fuel source with the greatest input value in each sector. The first five sectors in Table 3.13 are small components of food manufacturing. As indicated they total to Rp 26.8 billion of gross output. Added to sector 31270 (seasoning) the gross output amounts to Rp 47.6 billion and this is comparable in size to all the other identified sectors except cement whose value of gross output is Rp 133.5 billion. Thus, food manufacturing is an important energy consuming sector. The principal source for the sector is fuel oil. This finding has potential importance for policy since wages may be particularly sensitive to food prices. The relative energy-intensity of the food manufacturing sector could, perhaps, be an important factor in spreading an energy price increase through wage escalation. 2/

3.20 The next two sectors are subsectors of 351, manufacture of industrial chemicals (subsectors 35110 and 35140). They add to Rp 49.2 billion in gross output and their principal sources are fuel oil and kerosene. The omission of sector 35120, fertilizer manufacture, from Table 3.13 might seem puzzling. Its ratio of fuel plus lubricant to value added is only 0.04; it is intensive in its use of petroleum-based feed stock as a direct input. 3/ But even excluding fertilizer, industrial chemicals are particularly intensive users of fuel inputs as shown in Table 3.13. Sectors 36110, 36210, and 36220 can all be identified as building materials. Ceramic and porcelain, and glass and glass products, have particularly high fuel input to value-added ratios. The three sectors together total Rp 47.9 billion of gross output, and the principal sources are fuel and diesel oil. The last two sectors in Table 3.13 are cement, and iron and steel. These have very high

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1/ These data are based on the yet unpublished version of the BPS Table 8, "Value of fuel and lubricants used by industry code," in earlier surveys.

2/ This is discussed later. See Chapter 4 and Chapter 7.

3/ This would be reflected in the five-digit data on total inputs which we do not currently have.

Table 3.13: RATIOS OF FUEL AND LUBRICANT COST TO VALUE ADDED IN ENERGY-SENSITIVE INDUSTRIES

Sector No.	Title	Gross Output (Rp 000.000)		Value-added Ratio	Principal Fuel
31210	Flour manufacture	9.5		.13	Fuel oil
31220	Tea processing	7.2		.28	Other
31230	Ice manufacture	5.7	26.8	.34	Fuel oil
31241	Soya sauce	2.5		.11	Benzine
31242	Tahu, tempe, oncome, etc.	1.9		.29	Fuel oil
31270	Seasoning	20.8		.29	Fuel oil
35110	Basic chemicals except fert.	36.7		.13	Fuel oil
35140	Mosquito incense oil	12.5		.17	Kerosene
36110	Ceramic and porcelain	7.8		.30	Fuel oil
36210	Glass and glass products	16.1		.29	Diesel oil
36220	Sheet glass	24.0		.11	Diesel oil
36310	Cement	133.5		.25	Diesel oil
37100	Iron and steel	68.4		.29	Diesel oil

Source: BPS, Industrial Statistics, 1979 plus BPS computer printout of 5-digit energy cost data.

fuel input to value-added ratios, they are the energy-intensive sectors, and both use diesel oil as their principal source.

3.21 The data of Table 3.13, therefore, show that in the industrial sector of the economy, three areas stand out as potentially sensitive to energy prices: food manufacturing, industrial chemicals, and building materials including iron and steel. Food manufacture and chemicals have as a principal input fuel oil, which has a current price-opportunity cost ratio of 0.51. Building materials (including iron and steel), are intensive in their use of diesel oil which has a current price-opportunity cost ratio of 0.41. Elimination of subsidies to energy prices would, in the short-run, squeeze profits in all the sectors shown in Table 3.13 relative to the rest of the economy and would raise costs in building materials relative to food manufacture and chemicals. In the long-run, firms would adjust their use of energy primarily by moving, where possible, towards more energy-saving equipment and choice of technique. The ability of firms to make this sort of adjustment and substitute away from energy is discussed in detail in Chapter 4.

The Structure of Energy Consumption in Indonesian Households 1/

3.22 The major forms of energy consumed by Indonesian households are kerosene, firewood, charcoal, and electricity. Household energy expenditures -- i.e., the value of kerosene, charcoal, firewood, electricity and inputs into household electricity generation -- constituted about 5% of total household expenditure in Indonesia in 1978 (Table 3.14). While this share is relatively modest in comparison to the expenditure share of food, it is one of the largest items of non-food consumption. Moreover, the table also demonstrates that energy's expenditure share varies substantially by location and the share of combustible fuels (kerosene, charcoal and firewood) in total household energy expenditure is much higher in rural areas, where it is about 95% of the total, than in urban areas, where it was closer to 60%; this is primarily a result of the greater availability of electrical connections in urban areas.

3.23 Kerosene consumption varies quite significantly between Java and the outer islands; an average household consumes 40% more kerosene in Java than in the outer islands. The difference between kerosene consumption in the urban and rural areas is even more striking; the urban household consumes, on the average, twice as much kerosene as the rural one. (Table 3.15.) Also, as might be expected, the consumption of electricity is very much an urban phenomenon and is restricted mostly to Java. Similarly, charcoal is consumed more by urban households than rural ones -- by about 3-5 times -- whereas, there is little difference in the household average between Java and the outer

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1/ The data base used is SUSENAS 1978 Subround II conducted by BPS. The total sample size is 6,346 households out of about 28 million households estimated in 1978. The proportions of urban households and non-Java households in the sample are higher in the total population. Because of this bias towards urban and non-Java households, the population distribution, not the sample distribution, is used as a weights whenever the averages of four groupings are translated into entire Indonesia.

Table 3.14: HOUSEHOLD ENERGY EXPENDITURE AS A SHARE OF TOTAL HOUSEHOLD EXPENDITURE
(%)

	Share of Combustible Fuels 1/	Share of Total Household Energy Expenditures	Share of Combustible Fuels in Total Household Energy Expenditures
Rural Java	7.1	7.4	96.9
Urban Java	2.5	4.4	57.5
Rural Outside Java	2.6	2.9	92.1
Urban Outside Java	2.5	3.8	65.2
Indonesia	4.3	5.0	86.2

1/ Kerosene, charcoal and firewood

Table 3.15: HOUSEHOLD CONSUMPTION OF ENERGY PER MONTH, 1978

	All Indonesia	Java	Non-Java	Urban	Rural	Java Urban	Java Rural	Non- Java Urban	Non- Java Rural
Kerosene (litre)	137,322	62,146	75,176	89,166	48,156	43,130	19,016	46,036	29,140
Household average	21.6	25.9	19.0	31.6	13.7	40.8	14.2	26.0	13.3
Electricity (kWh)	212,212	111,072	101,140	197,552	14,660	109,137	1,935	88,415	12,725
Household average	33.4	46.4	25.6	69.9	4.2	103.3	1.4	50.0	5.8
Charcoal (kg)	3,629	1,391	2,298	2,861	828	1,255	136	1,606	692
Household average	0.58	0.58	0.58	1.01	0.24	1.20	0.10	0.92	0.32

islands. About 98% of rural households used some form of kerosene lighting as early as 1971, and the proportion of these households using a petromax lamp has increased significantly (15.7% of the total by 1976). A growing number of households now also have stoves, the majority of which probably use kerosene. In addition to lighting and cooking, kerosene is also used, to a very limited extent, for refrigeration. 1/

3.24 The different fuel consumption patterns between urban and rural households and between the different geographical regions of the country are shown in Table 3.16. It presents average monthly expenditures on kerosene, electricity, charcoal, and firewood and their share in household incomes. Indonesian households allocate, on average, 3% to 7% of their incomes to energy (kerosene, electricity, charcoal and firewood) depending on their geographical location. Although the rural households spend less, in absolute terms, on energy, its share in their income is slightly higher than that of the urban households. But the composition of energy expenditures is substantially different between the urban and rural sector. The urban household, on average, spends 1.8% of its income on kerosene, 1.4% on electricity, but only 0.6% on firewood, while the rural household allocates 2.2% of incomes to firewood, 1.7% to kerosene, and 0.2% to electricity. Also, on the average, households in Java spend more on energy both in terms of absolute amounts and in terms of relative income shares than do those in the outer islands.

3.25 The income level, the relative shares of energy expenditures in incomes, and the composition of different energy sources are shown in Table 3.17. As income levels rise, the shares of energy expenditures decline secularly in almost all groupings. Consumption data on charcoal and firewood by income group suggest that they are inferior goods (charcoal to a lesser extent than firewood). As the table indicates, their absolute levels of consumption increase as income rise, but start declining at certain levels of income. 2/

The Pattern of Demand for Energy in the Transport Sector

3.26 Virtually all of the energy consumed by the transport sector is

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1/ Quantities consumed in each use are very difficult to assess. A petromax lamp will burn 1 litre every 4 to 8 hours depending on its operating efficiency. A non-pressure wick-type lamp will burn only a small fraction of that and give off much less light. A litre of kerosene may be required to cook rice for a family consuming 2.5 kilograms of rice per day. The boiling of drinking water may require twice this amount.

2/ Income (more correctly expenditure) elasticities with respect to kerosene, firewood and charcoal demand are discussed in detail in Chapter 5.

Table 3.16: AVERAGE MONTHLY HOUSEHOLD EXPENDITURES ON ENERGY (Rp) AND THE SHARE IN HOUSEHOLD INCOME (%), 1978

	All Indonesia	Java	Non-Java	Urban	Rural	Java Urban	Java Rural	Non- Java Urban	Non- Java Rural
Kerosene									
Rp	655	713	620	912	449	1,080	423	812	465
%	1.8	1.9	1.7	1.8	1.7	1.7	2.4	1.8	1.5
Electricity									
Rp	349	451	287	735	39	1,004	14	574	55
%	0.9	1.2	0.8	1.4	0.2	1.6	0.08	1.3	0.2
Charcoal									
Rp	35	41	32	61	15	86	5	46	21
%	0.1	0.1	0.09	0.1	0.06	0.1	0.03	0.1	0.07
Firewood									
Rp	460	529	418	311	579	112	860	430	408
%	1.2	1.4	1.1	0.6	2.2	0.2	4.8	1.0	1.3
Total expenditure on energy									
Rp	1,499	1,734	1,357	2.019	1,082	2,282	1,302	1,862	949
%	4.1	4.6	3.7	4.0	4.2	3.7	7.3	4.2	3.1
Average monthly income	36,995	37,322	36,797	51,026	25,738	61,927	17,841	44,508	30,560

Table 3.17: SHARES OF EXPENDITURES ON ENERGY IN HOUSEHOLD MONTHLY INCOME BY INCOME GROUP, JAVA/NON-JAVA, AND URBAN/RURAL, 1978

Monthly per Capita Income (Rp)	Average Monthly Income (Rp)	Monthly Expenditures (Rp)					Shares in Monthly Income of Expenditures on (%)				
		Elec-tricity	Kero-sene	Char-coal	Fire-wood	Total Energy	Elec-tricity	Kero-sene	Char-coal	Fire-wood	Total Energy
Java urban											
0 - 3,000	12,974	63	543	20	383	1,009	0.5	4.2	0.15	3.0	7.8
3,000 - 5,000	21,648	154	820	44	268	1,286	0.7	3.8	0.2	1.2	5.9
5,000 - 7,000	31,462	268	1,000	114	102	1,484	0.9	3.2	0.4	0.3	4.7
7,000 - 9,000	41,837	528	1,201	87	85	1,901	1.3	2.9	0.2	0.2	4.5
9,000 - 11,000	52,444	723	1,237	130	37	2,127	1.4	2.4	0.2	0.07	4.1
11,000 - 13,000	60,036	605	1,258	144	17	2,024	1.0	2.1	0.2	0.03	3.4
13,000 over	133,552	2,700	1,258	79	17	4,054	2.0	0.9	0.06	0.01	3.0
Java rural											
0 - 3,000	10,750	3.6	290	0.6	763	1,057	0.03	2.7	0.006	7.1	9.8
3,000 - 5,000	16,294	3.4	427	3	908	1,341	0.02	2.6	0.02	5.6	8.2
5,000 - 7,000	22,212	10.2	555	9	1,006	1,580	0.05	2.5	0.04	4.5	7.1
7,000 - 9,000	33,516	66.1	699	27	1,042	1,834	0.1	2.1	0.08	3.1	5.5
9,000 - 11,000	33,134	44.6	611	24	734	1,414	0.1	1.8	0.07	2.2	4.3
11,000 - 13,000	44,918	161.5	646	13	1,192	2,013	0.4	1.4	0.03	2.7	4.5
13,000 over	75,691	148.5	990	26	541	1,706	0.2	1.3	0.03	0.7	2.3
Non-Java urban											
0 - 3,000	16,890	13	407	18	303	741	0.08	2.4	0.1	1.8	4.4
3,000 - 5,000	27,102	159	658	26	418	1,261	0.6	2.4	0.1	1.5	4.7
5,000 - 7,000	36,717	426	777	45	489	1,737	1.2	2.1	0.1	1.3	4.7
7,000 - 9,000	42,414	470	853	51	449	1,823	1.1	2.0	0.1	1.1	4.3
9,000 - 11,000	52,517	731	946	64	511	2,252	1.4	1.8	0.1	1.0	4.3
11,000 - 13,000	57,354	835	814	50	385	2,084	1.5	1.4	0.09	0.7	3.6
13,000 over	82,241	1,490	1,086	65	335	2,976	1.8	1.3	0.08	0.4	3.6
Non-Java rural											
0 - 3,000	13,850	3	273	2	256	534	0.02	2.0	0.01	1.8	3.9
3,000 - 5,000	22,680	13	400	7	349	769	0.06	1.8	0.03	1.5	2.4
5,000 - 7,000	30,466	48	463	26	444	981	0.2	1.3	0.09	1.5	3.2
7,000 - 9,000	36,682	95	566	35	438	1,134	0.3	1.5	0.95	1.2	3.1
9,000 - 11,000	43,074	90	600	40	602	1,332	0.2	1.4	0.93	1.4	3.1
11,000 - 13,000	47,781	171	636	49	492	1,348	0.4	1.3	0.1	1.0	2.8
13,000 over	57,635	146	639	27	503	1,315	0.3	1.1	0.05	0.9	2.3

derived from petroleum products. 1/ Table 3.18 shows the estimated consumption by type of refined product. Because all aviation fuel and almost all gasoline are used in the transport sector, estimates for these fuels are reasonably reliable. However, the breakdown of consumption of diesel and fuel oil among transport, industry, and power generation are more difficult to estimate. The estimates for 1978 shown in Table 3.18 are based on those of the Technical Working Team on Energy and Petroleum Products (TKT Energi) established under BAKOREN (the National Energy Coordinating Board) and appear to be realistic. Because of the poor quality of data for these products, time series are not estimated for diesel and fuel oil. The consumption of aviation fuel and gasoline in the transport sector has grown at average annual rates of 15.8% and 9.4% respectively over 1971-80. Assuming that the proportion of total automotive diesel consumed in transport has remained constant over this period, the average annual growth rate of transport consumption of this fuel has been about 19.6%.

3.27 The transport sector accounts for about 33% of consumption of petroleum products in Indonesia while the industrial and power sectors account for 32%, and the household sector, 34%. 2/ Estimated consumption by the transport sector for each major product as a percentage of total consumption of that product in 1978 is shown in Table 3.19. While transport accounts for almost all of the consumption of aviation fuel and gasoline, it apparently accounts for slightly more than one-third of diesel consumption, virtually none of the kerosene consumption, and one-tenth of fuel oil consumption. 3/

3.28 Estimates of fuel consumption by transport mode are summarized in Table 3.20. 4/ Although these estimates may be subject to some error, several important conclusions can still be made. First, the road subsector accounts for over two-thirds of fuel consumption in the transport sector. It accounts for virtually all gasoline consumption and probably more than two-thirds of

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1/ Of the 51,971 MBOE estimated consumption in the transport sector in FY 1979/80, 51,866 MBOE (99.8%) is from petroleum products and 0.105 MBOE is from steam coal. The latter, together with small amounts of fuel wood, is used by steam locomotives which are now being phased out by PJKA. Negligible amounts of electricity are also used by PJKA in the Jakarta region, although use of electric power by the railway may increase in the long-term.

2/ See Annex 1, Table A.1.2 in the Supplementary Report (Volume II). The Energy Assessment Report, 1981, had estimated that the transport sector accounts for about 41% of petroleum product consumption, but this was based on an overestimate of fuel oil consumption by transport, as discussed in Annex 1.

3/ Data from the Ministry of Finance (Annex 1, Table A.1.4) suggests that about 8% of gasoline is consumed in the industry and agriculture sectors, but this probably includes use for transport services in these sectors. It is assumed here that roughly 5% of gasoline is for non-transport uses, e.g., stationary engines or pumps.

4/ An unpublished monograph of Ministry of Communications (1979) estimates the modal distribution of fuel consumption as follows: road, 63.8%; sea, 17.3%, river and ferry, 12.0%; air, 6.1%; and rail, 0.8%. This appears to involve a substantial overestimate of consumption by the river and ferry subsector.

Table 3.18: CONSUMPTION OF PETROLEUM PRODUCTS IN THE TRANSPORT SECTOR (Millions of Barrels)

Year	Aviation Fuel a/	Motor Gasoline b/	Automotive Diesel (solar)	Industrial Diesel	Fuel Oil	Total Petroleum Products
1970	.9	9.3				
1971	9.1	10.0				
1972	1.3	10.5				
1973	1.8	11.5				
1974	2.3	12.6				
1975	2.7	14.2				
1976	2.9	15.5				
1977	3.0	17.2				
1978	3.6	19.3	17.2 c/	.9 c/	1.5 c/	46.7

a/ 100% of domestic sales of aviation gas and aviation turbo as shown in Annex 2, Table A.2.1 in the Supplementary Report.

b/ Assumes that 95% of total domestic gasoline sales as reported in Annex 2, Table A.2.1 is for transport sector. Includes both Super 98 and Premium.

c/ See Annex 1 in the Supplementary Report.

Table 3.19: ESTIMATED CONSUMPTION OF PETROLEUM PRODUCTS BY TRANSPORT SECTOR AS PERCENTAGE OF TOTAL CONSUMPTION (1980)

	Transport	Total for All Sectors a/	Transport as Percentage of Total
	(millions of barrels)		%
Aviation fuel	4.5	4.5	100
Gasoline	22.6	23.8	95
Automotive diesel (solar)	17.2	40.1	43
Industrial diesel	.9	7.8	11
Kerosene	0	48.9	0
Fuel oil	1.5	15.7	10
Total	46.7	140.9	33

a/ From Annex 2, Table A.2.1. in the Supplementary Report.

Table 3.20: ESTIMATED FUEL CONSUMPTION IN 1980 BY TRANSPORT MODE a/
(in million BBL)
(Percentage of total sector consumption shown in parenthesis)

Mode	Gasoline	Aviation Fuel b/	Diesel Fuel	Fuel Oil	Total
Road	21.6 (46)	--	12.1 (26)	--	33.7 (72)
Sea	--	--	4.9 (10)	1.5 (3)	6.4 (14)
River and ferry	1.0 (2) c/	--	.6 (1) d/	--	1.6 (3)
Air	--	4.5 (10)	--	--	4.5 (10)
Rail	--	--	.5 (1)	--	.5 (1)
Total	22.6 (48)	4.5 (10)	18.1 (39)	1.5 (3)	46.7 (100)

a/ See Annex 1 in the Supplementary Report.

b/ Includes both automotive and industrial diesel, of which latter is assumed to be consumed entirely by sea transport.

c/ Based on estimate in MOC (1979) for 1976.

d/ Derived as residual value.

the diesel consumption in the sector. Clearly, the road subsector deserves priority attention in promoting energy conservation and diversification. Second, the sea and river and ferry subsectors account for about one-third of the diesel consumption and all of the fuel oil consumption in the transport sector. Third, the railways subsector accounts for only about 1% of the transport sector's fuel consumption, and this very minor role in energy use in the sector is not expected to change in the coming decades.

3.29 Given the dominant role of the road subsector in energy consumption in the transport sector as a whole, it is useful to examine in some detail the composition of the road vehicle fleet in Indonesia. Official vehicle registration data for the nation as a whole are shown in Table 3.21. 1/ Although these data considerably overstate the actual number of vehicles in operation, 2/ they accurately reflect the very rapid rate of growth in the vehicle population in Indonesia. For the period 1974 to 1979, the annual growth rates for each type of vehicle have been as shown in Table 3.22. It should be noted that a significant percentage of vehicles registered as passenger vehicles are, in fact, light trucks or vans which are used primarily for commercial purposes. Except for motorcycles, the rate of growth of each type of vehicle has been accelerating.

3.30 The percentage of each type of vehicle using diesel is shown in Table 3.23 and it shows that the percentage of vehicles using diesel engines has been increasing. Based on the vehicle numbers by engine type and estimates of the average annual fuel consumption for each type of vehicle, 3/ the approximate breakdown of fuel consumption in the road subsector by type of vehicle and type of fuel is given in Table 3.24. 4/ These data indicate that trucks and buses account for over two-thirds of total fuel consumption in the subsector and hence about half of consumption in the transport sector as a whole. Trucks also account for about 80% of consumption of diesel in the subsector.

3.31 The composition of the maritime fleet in 1980 is given in Table 3.25. It should be noted that more than half of total tonnage is accounted for by specialized industrial vessels of which about half are oil tankers. The second and third largest categories of tonnage are Indonesia-flag ocean-going vessels for international cargo trade and international log carriers respectively; these two categories of shipping rely primarily on fuel oil

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1/ More detailed data are given in Annex 3, Table A.3.2 in the Supplementary Report (Volume II).

2/ In the Ministry of Communications (1979), op. cit. it is assumed that only 70% of registered vehicles are operative in each year.

3/ BPPT/Bechtel Energy Report (1980), op. cit. assumes that 40% of trucks, 40% of buses, and 0% of cars had diesel engines in 1978 (Table 4-9).

4/ These estimates of average annual fuel consumption are derived from Ministry of Communications (1979), op. cit. and are summarized in Annex 3 in the Supplementary Report (Volume II).

Table 3.21: NUMBER OF REGISTERED VEHICLES, 1966-79 a/
(in thousands)

Year	Passenger Vehicles b/	Trucks	Buses	Sub-total 4-Wheel	Motor-cycles c/	Total Motorized Vehicle
1966	179	93	20	292	282	574
1967	185	95	19	299	288	586
1968	202	93	20	315	308	623
1969	212	96	20	318	337	665
1970	239	103	24	365	440	805
1971	257	113	23	392	511	903
1972	277	131	26	439	615	1,050
1973	308	144	30	482	720	1,202
1974	338	166	31	536	945	1,480
1975	384	196	35	615	1,192	1,806
1976	420	222	40	683	1,417	2,100
1977	479	279	48	806	1,705	2,511
1978	534	333	58	925	1,974	2,900
1979	577	384	70	1,031	2,266	3,297

a/ Does not include military and diplomatic vehicles. The figures include inoperative vehicles which have not been deleted from the registration list.

b/ Includes light public transportation vehicles seating no more than eight people.

c/ Includes motorized three-wheel vehicles.

Source: Directorate of Traffic, Indonesian Police, August 1980.

Table 3.22: ANNUAL GROWTH RATES IN REGISTERED VEHICLES
(Percent)

	1970-74	1974-79	1977-80
Passenger vehicles	9.3	10.8	15.4
Buses	7.7	16.5	22.5
Trucks	13.7	17.2	19.4
Motorcycles	21.1	17.2	16.3

Table 3.23: ESTIMATED PERCENTAGE OF
VEHICLES USING DIESEL

	1976	Percentage 1980
Trucks [a/]	32	47
Buses [b/]	42	63
Sedans	3	4
Motorcycles	0	0

a/ Includes pickups.

b/ Include light and mini buses.

Table 3.24: ESTIMATED FUEL CONSUMPTION IN ROAD SUBSECTOR BY TYPE OF VEHICLE AS PERCENTAGE OF TOTAL SUBSECTOR CONSUMPTION (%)

	Gasoline	Diesel	Total in Road Subsector
Trucks	27	30	57
Buses	5	7	12
Sedans	19	1	20
Motorcycles	12	0	12
Total	63	38	100

Table 3.25: COMPOSITION OF MARITIME FLEET (1980) a/

Type of Service	Number of Vessels	Deadweight Tonnage
Regular Liner	338	371,000
Local	1,081	193,000
Pioneer	32	22,000
Motorized Sailing Vessels	2,600	174,000
Special (Domestic)	3	22,000
Offshore Industry	1,550	2,585,000
Ocean-going	60	760,000

a/ From Netherlands Maritime Institute, Integrated Sea Transport Study, Ministry of Communications, Government Indonesia, 1982.

rather than diesel. The remaining categories of inter-island shipping account for only 16% of total tonnage.

3.32 The estimated breakdown of fuel consumption in the maritime subsector by type of fuel and type of service is given in Table 3.26. Despite the weakness of the underlying data, it is clear that, as the relative tonnages would suggest, about two-thirds of consumption in the subsector is by the off-shore industry (primarily petroleum) and ocean-going vessels. Inter-island shipping (regular liner services and local shipping) accounts for only about one-fifth of subsector consumption and apparently consumes no fuel oil.

Table 3.26: ESTIMATED FUEL CONSUMPTION IN MARITIME TRANSPORT SUBSECTOR BY TYPE OF SERVICE AS PERCENTAGE OF TOTAL SUBSECTOR CONSUMPTION a/

Type of Service	Diesel	Fuel Oil	Total Fuel in Maritime Subsector
Regular Liner	19	--	19
Local	8	--	8
Pioneer	1	--	1
Special (Domestic)	3	--	3
Offshore Industry and Non-commercial Ships c/	37	--	37
Ocean-going b/	4	27	31
Total	73	27	100

a/ Based on Annex 1, Table A.1.5. in the Supplementary Report. Excludes international special carriers.

b/ Indonesian flag vessels only.

c/ Includes oil transport.

4. THE IMPLICATIONS OF ENERGY PRICING POLICIES FOR THE INDUSTRIAL SECTOR

Introduction

4.01 This chapter investigates the effects of energy pricing policies on the industrial sector at a fairly disaggregated level. 1/ Indonesian industry now produces a diverse range of goods using widely different technologies within the context of a non-neutral trade and incentives regime. Also, the industrial subsectors vary quite significantly in their intensity of total energy use (Table 3.7) and in the distribution of energy across types of energy source. And, as discussed in Chapter 2, energy sources, in turn, are not uniformly subsidized in Indonesia. One would, therefore, expect that a significant change in energy prices will have non-uniform effects on the industrial subsectors. Consequently, in order to develop a careful understanding of the implications of energy pricing policies on the industrial sector, one must go beyond an analysis of price effects on "the industrial sector" in general; it becomes almost mandatory to study the sector at a disaggregated level to obtain an impression of the impact of changing relative prices of energy sources on industries that differ in the intensity of their use of different energy sources.

4.02 The structure of energy demand in the industrial sector depends on the extent to which capital, labor and energy can be used in different proportions in response to changes in their prices, and on the characteristics of production. The substitutability of capital, labor and energy is a critical determinant of energy demand and the characteristics of production determine the extent to which fuels can be substituted for each other in the different industrial subsectors. If the long-run objective of the Government is to reduce the subsidy provided to energy, a basic understanding of the structure of energy demand, therefore, becomes necessary. For the industrial sector, in particular, issues that need to be resolved include the responsiveness of energy demand to price changes, the possibilities of interfuel substitutions within specific industrial subsectors, and the effect of energy price changes on the cost of manufactured output and, thereby, on Indonesia's international competitiveness. These, and other issues, are addressed in this chapter in the expectation that by doing so, one can better understand the disaggregated structure of energy demand and, thus, be able to design effective energy policies.

A Model of Industrial Energy Demand

4.03 There are many different analytical frameworks that can be used in analyzing energy pricing policies and their implications for the industrial sector. The approach taken here is the development of a model that is as

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1/ The industrial sector refers only to the manufacturing sector in this chapter. Moreover, the term "sector" is also used to designate a manufacturing subsector. The context makes clear whether the reference is to the entire manufacturing sector or to a specific subsector, e.g., cement, within the industrial sector.

general as possible in the sense that almost no a priori restrictions are imposed on the structure of demand. This model, therefore, represents an improved state of the art over other models to analyzing demand relationships and comes as close as is currently possible to representing reality. This model is used to derive energy demand relationships for 27 industrial subsectors at the three-digit level. 1/ The demand relationships are derived for five different energy sources -- electricity, gasoline, fuel oil, diesel and kerosene -- and by geographical location; viz., a distinction is made between Java and the outer islands (non-Java) and between urban and rural locations. 2/

4.04. * The model used here is similar to that used by Fuss and Pindyck. 3/ In this model, it is assumed that firms choose inputs so as to minimize the cost of production. The relationship between minimized cost of production and the prices of inputs is described by a translog cost function. Factor inputs include capital, labor, energy and materials. Materials are not explicitly included in the econometric analysis as they are assumed to be separable from all other inputs. This assumption is required by the lack of data to construct an appropriate price index for materials. The cost function estimated is a variable cost function in that the capital stock of firms is assumed to be fixed in the short run. Thus, the variable inputs are energy and labor, and it is the cost of these two factors which firms try to minimize in the short run.

4.05 * It is further assumed that energy is an aggregate of various component fuels: electricity, gasoline, fuel oil, diesel and kerosene. Under certain assumptions, the firms' input choice problem can be modeled as a recursive procedure. First, firms choose the shares of each of the five energy components (electricity, gasoline, fuel oil, diesel and kerosene) which minimize the cost of providing a unit of "aggregate" energy. Then firms choose the quantities of aggregate energy and labor which minimize the cost of producing output given its capital stock.

4.06 * The estimation procedure also has two stages. In the first stage -- referred to as the energy sub-model -- a set of share equations for the five fuels are estimated. The dependent variables are the shares of each fuel in the total energy expenditure of the firm. The estimated parameters of these share equations are used to calculate estimates of the (partial) demand elasticities for fuels. These demand elasticities tell us how the relative demand for each fuel responds to changes in the prices of each alternative fuel. The functional forms used in the estimation are translog; this has the

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1/ These three-digit ISIC subsectors are numbered 311 to 385, and are listed in Appendix I, Table I-4.

2/ The next few paragraphs (4.04 - 4.14) marked by an asterisk (*) describe the model and the data base. The reader may omit these paragraphs without any loss of continuity.

3/ See Fuss, Melvyn A. (1977), "The Demand for Energy in Canadian Manufacturing, Journal of Econometrics 5, pp. 89-116; and Pindyck, Robert S. (1979), The Structure of World Energy Demand. Cambridge: MIT Press.

advantage of placing only minimal restrictions on the elasticities of substitution and demand elasticities of inputs.

4.07 * In the second stage, the demand for aggregate energy and labor are modeled. A translog variable cost function and energy share equation are jointly estimated. From the parameter estimates, elasticities of demand for aggregate energy and labor are constructed with respect to their prices, the stock of capital and the level of output. In addition, elasticities of total cost with respect to the price of energy and to each individual fuels are estimated. Note that carrying out this second stage requires the estimation of the first stage. This is because the parameter estimates from the first stage are needed to calculate a price index for aggregate energy. [1/]

4.08 * The data used in the estimation are taken from the annual Industrial Surveys (Survai Industri) of 1976, 1977 and 1978, conducted by the Central Bureau of Statistics (Biro Pusat Statistik) of the Republic of Indonesia. These surveys contain information on the activities of a majority of Indonesian manufacturing establishments classified as medium and large, (about 7,000) defined as establishments with 20 or more employees. Though questions always arise about the quality of data in developing countries, in Indonesia, major advances have been made since the mid-1970s in improving the data base. There is also no evidence of any systematic under - or over - reporting by firms. Any errors that may be present are assumed to be randomly distributed and statistical tests have been performed on all the parameters to determine their precision. As will be seen, the econometric results correspond with one's prior notions of factor substitutability. Thus, the estimates are not consistent with extremely poor data.

4.09 * Prices for energy inputs were available from the questionnaires of firms which reported the use of those inputs. The prices facing firms which did not use an input were imputed to be the average price faced by firms in the same year in the same district (kabupaten/kotamadya), in the case of Java and Madura, or in the same province, in the case of the outer islands. There were 106 kabupaten/kotamadya in Java and Madura in 1976-78, and 20 provinces in the outer islands. It should be noted that prices <u>are</u> related to remoteness from primary markets. It is only because of this spatial price vaariation that we can use a cross-section for this type of analysis. The important point is that these prices are <u>exogenous</u> to the firms. The distance from a refinery or a port is a geographic phenomenon not easily altered by a firm. Firms in different geographic areas will face different relative prices for factors and will, therefore, employ factors in different proportions. Changes in these prices will lead to a movement along a cost function and not to a structural shift in this cost function.

4.10 * The five energy inputs studied -- electricity, gasoline, fuel oil, diesel fuel and kerosene -- accounted for about 86% of total energy use by value of large and medium manufacturing firms in 1977. Although the government nominally set the wholesale price of the four petroleum derivative fuels at unchanging levels during the years 1976-78, their prices did vary

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1/ A complete description of the theoretical model and the estimation procedure used is found in Volume III, Appendix II of this report.

over space and time at the point of final sale. For example, official published statistics for 1976 demonstrate a range of average provincial retail prices for kerosene ranging from Rp 29.11 to Rp 60.62 per litre. The range of prices in 1977 and 1978 was of the same magnitude. 1/

4.11 * Direct measures of capital stock are not available from the manufacturing surveys. Instead, capital was measured as the horsepower (hp) of installed machines. Although horsepower is probably a poor measure of the inter-sectoral variance of capital input, it captures well intra-sectoral, inter-firm variations in capital. This is all that is required with the relatively fine sectoral disaggregation with which we are working.

4.12 * The model described in the preceding sections was estimated separately for seven two-digit ISIC sectors -- 31, 32, 33, 34, 35, 36, and 38. Even at the two-digit level, it seems likely that the product mix will not be homogeneous across firms. That is, the cost functions for the three-digit sectors which comprise a two-digit sector may vary and, therefore, it would be inappropriate to estimate only a single cost function for each two-digit sector. In order to minimize the cost of estimating separate models for all three-digit sectors, but still get at inter-sectoral differences in elasticities, dummy variables representing three-digit ISIC codes were introduced. These dummy variables allow the intercepts of the share equations and the intercepts and linear term parameters of the cost equations to vary. In addition, as it is likely that product mix and production efficiency are also not homogeneous across regions, dummy variables representing firm location -- Java-Madura/outer islands (non-Java) and urban location/rural location -- were introduced in the same manner. Thus, there are four

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1/ In Indonesia, the Indonesian term "solar" is both the trade name for a product (high speed diesel) produced and sold by PERTAMINA, the Indonesian state oil company, and the generic name for a broad class of fuel oils. The term "solar", while not commonly used in the USA, was common in the Netherlands (solar olie) and the UK, although it is now considered archaic. Similarly, "minyak bakar", which is translated as "fuel oil" is both the trade name of a particular PERTAMINA product and a generic term encompassing a wide variety of petroleum fuels. Manufacturing firms in Indonesia consider the (generic) "minyak solar" to be the same as the (generic) "minyak bakar" as used in the BPS questionnaires. These questionnaires have translated both "minyak solar" and "minyak bakar" in the generic sense to mean "fuel oil". In 1971, 1972 and 1973, the common name for fuel oil in the Survey of Industry was designated "minyak bakar". In 1974/75, the Census of Manufacturing designated the fuel oil column as "minyak bakar/solar"; the use of the slash implying the equivalence of the two terms. After 1975, the column designated fuel oil dropped the term "bakar" and only used "minyak solar" translated as fuel oil. Thus, starting from the early 1970s, BPS has gradually transformed the designation of the fuel oil column from minyak bakar to minyak bakar/solar, to minyak solar. In all these cases, that column has always been translated by BPS to mean fuel oil. BPS has thus used the generic meaning of "solar" whereas, PERTAMINA uses the trade name, high speed diesel.

different cost functions for each three-digit sector, one for each geographic location. A description of the three-digit sectors, identified in the analysis is found in Appendix I.

4.13 * In the energy sub-model, the five share equations were estimated by two-limit probit regression maximum likelihood methods for each of the seven two-digit sectors analyzed. The dependent variables were the shares of electricity, gasoline, fuel oil, diesel and kerosene. The set of independent variables are the same in each share equation: the logarithms of the prices of the five fuels and dummy variables for island location (Java or outer islands), urban/rural location, and for all but one three-digit sector. Prices for fuels were expressed in Rupiahs (Rp) per ton of oil equivalent (TOE).

4.14 * The aggregate model estimates the parameters of the underlying variable cost function containing capital, output, labor and aggregate energy as factors. Capital and output are treated as fixed in the short run, and the price of energy is a price index whose weights are derived from the energy sub-model. In addition, the same set of location and three-digit ISIC dummy variables that appeared in the energy sub-model are also included in the estimation of the aggregate cost function. Note that these dummy variables allow both the intercept and the first-order slope terms for all factors in the cost function to vary.

4.15 Finally, a note on the applicability of the estimated elasticities to sectors more well-defined than three-digits or to other subgroups of firms. All the elasticities presented were calculated at the mean values of all the exogenous variables. Thus, they represent elasticities for a "typical" firm. Nevertheless, elasticities may vary substantially between urban and rural firms, firms in Java and outside, firms of different sizes and between five-digit ISIC subsectors within each three-digit subsector. Elasticities for all these subgroups can be calculated from the model presented. Doing so would result in a flood of numbers and tables that would overwhelm the reader. Nevertheless, sometimes further disaggregation may uncover some differences among firms in the sample. For example, this is true in distinguishing between cement manufacturing firms (36310) and other firms in the three-digit cement and cement products subsector (363). Comparing the demand elasticities of the five-digit cement subsector with those of the three-digit one shows that five-digit cement's energy demand is much less responsive to changes in its price than is the mean firm of sector 363; for five-digit cement, the elasticity is -0.43 compared to -0.83 for the mean firm in the three-digit sector. This is not surprising as cement manufacturing firms (36310) are much less numerous than other 363 firms, but are many times larger and more capital-using. Thus, the "typical" sector 363 firm has very different characteristics than the "typical" 36310 firm; and this distinction between three- and five-digit firms may well be true for many sectors. However, the costs of further disaggregation do not appear to exceed the benefits, particularly since the general thrust of the conclusions presented does not change. Consequently, the bulk of the discussion is based on three-digit subsectors.

Price Elasticities of Demand for Individual Energy Fuels

4.16 The own- and cross-price elasticities of demand for the 12 most energy-intensive subsectors are shown in Table 4.1. 1/ The first column identifies the three-digit sector, the second shows energy as a share of value-added, the third defines the energy source whose demand has been estimated 2/, and columns four to eight show the price elasticities of demand with respect to each energy source. These are partial elasticities reflecting the substitution possibilities among energy inputs which are consistent with a constant level of aggregate energy (see paras. 4.05 to 4.06); moreover, as mentioned before, these, and the other numbers in this chapter, are intended to be illustrative of the orders of maganitude involved and the directions of change. Thus, the demand for kerosene in the cement and cement products subsector shows that the (own-) price elasticity is -3.7 and the (cross-) price elasticity with respect to gasoline is 2.9. This suggests that a 10% increase in kerosene price will reduce the demand for kerosene in the cement and cement products subsector by 37%, and that an increase in the price of gasoline by 10% will increase the demand for kerosene in that subsector by 29%.

4.17 It should be noted that the price elasticities differ significantly by subsector and fuel source suggesting a differential impact of a price change on the demand for energy across subsectors. For example, the own-price elasticities for kerosene (Table 4.1) are -3.0 for structural clay products (364); -3.7 for cement and cement products (363); and -3.6 for other non-metallic mineral products (369); on the other hand, the cross-price elasticity of diesel with respect to gasoline varies from 1.2 for glass and glass products (362) to 3.9 for other food products (312) in Table 4.1 3/ This variation indicates that not only will different subsectors adjust their demand for energy sources differentially in response to a price change in that energy product, but also that the interfuel substitution possibilities vary considerably. For example, there is greater scope for substituting gasoline for diesel in the other food products subsector than in the glass and glass products subsector.

1/ A price elasticity of demand reflects the percentage change in the quantity demanded due to a one percentage change in the price. Own-price elasticities relate the quantity and price of the same product (fuel), whereas cross-price elasticities define the relationship between the quantity of one product (fuel) and the price of another, which may be a substitute or a complement. Cross-price elasticities, therefore, provide a quantitative measure for the possibilities of inter-fuel substitution. Tables I.5 to I.31 in Volume III, Appendix I presents own- and cross-price elasticities for each of the 27 three-digit subsectors. All price elasticities in this analysis are non-linear functions of the estimated coefficients of the model. See Volume III, Appendix II for details.

2/ Table 4.1 shows only two energy sources per subsector. In fact, for each subsector the demand for five energy sources has been estimated. Tables I.5 to I.31 in Appendix I have all the details.

3/ The full extent of variations can be seen by inspecting Tables I.5 to I.31 in Appendix I.

Table 4.1: PRICE ELASTICITIES OF DEMAND FOR SELECTED FUELS IN TWELVE SUBSECTORS

Sector		Energy as a Share of Value-Added (%)	Demand for (Energy Source)	Demand Elasticity With Respect to the Price of				
				Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
364	Structural Clay Products	74.31	Fuel Oil	0.82	*	-0.46	0.62	0.89
			Kerosene	*	2.33	*	*	-3.03
362	Glass and Glass Products	65.89	Diesel	0.52	1.21	*	-0.38	*
			Fuel Oil	0.66	*	-0.91	*	0.81
361	Ceramic and Porcelain	48.98	Diesel	0.50	1.23	*	-0.40	*
			Fuel Oil	0.70	*	0.76	*	0.82
363	Cement and Cement Products	41.24	Kerosene	*	2.94	*	*	-3.71
			Fuel Oil	0.74	*	-0.65	0.47	0.85
341	Paper and Paper Products	40.06	Diesel	*	*	1.09	-1.78	*
			Fuel Oil	0.34	1.00	-0.50	0.45	*
369	Other Non-Metallic Mineral Products	31.24	Fuel Oil	0.92	0.62	-0.22	0.81	0.96
			Kerosene	*	2.89	*	*	-3.66
314	Tobacco	27.10	Gasoline	0.32	-1.54	*	0.81	0.85
			Fuel Oil	0.58	*	-1.21	*	0.67
312	Other Food Products	22.67	Diesel	*	3.97	*	-4.58	*
			Fuel Oil	0.75	0.49	-0.65	0.48	0.80
355	Rubber	21.29	Diesel	*	*	1.05	-2.81	*
			Fuel Oil	0.33	1.39	-1.24	0.41	0.54
352	Other Chemical Products	19.50	Diesel	*	*	1.35	-3.69	*
			Fuel Oil	*	1.50	-1.56	*	*
311	Food Processing	17.48	Diesel	*	3.47	*	-4.06	*
			Fuel Oil	0.69	0.38	-0.80	0.33	0.75
382	Machinery	15.56	Gasoline	*	-1.37	*	*	1.32
			Fuel Oil	1.84	*	-0.93	*	*

* Indicates that the estimates are not significant at the 5% level.

Own-Price Elasticities of Demand

4.18 For all the industrial subsectors, the price elasticity estimates and the standard errors are shown in Tables I.5 to I.31 (in Appendix I). Five out of the 134 own-price elasticities presented in those tables have a positive sign. 1/ But in none of these five cases are the elasticities statistically different from zero at the 5% level of significance. They may, therefore, for all practical purposes, be treated as statistical aberrations. 2/ Of the 129 own-price elasticities which are negative, 117 (91%) are statistically significant (i.e., different from zero at the 5% level of significance). Out of these 117, 90 (77%) are less than -1 indicating a price elastic demand for energy in most industrial subsectors. Indeed, some of these elasticities, particularly those for kerosene and diesel, show the demand for these fuels to be very elastic; the largest price elasticity for kerosene is 4.5 (in absolute value) and for diesel it is 6.7 (also in absolute value) both in the wearing apparel subsector (Table 4.2). 3/ On the other hand, most of the inelastic (own-) price response is for fuel oil and electricity. For example, 16 out of the 27 price elasticities for fuel oil and 13 out of 27 price elasticities for electricity are greater than -1 (i.e., less than 1 in absolute value).

4.19 Table 4.2 demonstrates these facts and the ranges and variabilities of own-price elasticities for each fuel in each of the 27 subsectors. The mean value and variance for the price elasticities for each fuel are respectively: electricity: -1.4; 0.6; gasoline: -1.6; 0.8; fuel oil: -1.2; 0.7; diesel oil: -2.8; 4.6; and kerosene: -3.2; 1.4. One could also conclude that, on the average, the demand for kerosene and diesel are much more responsive to changes in their respective prices than are the demand for fuel oil and electricity. Therefore, if one were to generalize about energy demand in the industrial sector, it would be safe to presume that the price responsiveness of energy demand is quite significant, but that it varies quite substantially in magnitude across fuels and subsectors.

Interfuel Substitution and Cross-Price Elasticities 4/

4.20 An important consideration for energy policy formulation is the extent to which individual fuels can be substituted for each other. As energy

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1/ This violates the postulates of cost-minimizing factor demand theory.

2/ Moreover, the fuel shares in total costs in those sectors are very small; consequently, these estimates are not meaningful.

3/ Large (absolute) values of elasticities of demand are likely to arise in those sectors where the fuel shares in total cost are relatively small. See equations (19) and (20) in Appendix II, which present the formulae for the own- and cross-price elasticities of demand.

4/ The discussion of interfuel substitution is restricted to those fuels currently used in the industrial sector. Fuels that could be used in the future, such as natural gas, are not considered here as no historical data are available to estimate cross-price elasticities. The potential for such fuel use is discussed in the Energy Assessment Report (1981).

Table 4.2: OWN PRICE ELASTICITIES

	Sector	Electricity	Gasoline	Fuel Oil	Diesel Oil	Kerosene
311	Food Processing	-1.33	-2.30	-0.80	-4.05	-3.55
312	Other Food Products	-1.56	-2.09	-0.65	-4.58	-3.59
313	Beverages	-0.97	-1.79	-1.08	-5.24	-3.47
314	Tobacco	-0.91	-1.54	-1.21	-4.86	-3.97
3211	Spinning and Weaving	-0.75	*	-2.81	-5.34	-3.31
321	Textiles Except 3211	-0.95	*	-2.47	-5.97	-3.33
322	Wearing Apparel	-0.47	*	-3.54	-6.66	-4.54
323	Leather and Leather Substitutes	-1.01	*	-2.07	-5.48	-4.04
324	Leather Footwear	-0.98	*	-2.55	-5.96	-3.87
331	Wood and Wood Products	-1.11	-1.01	-0.27	*	*
332	Wood Furniture	-0.73	-1.01	-0.45	*	*
341	Paper and Paper Products	-0.72	-2.38	-0.50	-1.78	-1.70
342	Printing and Publishing	-0.35	-2.08	*	*	-1.70
351	Basic Chemicals	-0.74	-3.07	-0.89	-2.91	-4.14
352	Other Chemical Products	-0.61	-2.26	-1.55	-3.69	-3.43
355	Rubber	-0.66	-2.89	-1.24	-2.81	-3.76
356	Plastic Wares	-0.66	-3.11	-1.10	-3.07	-4.38
361	Ceramic and Porcelain	-1.74	-1.86	-0.76	*	-2.83
362	Glass and Glass Products	-1.77	-1.97	-0.91	*	-3.09
363	Cement and Cement Products	-1.44	-1.73	-0.64	*	-3.71
364	Structural Clay Products	-2.49	-1.93	-0.46	*	-3.03
369	Other Non-Metallic Metal Products	-2.99	-1.85	-0.22	*	-3.66
381	Fabricated Metal Products	-2.82	-1.34	-0.74	-1.46	-3.75
382	Machinery	-1.84	-1.37	-0.93	-1.59	-3.76
383	Electrical Machinery	-2.72	-1.25	-0.75	-1.45	-3.63
384	Transport Equipment	-2.60	-1.23	-0.75	-1.62	-3.89
385	Measuring and Optical Equipment	-1.76	-1.39	-1.12	*	-2.76
	Mean	-1.36	-1.55	-1.16	-2.75	-3.20
	Variance	.58	.79	.65	4.54	1.37

Notes: Asterisk (*) indicates statistical insignificance at the 5%. Mean and variance exclude insignificant observations.

prices increase or as reserves of energy decline in Indonesia, the ability of industrial users of energy to substitute away from more expensive forms of energy towards less expensive ones will affect the costs of manufacturing. For example, in the short term, the impact on the demand for say, fuel oil as a result of increases in electricity prices, will depend on the extent to which these two fuels are substitutes for each other in the different industrial subsectors. Consequently, an improved understanding of the extent of interfuel substitutability and the magnitudes of cross-price elasticities of fuel demands in the various subsectors is needed to evaluate the impact of changing energy prices.

4.21 Interfuel substitution possibilities in the manufacturing sector are as indicated by the various cross-price elasticities for the individual subsectors. Out of the 546 estimated, 266 (about 49%) are significantly different from zero. Two-hundred thirty-three out of the 266 statistically significant cross-price elasticities (i.e., about 88%) are positive. These elasticities indicate that, as would be expected, most fuels in most subsectors are substitutes. The analysis also reveals that electricity is never a complement with any fuel in any industrial subsector. The statistically significant cross-price elasticities of demand for all fuels, with respect to the price of electricity, are positive; i.e., the demand for all fuels (excluding electricity) is positively related to the price of electricity. Moreover, one of the strongest patterns of interfuel substitution appears to be between diesel and electricity. As Table 4.3 shows, 19 out of the 27 electricity cross-price elasticities (70%), with respect to the price of diesel, are statistically significant and positive. This is not a surprising result as diesel is an important energy input and is used primarily to drive prime-movers and in-plant electrical generating equipment. Electrical motors driven by purchased electricity can substitute well for prime-movers and in-plant power generation.

4.22 Gasoline and kerosene also seem to offer possibilities for interfuel substitution in the industrial sector. The elasticity of gasoline demand with respect to the price of kerosene ranges from 0.8 in the printing and publishing subsector (342) to 1.3 in the machinery subsector (382) and is significant in 44% of the cases. Kerosene and fuel oil offer yet another possibility for interfuel substitution. The elasticity of kerosene demand with respect to the price of fuel oil is large and significant in 18 out 27 cases (66.7%) and exceeds 1.0 in 17 out of these 18 cases. Thus, increases in the price of fuel oil may induce substantial substitution of kerosene for fuel oil, and increases in the price of kerosene may induce a substitution of gasoline for kerosene in many manufacturing subsectors. Consequently, it may be concluded that the potential for interfuel substitution is large in the industrial sector; the precise extent of such substitutions in each subsector will be indicated by the relevant cross-price elasticities. 1/

4.23 The above analysis indicates that the price elastictíes of demand differ significantly by industrial subsector and fuel source suggesting a differential impact of a price change on the demand for energy across subsectors. Thus, not only will different industrial subsectors adjust their

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1/ See also Tables I.5 to I.31, in Appendix I, for complete details.

Table 4.3: SELECTED CROSS-PRICE ELASTICITIES

	Industry	Electricity :Diesel	Gasoline :Kerosene	Kerosene :Fuel Oil
311	Food Processing	0.61	0.95	1.16
312	Other Food Products	0.62	0.89	1.18
313	Beverages	0.66	0.85	1.14
314	Tobacco	0.70	0.85	1.25
3211	Spinning and Weaving	1.03	*	1.18
321	Textiles Except 3211	1.04	*	1.19
322	Wearing Apparel	1.06	*	1.67
323	Leather and Leather Substitutes	1.04	*	1.46
324	Leather Footware	1.04	*	1.39
331	Wood and Wood Products	*	0.88	*
332	Wood Furniture	*	0.88	*
341	Paper and Paper Products	*	*	*
342	Printing and Publishing	0.55	0.75	*
351	Basic Chemicals	1.04	*	1.22
352	Other Chemical Products	0.94	*	1.03
355	Rubber	0.96	*	1.11
356	Plastic Wares	0.96	*	1.29
361	Ceramic and Porcelain	*	*	*
362	Glass and Glass Products	*	*	*
363	Cement and Cement Products	*	*	*
364	Structural Clay Products	*	*	*
369	Other Non-Metallic Metal Products	*	*	*
381	Fabricated Metal Products	0.98	1.30	1.09
382	Machinery	0.96	1.32	1.09
383	Electrical Machinery	0.97	1.22	1.06
384	Transport Equipment	0.97	1.20	1.12
385	Measuring and Optical Equipment	0.96	1.34	0.88

Notes: 1. Asterisk (*) indicates statistical insignificance at the 5%.

2. The column heading, "Electricity: Diesel" refers to the demand for electricity with respect to the price of diesel.

demand for energy sources differentially in response to a price change in that energy product, but also that the possibilities for interfuel substitution vary considerably. This suggests that any strategy for eliminating energy subsidies which involves a significant change in the relative prices of different forms of energy may have unintended and perhaps undesirable consequences as a result of interfuel substitution. But it should also be noted that the current domestic relative prices of different fuels are not the same as the international relative prices; thus, in the long-run domestic relative prices will have to change.

Price Elasticities for (Aggregate) Energy and Labor

4.24 The preceding sections discussed elasticities of demand for individual fuels. Now we turn to the demand for aggregate energy and labor -- the two variable inputs in the estimated model -- and their own- and cross-price elasticities. Such an aggregate analysis permits one to make statements and draw conclusions that are broader in nature regarding the demand for energy and labor in the industrial sector and the possibilities of substitution both in the short and the long run.

4.25 The various elasticities for energy and labor are shown in Table 4.4 for all 27 three-digit manufacturing subsectors; they are ranked by the own-price elasticity of energy. All of the own-price elasticities of energy and labor are negative and statistically significant, except for those of the wood furniture sector (332). The own-price elasticities for energy range from -0.8 for cement and cement products (363) to -0.4 for printing and publishing (342). 1/ In addition to cement and cement products, other industrial subsectors most responsive to energy prices are structural clay products (elasticity = -0.8), other non-metallic mineral products (-0.8), beverages (-0.7), food processing (-0.7), tobacco (-0.7), and other food products (-0.7). In fact, 21 out of the 27 subsectors (almost 78%) have a price elasticity of demand for energy larger, in absolute value, than 0.5 (Table 4.4.) These results clearly support the earlier conclusion that the demand for energy in Indonesian manufacturing is quite responsive to its price. These price elasticities also demonstrate the inappropriateness of procedures which use fixed coefficient input-output tables as the basis for projections of future energy demand.

4.26 Own-price elasticities for labor are generally much smaller in magnitude than they are for energy. They range from a low of -0.04 in the measuring and optical equipment subsector (385) to -0.4 in the ceramic and porcelain subsector (361). Moreover, 25 out of 27 of them are less than 0.25 in absolute value, and 12 of these are less than 0.10. Furthermore, in every subsector, the own-price responsiveness of labor was less than that of energy (Table 4.4). Pindyck obtained a similar result in the ten developed countries he studied. 2/

1/ The own-price elasticity for energy in the wood furniture sector is lower in absolute value, 0.07, but it is not statistically significant.

2/ See Pindyck (1979), op. cit.. Also it should be noted that these elasticties represent short-run responses. Long-run responses of both labor and energy may be of different magnitude.

4.27 In an analytical framework with only two variable factors such as the one used here, cross-price elasticities are equal to minus the own-price elasticities. 1/ This is because firms choose the amounts of energy and labor on the basis of the relative price of energy to the wage rate. Clearly, it makes no difference whether this price ratio varies as a result of differences in the energy price or the wage rate. Thus, subsectors in which energy demand is very responsive to changes in energy prices are precisely those subsectors in which energy demand is responsive to changes in the wage rate. In addition, because energy and labor are necessarily substitutes in the short run, increases in energy prices will increase employment. Subsectors which will increase employment in the greatest proportion in response to an energy price rise -- those with the highest cross-price elasticities of labor with respect to the price of energy -- are ceramics and porcelain (elasticity = 0.5), glass and glass products (0.3), other non-metallic metal products (0.2), other food products (0.2), and rubber (0.2), (Table 4.4). These are the subsectors in which employment will increase most significantly, in the short run, due to increases in energy prices. Analysis undertaken in other countries shows that, in the long run also, energy and labor are substitutes and, thus, increases in energy prices would also lead to long-run increases in employment.

Other Elasticities: The Implications for the Scale of Operations

4.28 The analytical framework used also provides estimates of the elasticities of energy and labor demand with respect to the levels of output and capital. 2/ These elasticities are useful in determining whether larger scale plants are more or less energy-efficient than smaller scale ones; and the answer, as expected, differs by subsector. The elasticities of energy demand with respect to output and capital for the 27 subsectors, are shown in Table 4.5. Because output and capital are fixed in this analysis, the

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1/ i.e., $\eta_{EL} = -\eta_{EE}$ and $\eta_{LE} = -\eta_{LL}$, where η = elasticity and subscripts E and L refer to energy and labor respectively.

2/ The complete set of these elasticities is presented in Tables I.33, 36, 39, 42, 45, 48 and 51 in Appendix I.

Table 4.4: PRICE ELASTICITIES OF DEMAND [1]

Rank	Sector	Industry Name	Own-Price Elasticity of Energy	Own-Price Elasticity of Labor	Cross-Price Elasticity: Energy/Labor	Cross-Price Elasticity: Labor/Energy
1	363	Cement and Cement Products	-.82	-.10	0.82	0.10
2	364	Structural Clay Products	-.78	-.10	0.78	0.17
3	369	Other Non-Metallic Metal Products	-.75	-.20	0.75	0.20
4	313	Beverages	-.72	-.11	0.72	0.11
5	311	Food Processing	-.70	-.17	0.70	0.17
6	314	Tobacco	-.68	-.06	0.68	0.06
7	312	Other Food Products	-.67	-.21	0.67	0.21
8	362	Glass and Glass Products	-.64	-.33	0.64	0.33
9	3211	Spinning and Weaving	-.62	-.16	0.62	0.16
10	323	Leather and Leather Substitutes	-.61	-.11	0.61	0.11
11	321	Textiles Except 3211	-.60	-.09	0.60	0.09
12	381	Fabricated Metal Products	-.57	-.10	0.57	0.10
13	356	Plastic Wares	-.57	-.14	0.57	0.14
14	351	Basic Chemicals	-.57	-.16	0.57	0.16
15	355	Rubber	-.56	-.19	0.56	0.19
16	383	Electrical Machinery	-.55	-.08	0.55	0.08
17	361	Ceramic and Porcelain	-.52	-.44	0.52	0.44
18	382	Machinery	-.51	-.06	0.51	0.06
19	384	Transport Equipment	-.50	-.05	0.50	0.05
20	352	Other Chemical Products	-.50	-.06	0.50	0.06
21	341	Paper and Paper Products	-.49	-.11	0.49	0.11
22	324	Leather Footwear	-.47	-.04	0.47	0.04
23	322	Wearing Apparel	-.46	-.03	0.46	0.03
24	331	Wood and Wood Products	-.41	-.07	0.41	0.07
25	385	Measuring and Optical Equipment	-.41	-.03	0.41	0.03
26	342	Printing and Publishing	-.37	-.04	0.37	0.04
27	332	Wood Furniture	-.07*	-.00*	0.07	0.00

[1] Ranked by own-price elasticity of energy. Note that the cross-price elasticity of energy/labor is the elasticity of demand for energy with respect to the price of labor.

* Statistically not significant.

interpretation of these elasticities is slightly different from the traditional one. This is best demonstrated with an example. The elasticity of energy demand with respect to capital in the leather footwear sector (324) is 0.5 (Table 4.5). This means that a firm in this subsector producing the same level of output as another firm in that same subsector, but using 10% more capital, would consume 5% more energy. The estimated elasticities of energy demand with respect to capital range from 0.1 in other non-metallic mineral products (369) to 0.5 in leather footwear. This complementarity is found between energy and capital in all sectors, but it should be noted that this applies only in the short run. As Pindyck has noted, 1/ complementarity between energy and capital may be expected to be observed in the short run and substitutability in the long run. As might be expected, the pattern of industrial consumption of energy cannot change rapidly in the short run as most capital equipment is designed to use a certain amount of energy. Thus, capital equipment and energy must be used together complementing each other as producers do not have the flexibility to substitute less energy-intensive forms of capital. In the long run, however, the situation would be substantially different as producers, over time, would be able to adjust and substitute (energy-efficient) capital for energy. 2/

4.29 The elasticity of energy demand with respect to output can be interpreted in the same manner as the energy-capital elasticity; viz., it shows the increase in the demand for energy by a firm using the same level of capital as another firm in that subsector, but producing 1% more output. Thus, in the beverages subsector (313), a 10% increase in output (with capital fixed) would result in a 3% increase in the demand for energy. These elasticities are also presented in Table 4.5 and range from 0.3 for beverages to 0.8 for cement and cement products.

4.30 A word of caution, however, is necessary here. These energy-output elasticities should not be interpreted as measuring the energy intensity of firms at different scales of operation because these elasticities treat the stock of capital as fixed. Scale effects on energy intensity should measure the energy demand response to proportionate increases in all fixed factors, in this case, output and capital. Such a measure is obtained by summing the energy-capital and energy-output elasticities of Table 4.5. Doing so reveals that in only one subsector does this sum exceed 1. Thus, the energy-output ratio increases with the scale of plant only in the leather footwear subsector (324). This implies that larger scale plants are more energy-efficient than smaller ones in all other sectors; viz., the energy-output ratio declines with increasing scale of operations in all except one, the leather footwear, subsector with the greatest energy savings found in the food processing sectors (312, 311, 313). (See Table 4.5.)

The Impact on the Costs of Manufacturing

4.31 Since there are differing subsidy rates on energy products currently in force (para. 2.08), removing these subsidies will change the relative

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1/ Pindyck (1979), op. cit.

2/ This adjustment process is discussed in detail in Chapter 8.

Table 4.5: ELASTICITY OF ENERGY DEMAND WITH RESPECT TO CAPITAL AND LABOR AND THE ENERGY INTENSITY OF SCALE [1/]

Rank	Sector	Industry Name	Energy Intensity of Scale	Elasticities of Energy With Respect To	
				Capital	Output
1	324	Leather Footware	1.07	0.49	0.58
2	363	Cement and Cement Products	0.97	0.21	0.75
3	364	Structural Clay Products	0.90	0.27	0.62
4	332	Wood Furniture	0.89	0.32	0.57
5	3211	Spinning and Weaving	0.89	0.29	0.59
6	322	Wearing Apparel	0.88	0.27	0.60
7	342	Printing and Publishing	0.87	0.43	0.44
8	321	Textiles Except 3211	0.85	0.21	0.64
9	352	Other Chemical Products	0.85	0.32	0.53
10	382	Machinery	0.85	0.36	0.48
11	384	Transport Equipment	0.81	0.27	0.54
12	385	Measuring and Optical Equipment	0.81	0.39	0.41
13	361	Ceramic and Porcelain	0.81	0.23	0.58
14	383	Electrical Machinery	0.80	0.21	0.59
15	369	Other Non-Metallic Metal Products	0.78	0.13	0.64
16	362	Glass and Glass Products	0.77	0.23	0.53
17	355	Rubber	0.76	0.33	0.42
18	356	Plastic Wares	0.75	0.23	0.52
19	341	Paper and Paper Products	0.74	0.35	0.38
20	314	Tobacco	0.74	0.20	0.53
21	381	Fabricated Metal Products	0.72	0.25	0.46
22	351	Basic Chemicals	0.70	0.22	0.47
23	331	Wood and Wood Products	0.69	0.26	0.43
24	323	Leather and Leather Substitutes	0.61	0.23	0.37
25	312	Other Food Products	0.57	0.23	0.34
26	311	Food Processing	0.56	0.19	0.37
27	313	Beverages	0.47	0.21	0.26

1/ Ranked by energy intensity of scale.

prices of energy sources and thus affect energy-using industries differentially. Consequently, the manufacturing subsectors would be differentially sensitive to the prices of different fuels. Table 4.6 provides estimates of the elasticities of total costs with respect to all energy prices; viz., the price of aggregate energy and the price of each of the five fuels. These elasticities indicate the effect of increases in energy prices on the total cost of production, with unchanged or constant levels of output and capital; i.e., these elasticities tell us by what proportion the prices of manufactured output would rise (or profit rates would decline in an open economy) in response to an increase in the price of energy.

4.32 Figure 4.1 presents the essence of Table 4.6; it provides a summary of those sectors whose costs of production demonstrate the greatest proportionate increase in response to higher energy prices. As can be seen, the impact of fuel oil prices dominates the impact of the prices of other energy sources. Also, sectors in the two-digit sector 36, non-metallic mineral products, are the five whose total costs are most sensitive to the price of energy. A 10% increase in the price of energy will result in a 1.6% and 0.8% increase in the cost of producing ceramics and porcelain (361) and glass and glass products (362) respectively. The other sectors whose cost of production are sensitive to the price of energy are structural clay products (0.8%) and other non-metallic metal products (0.5%). 1/ After these four non-metallic minerals sectors, the most energy-cost sensitive sectors are basic chemicals (351), spinning and weaving (3211), other food products (312) and cement and cement products (363). The elasticity of total cost with respect to the price of energy for cement and cement products, 0.03, is about one-fifth that of the first-ranked sector, ceramics and porcelain (361). It might seem odd that the cement and cement and products subsector should rank so low. As discussed earlier, (para. 3.17) this is due to the aggregation problem. Sector 363 contains very few cement manufacturing firms and a large number of cement products firms. Dissaggregating to the 5-digit level (subsector 36310) shows that the price elasticity of demand for this subsector is, in fact, -0.4, and that the total cost elasticity is 0.1. Both elasticities would be the second highest elasticity (in absolute value) after ceramics and porcelain. For 18 out of the 27 sectors analyzed, a 10% increase in energy prices results in a 0.03% increase in total costs or less. 2/ These estimates indicate that increases in the price of energy are not likely to lead to a significant increase in the costs of production in the industrial sector (see also paras. 4.35 to 4.45).

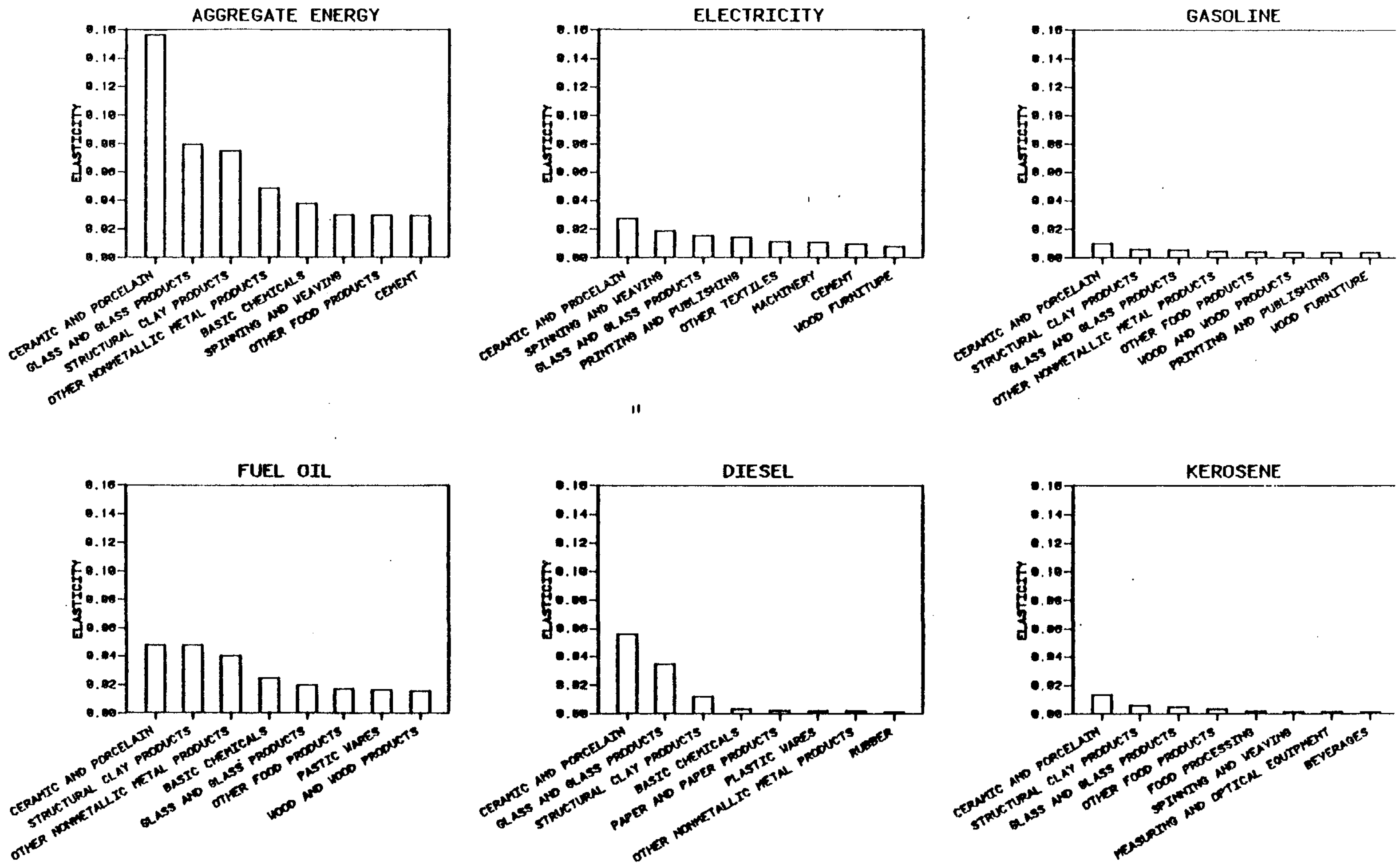
1/ The numbers in brackets refer to the percentage increase in total costs due to a 10% increase in energy prices.

2/ These total cost elasticities would appear to be lower than those estimated by Pindyck for the manufacturing sectors of 10 industrialized countries. See Pindyck (1979), op. cit. His estimates for 1972 ranged from 0.032 in the United States to 0.067 in Italy. The simple average of the Indonesian total cost elasticities is about 0.029 which is comparable to Pindyck's estimate, also of 0.029, for the United States manufacturing sector in 1963.

Table 4.6: ELASTICITY OF TOTAL PRODUCTION COST TO ENERGY PRICE

	Sector	Total	Energy Source				
			Electricity	Gasoline	Fuel Oil	Diesel	Kerosene
311	Food Processing	.0184	.0038	.0019	.0090	.0013	.0024
312	Other Food Products	.0296	.0032	.0044	.0173	.001	.0036
313	Beverages	.0136	.0050	.0030	.0037	.0002	.0017
314	Tobacco	.0028	.0011	.0008	.0006	.0001	.0002
3211	Spinning and Weaving	.0300	.0185	.0015	.0064	.0015	.0021
321	Textiles Except 3211	.0213	.0113	.0016	.0063	.0006	.0015
322	Wearing Apparel	.0099	.0076	.0012	.0009	.0001	.0001
323	Leather and Leather Substitutes	.0076	.0036	.0007	.0029	.0003	.0002
324	Leather Footware	.0141	.0071	.0023	.0039	.0004	.0005
331	Wood and Wood Products	.0222	.0015	.0041	.0159	.0004	.0002
332	Wood Furniture	.0220	.0079	.0039	.0101	.0000	.0001
341	Paper and Paper Products	.0235	.0041	.0027	.0125	.0025	.0014
342	Printing and Publishing	.0240	.0142	.0040	.0038	.0004	.0016
351	Basic Chemicals	.0377	.0047	.0030	.0246	.0038	.0016
352	Other Chemical Products	.0134	.0039	.0030	.0049	.0003	.0013
355	Rubber	.0141	.0032	.0014	.0069	.0016	.0009
356	Plastic Wares	.0289	.0069	.0022	.0165	.0023	.0009
361	Ceramic and Porcelain	.1567	.0274	.0109	.0045	.0565	.0136
362	Glass and Glass Products	.0799	.0154	.0045	.0482	.0351	.0053
363	Cement and Cement Products	.0293	.0099	.0037	.0196	.0008	.0007
364	Structural Clay Products	.0752	.0032	.0054	.0142	.0123	.0062
369	Other Non-Metallic Metal Products	.0486	.0004	.0044	.0480	.0023	.0013
381	Fabricated Metal Products	.0166	.0049	.0023	.0072	.0010	.0011
382	Machinery	.0210	.0107	.0026	.0058	.0005	.001[illegible]
383	Electrical Machinery	.0117	.0035	.0020	.0047	.0007	.000[illegible]
384	Transport Equipment	.0093	.0030	.0017	.0038	.0002	.0005
385	Measuring and Optical Equipment	.0097	.0053	.0011	.0015	.0000	.0018

FIGURE 4.1
ELASTICITY OF TOTAL COST WITH RESPECT TO THE RELEVANT ENERGY PRICE



4.33 One point worth mentioning here is that the finding that food manufacturing is a relatively energy-intensive sector (para. 3.19) and that the cost of production in this sector is relatively sensitive to the price of energy has potential importance for policy since wages may be sensitive to food prices. These aspects could be important factors in spreading energy price increases throughout the rest of the economy through wage escalation. 1/ In particular, since a principal energy source for this sector is fuel oil (Table 3.13), which has a current price-opportunity cost ratio of 0.51, elimination of the fuel oil subsidy working its way through the food manufacturing sector and food prices could have second-round (indirect) effects on the economy through increased levels of wages. Thus, if wages are particularly sensitive to food prices, removal of energy subsidies, particularly that on fuel oil, could result in wage escalation that is faster and larger in magnitude than generally anticipated. This emphasizes the importance of wages in the escalation process, and it raises the possibility of considering an attempt to offset the effect of an energy price increase on food prices, at least at the initial stages of the subsidy removal. However, as is shown later (paras. 4.35 and 4.36), the ability of most subsectors to substitute away from energy as energy prices increase significantly tends to mitigate the effect on total costs and, thus, on the prices of final outputs.

4.34 Figure 4.1 also provides estimates of total cost elasticities with respect to the prices of individual fuels; the largest of these elasticities are highlighted there. As might be expected, non-metallic mineral sectors (ISIC 36 at the two-digit level) dominate the top ranks in all cases. Fuel oil's price would appear to be the most important of the five energy sources in influencing costs of production, with kerosene being the least important. The total cost elasticities with respect to the price of fuel oil for the top eight sectors ranges from 0.05 to 0.02, whereas that with respect to the price of kerosene ranges from 0.01 to 0.02. Thus, an increase in kerosene prices is likely to have relatively the least impact on the costs of manufacturing while an increase in fuel oil prices is likely to have the most. This is not a surprising conclusion given that fuel oil, in 1978, accounted for 42% of total energy consumption by the industrial sector while kerosene accounted for only 9%.

Simulating The Impact of Increased Energy Prices

4.35 The total cost elasticities and the aggregate demand elasticities discussed above are accurate only for predicting relatively small changes in energy prices. To analyze the effects of large changes in energy prices on the costs of manufacturing, the estimated model is used to simulate four

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1/ See Chapter 7 for a discussion of the possible macroeconomic implications of increasing energy prices.

different price regimes. 1/ These regimes analyse the implications of increasing energy prices to different levels as shown in Table 4.7. Regime 1 is equivalent to raising the base period prices used in the model (1976/1978) to those prevailing in May 1980; i.e., the second discrete increase in energy prices in Indonesia since 1978. Regime 2 investigates the next discrete jump, from May 1980 to January 1982. In both these regimes, it has been necessary to make some assumptions about the change in the wage rate. It has been assumed that the real wage in the manufacturing sector has increased by 3% per annum over this period. 2/ Thus, price regimes 1 and 2 present the changes as a result of changing prices of energy and labor. Regime 3 is presented to isolate the effect of the discrete energy price change of Regime 2 without a comensurate change in the price of labor. 3/ Finally, Regime 4 draws out the implications of an (instantaneous) shift from current energy price levels to international levels. The purpose of this exercise is to demonstrate the sensitivity of long-run total costs to differing price regimes and is intended to be illustrative. 4/

4.36 Table 4.8 presents, for each of the 27 subsectors, the proportional changes in the relative prices of energy and labor for the four different price regimes. It shows the relative attractiveness of energy to labor. Values lower than one indicate that energy is more attractive; this can be seen to be true in Regime 1, for the spinning and weaving (3211) and the wearing apparel (322) subsectors. The reason that these price ratios are less than one is because they are heavy electricity-using sectors and, as Table 4.7 shows, the proportional changes in prices for all fuels, except electricity, is higher than that of the wage rate, and the electricity weight is very large in these two subsectors. The other regimes show values greater than one indicating that the proportional increases in energy prices exceeded that of labor and, thus, energy has become relatively less attractive to use.

1/ Strictly speaking, the earlier elasticities were point elasticities and are, therefore, valid only for small changes. These simulations implicitly compute arc elasticities which are valid for large changes. Also, it is worth mentioning that within this analytical framework, an increase, say, a doubling of the energy price could occur if the price of each fuel component doubled, or if some price components more than doubled and there was substitution away from the more expensive energy sources.

2/ Preliminary analysis for the manufacturing sector indicates that this may be a slight underestimate.

3/ Since these are discrete jumps in prices, conceptually, Regime 3 outlines the implications of the instantaneous change in energy prices without any change taking place in the wage rate.

4/ In this analytical framework, the short-run and long-run total costs elasticities are related if it is assumed that firms optimize their use of fixed factors; i.e., they use cost-minimizing levels of capital stock. See N.A. Schakerman and M. Ishaq Nadiri (1980), "Variable Cost Functions and the Rate of Return to Quasi-Fixed Factors: An Application to R and D in the Bell System." New York University/NBER, Discussion Paper 80-17; C.V. State Center for Applied Economics, New York.

Table 4.7: ALTERNATE RELATIVE ENERGY PRICE REGIMES

	Regime 1	Regime 2	Regime 3	Regime 4
Elasticity	1.40	1.39	1.39	1.49
Gasoline	2.14	1.60	1.60	0.80
Fuel Oil	2.05	1.66	1.66	1.86
Diesel	2.05	1.66	1.66	2.64
Kerosene	2.08	1.60	1.60	3.48
Wage Rate	1.63	1.28	1.0	1.0

Note: The relative prices shown indicate the ratio of the price in that particular regime to the price prevailing in the base period (1976/8). The relative change in energy and labor prices for the different price regimes is as follows:

Regime 1: 1976/78 to May 1980.
Regime 2: May 1980 to January 1982.
Regime 3: Regime 2 energy price changes with no change in the wage rate.
Regime 4: International price levels for all energy sources; January 1982 wage rate.

Table 4.8: PROPORTIONAL CHANGES IN THE ENERGY-WAGE PRICE RATIO

	Sector	Regime 1	Regime 2	Regime 3	Regime 4
311	Food Processing	1.16	1.23	1.58	1.80
312	Other Food Products	1.21	1.25	1.61	1.74
313	Beverages	1.10	1.19	1.53	1.54
314	Tobacco	1.09	1.19	1.52	1.39
3211	Spinning and Weaving	.99	1.15	1.48	1.65
321	Textiles Except 3211	1.03	1.17	1.50	1.63
322	Wearing Apparel	.94	1.12	1.44	1.43
323	Leather and Leather Substitutes	1.06	1.19	1.52	1.59
324	Leather Footware	1.04	1.17	1.51	1.48
331	Wood and Wood Products	1.23	1.27	1.63	1.58
332	Wood Furniture	1.10	1.20	1.54	1.48
341	Paper and Paper Products	1.18	1.24	1.60	1.75
342	Printing and Publishing	1.01	1.15	1.48	1.48
351	Basic Chemicals	1.20	1.26	1.81	1.79
352	Other Chemical Products	1.13	1.21	1.56	1.54
355	Rubber	1.15	1.23	1.58	1.75
356	Plastic Wares	1.15	1.23	1.58	1.73
361	Ceramic and Porcelain	1.18	1.25	1.60	2.01
362	Glass and Glass Products	1.17	1.24	1.60	2.06
363	Cement and Cement Products	1.11	1.21	1.55	1.58
364	Structural Clay Products	1.24	1.28	1.64	1.93
369	Other Non-Metallic Metal Products	1.25	1.29	1.65	1.77
381	Fabricated Metal Products	1.13	1.22	1.56	1.64
382	Machinery	1.04	1.17	1.50	1.56
383	Electrical Machinery	1.13	1.21	1.56	1.60
384	Transport Equipment	1.11	1.21	1.55	1.53
385	Measuring and Optical Equipment	1.02	1.16	1.49	1.67

4.37 Table 4.9 shows the percentage changes in energy consumption and total costs due to the increasing energy prices as identified by Regimes 1 to 4. In Regime 1, only the spinning and weaving (3211) and wearing apparel (322) subsectors show an increase in energy consumption and total cost. The reason being the relative attractiveness of energy in these two subsectors despite the May 1980 energy price increase. The rest of the sectors show declines in energy consumption and increases in total costs. Regime 2 shows the effects of the January 1982 energy price increases. This price increase is predicted to reduce energy demand by more than 10% in most sectors. As might be expected, the reduction in energy use is as much as 17% in structural clay products (364) and other non-metallic mineral products (369), and as little as 2.7% in wood furniture (332). In addition to the non-metallic mineral sectors (36), food processing, other food products, beverages, and tobacco also show relatively large reductions in energy consumption as a result of this price increase.

4.38 In Regime 2, the ability of firms to substitute away from energy in response to an increase in its price, combined with energy's relatively small share in total cost, results in a relatively small increase in total costs of production for most subsectors. Except for one subsector, the ceramics and porcelain subsector (361), the cost increases are less than 2% (Table 4.9). Moreover, the distribution of cost increases is heavily skewed towards the lower end; i.e., the increases are under 1% for all subsectors except for three, all of which are in the non-metallic metal products group (sector 36). Where certain subsectors exhibit relatively large percentage reductions in energy consumption, they do not always exhibit relatively greater percentage reductions in total costs. In other words, two sectors exhibiting almost the same percentage change in energy consumption may, in fact, show dissimilar percentage changes in total costs because of the differential ability of sectors to substitute away from energy and the differential share of energy costs in total costs. Contrast, for example, in Regime 2, the change in energy consumption and in total costs in the fabricated metal products subsector which are -11.6% and 0.4%, respectively, with those in the ceramics and porcelain one (-11.01%; 3.9%).

4.39 Regime 3 isolates the effects of the January 1982 energy price increase; i.e., no change in the wage rate is assumed here (see Table 4.7). As might be expected, the relative energy-labor price ratio is lower than in Regime 2 (Table 4.8), and, therefore, the reduction in energy demand and the increase in total costs are much higher. Energy is much less attractive to use in this regime than labor, and, consequently, the expected effects are larger. 1/ The last two columns of Table 4.9 (Regime 4) provide predictions of the effects of a further energy price increase to international price levels. In all but five subsectors, the demand for energy would fall by more than 20%. Only in wood furniture manufacturing (332) is the fall less than 10%. The resulting increases in total cost are, however, rather modest. In only six sectors will total costs rise by more than 2%. The highest cost increase is registered by the ceramics and porcelain subsector (361) -- 14.7% -- and the lowest by the tobacco subsector (314) -- 0.1%. Besides the non-

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1/ The difference in the results between Regimes 2 and 3 isolates the wage effect on energy consumption and total costs. This is not shown here.

Table 4.9: CHANGE IN ENERGY CONSUMPTION AND IN TOTAL COSTS
(%)

	Sector	Regime 1		Regime 2		Regime 3		Regime 4	
		Change in Energy Consumption	Change in Total Cost	Change in Energy Consumption	Change in Total Cost	Change in Energy Consumption	Change in Total Cost	Change in Energy Consumption	Change in Total Cost
311	Food Processing	-10.48	.29	-14.04	.42	-27.87	.88	-33.95	1.31
312	Other Food Products	-12.44	.60	-14.40	.75	-27.65	1.52	-31.11	2.06
313	Beverages	-6.92	.14	-12.28	.26	-26.67	.60	-26.88	.68
314	Tobacco	-6.00	.02	-11.34	.05	-25.09	.11	-20.43	.10
3211	Spinning and Weaving	.18	-.01	-8.68	.45	-21.76	1.17	-26.66	1.74
321	Textiles Except 3211	-1.88	.07	-9.31	.36	-21.90	.87	-26.08	1.24
322	Wearing Apparel	2.64	-.06	-5.41	.12	-14.96	.34	-16.38	.40
323	Leather and Leather Substitutes	-3.55	.05	-10.24	.14	-23.01	.33	-25.22	.43
324	Leather Footware	-2.12	.06	-7.76	.25	-17.74	.59	-18.93	.69
331	Wood and Wood Products	-8.61	.49	-10.19	.64	-19.19	1.22	-19.25	1.46
332	Wood Furniture	-.56	.21	-2.67	.46	-2.63	.97	-9.77	1.21
341	Paper and Paper Products	-7.97	.41	-10.54	.59	-20.84	1.18	-25.01	1.81
342	Printing and Publishing	-.43	.03	-5.38	.36	-12.89	.90	-15.23	1.13
351	Basic Chemicals	-10.12	.72	-12.54	.98	-24.18	1.94	-28.35	2.90
352	Other Chemical Products	-6.07	.17	-9.44	.27	-19.66	.59	-20.62	.71
355	Rubber	-8.03	.21	-11.35	.34	-23.02	.69	-26.98	1.05
356	Plastic Wares	-7.80	.40	-11.56	.65	-23.32	1.35	-27.04	1.97
361	Ceramic and Porcelain	-8.38	2.72	-11.03	3.89	-21.92	8.07	-30.63	14.75
362	Glass and Glass Products	-9.68	1.31	-13.18	1.93	-25.95	3.99	-36.92	7.37
363	Cement and Cement Products	-8.39	.31	-14.89	.59	-30.75	1.32	-31.72	1.47
364	Structural Clay Products	-15.68	1.67	-17.59	1.96	-32.20	3.91	-40.21	5.67
369	Other Non-Metallic Metal Products	-15.94	1.15	-17.40	1.34	-31.49	2.59	-34.94	3.30
381	Fabricated Metal Products	-6.94	.21	-11.06	.36	-22.99	.78	-25.54	1.04
382	Machinery	-2.06	.08	-8.22	.36	-19.12	.87	-21.88	1.14
383	Electrical Machinery	-6.75	.15	-10.67	.26	-22.21	.55	-24.04	.70
384	Transport Equipment	-5.57	.11	-9.62	.20	-20.21	.43	-20.98	.51
385	Measuring and Optical Equipment	-1.15	.03	-6.35	.16	-14.97	.39	-22.02	.63

metallic minerals sectors (36), the sectors most affected are basic chemicals (2.2%), other food products (2.1%), plastic wares (1.9%), paper and paper products (1.8%), and spinning and weaving (1.7%). These are the sectors, therefore, in which profits are most likely to be squeezed as a result of increases in energy prices. However, if producers are able to maintain their profit margins in the presence of the increased costs of energy, then the ouput prices would also increase by the same percentages as total costs. However, since most industrial products are internationally traded, it is unlikely that producers will, in fact, be able to maintain their profits unless the trade regime is altered.

The Subsidy Effects

4.40 The energy price increases that have taken place to date in Indonesia have reduced the economic subsidy provided to the large- and medium-scale manufacturing firms. This change in the economic subsidy is predicted in Table 4.10 for two price regimes, Regimes 2 and 3. The January 1982 price increases (over the energy and labor prices that prevailed in May 1980) indicate that the economic subsidy provided to manufacturing would fall by at least 20% in every subsector and by as much as 34% in the tobacco subsector. On average, it would appear that the January 1982 price increase is likely to eliminate about 25% of the subsidy provided to the manufacturing sector as a whole. Isolating the effect of only the energy price increase (Regime 3) shows that, had labor prices not also increased -- thus, increasing the (relative) disincentive to consume energy -- increases in energy prices would have resulted in even a greater reduction in subsidies to the manufacturing sector.

Effects on the International Competitiveness of the Manufacturing Sector

4.41 The analysis above shows that the positive effects of increasing energy prices in Indonesia are partially offset by increasing (nominal and real) wages. But the analysis also shows that despite increases in wages, increasing energy prices can reduce the demand for energy and are not going to result in large increases in the costs of manufacturing. The most significant feature of the above analysis is the relatively small effect on total costs of substantial increases in energy prices. 1/ Thus, fears about a significant loss of international competitiveness of the manufacturing sector are misplaced. Clearly, the small increases in total costs resulting from the differing energy price increases do not seem large. Indeed for 22 out of 27 sectors, the cost increases are likely to be less than 2% if energy prices are raised to international levels (Regime 4, in Table 4.9). The arguments, therefore, presented to provide subsidized energy to the industrial sector on the grounds of encouraging industrial development are not well-founded. On the contrary, as discussed earlier (para. 2.14), the provision of subsidized energy fosters energy- (and thus capital-) intensive industries, some of which show low social rates of return in Indonesia. What is essential, of course, is the adequate supply of energy (rather than cheap energy) that is priced to reflect its scarcity value to Indonesia. Moreover, the cost increases

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1/ A similar conclusion has been obtained for Canada and other developed countries. See Fuss (1977) op. cit. and Pindyck (1978) op. cit.

Table 4.10: THE SUBSIDY EFFECTS ON THE MANUFACTURING SECTOR

Rank	Sector	Changes in Economic Subsidy (%) Regime 2	Regime 3
311	Food Processing	-24.41	-41.69
312	Other Food Products	-26.61	-43.68
313	Beverages	-28.26	-48.23
314	Tobacco	-33.69	-54.89
3211	Spinning and Weaving	-22.53	-43.34
321	Textiles Except 3211	-24.10	-44.40
322	Wearing Apparel	-25.82	-50.46
323	Leather and Leather Substitutes	-26.18	-46.16
324	Leather Footwear	-28.46	-49.74
331	Wood and Wood Products	-31.52	-48.93
332	Wood Furniture	-31.10	-51.09
341	Paper and Paper Products	-25.80	-43.09
342	Printing and Publishing	-27.04	-49.35
351	Basic Chemicals	-25.77	-42.56
352	Other Chemical Products	-29.39	-48.71
355	Rubber	-25.29	-42.86
356	Plastic Wares	-25.84	-43.53
361	Ceramic and Porcelain	-21.73	-37.90
362	Glass and Glass Products	-21.07	-37.12
363	Cement and Cement Products	-28.06	-47.22
364	Structural Clay Products	-24.16	-40.10
369	Other Non-Metallic Metal Products	-27.38	-43.67
381	Fabricated Metal Products	-26.90	-45.52
382	Machinery	-25.97	-46.72
383	Electrical Machinery	-27.83	-46.71
384	Transport Equipment	-29.44	-48.96
385	Measuring and Optical Equipment	-22.59	-43.00

described above seem particularly small when compared to the effect on total costs of manufacturing of such government interventions as import tariffs, sales taxes, export disincentives (through negative rates of effective protection), subsidized borrowing, industrial licensing, and investment regulations. Alterations in these programs will have a much greater impact on the competitiveness and prices of most manufacturing subsectors than large energy price adjustments.1/

4.42 The only subsector which might be seriously disadvantaged by a large energy price rise appears to be ceramics and porcelain (361). However, the social profitability of this subsector is, in fact, quite low (para. 2.14) and, thus, an increase in energy prices may well be a blessing in disguise. Furthermore, an often overlooked positive effect of an energy price rise is the increased labor intensity of production that would result. As mentioned earlier (para. 4.24), many studies have found that energy and labor are substitutes in the long run. 2/ In Pindyck's work, elasticities of substitution for several developed countries were estimated to be close to 1.0. For the United States these estimates vary from 0.65 to 2.16 3/ and for Western European countries these elasticities range from 0.72 for Denmark to 0.87 for Belgium. 4/ Thus, the long-run impact of increased energy prices on employment generation are substantial and should not be ignored.

4.43 The conclusions regarding the reduction in energy consumption and the realtively small increases in total costs of manufacturing due to increased energy prices are not unique to Indonesia. If the industrial countries are any guide, the potential for energy savings is sizeable in the manufacturing sector. For example, for Canadian manufacturing, the price elasticity of demand for energy was found to be -0.5, and that a large increase in energy price could be accommodated by only small increases in total costs; a doubling of the price led to a 2% - 4% increase in average production costs. 5/ A recent study of energy demand in ten developed countries shows price elasticities of demand for aggregate energy ranging from -0.75 for the U.S. to -0.841 for the U.K., Sweden, Netherlands, Japan and Italy. Also, in the U.S., it has been shown that a 10% rise in the cost of energy would lead to a 0.3% increase in the average cost of industrial output, and for Italy, Sweden and

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1/ This issue has been dealt with extensively in Indonesia: Selected Issues of Industrial Development and Trade Strategy, Report No. 3182-IND, The World Bank, July 15, 1981, Washington, D.C.

2/ See Pindyck (1979), op. cit., and Fuss (1977), op. cit.

3/ E.R. Berndt and D.O. Wood (1975), "Technology Prices and the Derived Demand for Energy," Rev. Econ. Statist., 57, 259-68; and E.A. Herdson and D.W. Jorgenson (1974), "U.S. Energy Policy and Economic Growth," 1975-2000, Bell J. Econ., 5, 461-514.

4/ J.M. Griffen and P.R. Gregory (1976), "An Intercountry Translog Model of Energy Substitution Responses," American Economic Review, 66, 845-857.

5/ Fuss (1977), op. cit.

Japan, this cost increase would be about 0.7%. 1/ Another study showed similar elasticities for developed countries; the range was -0.77 for Belgium and Norway to -0.80 for France, West Germany and the United Kingdom.

4.44. These studies also suggest that the short-run response of energy demand to changing prices is likely to be relatively more inelastic than thelong-run response. 2/ Moreover, preliminary evidence indicates that, in many developing countries, the prospects for reducing energy demand by industry through proper pricing policies are promising and that the impact of increased energy prices on costs in the industrial sector are not large. However, in those industries in which energy costs account for a relatively large share of total costs, then the effect of increased energy prices may be significant. For example, in Korea, in sectors such as aluminum ingot production, copper refining, and production of elemental phosphorous, energy costs account for more than 15% of total costs; but such industries, in general, account for a relatively small share of value-added in most developing countries, including Indonesia. Consequently, the incidence of increased energy prices would be highly skewed towards these sectors, and a vast majority of the remaining sectors would not have their profit margins squeezed significantly as a result of increased energy prices.

4.45 Also, in Korea, as a result of significant increases in energy prices, in combination with a comprehensive energy conservation program, a change in the capital stock took place over time; as opposed to improvement in the energy efficiency of older plants, new capital equipment which was, in general, more energy efficient than older equipment, was installed. As a result, the energy intensity of the industrial sector declined from (an index of) 0.6% to 0.55% over the period 1973-77. In Brazil, over the period 1973-76, the decline in industrial energy consumption was even greater than in Korea as a result of proper energy pricing and conservation policies. This has been explained, in part, by the shift to new energy-efficient capital equipment and a substitution away from traditional fuels towards modern fuels which are more efficient in end use. 3/ India, however, is an example of a country in which energy conservation policies have not had the same impact on energy demand as in Korea or Brazil, partly because of the Government's industrial policy environment that discouraged modernization which could have resulted in an adjustment towards more energy-efficient capital equipment. Thus, improper industrial policies can, at least partly, negate the beneficial effects of proper energy pricing policies. This is an important related issue and needs to be given consideration by policy makers when formulating and implementing energy policies in Indonesia.

The Use of Natural Gas by the Industrial Sector

4.46 Natural gas is used in Indonesia as feedstock by some industries and as town gas. Current major consumers are fertilizer, steel (Krakatau) and

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1/ Pindyck (1979), op. cit.

2/ Griffen and Gregory (1976), op. cit.

3/ Ridker, R. (1981), op. cit.

cement plants. It is also used by PERTAMINA in LPG production and by city gas companies in Jakarta and Cirebon and by PLN for electricity generating in Jakarta and Cirebon. A study done by Gaffney, Cline and Associates (U.K.) in May 1981 for MIGAS under the IDA Credit No. 451-IND included some demand and supply projections in Java and Sumatra. The consultants estimated that total demand in Java would increase from 275 MMSCFD in 1979 to 694 MMSCFD in 1983 and in Sumatra from 137 MMSCFD in 1979 to 185 MMSCFD in 1981; this implies a rapid growth in demand for natural gas. Present supply capacity of onshore and offshore fields in West Java is about 300 MMSCFD indicating a deficit of about 394 MMSCFD from 1984 onwards. This could be met by the development of new onshore fields at an investment cost estimated at about $581 million; these figures are based on historical investment in Indonesian fields but updated to 1980 costs. In Sumatra no major supply deficit is anticipated and the alternative of a pipeline from Sumatra to West Java is considered too expensive.

4.47 The consultants also studied the pricing strategy which would ensure an optimum allocation of gas if production of gas is to be encouraged for domestic use. In the final analysis, such an objective would of course require that the gas be priced at a level equivalent to its opportunity cost. However, given the constraints resulting from some non-economic considerations taken into account my MIGAS in setting gas prices, the consultants recommend the principle of "marginal cost pricing" as the optimal pricing policy for gas which would result in an average price of $3.08/MMSCFD for West Java Gas and $2.68/MMSCFD for Sumatra gas in 1980. These prices would, however, vary from customer to customer according to consumer location to reflect pipeline costs involved. Gas prices should, therefore, be determined in two stages - a uniform commodity charge reflecting the cost of supplying incremental gas plus a differential distribution charge. The difference would range from $0.60/Mscf for consumer around Cirebon to $1.17/Mscf at Krakatau Steel.

4.48 Current gas prices are, however, much lower than those suggested above. The current level of prices according to customers is as follows: PUSRI fertilizer: $0.35 - $0.65/Mscf; Krakatau Steel and Kujang Fertilizer: $0.65/Mscf; and Local Industry: $1.25 - $1.92/Mscf. The wide differences between current gas prices and those recommended above indicate the existence of substantial economic subsidies. If the prices are set at levels recommended above, substantial savings would occur to the economy when costs of using alternative fuels in place of gas are taken into account; this assumes that the price of alternative fuels reflect their true scarcity values. The consultants estimated that these savings could amount to about $500 million in West Java alone. When all competing fuels are priced at their true opportunity costs, gas priced at marginal cost would have a significant advantage in all applications except cement making where coal would be cheaper to use and in glass making where electricity would compete successfully with gas. But if all fuels are not properly priced, then the price signals would be distorted and underpriced oil would be allocated to local uses to replace gas and the demand for gas would decline. The value of foregone oil exports would represent a significant loss for the economy. Moreover, in order to compete with underpriced oil, present gas producers would reduce their gas prices to or below parity with oil. In this case, if the average cost of gas is higher than this oil parity price, the economy would suffer further losses which will have to be incurred by the gas distributors.

4.49 The impact of gas price increases on output costs would depend on the make-up of final output prices; i.e. the respective share of wages, fuel, capital and other inputs. For example, fuel input in fertilizer production amounts to about 34% of total costs. On this basis, a gas price of $3.25/Mcf or five times the current price at the Kujang plant would increase the fertilizer price ex-factory by some 65%, but it would only change fertilizer use and rice yield marginally; fertilizer use would decline by about 15% and rice yield by only 15% because, in Indonesia, the fertilizer demand curve is relatively inelastic.

4.50 Finally, the value of gas to the Indonesian economy could be analyzed in the context of local utilization versus export (LNG). The calculations made by the consultants indicated that LNG exports to Japan with a net resource value 1/ in the range of $0.7 - $0.8/Mcf (or at $5.37 equivalent f.o.b. price) would look attractive against all but the highest value uses of gas in local utilization. However, the net resource value for exports of LNG to the United States would be negative and exports to USA would not be attractive.

1/ For LNG, net resource value is a straightforward monetary value derived by netting-off costs of supply from the realized price but for local use the market realization is the sum the consumer is required to pay for gas and would not necessarily reflect the value which the consumer place on gas supply. For gas there is no international market as such - in 1980, LNG accounted for only 2.5% of world gas consumption and this limited trade was carried out on the basis of bilateral contracts.

5. THE DEMAND FOR ENERGY BY HOUSEHOLDS

Introduction

5.01 This chapter shifts the focus to the household sector. Households consume about 25% of commercial energy (and 65% of total energy, in 1978) in Indonesia, and spend, on the average, about 4% of their income on energy. Expenditures on kerosene, however, account for over 45% of their total expenditures of energy. Moreover, as discussed earlier, kerosene is the most heavily subsidized source of energy. Consequently, reducing subsidies on kerosene and other energy sources consumed by the households could have profound impact on their welfare. This chapter, therefore, attempts to address several issues that may be of importance to policy makers in Indonesia. These issues include the extent to which higher energy, and in particular kerosene, prices will reduce its demand and, thereby, the economic subsidy; the effect of such an increase on the demand for wood fuels and its implication for the problem of deforestation, particularly in rural Java; the effect on the demand for important household fuels due to future growth in the income of the households; the impact of changes in fuel prices and income on households differentiated by geographical regions of the country, urban/rural location, and income class; the implications of any differential effects; and finally, who would benefit and who would lose as a result of increasing energy prices at differential rates of growth.

The Analytical Framework

5.02 The structure of energy demand by the household sector depends in large measure on the preferences of the consumers. The substitution away from energy as energy prices increase depends on the willingness of consumers to substitute between energy and other goods in the consumption basket as well as on the extent to which there would be a reduction in the purchases of energy consuming appliances, such as kerosene stoves or petromax lamps, and the replacement of existing appliances with those that use energy more efficiently. Income growth is also an important characteristic of energy demand; the increase in the demand for energy and the extent of substitution from one source of energy to another as household incomes rise are important considerations here. Finally, the extent to which fuels are substitutes for one another as their relative prices change is likely to be dependent on the urban/rural nature of the household and its geographical location in the country. These characteristics fundamentally determine the structure of household energy demand in Indonesia.

5.03 The analysis used in this chapter is restricted to combustible fuels only; viz., kerosene, charcoal and firewood. In all of Indonesia, the share of combustible fuels in total household energy expenditure is about 86%, while it amounts to almost 97% in rural Indonesia and 58% in urban areas (Table 3.16). Electricity, which is also consumed by Indonesian households, is difficult to model because individual households cannot be presumed to face a perfectly elastic supply of electricity at its market price. Only 6% of Indonesian households have access to electricity. Many households that may wish to consume electricity given its price are not able to do so because access to distribution facilities is rationed. For those households that cannot obtain an electrical connection, the price of a watt of power is irrelevant in their energy consumption decisions. Even households with electrical connections may be restricted from achieving desired consumption levels due to wattage limitations on their connections. Consequently, the analysis excludes the price of electricity in studying the demand for combustible fuels. 1/

5.04 * Expenditure equations relating household expenditure of each combustible fuel to its price, the prices of competing fuels, the level of total household expenditure and a set of household characteristics are estimated. In estimating the parameters of the set of equations above, the price of firewood and charcoal are assumed to vary in fixed proportion to each other. This assumption is required by the lack of price data for firewood, but this assumption is not restrictive. Charcoal is merely refined firewood and is widely produced in a competitive market using simple technologies. If charcoal and firewood prices do move together, it is not possible to estimate separate price coefficients for them in the fuel expenditure equations. Estimated response to charcoal prices alone would, in fact, be the sum of consumer responses to both firewood and charcoal prices. Therefore, this aggregate price will, henceforth, be denoted by the "wood fuel" price.

5.05 * The household characteristic variables used are the logarithms of household size and the number of household members of age 11 or above, and 0-1 dummy variables for rural/urban and Java/outside Java locations. These location variables allow for differences in fuel consumption independent of differences in prices, total expenditure and other household characteristics. Recognizing that household demand responses to exogenous variables may vary across expenditure groups, all of the slope parameters of the underlying expenditure equations are allowed to vary linearly with the logarithm of per capita expenditure.

5.06 * The expenditure equations for kerosene, charcoal and firewood are estimated with cross-section data on the consumption of individual households. Most households do not consume all three fuels, and thus zero consumption levels are often observed. In such cases, it is well known that application of ordinary least squares estimation techniques would result in biased estimates of the expenditure equation parameters. The bias would be very small in the case of kerosene since it is consumed by 98.8% of the households in the sample, but would be quite large for charcoal and firewood which are consumed by 19.4% and 47.3% of sample households respectively. The equations are, therefore, estimated with tobit maximum likelihood techniques, which specifically take into account zero consumption of certain fuels by some households. 2/

1/ The next 4 paragraphs (5.04 - 5.07), marked with an asterisk, outline the model and the data base and may be omitted by the reader without any loss of continuity.

2/ Tobin, James (1958). "Estimation of Relationships for Limited Dependent Variables," Econometrica, 26, pp. 24-36.

5.07 * The data used in the estimation are from the tapes of the Survai Sosial Akonomi (SUSENAS), subround 2, 1978, conducted by the Biro Pusat Statistik (Central Bureau of Statistics). Households reported their expenditure on kerosene, charcoal and firewood as well as the physical quantities of kerosene and charcoal consumed for the previous month. For kerosene, prices were calculated at the village level by grouping sample households into their respective villages and calculating the average price of the kerosene consumed. For charcoal, prices were calculated at the kabupaten level through a similar grouping procedure. The sample size used in the analysis totaled 5,880 households.

5.08 Table 5.1 provides basic information on the levels of fuel expenditure, consumption and prices faced by the sample of households used in estimating the set of expenditure equations. As the table shows, the relative allocation of expenditure among fuels varies markedly according to household location. In urban areas of both Java and the outer islands, kerosene expenditure exceeds that of the two wood fuels combined. Rural households outside of Java spend only slightly more on kerosene than on wood fuels, but rural Javanese households spend twice as much on firewood than on kerosene. The prices of these fuels also vary substantially by location. The greatest level of kerosene consumption occurs in urban Java where average prices are the lowest. In contrast, kerosene prices are highest in rural areas outside Java and household monthly consumptions is the least.

5.09 Firewood consumption is of greatest importance in rural Java. This region was estimated to account for 78% of all Indonesian household firewood consumption, with the average rural Javanese household consuming 13 times the firewood of urban Javanese households. Firewood prices, as proxied by the charcoal price, are also significantly lower in rural Java than in the other regions. Even though the stock of trees is clearly smaller in Java than in most areas outside of Java, the largest component of the firewood price is probably labor costs. Thus, it is not surprising that rural Java has a low firewood price given its relatively low wages.

5.10 Separate sets of price elasticties were calculated for seven different population groups. 1/ Elasticities (and approximate standard errors) were computed at the means of the exogenous variables for households in four geographic locations: rural Java, urban Java, rural outside Java and urban outside Java. In addition, elasticities were calculated for three representative households which are identical except for total expenditure levels. Each of these three households has five members, three of whom are 11 years or above and have mean values for all other independent variables except total expenditure. These households, having total monthly expenditure levels of Rp 20,000, Rp 35,000 and Rp 50,000, represent the 47th, 77th and 90th percentiles of the per capita monthly expenditure distribution. The elasticities for households by geographic location have also been weighted and summed to obtain elasticities for larger geographical aggregates such as Java.

1/ Parameter estimates for the three fuel expenditure equations, as well as associated sets of test statistics, are presented in Appendix III. The formulae used in calculating the price and income elasticities and their standard errors can also be found there.

Table 5.1: EXPENDITURE, CONSUMPTION AND PRICES OF KEROSENE, CHARCOAL AND FIREWOOD [1]

		Rural Java	Urban Java	Rural Outside Java	Urban Outside Java	Indonesia
Kerosene	Expenditure (Rp/Month)	426.74	1089.71	461.22	790.87	538.98
	Quantity (liters/month)	14.06	40.67	12.38	24.78	17.36
	Price (Rp/Liter)	30.34	26.79	37.27	31.91	31.05
Charcoal	Expenditure (Rp/month)	5.21	87.47	22.88	52.97	21.24
	Quantity (kg/month)	0.11	1.20	0.36	0.87	0.36
	Price (Rp/kg)	47.14	72.93	64.05	60.93	58.23
Firewood	Expenditure (Rp/month)	856.73	101.72	411.16	436.21	605.07
	Share of total firewood expenditure attributable to this group (%)	72.3	1.9	20.7	5.1	100.0
	Share of total firewood consumption attributable to this group (%) [2]	78.0	1.3	16.4	4.3	100.0
	Index numbers of monthly household firewood consumption (all Indonesia average = 100)[b]	152.7	11.7	53.9	60.2	100.0

1/ The figures shown are the mean values per household for a sample of 5880 Indonesian households.

2/ Estimates based on the proportionality of firewood and charcoal prices.

Source: SUSENAS 1978, Subround II.

Price Elasticities of Demand: Kerosene and Firewood Consumption and the Issue of Deforestation

5.11 As mentioned earlier, the demand for each fuel consumed by Indonesian households, i.e., kerosene, charcoal and firewood, depends on its own price, the prices of the other two competing fuels, 1/ its geographical location (Java/outer islands), whether the household is an urban or rural one, and the expenditure level of the household. 2/

5.12 Table 5.2 presents the own- and cross-price elasticities of demand for kerosene, charcoal and firewood by location and their income/expenditure levels. These and other numbers in this chapter are intended to be illustrative of the orders of magnitude involved and the directions of change. The table shows that for kerosene, the own-price elasticity of demand is close to -1. 3/ The range of elasticities, shown in the first column of Table 5.2, does not vary significantly by household characteristic -- i.e., by geographical location and income/expenditure levels -- and are all statistically significant. Thus, for rural Java the price elasticity is -1.1; for urban Java it is -0.9, and for all of Indonesia it is -1.0. Consequently, a 10% increase in the price of kerosene will reduce its demand in Indonesia by 10.0%. The estimated elasticities of kerosene demand with respect to the price of "wood fuel" are fairly small. These cross-price elasticities range from 0.08 in rural Java to 0.04 in urban Java and are all statistically significant. 4/

5.13 The impact of a kerosene price increase on the absolute level of kerosene consumption would be the largest in urban areas because, given the approximately equal price elasticities of demand between urban and rural Indonesia (Table 5.2), it is in the urban areas where the bulk of kerosene is

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1/ The reader is reminded that elasticities with respect to the price of wood fuels represents the sum of the two individually (unmeasurable) elasticities with respect to firewood and charcoal (see para 5.04).

2/ Since the SUSENAS data are expressed only in expenditure categories rather than income ones, expenditure data serve as a measure of income. Consequently, the income elasticities discussed in this chapter are more correctly expenditure elasticities, but, following tradition, they will be referred to as income elasticities.

3/ This is in contrast to a rather high long-run elasticity estimate of -1.78 obtained by Strout from 1969 SUSENAS data and estimates of -0.3 to -0.5 reported by Strout and Summers. See Strout (1978), *op. cit.*, and Strout and Summers (1979), *op. cit.* However, Strout's analysis does not take any account of the relative price of competing fuels, and does not permit the estimated (price or income elasticities) to vary by levels of household expenditure. As expected, the omission of crucial variables in the econometric estimation tends to bias the estimates of the included variables upwards. Hence the large elasticities obtained by Strout.

4/ Strout, however, guesses these cross-price elasticities to be between 0.2 and 0.4. See Strout (1978) *op. cit.*

Table 5.2: PRICE ELASTICITIES OF DEMAND 1/

Household Characteristic	Kerosene: Price of Kerosene	Kerosene: Price of "Wood Fuel" 2/	Charcoal: Price of "Wood Fuel" 2/	Charcoal: Price of Kerosene	Firewood: Price of "Wood Fuel" 2/	Firewood: Price of Kerosene
1. Rural Java	-1.09 (.04)	.08 (.02)	-.71 (.15)	-1.43 (.34)	-1.10 (.03)	-.00* (.07)
2. Urban Java	-.93 (.03)	.04 (.01)	-.70 (.08)	-.24 (.16)	-1.13 (.09)	1.22 (.18)
3. Rural Outer Islands	-1.01 (.04)	.08 (.02)	-.65 (.10)	-.98 (.23)	-1.10 (.03)	.26 (.07)
4. Urban Outer Islands	-.97 (.03)	.05 (.01)	-.71 (.07)	-.55 (.15)	-1.12 (.05)	.57 (.10)
5. RP 20.000 household expenditure	-1.09 (.04)	.08 (.02)	-.71 (.15)	-1.39 (.33)	-1.11 (.04)	-.00* (.08)
6. RP 35,000 household expenditure	-.98 (.03)	.06 (.01)	-.67 (.08)	-.72 (.18)	-1.10 (.04)	.40 (.08)
7. Rp 50,000 household expenditure	-.93 (.04)	.05 (.02)	-.64 (.09)	-.42 (.19)	-1.10 (.05)	.71 (.11)
8. Java	-1.03 (.04)	.06 (.01)	-.70 (.07)	-.56 (.16)	-1.10 (.03)	.03* (.07)
9. Outer Islands	-1.00 (.03)	.07 (.01)	-.68 (.08)	-.76 (.19)	-1.10 (.03)	.29 (.07)
10. Rural	-1.06 (.04)	.08 (.02)	-.68 (.12)	-1.21 (.28)	-1.10 (.03)	.07* (.07)
11. Urban	-.94 (.03)	.04 (.01)	-.70 (.07)	-.32 (.16)	-1.13 (.06)	.81 (.12)
12. Indonesia	-1.02 (.03)	.06 (.01)	-.70 (.07)	-.63 (.17)	-1.10 (.03)	.11* (.07)

1/ Approximate standard errors are shown in parenthesis. An asterisk (*) indicates that the estimated elasticities are not statistically significant from zero at the 5% level of significance.

2/ The price of "wood fuel" is a composite of the price of firewood and charcoal. See para. 5.04 for the reasons.

consumed; urban households in Indonesia consumed twice as much kerosene as rural ones in 1978 (Table 3.15). Also, in relative terms, the rural household would suffer less than the urban ones because rural households spend a lower fraction of their energy budget on kerosene than do urban households; 40% compared to 45% in 1978 (Table 3.16). 1/ However, since the kerosene and the firewood markets are strongly linked, firewood prices, at least on Java, could be expected to increase as a result of increasing kerosene prices and, thus, would affect the welfare of the rural households. 2/

5.14 As far as income levels go, since higher income groups in rural Java consume more kerosene than lower income groups (Table 3.17) the quantitative impact of increased kerosene prices would be relatively greater for the higher income groups. Also, since the highest income group (above Rp 13,000/month) spends 56% of its energy expenditures on kerosene, compared to 27% for lowest (Rp 0-3000/month), the latter group would suffer relatively less than the former assuming no changes in firewood prices. If, however, there were a commensurate increase in firewood prices, then it is conceivable that the lowest income group would be hurt relatively more than the highest because expenditures on kerosene and firewood together account for about 100% of total energy expenditures for this group compared to only 39% for the highest income group. Survey data for 1976 also indicates that the poorest 40% of the population used only 20% of the kerosene. Thus, the kerosene subsidy, though it helps the poor, is very strongly biased towards the rich. 3/

5.15 Own-price elasticities for charcoal are somewhat smaller in absolute value than those of kerosene or firewood, and differences in the estimates for households with differing characteristics are rather small. The elasticity of charcoal consumption with respect to the price of kerosene is negative and, in some cases, large in absolute value. For example, in rural Java this elasticity is -1.4 and it appears to be larger in rural areas and in the outer islands than in other parts of Indonesia. These cross-price elasticities indicate that charcoal and kerosene are complements; i.e., an increase in the price of kerosene will lead to a decrease in the demand for charcoal, just as would an increase in the price of charcoal. The charcoal/kerosene complementarity may reflect the limited, but specialized use of charcoal by households. Kerosene is the primary fuel for lighting purposes and can substitute for firewood in cooking. 4/ In cooking, however, kerosene can impart an oily taste to food and is particularly unsuited for the grilling of meat (sate). As a result, the substitution of kerosene for firewood in cooking also involves the increased use of charcoal for those cooking purposes in which kerosene is inappropriate on taste grounds. Charcoal is rarely used

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1/ This is discussed more fully in paras. 5.29 to 5.41 in this chapter.

2/ See also paras 5.23 to 5.28 where a large price in kerosene prices is simulated to determine its effect on kerosene and firewood consumption.

3/ The issue of who wins and who loses by income group and other household characteristics is taken up in much greater detail in paras. 5.29 to 5.41.

4/ The cross-price elasticity of firewood and kerosene is discussed in the subsequent paragraphs.

as the major cooking fuel and, as Table 5.1 demonstrates, it is of relatively minor importance. Besides its use in cooking, charcoal is used mainly for ironing.

5.16 Own-price elasticities of firewood are greater in absolute value than unity for households across all characteristic groupings (Table 5.2). From the policy point of view, however, of greatest importance is the elasticity of demand for firewood with respect to the price of kerosene. This cross-price elasticity, particularly for rural Java, is at the heart of one justification for the kerosene subsidy; viz., the problem of deforestation. The justification, as outlined in Chapter 2 (para 2.11), has been that higher domestic kerosene prices would encourage a shift to firewood and, thereby, aggravate an already serious deforestation problem. As Table 5.2 demonstrates, the demand for firewood is rather inelastic with respect to the price of kerosene; viz., an increase in kerosene prices will not significantly alter the demand for firewood. For Indonesia, a 10% increase in the price of kerosene will result in almost no change in the demand for firewood. 1/ The same result emerges for rural Java where the problems of deforestation are the most severe. This finding would argue that an often noted rationale for kerosene subsidy, viz., that it prevents further deforestation in rural Java, is not supported by the data. Interestingly, one study has indicated that, in 1978, the kerosene subsidy protected at most 20,000 hectares of land in Indonesia. In FY79-80, the kerosene subsidy amounted to $77,000 per hectare of protected land. The cost associated with the most expensive replanting program were estimated to the $500 per hectare; thus, the kerosene subsidy turns out to be an extremely expensive mechanism of preventing soil erosion. 2/

5.17 It should, however, be noted that in the other three geographic regions, this cross-price elasticity is positive and statistically different from zero (at the 5% level of significance). It is particularly high in urban Java where it exceeds unity. However, the all-Java firewood demand elasticity with respect to kerosene prices is only 0.03 -- a value which is not statistically significantly different from zero -- because urban households account for only 2% of firewood consumption in Java. 3/ On the other hand, the situation outside Java is quite different. In both rural and urban areas outside Java, this cross-price elasticity is positive and significant, and for all of outside Java it is 0.3. However, increased levels of wood consumption outside Java have not been a serious matter of concern since the problems of deforestation and erosion resulting from household wood gathering outside Java are much less severe than in Java.

5.18 The above analysis indicates that rural households, which account for a significant consumption of the total demand for firewood (65% in 1978) do not perceive kerosene as an important substitute; thus, raising the price

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1/ The cross-price elasticity of 0.118 shown in Table 5.2 is not statistically different from zero at the 5% level of significance.

2/ See Gillis (1980) op. cit., and CEM (1981) op. cit.

3/ The price elasticities of demand are non-linear functions of the parameter estimates and expenditure shares. See Appendix III.

of kerosene, over the long run, is not likely to have a significant effect on the demand for firewood. One explanation presented for the low cross-price elasticity (zero in rural Java) is that the bulk of firewood demand is accounted for by the subsistence consumption of rural households; viz., by household consumption of own fuel production. 1/ As Table 5.2 shows, the demand for firewood by rural household is quite responsive to its own price - which represents the opportunity cost of subsistence consumption - but is relatively unresponsive to the price of kerosene.

5.19 It is reasonable to presume that the argument that higher kerosene prices would lead to deforestation may apply in the short run when the stock of trees is essentially fixed and, therefore, the supply of firewood can be increased only through cutting existing trees. If illegal cutting leads to more land clearing and planting of crops on steep slopes, then the problems of soil erosion would intensify. However, the increased demand and the resulting higher prices for firewood would make it more profitable to grow quick-maturing trees for firewood and charcoal and this, over the long run, could lead to reforestation rather than deforestation, the increased supply would then lead to downward pressure on firewood prices. This reforestation is being actively promoted by the Government as part of its "regreening" (*penghijanan*) movement and, in some parts of Java, farmers are also spontaneously planting fast-growing trees for firewood. Intensification of commercial firewood production, therefore, reduces the problem of deforestation and also provides income to the farmers. Higher firewood prices through the growing shortage of firewood in the short run, would, therefore, provide a strong incentive for increasing the proportion for of fast-maturing trees. 2/

5.20 Rows 5, 6 and 7 of Table 5.2 provide estimates of demand elasticities for three representative households which are identical in all characteristics except for total household expenditure levels. In every case, own-price elasticities do not appear to be very sensitive to household expenditure. On the other hand, cross-price elasticities do vary across expenditure levels. For example, the elasticities of charcoal and firewood with respect to the price of kerosene demonstrate great sensitivity to the

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1/ Dick, H. (1980). "The Oil Price Subsidy, Deforestation and Equity", *Bulletin of Indonesian Economic Studies*, XVI, November, pp. 32-60. Dick argues that a critical distinction must be made between subsistence and market demand and that in many parts of the world such as Northern India, Greece, Italy and Northern China, it is subsistence consumption that has been the major cause of deforestation. This is particularly true in rural Java, where increasing population densities have led to a severe shortage of firewood in most Javanese villages and this has led household labor to scour the hillsides for any combustible matter.

2/ A village north of Yogyagarta has, since the 1960s, specialized in firewood production. See Dick (1980) *op. cit.* The reader should be reminded that though there may be some weak relationship between kerosene prices and deforestation, it is important to recognize that other factors, such as population pressures and changes in land prices, have a far greater influence on deforestation than kerosene prices.

expenditure levels of households. In the case of firewood, poorer households are less sensitive to kerosene price changes than richer households, while for charcoal, wealthier households are less price sensitive; this may well reflect the urban/rural distribution of income or expenditure levels. The same response pattern as for charcoal also holds for the demand for kerosene with respect to "wood fuel" prices.

Effects on Energy Demand due to Income Growth

5.21 Income elasticities show how the demand for a particular fuel will change with increasing levels of income. Usually, these elasticities are presented with respect to GDP or GNP (as in Chapter 3). In this case, the elasticities are derived with specific reference to the expenditure levels of households. These are presented in Table 5.3. For all three fuels, these elasticities vary substantially across households with different characteristics or in different geographical locations. Kerosene demand elasticities with respect to household expenditure levels are twice as high in rural Indonesia than in urban Indonesia; they are 0.5 for rural areas compared to 0.3 for urban ones. This same relationship holds for rural and urban Java. Consequently, as income levels rise in Indonesia, there will be increased demand for kerosene; the distribution of this incremental demand will be skewed towards the rural areas. This suggests that unless a proper pricing structure is established, economic growth in Indonesia will necessitate continuing and increasing economic and budgetary subsidies, and these, over the long run, would begin to have a detrimental effect on resource allocation and the growth process itself. In addition, the different income elasticties of demand for kerosene by rural and urban households indicates that as long as kerosene prices remain subsidized and income levels rise, the larger incremental demand for kerosene by rural households will increase their welfare loss, if energy prices are eventually increased. 1/ This in turn, will make it even more difficult for the Government to adjust kerosene prices to higher levels. The table also shows that the income elasticities for kerosene fall as levels of expenditure rise. The elasticities drop from 0.6 for households with expenditure levels of Rp 20,000 per month to 0.3 for households at the Rp 50,000 per month levels. 2/ This merely indicates that for households at the higher expenditure levels, the demand for kerosene is less responsive to changes in expenditure.

5.22 Regarding firewood, most of the income elasticities are negative indicating that firewood is an inferior good; viz., as income levels rise, the demand for firewood declines. As expected, these elasticities are higher (in absolute value) for households with higher expenditure levels. Moreover, for Java as a whole, the elasticity is -0.4, and for rural Java it is -0.38. These values suggest that continued income growth will aid substantially in alleviating the deforestation and soil erosion problem, particularly in rural Java where the problem is the most serious. In rural areas outside of Java, however, continued income growth will increase the demand for firewood, although for Indonesia as a whole the income elasticity is negative (-0.2). This effect for Indonesia is, however, offset to some extent by the relatively high income elasticity of demand for charcoal (0.9); this value at 3.0, is particularly high in rural Java.

1/ Paras 5.29 to 5.41 discuss the welfare loss incurred by rural and urban household in Indonesia as a result of increasing energy prices.

2/ All the elasticity estimates for kerosene are below the estimate of 0.78 obtained by Strout using 1969 SUSENAS cross-section data and that of 1.0, with respect to GNP, estimated by Summers using aggregate time-series data. See Strout (1978), op. cit and Summers (1979), op. cit.

Table 5.3: INCOME ELASTICITIES OF HOUSEHOLD FUEL DEMAND 1/

Household Characteristic		Kerosene	Charcoal	Firewood
1.	Rural Java	.54 (.02)	2.95 (.21)	-.37 (.04)
2.	Urban Java	.22 (.01)	.05 (.07)	-1.84 (.12)
3.	Rural Outside Java	.53 (.02)	1.92 (.16)	.39 (.04)
4.	Urban Outside Jave	.36 (.02)	.51 (.09)	-.01* (.06)
5.	Rp 20,000 Household Expenditure	.58 (.02)	2.72 (.17)	-.17 (.03)
6.	Rp 35,000 Household Expenditure	.38 (.01)	1.35 (.11)	-.41 (.04)
7.	Rp 50,000 Household Expenditure	.30 (.02)	.73 (.11)	-.60 (.07)
8.	Java	.43	.83	-.42
9.	Outside Java	.48	1.20	.34
10.	Rural	.54	2.45	-.14
11.	Urban	.26	.18	-.68
12.	Indonesia	.45	.96	-.17

1/ Approximate standard errors in parenthesis.
Asterisks (*) indicate that the estimates are not statistically significant at the 5% level.

The Impact of Large Price Changes

5.23 In order to analyze the effect of a large change in the price of kerosene on kerosene and firewood consumption and on the economic subsidy afforded to households, the estimated fuel expenditure equations are used to simulate a 60% increase in the price of kerosene. 1/ Table 5.4 presents the results for kerosene and firewood consumption as a result of this price change. It should be pointed out, that these simulations only predict changes as a result of a change in the price of kerosene, assuming all other prices do not change. Thus, the effect of a kerosene price increase is isolated. But because the kerosene and firewood markets are interlinked, a change in kerosene price will also result in some (unknown) change in the price of firewood. The data available are not adequate to determine the relationship between these two prices and, therefore, it has not been possible to predict the resulting increase in the price of firewood. Also since firewood is a home good, i.e., it is not internationally traded, it has also not been possible to make simplifying assumptions linking the price change in the domestic market with that in the international market. 2/

5.24 Table 5.4 indicates that, as a result of a 60% increase in the price of kerosene, rural households will reduce their consumption of kerosene proportionately more than urban households; 40% compared to 36%. However, the table also demonstrates that, in absolute amounts, urban households reduce their kerosene demand more than rural ones. For Indonesia as a whole, a 60% increase in the price of kerosene, ceteris paribus, would reduce its demand by households by 38%. The effect of this large kerosene price increase on firewood consumption is almost nil in rural Java. This substantiates the earlier result on the cross-price elasticities for rural Java. Urban firewood consumption would experience a large proportionate increase, but this would be on a very small base; urban households account for only 2% of firewood consumption in Java. As a result, average household firewood consumption in Java would rise a mere 1%. Outside Java, the increase would be nearly 14%, and for Indonesia as a whole the increase is only 5%. As stated earlier

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1/ It is essential to use the expenditure equations for these simulations rather than multiplying the price elasticities of Table 5.2 by 0.60; this is because these elasticities are point elasticities of demand. Moreover, because of the nonlinear nature of our model, these elasticities are themselves functions of the price of kerosene and other independent variables. See Volume III, Appendix III for these formulae.

2/ It is for this reason that the simulation has been restricted to a 60% price increase. Simulations were made with larger price increases, but so long as the price of firewood is assumed unchanged, the results become increasingly meaningless with larger kerosene price changes. The 60% price change gives numbers that are to be treated as illustrative and are suggestive of the orders of magnitude given the relatively low cross-price elasticities. They also demonstrate that using point price elasticities alone do not suffice to analyze such large changes. However, as mentioned above, they do isolate the "pure" effect of a change in the kerosene price.

Table 5.4: SIMULATED CHANGES IN KEROSENE AND FIREWOOD CONSUMPTION DUE TO KEROSENE PRICE INCREASES

	Kerosene Consumption without Price Rise (liters/month)	Kerosene Consumption with 60% Price Rise (liters/month)	Absolute Change in Kerosene Consumption due to 60% Price Rise (liters/month)	Percent Change in Kerosene Consumption due to 60% Price Rise	Percent Change in Firewood Consumption due to 60% Kerosene Price Rise
Rural Java	14.06	8.40	-5.66	-40.2	-0.25
Urban Java	40.67	26.21	-14.46	-35.5	+71.43
Rural Outside Java	12.37	7.68	-4.70	-37.9	+12.74
Urban Outside Java	24.78	15.69	-9.09	-36.7	+29.60
Java	18.92	11.66	-7.27	-38.4	+1.29
Outside Java	14.74	9.20	-5.53	-37.6	+13.90
Rural	13.44	8.13	-5.30	-39.5	+3.15
Urban	34.59	22.17	-12.40	-35.9	+43.65
Indonesia	17.36	10.74	-6.62	-38.1	+5.03

(para. 5.23), this increase in consumption of firewood is due only to an increase in the price of kerosene; and this increased consumption is proportionately rather small; i.e., 60% kerosene price increase would induce only a 5% increase in firewood. However, in the short run the increase in the demand for firewood would also induce a rise in its price and, thus, increased incentives for reforestation would also be provided through this mechanism.

The Subsidy Effects

5.25 An increase in kerosene prices will also lead to a decline in the economic subsidy. The subsidy effects of a 60% increase in the price of kerosene are shown in Table 5.5. The first column provides estimates of the actual subsidy per month provided to each household for the period April-June 1978, the period covered by the SUSENAS 1978 Subround II Survey. 1/ The strong urban bias of the kerosene subsidy program is quite apparent, and does not appear to have changed since 1976 (see para 2.14). Urban households in Indonesia received more than two and one-half times the subsidy of rural households. Urban Javanese households received the greatest level of subsidy of all households, about Rp 915 per month, which is almost three times the amount of subsidy received by households in rural Java, and about 3.3 times that received by rural households outside of Java who received the lowest amount. As a whole, households in Java received 29% more subsidy than those outside of Java.

5.26 The second column of Table 5.5 provides estimates of the monthly subsidy per household implied by a 60% kerosene price increase. 2/ For Indonesia as a whole, the net kerosene subsidies provided to households would fall by nearly 80% as a result of this price increase. The urban bias would remain, but as column 3 indicates, urban, and to a lesser extent Javanese, households would bear the greatest absolute loss in subsidy. The subsidy provided to urban households would drop by Rp 612/month compared to Rp 241/month for rural households. The difference in the subsidy provided urban and rural households would fall from Rp 476 to Rp 106 per month. Households in urban Java would have their subsidies reduced by an even larger amount, Rp 719 per month compared to Rp 253 per month for rural Java.

5.27 The effect of kerosene price increases on the total subsidy provided to households is summarized by the elasticity of subsidy with respect to the price of kerosene; this is shown in the last row of the table. This elasticity was estimated to be -2.1 in April-June 1978, suggesting that a 1% increase in the actual kerosene price would have reduced the aggregate economic subsidy of the Government by 2.1%. If the price had been 60% higher than it was - and, thus, the total subsidy cost 80% less as a result - a further 1% rise in domestic kerosene prices would have reduced the cost of

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1/ A comparison of the official wholesale kerosene price of Rp 25/liter with an f.o.b. price ex-Singapore for the April-June 1978 period, as reported by the Petroleum Economist, suggests an economic subsidy of Rp 22.50/ liter.

2/ In April-June 1978, a 60% price rise would have resulted in an economic subsidy of Rp 7.50/liter.

Table 5.5: SUBSIDY EFFECTS UNDER ALTERNATIVE KEROSENE PRICE REGIMES
(Rupiahs per household per month)

	April-June 1978			May 1980 1/		
	Subsidy At Actual Prices (1)	Subsidy with 60% Price Rise (2)	Absolute Change in Subsidy (3)	Subsidy At Actual Prices (4)	Subsidy with 60% Price Rise (5)	Absolute Change in Subsidy (6)
Rural Java	316	63	-253	2074	1050	-1024
Urban Java	915	196	-719	5999	3276	-2723
Rural Outside Java	279	58	-221	1826	960	-866
Urban Outside Java	558	118	-440	3655	1961	-1964
Java	426	87	-339	2791	1458	-1333
Outside Java	331	69	-262	2173	1150	-1023
Rural	302	61	-241	1981	1016	-965
Urban	778	166	-612	5099	2771	-2328
Indonesia	391	81	-310	2561	1343	-1218
Elasticity of the Subsidy with Respect to the Price of Kerosene 2/	-2.14	-6.36	—	-1.28	-1.51	—

1/ May 1980 kerosene prices and subsidies per liter applied to April-June 1978 (SUSENAS 1978, Sub-Round II) consumption pattern.

2/ Percent change in aggregate kerosene provided Indonesian households in response to a one percent increase in the price of kerosene. Formula is provided in the Appendix.

subsidy to the Government by 6.4 %. These figures indicate first, that a small proportional change in the price of kerosene can have a significant effect on reducing the economic subsidy, and second, that the effect on the economic subsidy is greater the higher the absolute level of kerosene prices.

5.28 The last three columns of Table 5.5 are calculated in the same fashion as the first three columns except that they are based on the subsidy due to the prices in effect in May 1980. Column 4 of that table provides estimates of the monthly household subsidy resulting from the level of May 1980 prices, but assumes the same consumption pattern of April-June 1978. 1/ The economic subsidy in May 1980 was estimated at Rp 147.50/liter with the resulting subsidy rates per household shown in column 5. The average monthly subsidy of Rp 2,561 for Indonesia as a whole is more than 6.5 times that of two years earlier. It should also be pointed out that while a 60% kerosene price increase would have reduced subsidy outlays by nearly 80% in April-June 1978, the same percentage increase in price would have reduced the subsidy by only 48% in May 1980. This reflects the much larger rate of subsidy per liter in 1980. Also in the May 1980 situation, the subsidy elasticities are much smaller than those of April-June 1978, reflecting again, the much larger rate of subsidy per liter in effect at that time. And this, in turn, indicates that the increase in the domestic price of kerosene (from the prevailing level in 1978 to the new level in 1980) was less than the increase in the international price. This suggests that, despite periodic increases in the domestic price levels of oil products in Indonesia, the economic subsidy will continue to rise if the changes in the domestic prices are less than those in the international prices, or if even the proportional changes in the domestic and world prices are the same. 2/ To reduce the economic subsidy, the proportional change in the domestic price must exceed that in international prices by an extent sufficient to ensure that the absolute change is larger than that of the international price level. 3/

The Welfare Implications of Increasing Energy Prices

5.29 An important aspect of energy pricing policy is the distributional effects of a change in the existing policy. Consumers, and particularly those in the household sector, can be distinguished by income, geographical region of the country, and the size of the household. Consequently, a crucial aspect of a policy recommendation of increasing energy prices is the differential impact on different groups of such household consumers. For obvious reasons, this is of major concern to policy makers in Indonesia and, in this section, an attempt is made to provide some preliminary answers to questions such as: Which groups of households are likely to benefit relatively more from a change

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1/ Consumption patterns for May 1980 were not available at the time this analysis was conducted.

2/ The latter condition implies that the absolute changes in domestic prices are smaller than those for international prices because the percentages increase in the domestic prices is from a relatively lower level.

3/ This issue of the relative rates of change in domestic and international prices of energy is discussed in some detail in Chapter 8.

in the energy price policy? Which groups are likely to benefit the least? And, how do the distributions of welfare among different groups of households compare before and after the implementation of the suggested policy of increasing energy prices?

5.30 The basic welfare measure used in this analysis is the net "compensating variation," that is, the minimum amount of additional budget expenditure that would be required under the new price regime to restore a consumer to the level of welfare enjoyed prior to the increase in energy prices. The compensating variation so computed will be, in general, different for different groups of consumers reflecting the differential needs and tastes of these groups. The computation of the compensating variation also takes into account the adjustments of the consumers in response to the new situation; i.e., their responses to changes in prices and incomes. 1/ Thus, group-specific compensating variations can be used to assess the relative distribution of the burdens of the suggested policy change across different groups; i.e., they provide a measure of the welfare loss or gain due to a policy change. 2/

5.31 An example may help to clarify the concept of compensating variation. Suppose that a consumer has a fixed budget of 1,000 rupiahs. Suppose further that the consumer regularly purchases 100 rupiahs worth of fuel. If the price of fuel were doubled, the quantity of fuel that the consumer could purchase with 100 rupiahs would be halved. In the absence of any compensation, the welfare of the consumer would be clearly lowered unless the actual consumption of fuel before the increase in the price of fuel was zero. For the consumer to purchase the same quantity of fuel as before the increase in the price of fuel, he would have to be paid an additional 100 rupiahs. With the additional 100 rupiahs as compensation, the consumer would be able to enjoy a level of welfare that is at least as high as before the increase in the price of fuel because he could purchase, with his augmented budget, precisely the same bundle of goods as before.

5.32 However, in order to maintain the same level of welfare, it is not necessary for the consumer to maintain the same bundle of consumption goods. This is because, in general, the consumer can substitute one commodity with another. For example, a consumer may start out with a consumption bundle consisting of five units of clothing and two units of fuel. If the price of fuel is doubled, then the consumer can only afford to have five units of clothing and one unit of fuel. Without compensation, he is clearly worse off. However, the compensation does not have to take the form of units of fuel. Instead, the consumer may be offered additional units of clothing. For

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1/ This approach is briefly discussed in Appendix IV. A more detailed analysis than presented here is currently underway in a World Bank research project entitled "The Welfare Implications of Eliminating Energy Subsidies in Indonesia" (Research Project No. 672-70).

2/ A similar exercise was undertaken to analyze the impact of oil price decontrol in the U.S. See D.W. Jorgenson, L.J. Lau, and T.M. Stoker (1980), "Welfare Comparisons Under Exact Aggregation," American Economic Review, Vol. 70, No. 2, May, pp. 262-272.

example, the consumer may be indifferent between the original bundle of five units of clothing and two units of fuel and a new bundle consisting of ten units of clothing and one unit of fuel. The compensation required to maintain the consumer at the same level of welfare -- so that he is indifferent -- is therefore at most the cost of five units of clothing, which may be considerably less expensive than one unit of fuel.

5.33 Compensating variation is, therefore, the minimum amount of money that must be paid to the consumer so that his level of welfare under the new price regime remains the same as before. Obviously, in our example, 100 rupiahs would be sufficient to maintain the same level of welfare. However, to the extent that there is substitutability between different goods within the consumer's budget, 100 rupiahs would not be necessary and a smaller amount may well be sufficient. What this amount is depends on the degree of substitutability between the different commodities. In this analysis, the degree of substitution between different commodities is estimated through a system of six demand functions -- i.e., food, clothing, transportation, fuel, housing and miscellaneous. From this system of demand functions, a utility function representing the preferences of the consumer is derived. From this utility function, the compensating variation, that is, the minimum amount of additional money that would be required to maintain the consumer at the same level of utility or welfare, can be calculated. 1/

5.34 Table 5.6 shows the average budget share devoted to each of the six expenditure categories. There is clearly a significant seasonal pattern especially with regard to food and clothing expenditures. Food expenditures dominate the average budget, constituting more than 70%. The remaining categories are approximately comparable in magnitude with the exception of transportation. Transportation accounts for such a small share of the average budget -- less than 0.3% -- that consideration should be given to aggregating it with another expenditure category in any future analysis.

5.35 Compensating variation calculations are made for each of the three subrounds of the 1976 SUSENAS survey as well as for the year as a whole. Two alternative sets of parameters are used: those estimated from the data of each subround by itself and those estimated from the pooled data of all three subrounds. The resulting compensating variations calculated from the two alternative sets of parameters turn out not to differ appreciably, especially when considered on an annual basis. This holds true for the urban as well as the rural areas.

5.36 Moreover, as Table 5.7 shows, the compensating variations required for a household with five members in the urban area are consistently higher than the compensating variations required for a household with five members in

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1/ The data used in this analysis are taken from the 1976 SUSENAS survey conducted by the Bureau of Statistics (BPS). The surveys are conducted in three subrounds -- January-April, May-August, September-December. These data are supplemented by price data also obtained from the BPS. In each of the three subrounds the number of households included in the analysis are 7,341, 7,098, and 8,025 respectively. Appendix IV has an extended discussion of the data and the model used.

Table 5.6: AVERAGE BUDGET SHARES OF HOUSEHOLDS, 1976
(percent)

	Subround		
	(1) Jan.-Apr.	(2) May-Aug.	(3) Sept.-Dec.
Food	72.1	72.3	70.9
Clothing	7.5	8.3	13.6
Transportation	0.3	0.2	0.2
Fuel	4.3	4.5	4.2
Housing	6.5	6.7	7.0
Miscellaneous	9.3	8.0	4.1

Source: SUSENAS, 1976

Table 5.7: COMPENSATING VARIATIONS FOR URBAN AND RURAL HOUSEHOLDS FOR 25%, 50% AND 100% INCREASE IN THE PRICE OF ENERGY (Rp)

Province	Annual Expenditure (Rp)	Urban			Rural		
		25%	50%	100%	25%	50%	100%
Jakarta	135686.	2087.	3923.	7067.	0.	0.	0.
Jawa Barat	104752.	1575.	2961.	5338.	912.	1718.	3103.
Jawa Tenga	78618.	1292.	2425.	4361.	726.	1366.	2463.
Yogjakarta	86618.	1305.	2454.	4423.	654.	1231.	2221.
Jawa Timur	103958.	1666.	3128.	5628.	712.	1340.	2418.
D.I. Aceh	121585.	1054.	2016.	3722.	513.	1000.	1898.
Sumatera Utara	104499.	1090.	2070.	3784.	547.	1053.	1964.
Riau	93095.	913.	1737.	3186.	633.	1221.	2279.
Jambi	108071.	1277.	2417.	4395.	716.	1367.	2520.
Sumatera Barat	102077.	993.	1891.	3470.	476.	919.	1716.
Sumatera Selatan	97640.	1134.	2146.	3905.	720.	1383.	2567.
Bengkulu	106103.	1174.	2226.	4059.	707.	1361.	2536.
Lampung	75005.	1032.	1944.	3514.	844.	1601.	2919.
Kalimantan Barat	101534.	1002.	1907.	3497.	734.	1412.	2629.
Kalimantan Tengah	107539.	1204.	2281.	4158.	853.	1631.	3007.
Kalimantan Selatan	96115.	1031.	1957.	3573.	590.	1135.	2115.
Kalimantan Timur	182444.	2096.	3968.	7224.	973.	1851.	3390.
Bali	66234.	928.	1748.	3159.	728.	1377.	2503.
Sulawesi Utara	95263.	1060.	2010.	3663.	717.	1374.	2544.
Sulawesi Tengah	64522.	716.	1358.	2476.	707.	1354.	2505.
Sulawesi Selatan	70431.	691.	1316.	2414.	594.	1136.	2099.
Sulawesi Tenggara	115125.	1215.	2306.	4215.	546.	1046.	1939.
Nusa Tenggara Barat	65457.	889.	1675.	3030.	587.	1113.	2031.
Nusa Tenggara Timur	129359.	903.	1746.	3271.	576.	1108.	2060.
Maluku	103455.	1289.	2434.	4416.	578.	1094.	1989.
Average	128086.	1507.	2851.	5185.	609.	1163.	2143.

the rural areas (with the possible exception of the province of Sulawesi Tengah). 1/ The precise ratio of compensating variations required for a 25% increase in the price of energy between the urban and rural areas differ across provinces and can be as high as two and a half. The average ratio is around two, indicating a very significant difference. This implies that if energy prices are increased by 25%, urban households are likely to have their welfare lowered by, on the average, double that of the rural households; i.e., the urban households will require, on the average, twice the additional budget expenditure under the new price regime than that required by the rural households to keep them at the level of welfare enjoyed prior to the price increase.

5.37 As can be seen, the welfare loss of the rural household is consistently less than that of the urban ones not only across the different geographical regions of the country, but also for different energy price increases. For Indonesia as a whole, the average welfare loss of the urban households is 247% more than that of the rural household due to a 25% increase in the price of energy. For a 50% and 100% increase in energy prices the welfare loss of urban relative to rural households is 245% and 242% respectively. These figures demonstrate that even though there would be reduction in welfare due to an increase in the price of energy, the urban households would be hurt much more than the rural ones -- by about two and a half times as much -- and this relative welfare loss is approximately the same whether prices are increased by 25%, 50% or 100%.

5.38 From Table 5.7, it is also apparent that while the compensating variations required are higher the higher the increase in the price of energy, they are not proportional to the increase in the price of energy. The compensating variations appear to increase at a somewhat slower rate than the increase in the price of energy. The national average annual compensation for a household with five members in the urban area increases from 1,507 rupiahs for a 25% increase in the price of energy to 2,851 rupiahs for a 50% increase in the price of energy and further to 5,185 rupiahs for a 100% increase in the price of energy. Similarly, the national average annual compensation in the rural area increases from 609 rupiahs to 1,163 rupiahs and further to 2,143 rupiahs. Consequently, the change in the welfare loss is less than

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1/ The reason for using households with five members is because the average household in Indonesia consists of approximately five members. Based on the 1976 SUSENAS survey, the average numbers of members per household for each subround and for urban and rural areas are:

Average Number of Members per Household, 1976

Subround	Urban Area	Rural Area
1	5.7	5.1
2	5.5	4.9
3	5.5	5.1

Five is thus a reasonable number to use. Moreover, the results do not change when the compensating variations are calculated for all households.

proportional to the increase in the price of energy; i.e., doubling the increase in the price of energy -- from a 25% increase to a 50% one, or from a 50% increase to a 100% one -- results in a less than doubling of the compensating variation.

5.39 For both urban and rural areas, Table 5.7 also shows that the loss in welfare varies significantly across the various provinces of Indonesia. For example, for urban households, the values of the compensating variation or welfare loss due to a 25% increase in energy price ranges from Rp 2096 in Kalimantan Timur to Rp 691 in Sulawesi Selatan -- a ratio of almost three to one. In rural areas, this ratio for a 50% increase in the price of energy is about two to one; the highest welfare loss being in Kalimantan Timur (Rp 1851) and the lowest in Sumatera Barat (Rp 919). This finding suggests that the incidence of an increase in the price of energy is likely to differ significantly across the provinces and any policy designed to compensate for the increase in the price of energy should take these geographical differences into account.

5.40 Furthermore, as might be expected, the welfare loss also varies with the size of the household as measured by the number of members in the household. Tables 5.8, 5.9 and 5.10 show this variation for three representative provinces -- Jawa Barat, Sumatera Utara, and Kalimantan Tengah 1/ - distinguished by urban and rural households in response to a 25%, 50% and 100% increase in the price of energy. In most cases, the level of compensating variations increase with the size of the household; i.e., larger households suffer a greater welfare loss than smaller households. This increase in the welfare loss, however, appears to be less than proportional to the number of members in the household, at least in the middle of the size range, say between two and eight members. The levels of compensating variations at the two ends of the size range are less reliable because of the relatively small number of households in those categories within the SUSENAS survey sample. Thus, for Jawa Barat (Table 5.8) it can be seen that for rural households with two members the compensating variation is Rp 662 due to a 100% increase in the price of energy, whereas for a household double that size (four members) the compensating variation less than doubles to Rp 923; this represents an increase of 1.4 times the compensating variation for the two-member household. Furthermore, for an eight-member household, the compensating variation increases to Rp 1,695, an increase of almost 2.5 times for a household size that has been quadrupled. Similar variations can be observed in the other provinces of Indonesia.

5.41 As mentioned earlier (para. 5.29) these results are preliminary and are subject to further refinement and more detailed analyses. The basic conclusions that emerge are, however, unlikely to change; viz., an increase in energy prices will hurt all households in Indonesia, but the urban households will suffer much more than the rural ones in all geographical regions of the country. To the extent that the richer households are in urban areas, and the poorer ones in rural ones, the rich will suffer a greater welfare loss than the poor for any level of increase in the energy price. The welfare loss,

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1/ Similar variations are observed in all 25 provinces, but the other tables are not presented in this report.

Table 5.8: COMPENSATING VARIATIONS (Rp) AND HOUSEHOLD SIZE IN JAWA BARAT

Urban Households

No. of Household Members	No. of Observations	Base Expenditure (Rp)	Increase in Energy Price 25%	50%	100%
1	3	14238.	220.	413.	744.
2	9	26156.	364.	686.	1239.
3	14	27517.	414.	779.	1405.
4	23	34501.	498.	937.	1691.
5	17	29537.	431.	612.	1465.
6	14	33133.	513.	964.	1736.
7	15	35751.	535.	1006.	1813.
8	8	39189.	584.	1099.	1982.
9	3	95219.	1416.	2663.	4802.
10	8	61793.	920.	1730.	3119.
Average	117	37561.	483.	912.	1653.

Rural Households

No. of Household Members	No. of Observations	Base Expenditure (Rp)	Increase in Energy Price 25%	50%	100%
1	12	5153.	76.	143.	258.
2	58	14144.	194.	366.	662.
3	95	16634.	232.	436.	788.
4	102	19034.	272.	511.	923.
5	100	22373.	320.	601.	1086.
6	74	24311.	343.	646.	1167.
7	47	30120.	423.	796.	1438.
8	31	35107.	499.	939.	1695.
9	17	40673.	517.	975.	1768.
10	5	32425.	467.	878.	1585.
Average	547	22237.	276.	521.	945.

Table 5.9: COMPENSATING VARIATIONS (Rp) AND HOUSEHOLD SIZE IN SUMATERA UTARA

Urban Households

No. of Household Members	No. of Observations	Base Expenditure (Rp)	Increase in Energy Price 25%	50%	100%
1	0	0.	0.	0.	0.
2	4	13617.	127.	242.	445.
3	10	23679.	245.	466.	852.
4	12	30620.	339.	642.	1171.
5	12	37052.	369.	702.	1286.
6	6	38338.	414.	785.	1434.
7	10	34977.	356.	677.	1239.
8	6	45518.	445.	846.	1553.
9	4	46375.	388.	743.	1375.
10	6	40712.	399.	759.	1392.
Average	72	34608.	280.	538.	997.

Rural Households

No. of Household Members	No. of Observations	Base Expenditure (Rp)	Increase in Energy Price 25%	50%	100%
1	8	8586.	67.	128.	238.
2	20	15775.	97.	189.	357.
3	40	17132.	130.	250.	465.
4	48	23253.	176.	339.	631.
5	51	23794.	181.	348.	648.
6	45	25875.	169.	329.	619.
7	40	33085.	252.	484.	901.
8	20	34377.	265.	510.	948.
9	10	38084.	258.	600.	938.
10	6	33374.	229.	443.	831.
Average	291	24944.	137.	268.	512.

Table 5.10: COMPENSATING VARIATIONS (Rp) AND HOUSEHOLD SIZE IN KALIMANTAN TENGAH

Urban Households

No. of Household Members	No. of Observations	Base Expenditure (Rp)	Increase in Energy Price 25%	50%	100%
1	0	0.	0.	0.	0.
2	2	31569.	320.	609.	1114.
3	4	20251.	215.	408.	746.
4	5	22009.	221.	420.	770.
5	3	24765.	253.	481.	880.
6	2	35555.	381.	724.	1322.
7	3	38697.	397.	754.	1379.
8	3	30860.	301.	572.	1050.
9	2	53384.	479.	915.	1686.
10	0	0.	0.	0.	0.
Average	25	31423.	258.	496.	918.

Rural Households

No. of Household Members	No. of Observations	Base Expenditure (Rp)	Increase in Energy Price 25%	50%	100%
1	3	7127.	69.	132.	241.
2	27	23206.	197.	378.	698.
3	31	27403.	218.	418.	777.
4	27	30596.	263.	503.	929.
5	33	35496.	321.	613.	1129.
6	29	38913.	341.	652.	1203.
7	35	38282.	330.	631.	1165.
8	20	48263.	449.	856.	1574.
9	9	46206.	406.	777.	1433.
10	11	46535.	420.	802.	1478.
Average	229	35388.	241.	467.	876.

however, is less than proportional to the increase in the price of energy and to the size of the households. However, there are significant variations in the welfare loss across the different regions of the country for both urban and rural households. These conclusions not only have policy implications if the Government chooses to compensate the losers -- and this, of course, has administrative implications -- but also demonstrate, as stated earlier, that the current price policy regime benefits the richer households, not the poorer ones, as intended by the Government. Thus, subsidizing energy prices worsens, not improves, the distribution of income in Indonesia. 1/

Household Consumption of LPG

5.42 So far, LPG has not been discussed because the total consumption of LPG in Indonesia is very low, about 0.85 million barrels in 1981/82. Of this amount, households account for about 50%. Five million barrels or about 80% of the LPG produced in Indonesia is, in fact, exported primarily to Japan and to the Philippines, leaving around 20% for domestic consumption. Moreover, the share of LPG in total consumption of LPG and kerosene by households amounts to only 1% in Indonesia compared to 7% in Nigeria; 21% in Egypt; 37% in the Philippines; 61% in Mexico and 80% in Brazil. This relatively low share of LPG consumption in Indonesia reflects its high domestic price relative to kerosene. The relative price ratio of LPG to kerosene is 3.0 in Indonesia and 0.35 in Brazil, where LPG is much cheaper than kerosene. In Mexico, Egypt and the Philippines, the two prices are approximately the same.

5.43 Analysis shows that when bottling and distribution costs ($6 to $12/bbl) are added to the f.o.b. export price ($13.87/bbl) or to the domestic production cost ($7 to $13/bbl), the total cost for LPG would be in the range of $20 to $25/bbl. The domestic sales price, however, is set at $43/bbl; about 40-50% higher. Consequently, there are strong disincentives to using LPG -- hence the low rate of LPG consumption for cooking -- and, given the existing low kerosene prices, there are strong incentives in favor of kerosene consumption. Equalizing the domestic price of these two fuels by reducing LPG prices by 50% and increasing kerosene prices by the same proportion would alter the current bias in favor of kerosene consumption and against that of LPG; there would now be very strong incentives for consumers to use more LPG. The substitution of kerosene by LPG would take place primarily in the urban areas where most of the kerosene is used for cooking; in rural areas, kerosene is used for lighting. Preliminary estimates indicate that on the average, one liter of LPG will replace about one liter of kerosene. Moreover, it is estimated that through such a policy change, about 20% - 40% of kerosene used in urban areas for cooking could be replaced by LPG; the resulting benefits to Indonesia would be about $100 - 150 million per year by 1990. Analysis also indicates that though such a policy would reduce Pertamina's earnings in the short run, it would not increase the economic or the production cost subsidy.

1/ It should be mentioned that the above analysis places equal weights on urban and rural households. If, for purposes of income distribution, the Government places a greater weight on rural households than urban ones, then the absolute levels of welfare loss presented earlier would have to be adjusted appropriately to reflect these weights.

5.44 Moreover, the costs of bottling LPG could be reduced by permitting more bottles to be imported into Indonesia until such time as Indonesia's production capacity is capable of supplying the market efficiently. The current shortage of bottles in effect increases the cost of using LPG. In addition, lowering the price of LPG will also make LPG more accessible to the poorer households. However, the majority of the LPG stoves sold in Indonesia are the high quality two-burner variety which cost between Rp 50 - 100,000, and these can only be afforded by the wealthier households. The poorer households would be able to afford cheaper one-burner stoves whose prices are comparable to those of kerosene stoves; one-burner LPG stoves cost about Rp 7,500 - 10,000 each compared to kerosene stoves which sell for Rp 5,000 to Rp 10,000. Increased production and imports of the cheap one-burner LPG stoves should, therefore, be encouraged so that poorer households may also benefit from the lower price of LPG.

6. THE EFFECTS OF ENERGY PRICING POLICIES ON THE TRANSPORT SECTOR

Introduction

6.01 The preceding two chapters focused on the industrial and household sectors. In this chapter, we turn our attention to the transport sector which consumes about 29% of total commercial energy in Indonesia. At the outset, two observations need to be made regarding this sector. First, available data on energy consumption in the transport sector is generally of poor quality. Thus, many of the figures cited in this chapter are approximations only. Nonetheless, it is possible to discuss many policies and programs on the basis of this approximate data particularly with respect to pricing and nonprice conservation measures. Second, it should be borne in mind that fuel efficiency in the transport sector is only one aspect of overall efficiency of transport services. Therefore, many of the possible measures to conserve fuel in the sector are desirable not because of fuel savings *per se* but because they involve lower transport costs in total. Consequently, any program to improve energy efficiency in the sector must be an integrated part of the development plans for the sector as a whole.

6.02 In keeping with the theme of this report, the primary focus here is on pricing policies. The discussion revolves around the energy subsidies currently provided to the transport sector, the short- and long-run impact of higher fuel prices on the demand for energy and transport services and the implications of relative energy price adjustments on the transport sector. Those interested in the details of other related issues of non-price conservation measures and alternative fuels in transportation are referred to the attached Supplementary Report. 1/

Subsidies to the Transport Sector

6.03 As discussed earlier (Chapter 2), the domestic sales of petroleum products have generated substantial budgetary and economic subsidies; in FY80/81, the total budgetary subsidy for all sectors of the economy amounted to Rp 828 billion and the economic subsidy to Rp 3.8 trillion; in FY82/83 these subsidies are estimated to be Rp 924 billion and Rp 2.3 trillion, respectively. The budgetary subsidy of Rp 924 billion in FY82/83 was large at about 10% of the 1982/83 development budget. This subsidy was, in fact, almost equal to the entire 1982/83 development budget for the transport sector. Thus, further increases in diesel, kerosene, and fuel oil prices would make substantial revenues available to the Government. The energy subsidies afforded to the transport sector itself in FY80/81 are shown in Table 6.1. As the table indicates, after the January 1982 fuel price increases, aviation fuel and gasoline prices remained above their respective international prices, generating net budget revenues of about Rp 545

1/ "Indonesia: Energy Use in the Transport Sector," a supplement to this report.

Table 6.1: ESTIMATED SUBSIDIES ON PETROLEUM PRODUCTS IN TRANSPORT SECTOR [a/]
(billion Rupiah)

Product	FY80/81		Estimated FY82/83	
	Budget Subsidy	Economic Subsidy	Budget Subsidy	Economic Subsidy
Aviation fuel	-23	11	-69	-30
Super gasoline	-15	-5	-15	-11
Premium gasoline	-174	63	-433	-227
Automotive diesel	138	526	184	358
Industrial diesel	9	28	11	20
Fuel oil	14	26	22	26
Total (net)	-51	649	-300	136

a/ Assumes that transport share of sales and subsidies are aviation fuel, 100%; gasoline, 95% (premium, 100%; regular 94%); automotive diesel, 43%; industrial diesel, 11%; and fuel oil, 10%. The ratio of motor and industrial diesel used in transport is based on Ministry of Mining and Energy estimates.

billion and imposing an economic tax on their use. Diesel and fuel oil, however, remain heavily subsidized. Because almost all gasoline, but only a part of diesel and fuel oil are consumed in the transport sector, the net effect is the generation of budgetary revenues from energy consumed by that sector and a relatively small economic subsidy. 1/

The Impact of Higher Fuel Prices

6.04 A major area of concern to policy makers in Indonesia is the impact of increased energy prices on the transport sector. The available evidence, however, indicates that this impact is not likely to be very significant; increases in transport costs and thus, the impact on the price of delivered commodities are likely to be quite limited. In part, this is due to the relatively low share of fuel in total transport costs; the shares range from 8.8% for urban bus transport to 33.4% for air transport (Table 6.2). 2/ Based on these fuel shares, it has been estimated that the 62% increase in the price of diesel fuel in January 1982 would lead to only an 8% increase in the costs of road transport. More generally, the across-the-board energy price increase of January 1982 is likely to lead to about a 12% - 18% increase in total transport costs; i.e., by about one-fourth the change in fuel prices. 3/ The adjustment in transport tariffs after the January 1982 energy price increase is shown in Table 6.3. The figures there reflect not only the impact of the fuel price increases, but also other cost increases that occurred since the previous transport tariff adjustment, and they range from a high of 55% for passenger road transport to about 15% for rail cargo.

6.05 Officials tariffs for road transport, however, are only maximum tariffs and actual tariffs are determined by the competitive market. The actual tariff increases, therefore, are likely to be in proportion to the increases in fuel costs. With respect to passenger rail services, tariff increases were much higher for luxury than for economy service reflecting the long-standing practice of cross-subsidization among classes of passengers.

1/ These estimates do not take into account the domestic price increases of January 1983, the devaluation on March 30, 1983 or the OPEC oil price reductions in February 1983. Following these recent developments, domestic prices of aviation fuel and gasoline remain well above their import prices, while the domestic kerosene prices, automotive diesel, industrial diesel and fuel oil are well below their import prices. Specifically, the ratios of domestic to international prices in April 1983 are: kerosene: 0.40; automotive diesel: 0.61; industrial diesel: 0.55; and fuel oil: 0.75.

2/ These figures are based on the pre-January 1982 energy prices in Indonesia.

3/ Another estimate indicates that doubling fuel prices would increase transport costs by at most 15%. See T.P. O'Sullivan and Partners Consulting Engineers (1982). The Oil Fuel Subsidy and Transport Policy, Task A.1 of the Transport Research and Planning Project, Government of Indonesia, Ministry of Communications, draft report.

Table 6.2: FUEL COSTS AS SHARE OF TOTAL COSTS

Transport Mode	Share of Total Costs (%)
Road	
Intercity	10.5
Urban bus	8.8
Air	33.4
Rail	18.0
River	23.5
Sea	17.0

Source: Ministry of Communications.

Table 6.3: AVERAGE PERCENTAGE INCREASES IN OFFICIAL TRANSPORT TARIFFS FOLLOWING JANUARY 1982 FUEL PRICE INCREASES

Mode	Percent
Road	
Passenger	55 a/
Cargo	37.5 a/
Sea	28.2
Air	29.3
Rail	
Passenger	About 25 b/
Cargo	

Source: Ministry of Communications and press reports.

a/ For Region I (Java, Bali, and Lampung)

b/ Ranging from about 49% for luxury to 16% for lowest-cost services.

6.06 The impact of increased costs on final commodity prices is also on average quite limited because the transport cost component is a small part of the total costs of production and marketing. For example, the average transport cost for domestically produced rice is estimated at about Rp 5.5/kg in 1979 or about 3% of its market price. 1/ In total, it is estimated that the 60% increase in fuel prices in the transport sector in January 1982 would bring about a 2.5% - 5.5% increase in the overall price index. 2/

6.07 Although the aggregate impact of higher fuel prices on transport and final commodity prices may be small, certain consumer groups may be affected more than others. For example, the urban poor for whom public transport costs constitute an important component of total living expenses, and those people in very isolated regions for whom access to external markets may be sensitive to transport costs, may be adversely affected. Various measures can and have been taken by the Government to mitigate the cost impact on such groups. In particular, the fare for urban public bus service in Jakarta had been held constant from 1977 to 1982 at Rp 50 per person for any distance, and, although the fares for privately-owned mini-buses were allowed to double to Rp 100 per person, this public bus fare was maintained in January 1982. Also, the Government has, for the past decade, tried to develop "pioneer" bus, air, and shipping services at subsidized tariffs for especially isolated regions, thereby targetting the transport subsidy to people in these regions.

6.08 It, therefore, appears that the impact of increased fuel prices on transport tariffs and final commodity prices is sufficiently small that this issue need not be of overriding concern; this is particularly so because the direct effect on particularly vulnerable low-income groups can, on distributive grounds, be partially offset by other measures.

<u>The Price Elasticity of Demand</u>

6.09 Permitting fuel prices to reflect their opportunity costs or scarcity values has been justified in this report on the grounds of efficient resource allocation and interfuel subsitution. Within the transport sector, as part of the resource allocation process, increasing energy prices of the currently subsidized fuels so that they may reflect their true scarcity values would necessarily involve a reduction in the demand for fuel (and thus lead to fuel conservation) and, indirectly, in the demand for transport services.

6.10 The effect of a fuel price increase on the demand for transport services may be somewhat limited in the short to medium run, primarily reflecting two factors. First, as mentioned above, the fuel component of total transport cost, especially for the major mode of road transport, is small, and the transport component of the final price of commodities is also small. Second, given the relatively immutable geographic distribution of resources, production facilities, and consumers, the pattern of and total demand for transport services is rather rigid in the short to medium run. These factors mean that increased fuel prices are largely passed on to the final beneficiaries or consumers of transport services without significantly affecting the total demand for those services in the short to medium run.

1/ Mears, L. (1981). <u>The New Rice Economy of Indonesia</u>, Gajah Mada University Press, Gajah Mada, Indonesia.

2/ This estimate by a group of Indonesian economists is reported in <u>Kompas</u>, January 5, 1982. T. P. O'Sullivan <u>op. cit</u>, estimates that a doubling of fuel prices would contribute to no more than 3% of the overall price level.

6.11 However, although the demand for transport services may be inelastic with respect to fuel prices, the fuel efficiency with which a given level of transport services is performed can be improved, and this gives rise to at least some short-run price responsiveness of fuel consumption in the transport sector. Such short-run improvements in fuel efficiency in response to higher prices can come about by diverse means. For example, truck companies may find it economical to spend more on maintenance (e.g., more frequent replacement of air filters, better lubricants, more frequent tune-ups) to improve the fuel efficiency of their vehicles. Ship owners may choose slower speeds for vessels, thereby saving fuel but increasing delivery times. Private car owners may reduce discretionary driving and some people may substitute bus transport for private cars or bicycles for motorcycles. Industries may substitute rail or sea transport for road transport as the relative prices of these services change to reflect their true costs. By such adjustments and substitutions, the demand for fuel in the transport sector can respond to increased fuel prices without decreases in the total level of transport services.

6.12 The responsiveness of the consumption of fuel in the transport sector to price increases is certainly much greater in the long run than in the short run. Over a period of years, more users of fuel will make the kind of adjustments and substitutions just noted. Lighter, more fuel efficient vehicles will be substituted for heavier, less efficient vehicles. Industries may choose locations closer to their final market or their source of inputs in order to reduce total transport costs, even if those locations have other disadvantages such as higher land acquisition costs. Individuals may choose homes closer to their work places. Total transport services in the economy may grow less rapidly than otherwise because the benefits of some of these services may no longer exceed their cost. Some production may be foregone as, for example, when areas more distant from the city can no longer sell, say fruits and vegetables, at a price which covers transport costs. Vehicles may be adapted to run on less expensive, non-conventional fuels. 1/ In summary, if fuel prices and hence transport costs reflect their true scarcity value, the economy will evolve towards a more efficient, less energy-intensive structure as myriad of minor adjustments and substitutions are made such that activities are undertaken at the lowest economic cost to the country. The longer the delay in raising energy prices to their opportunity costs, the more the economy will be locked into a pattern of location and capital stock which is less energy efficient than it could be.

6.13 The weak data base on fuel consumption in the transport sector in Indonesia does not permit quantification of either the short-run or the long-run impact of higher fuel prices. However, most studies of demand for fuel in the transport sector in developed countries indicate short-run price

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1/ This is discussed in much greater detail in the supplementary report "Energy Use in the Transport Sector."

elasticities of about 0.1 to 0.2. 1/ Analysis of the time series on gasoline consumption in Indonesia indicates a similar order of magnitude, although the statistical significance of these results is low. In the absence of a reasonably reliable time series for diesel and fuel oil consumption in the transport sector, no such analysis for those products can be attempted. Studies of developed countries also indicate that long-run price elasticities are much greater than short-run and are likely to exceed 1.0 over a 10-year period (see Table 6.4).

6.14 Despite low short-run elasticities, the potential magnitude of fuel price adjustments in Indonesia could lead to immediate and noticeable reductions in the rate of consumption growth. Assuming elasticities of only 0.1 for all products used in transport, the 60% price increases in January 1982 would induce, other things being equal, about 6% decrease in the consumption of fuel. A further increase in the diesel price from the January 1982 level to the import parity level (an 118% increase) would reduce demand an additional 12% even in the short run. Much more importantly, the conservation of fuel in the long run would be quite significant.

6.15 In summary, domestic price adjustments are an important policy instrument to promote fuel efficiency, conservation and resource allocation, especially in the longer run. Given the limited impact of higher fuel prices on transport costs and on final commodity prices, such adjustments are likely to have little impact on the overall price level, and specific measures can be taken to partially offset their impact on particularly vulnerable groups. Since diesel and fuel oil today remain quite heavily subsidized, price increases for these products would also generate substantial budget revenues.

Diesel/Gasoline Relative Price Adjustments

6.16 As already noted, aviation fuel and gasoline are now priced above their import prices while diesel and fuel oil are well below world prices, thus incurring substantial budget and economic subsidies. Although questions could be raised about the level of the tax on gasoline, clearly the most important issue still confronting the Government is the price of diesel and fuel oil relative to their world market prices and to the prices of other petroleum products.2/ These price ratios are shown in Table 6.5.

6.17 For more than a decade, the Government has maintained the ratio of automotive diesel price to gasoline price well below that which exists in the

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1/ For a survey of the literature, see Energy Pricing in Developing Countries: A review of the literature; (1981), Energy Department Paper No.1, The World Bank, Washington, D.C. Gillis (1980), op. cit. assumes short-run price elasticities (over one to two years) for aviation fuel, gasoline, automotive diesel and fuel oil of .15, .1, and .15 respectively.

2/ Another important issue is the relative price of LPG which is a promising transport fuel for some uses, but for which the domestic price is now much higher than its export value. On this issue, see Chapter 3 of the Supplementary Report.

Table 6.4: PRICE ELASTICITIES OF GASOLINE DEMAND a/

Country	Length of Adjustment Period Year (1)	(5)	(15)	(25)
Belgium	0.124	0.581	1.24	1.51
Canada	0.110	0.481	1.01	1.23
France	0.126	0.596	1.30	1.60
Italy	0.051	0.328	0.838	1.13
Netherlands	0.121	0.565	1.22	1.51
Norway	0.137	0.683	1.54	1.94
Sweden	0.119	0.551	1.19	1.47
Switzerland	0.120	0.560	1.20	1.48
U.K.	0.131	0.642	1.42	1.77
U.S.	0.111	0.490	1.03	1.26
West Germany	0.117	0.530	1.13	1.38
Total	0.111	0.501	1.06	1.31

a/ All of these elasticities are negative, but the minus signs have been left off.

Source: World Bank (1981). Energy Pricing in Developing Countries: A Review of the Literature, Energy Department Paper No. 1.

Table 6.5: RATIO OF DOMESTIC PRICE OF AUTOMOTIVE DIESEL TO PRICES OF GASOLINE, KEROSENE AND FUEL OIL, 1972-1982

	Automotive Diesel / Premium Gasoline	Automotive Diesel / Kerosene	Automotive Diesel / Fuel Oil
1972	.40	1.40	2.15
1973	.39	1.39	2.13
1974	.41	1.46	1.58
1975	.39	1.38	1.16
1976	.36	1.39	1.14
1977	.36	1.39	1.14
1978	.36	1.39	1.14
1979	.35	1.40	1.17
1980	.35	1.40	1.17
1981	.35	1.40	1.17
1982	.35	1.42	1.13

world market (0.35 compared to about 1.0 in 1982). This price distortion in favor of diesel has encouraged the more rapid growth in consumption of that product and a rapid increase in the percentage of vehicles using diesel. Between 1971 and 1980, domestic gasoline sales in Indonesia grew at an average annual rate of 9.4%, while automotive diesel sales to all sectors, and hence probably to transport, grew at 19.6%. Since 1976, the annual growth rates for gasoline and automotive diesel consumption have been 10.1% and 13.8%, respectively. In 1970, diesel-engine vehicles accounted for only 2% of sedans, 22% of buses, and 21% of trucks, while in 1980 they accounted for 4%, 63%, and 47% of these vehicles respectively. 1/ This conscious policy of "dieselization" of the road vehicle fleet reflected recognition of the greater fuel efficiency of diesel compared to gasoline in terms of kilometers per liter of fuel. However, the extent to which diesel engines should be preferred to gasoline engines for specific uses should be determined by economic criteria based on the total costs of owning and operating the vehicles. By distorting these costs in favor of diesel by more than the world market prices and what relative technical efficiencies would otherwise dictate, Indonesia has undoubtedly encouraged a more rapid rate of dieselization than economically desirable. The policy of maintaining a low ratio of diesel to gasoline prices has also been based on the argument that gasoline should be taxed because it is consumed primarily by private cars and is, therefore, a luxury good while diesel should be subsidized because it is an essential input to commercial activity. Although this raises important issues about taxation policy which cannot be discussed fully here, it must be noted that adequate and equitable cost recovery in the road subssector would require that road users pay taxes in proportion to the costs which they impose on the system. Following this principle, users of diesel, i.e., trucks and buses, should pay more taxes in aggregate than users of private cars since it is the heaviest vehicles which do most damage to the roads. 2/

6.18 The economic cost of the existing distortion in the relative price of diesel will increase as Indonesia completes its own program of expanding refinery capacity and approaches self-sufficiency in refined products. To date, domestic refinery production has been lower than domestic consumption of all products, necessitating net imports. 3/ Upon completion of the three refinery expansion projects at Cilacap, Balikpapan, and Dumai, and given projected domestic demand for each refined product, it is likely that Indonesia will become a net exporter of gasoline, aviation fuel, and fuel oil, but will probably remain a net importer of diesel. The incremental value of gasoline to the economy will, therefore, be the Indonesian export (fob) price while the incremental value of diesel will continue to be the Indonesian import (cif) price. For each barrel of domestic consumption shifted from diesel to gasoline, Indonesia will save roughly the sum of the transport costs

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1/ See Annex 2, Table A.2.2, in the Supplementary Report.

2/ For a full discussion of the issue of cost recovery and its implications for fuel pricing, see Halcrow Fox and Associates, Inc., 1982, Highway and Road Consultancy Project: Volume 2, Road Users Charges Implementation Study, Department of Communications, Government of Indonesia.

3/ See Annex 2, Table A.2.6 in the Supplementary Report.

to and from the major world market at the Singapore refineries. Moreover, since many countries have held domestic diesel prices below gasoline prices, world demand for diesel has risen faster than world refinery capacity to produce diesel. There has, therefore, been a tendency for diesel prices to rise relative to gasoline, and there is even a possibility in the late 1980s that diesel prices will exceed gasoline prices in the world market. In that event, a shift in domestic demand from diesel to gasoline would earn Indonesia not only the transport differentials mentioned above, but also the price differential between these products in the world market.

6.19 In order to reduce this distortion currently in favor of diesel consumption and, thereby, reduce the aggregate budget and economic subsidies given to fuel, the nominal price of diesel should be increased more rapidly than that of gasoline during coming years. 1/ In fact, given that the gasoline price is already above world price levels and assuming no significant increases in the world price in the next few years, it may be argued that the real gasoline price need not be increased at all. This raises the issue of whether or not the diesel price can be increased more rapidly than the kerosene price given that kerosene can, at least in part, be substituted for diesel in the industrial sector, and to a lesser extent, in transport. As kerosene is consumed directly by the poor for both cooking and lighting, any increase in its real price would also have an effect on the welfare of the poor as discussed earlier (see Chapter 5). Therefore, one option may be that such price increases can be made only over a longer period during which other sources of income growth can more than offset any adverse impact on the poor of kerosene price increases. 2/

6.20 If diesel prices are, nevertheless, increased more rapidly than kerosene so that their ratio exceeds the 1.4 maintained over the last decade, some substitution of kerosene for diesel can be expected. However, there are technical limits to the use of kerosene in diesel engines. Available information suggests that when kerosene approaches 20% of the fuel mixture, engine performance deteriorates and maintenance costs increase. This is probably the case for both stationary and for vehicle engines. Therefore, although there may be a one-for-one substitution of kerosene for diesel in some industrial uses (e.g., process heat) given a higher price ratio, there will be much less than a one-for-one substitution in the aggregate. The fact that several countries have maintained very high ratios of diesel to kerosene price while continuing to consume substantial quantities of diesel confirms this conclusion. 3/ Thus, substitution will be limited and there would be a substantial net reduction in the budget and economic subsidies for diesel and kerosene taken together. Furthermore, the Government could seek to reduce such substitution even further in two ways. First, as recommended previously

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1/ See also Chapter 8 for a discussion of the possible relative rates of increases of various fuels.

2/ See Chapter 8 for a fuller discussion of policy options and adjustment costs.

3/ For example the ratio of diesel to kerosene prices in 1979 in Great Britain was 2.24, in Finland 1.79, in Belgium 1.63, and in Sri Lanka 3.22.

by the World Bank 1/ the Government could attempt to dissuade industrial consumption of kerosene by taxing bulk transport and bulk sale. This technique has worked well in other countries such as India. To determine its effectiveness in Indonesia, it could be implemented first on a geographically limited, experimental basis. Second, the Government through LEMIGAS could conduct research on the reduced performance and increased maintenance costs associated with blending kerosene with diesel in diesel engines and could disseminate this information to truck and bus companies and industrial associations so as to discourage such substitution. In addition to disseminating technical information, it may be important for GOI and the association of trucking companies to reconsider and recommend changes in common industry practice according to which drivers pay for fuel, but have no responsibility for maintenance and repair. Under such an arrangement, a driver might buy a less expensive diesel-kerosene blend without regard to the damage this might cause to the vehicle's engine. However, the costs and expected benefits of conducting such research and dissemination should be carefully evaluated as the alternative approach of permitting the price to increase and individual users to make their own adjustments may be more effective.

6.21 The Government has recognized the problem of the rapid growth in diesel consumption discussed above and has considered measures for "selective dieselization" intended to limit the consequences of the existing price distortion in favor of diesel. Consideration was being given by the Government to prohibiting by regulation the production or assembly of sedans and light trucks and buses with diesel engines and to providing higher duties and taxes on certain diesel-engine vehicles. Such a regulatory approach, if enforceable, may correct one consequence of the existing price distortion, i.e., the incentive for consumers to choose diesel engine rather than gasoline engine vehicles. However, for most buses and trucks it continues to make economic sense to use diesel engines and improving the fuel efficiency of these vehicles provides the greatest potential for limiting the growth of diesel consumption. In other words, priority should be given to improving the efficiency in the use of diesel engines rather than substituting gasoline for diesel engines. Although nonprice measures may contribute to this objective, an increase in the diesel price will be the most effective means to limit diesel consumption growth, and any necessary substitutions to gasoline engines will be made by the public reflecting the relative costs of owning and operating diesel and gasoline powered vehicles.

1/ See the Energy Assessment Report, 1981.

7. A MACROECONOMIC ANALYSIS OF ENERGY PRICE DECONTROL

Introduction

7.01 The previous chapters discussed at length the implications of increasing energy prices on the three major energy-consuming sectors; viz., the industrial, household and transport sectors. This chapter focuses on the macroeconomic aspects of the likely effects of decontrol of the domestic price of energy in Indonesia. By decontrol we mean removal of the subsidy to domestic consumers, either suddenly or gradually. While most analyses of the topic deal fully with the microeconomic aspects, they implicitly assume full employment of resources and flexible nominal prices. 1/ The macroeconomic analysis focuses on the possibility of the effects of rising energy prices on nominal wages, and the possible result that the nominal price structure is escalated. In the limit, the escalation could be complete, so that no relative prices are changed. The key issues in this macroeconomic analysis are the degree of wage sensitivity to the energy price increase and the degree of monetary accommodation to the resulting increase in the price level.

7.02 In this chapter, the basic macroeconomic analysis is presented in the simplest aggregate model that exposes the structure of the problems. This aggregate model has two producing sectors -- the modern and the traditional (say industry and agriculture) -- using energy as an input and consumer-workers consuming energy directly as well as the two other outputs. A transaction demand for money limits nominal expenditure on the modern sector good and, thus, the nominal demand for the output of the modern sector is fixed by the money supply. 2/ The modern sector uses labor, energy and capital to produce its output, and the traditional sector supplies food at a constant price which is not sensitive to the energy price. This assumption is later relaxed to see its effects. This simple analytical framework has enough structure to show the importance of: (a) the wage response; (b) the sensitivity of the traditional good (agriculture) price to the price of energy; (c) differences in input proportions across sectors; and (d) the degree of monetary accommodation, i.e., the growth in the money supply which accommodates an increase in the demand for money resulting from increased output prices, and the resulting effects on the CPI, output, employment, and profits in the modern sector, and input demands. A range of results under varying assumptions regarding points (a) through (d) above are then presented. The purpose of this analysis is to point out the key parameters or channels of effects of energy price increases that might be missed by the usual microeconomic analysis. More useful work could be done in all areas of the analysis, particularly in terms of obtaining better estimates of the key parameters. Here we point the way for those further lines of study.

1/ See for example, the World Bank's Egypt Study 5/ "Energy Pricing in Developing Countries: Lessons from the Egypt Study," The World Bank, Energy Dept. Paper No. 3, December, 1981.

2/ This makes the price elasticity of demand equal to -1.

The Aggregate Effects of an Energy Price Increase

7.03 Since the focus is on supply relationships, the key aspect of this macroeconomic analysis of adjustment to an energy price increase is the possibility of a wage response. If an increase in energy prices does not induce a rise in nominal wages, then it can be treated essentially as a change in relative prices, with no escalation effect on the overall price level. 1/ The alternative would be to assume that the energy price increase raises the nominal wage through its effect on consumer prices. As energy prices rise, prices of consumer goods rise and this raises wage demands. The increase in wages then spreads the effect of the energy price increase through the economy and which results in a general escalation of prices.

7.04 The plausibility of this view of the macroeconomic effects in Indonesia is supported by recent work on Indonesian labor markets. The basic result that will be important in our analysis revolves around the debate about the constancy of the real wage. The argument on wage behavior in Indonesia seems to be between researchers who see a roughly constant real wage and others who see an emerging labor shortage. 2/ This suggests that the possibility of labor being supplied at a constant or rising real wage should be considered. This would imply that a rise in energy prices would be passed through to an increase in nominal wages, and thus spread to an overall price increase. The analytical point of this exercise is to see how the energy price increase is passed on to the price of output, both directly and indirectly through the effects on wages. We also want to be able to see how the answers are influenced by: (a) whether the money stock is held constant or whether money supply is increased to fully accommodate the increased demand for money resulting from increased prices; (b) the existence of differences in energy use across sectors and (c) by differences in factor shares of output. 3/

Parameter Estimates for Indonesia

7.05 Estimates of the parameters are obtained from various World Bank and Indonesian sources. The energy, labor and capital shares in value-added for the modern sector are obtained from Industrial Statistics at the two-digit level. The average shares for energy, labor and capital in 1979 were:

1/ This is the approach taken in the World Bank's Egypt Study: "The model contained no wage formation equation to link prices and wages. The latter are controlled in Egypt, but over the long term some linkage is still likely." Here a wage effect is recognized but assumed away. See Energy Dept. Paper No. 3, 12/81, op. cit., p. 4.

2/ On the side of a constant real wage, see Wages and Employment in Indonesia, World Bank, Report No. 3586-IND, September 30, 1981. The idea of an emerging labor shortage is discussed in H.W. Dick, "Survey of Recent Developments," Bulletin of Indonesian Economic Studies, 3/82, pp. 41 ff in the Working Draft version of 01/22/82.

3/ Appendix V presents the model, its solution and the various cases discussed in this chapter in detail.

Energy Share = α_2 = .08

Labor Share = α_1 = .21

Capital Share = β = .71

In this framework, the private sector consumes food, industrial output, and energy. Their prices make up the consumer price index, CPI. The estimates of consumption shares are 0.40 for food, 0.10 for energy and 0.50 for the modern sector output. 1/ Thus, on the consumption side we have these figures as the weights in the consumer price index.

7.06 The consumption shares suggest that a 10% increase in the energy price would raise the CPI directly by about 1%. The shares of value-added, however, are quite unusual. The capital share of about 0.7 and the labor share of 0.2 are roughly the reverse relationship normally found in industrial countries. Since a large capital share reduces the sensitivity of the overall price index to a rise in energy costs, these particular data deserve further scrutiny. 2/

Estimates of Price Sensitivity

7.07 In this section, a range of estimates of the sensitivity of the price of the modern sector (industrial) output and the CPI to an increase in the energy price are presented. 3/ These estimates assume that the prices of materials rise along with the prices of other industrial goods. Alternative estimates based on the assumption that material prices do not change are also presented. 4/ To obtain some feel for the sensitivity, two extreme macroeconomic assumptions are made. In the first set of estimates, we will assume no (monetary) demand accommodation. This means that there is no change in the rate of growth of money supply and, thus, any increase in the price of

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1/ CEM (1982) op. cit.

2/ Equation (9) in Appendix V demonstrates the relationship between capital share and the price of the modern sector output and thus the overall price index. Also the capital share is computed as a residual. Input costs and indirect taxes are subtracted from gross output to obtain the data for value-added. Employment costs are then subtracted to obtain capital share as a residual. Thus any bias toward underestimation of input costs or employment costs would appear as a bias toward overestimation of the capital share. So these data should be handled with care.

3/ The industrial sector is defined to include industries that produce materials. Industrial output is measured net of material inputs but inclusive of energy.

4/ As shown in the Appendix V, the effects on price of industrial output P_Q are obtained from equation (9). The effects on the CPI (and the nominal wage rate) came from equation (2) and the effect on industrial output Q follows from equation (1).

the industrial output is fully reflected in a reduction of its demand. In the second set of estimates, we will assume full demand accommodation implying that the growth in money supply fully accommodates the price rise of industrial output, thus resulting in no change in industrial output.

7.08 Under each alternative assumption on demand accommodation, a variety of assumptions are considered concerning parameter estimates and the reaction of the agricultural price to an energy price increase. These are presented as four alternative cases.

Case 1: Base case with Indonesian data showing labor share $(\alpha)_1 = 0.21$ and capital share $(\beta) = 0.7$ (para 7.05) and no change in agricultural price ($\hat{P}_A = 0$).

Case 2: Reverse labor and capital shares, (i.e., $\alpha_1 = .71$; $\beta = .21$) and no change in agricultural prices.

Case 3: Retain Indonesian share data, as in Case 1, but assume that agricultural price reacts to a change in the price of energy in the same way as the industrial price; i.e., $\hat{P}_A = \hat{P}_Q$.

Case 4: Combine Cases 2 and 3, i.e., reverse input shares and assume that agricultural and industrial prices react in the same way to a change in the energy price.

Discussion of these cases presents a clear idea of which are the key parameters in assessing the macroeconomic effects of an energy price increase.

Results with No Demand Accommodation

7.09 The results for price sensitivity with no demand accommodation are shown in the first two columns of numbers in Table 7.1. 1/ In the base case, with Indonesian share data and no change in the price of agriculture, a 10% increase in energy prices would raise the price of industrial output by 1.13% and the CPI by 1.57%. Thus, with nominal expenditure on industrial output fixed, output would fall by 1.13%.

1/ In terms of the supply-demand diagram in Figure 1, in volume III, Appendix V, these result from an upward shift in the supply curve along a fixed demand curve. The assumption of a fixed nominal expenditure on Q means that $Q = - P_Q$. The reader is again reminded that the numbers presented in this chapter are intended to be illustrative of the orders of magnitude and the directions of change involved.

Table 7.1: PRICE AND INPUT ELASTICITIES WITH NO DEMAND ACCOMMODATION

Case	Percent Changes with respect to 1% Change in Price of Energy			
	Industrial Prices	Consumer Price Index	Labor	Energy
1. Indonesian shares/No change in agricultural prices	.113	.157	-.15	-.99
2. Reverse shares/No change in agricultural prices	.234	.217	-.43	-.58
3. Indonesian shares/Change in agricultural prices	.125	.212	-.21	-.98
4. Reverse shares/Change in agricultural prices	.418	.476	-.58	-.73

Table 7.1A: PRICE ELASTICTIES WITH NO ACCOMMODATION AND FIXED MATERIALS PRICES

Case	Percentage Changes with respect to 1% Change in Price of Energy	
	Industrial Prices	Consumer Price Index
1. Indonesian shares/No change in agriculture prices	.041	.121
2. Reverse shares/No change in agricultural prices	.084	.142
3. Indonesian shares/Change in agricultural prices	.045	.169
4. Reverse shares/Change in agricultural prices	.150	.342

7.10 The results with the capital and labor share reversed are shown as Case 2. The sensitivity of industrial price to the price of energy is doubled, and the CPI elasticity increases to about 0.22. Again, with fixed nominal expenditures, a reduction of 2.34% in industrial output would follow from an increase of 10% in the energy price in this case. As can be seen, the range of plausible assumptions on capital and labor shares yields a range of more than 100% in the elasticity of industrial prices with respect to the price of energy.

7.11 In Case 3, we show the result if the agricultural price responds to energy prices and also increases by as much as the industrial price. The increase in the elasticity of industrial prices with respect to the energy price is small -- from 0.11 to 0.12 -- but the CPI elasticity rises from 0.16 to 0.21. This is because the agricultural price affects industrial prices not only through the wage share (of 0.21) but, in addition, it also enters the CPI directly with a consumption share of 0.4. Thus, the result for the CPI sensitivity depends crucially on the response of the price of agricultural output to an increase in energy prices. Finally, Case 4 shows the power of the interaction between an increase in the sensitivity of industrial prices to energy prices through wage escalation (Case 2) and a response of agricultural prices to energy prices (Case 3). The elasticity of the industrial price rises to 0.418, and of the CPI to 0.476. Thus, with the (extreme) alternative assumption on shares and full response of the agricultural price, the CPI could rise by as much as 50% of the energy price increase, even without demand accommodation; i.e., with the money supply being kept fixed.

7.12 The reactions of the prices of output and the CPI from Table 7.1 are recalculated in Table 7.1A for the case where material prices to industry are held constant. The "industrial prices" column in Table 7.1A is 0.36 times that in Table 7.1, and the "consumer price index" column reflects that change. Under this assumption, the base case gives an elasticity of 0.041 for industrial prices and 0.12 for the CPI. These figures are consistent with those of Chapter 4 where material prices to industry are also implicitly held constant.

7.13 Which of the estimates in Table 7.1 and 7.1A is likely to be closest to the actual outcome? It is impossible to know without extensive further work, but Case 3 appears to be the most likely. In the absence of better information, Indonesian shares of capital, labor and energy in value-added as obtained from the available data should be treated as reasonably approximate. Also, agricultural prices can be assumed to respond to energy prices in the same way as do industrial prices because the energy share in agriculture could be close to the 0.08 share in industry, and the implicit share of capital may be quite high, though perhaps not as high as in industry. This would imply roughly the same "structure" in agriculture as in industry, and roughly the same cost response to an increase in energy prices. So with a 10% increase in energy prices, an estimate of about 1.5% to 2.0% increase in the CPI with industrial prices rising by about 0.5% to 1.5% appears to be plausible. Since most industrial goods are tradeable, any increase in industrial prices will be restricted by import competition. Thus, an energy price increase of 10% would translate into an increase in the costs of production of about 0.5% to 1.5%.

Results with Demand Accommodation

7.14 With no demand accommodation, an energy price increase reduces output in the industrial sector by raising costs. We now consider the possibility that monetary policy accommodates the cost increase by expanding the money stock enough to hold output in industry constant. 1/ The results of the sensitivity of industrial prices and the consumer price index to energy prices in the presence of full demand accommodation are summarized in the first two columns of numbers of Table 7.2 for Cases 1 to 3. In Case 1, with Indonesian share data and no change in agricultural prices, the industrial price elasticity is 0.55 and the CPI elasticity is 0.37. A 10% increase in the energy price would, therefore, raise the CPI by 3.7% with full monetary accommodation. If we reverse the share assumptions so that the labor share is 0.71 and the capital share is 0.21 (Case 2), the elasticities go down with monetary accommodation. Comparison of Tables 7.1 and 7.2 shows that accommodation increases the industrial price and CPI elasticities in all cases, but reverses the effect of changing the share assumption.

7.15 Finally, in Case 3, assuming that the price of agricultural goods rises by the same amount as the industrial price, full price escalation results with monetary accommodation. All prices and the money stock rise by the same proportion as the price of energy, leaving no relative price effects. This result shows the danger of demand accommodation if one is not certain about the stickiness of the price of agricultural output. Case 1 demonstrates the situation with no change in (i.e., sticky) agricultural prices, whereas Case 3 demonstrates the other extreme situation. Consequently, an important aspect for policy makers is to recognize that removing the energy subsidy and then expanding demand to maintain output in the previously subsidized sector can mean undoing the originally intended relative price effects. This analysis also shows that, with demand accommodation, the importance of the relative shares of labor and capital is diminished, since both "pass on" the energy price increase. Case 3, therefore, highlights the key question; viz., whether there is any sector of significant size in the economy, such as agriculture, whose price is not sensitive to the price of energy. If there is none, i.e., if there is a sector of significant size whose price is sensitive to the price of energy, then full wage escalation emerges as a possibility.

7.16 The price elasticities with full monetary accommodation and constant material prices are shown in Table 7.2A. The range for the three cases is from 0.13 to 0.36 for industrial prices and 0.16 to 0.07 for the consumer prices index. These estimates are lower than those shown in Table 7.2 which assumes flexible material prices.

1/ Accommodation can be interpreted to mean a demand expansion sufficient to increase nominal profits in proportion to final sales, holding the profit rate constant. Another way to interpret accommodation is to note that if it holds output constant, then the fixed stock of capital will have the same marginal productivity as before the energy price increase. Thus, with monetary accommodation the profit rate does not fall, and capital joins labor in "passing along" the energy price increase.

Table 7.2: PRICE AND INPUT ELASTICITIES WITH FULL DEMAND ACCOMMODATION

Case	Industrial Prices	Consumer Price Index	Labor	Energy
	Percent Changes with respect to 1% Change in Price of Energy			
1. Indonesian shares/No change in agricultural prices	.546	.373	.17	-.45
2. Reverse shares/No change in agricultural prices	.3347	.274	.07	-.23
3. Indonesian shares/Change in agricultural prices	1.0	1.0	0	0

Table 7.2A: PRICE ELASTICITIES WITH FULL DEMAND ACCOMMODATION AND FIXED MATERIALS PRICES

Case	Industrial Prices	Consumer Price Index
	Percentage Changes with respect to 1% Change in Price of Energy	
1. Indonesian shares/No change in agricultural prices	.197	.198
2. Reverse shares/No change in agricultural prices	.125	.163
3. Indonesian shares/Change in agricultural prices	.360	.680

Effects on Labor and Energy

7.17 The first two columns of Tables 7.1 and 7.2 show the macroeconomic general equilibrium effects on all prices as the price of energy changes including in the calculation the macroeconomic aggregate demand constraint. This analytical framework can be used to obtain the effects on industry demands for labor and energy. An increase in industrial price alone will raise input demands, while an increase in price of energy or agriculture will reduce them. The net effect on input demands on our various cases are shown in the last two columns of Table 7.1 and 7.2.

7.18 In Table 7.1, we see that in all cases, both input demands fall, energy proportionately more than labor as the relative price of energy to labor rises. In general, with a fixed stock of capital in the short run, the demand for other inputs falls more than proportionately to output. In the base case, for example, output in industry falls by 0.11% of the rise in the energy price, while demand for labor falls by 0.15% and for energy falls by 0.99%. Note that labor and energy both have small shares in the production function in this case; (i.e. 0.21 and 0.08 respectively). The numbers in Table 7.1 suggest that with no monetary accommodation, the short-run effects of price increase on aggregate energy demand in the economy could be substantial, as could the effects on labor demand.

7.19 The results with full demand accommodation that holds output constant are shown in the last two columns of Table 7.2. With output and the capital stock held constant, as discussed earlier in Chapter 4, there are substitution effects due to the change in the relative energy to labor price ratio. In the base case, with a large capital share, there is proportionately larger substitution of labor for energy, than in Case 2 with the larger labor share. In Case 3, with all prices increasing proportionately to the energy price and demand accommodation, there is no change in factor demands.

Effects on the Profit Rate in Industry

7.20 The effects of an energy price increase on the profit rate in the short run with a fixed capital stock can be obtained directly from the expression for the marginal product of capital and the results of Tables 7.1 and 7.2. 1/ The percentage reduction in output with no accommodation relative to the increase in the energy price is given by the negative of the first column in Table 7.2. With nominal expenditures fixed by the money stock, the entries in the first column of Table 7.2 also give the percentage reduction in

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1/ From the original production function

$$Q = L^{\alpha_1} E^{\alpha_2} K^{\beta},$$

The marginal product of capital is given by

$$MPK = \beta L^{\alpha_1} E^{\alpha_2} K^{\beta-1} = \beta Q/K.$$

Thus with capital fixed, the percentage change in MPK, or the profit rate, is equal to the percentage reduction in output in industry.

the profit rate. With a 10% increase in energy prices, then in the base case, for example, the profit rate falls by 1.13% in the short run. This reduction in the profit rate increases to 2.37% if we assume that capital and labor shares are reversed, as in Case 2. In the case of full demand accommodation, there is no effect on output, and thus no reduction in the profit rate.

7.21 With no demand accommodation, the reduction in the profit rate in industry would lead to disinvestment in a static economy, or a reduction in investment in a growing economy. This, in turn, would lead to a relative shrinkage of the industrial sector, with the industries whose profit rates fall the most initially shrinking fastest. The industries that end up shrinking the most would be those whose unit cost functions shifted up the most as energy prices rise. The results on relative energy intensity in the cost functions have been provided in Chapter 4. While the disinvestment in industry may seem counter to a policy of industrial growth, it is the implictly intended effect of removal of the energy price subsidy. Naturally the previously subsidized activity will shrink until its profit rate is restored to the prevailing rate in the economy. The first column of Table 7.1, therefore, gives some estimates of the initial impact on profit rates that must be reversed by disinvestment in the movement to a long-run equilibrium.

The Crucial Factors

7.22 The discussion developed in this chapter is simple, but it has enough structure to illustrate the important points highlighted by a macroeconomic analysis of the effects of an energy price increase. These are the importance of:

(a) the degree of nominal wage response to the CPI;

(b) the shares of capital, energy, and labor in the industrial sector;

(c) the existence of a significant sector such as agriculture whose price does or does not respond to an increase in the energy price; and

(d) whether demand management policy attempts to prevent the reduction in industrial sector output following the energy price increase.

The assumption that labor is elastically supplied at a constant real wage is consistent with the most recent analysis of Indonesian labor markets, but this in no way restricts or alters the conclusions above. Moreover, the analysis can be modified to incorporate alternate assumption about the labor markets. Nevertheless, based on this assumption, Tables 7.1 and 7.2 give the increases in industrial prices and the CPI that would follow from a removal of the energy subsidy, or increase in the energy price, under a range of assumptions on points (b) through (d). Clearly, the actual effects of the elimination of the energy subsidies will depend on the correct assumptions regarding all four of the points (a) to (d). Thus, this macroeconomic analysis points to those four areas where input from existing or future research is most important.

Balance of Payments Aspects

7.23 The effects of the removal of energy price subsidies on petroleum exports and the balance of payments is an important area, and that is briefly discussed here. As of January, 1982, the weighted average subsidy on kerosene, motor diesel, industrial diesel, and fuel oil in Indonesia was 60%. 1/ That is, the average domestic price was 40% of world opportunity cost. Elimination of the subsidy will raise the domestic price and reduce consumption, freeing production to be exported. The initial effect of this will be an increase in the value of exports and a reduction in the balance-of-payments deficit. This will create room for additional imports approximately in the amount of the rise in export value.

7.24 The effect of the removal of the subsidy on the exportable surplus is calculated in Table 7.3. 2/ The table begins with the weighted subsidy of 0.6. The estimated long-run price elasticity of demand is -0.3, so removal of the energy subsidy should reduce consumption by about 18%, holding income constant. Consumption of petroleum with the subsidy in 1990/91 is projected to be 401 billion barrels (crude equivalent). So an 18% reduction would cut consumption by 72 million barrels, releasing this amount for export.

7.25 The projected nominal price of oil by 1990/91 is $70 per barrel. 3/ It represents an annual rate of increase from 1982-1990/91 of slightly more than 8% per year. At a price of $70 per barrel the increase in the exportable surplus would be approximately $5 billion, as shown in line (7) of Table 7.3. Projections for the 1990-91 total exports, payments balance and net official reserves with the energy price subsidy remaining in place are shown in lines (8)-(10) of Table 7.3. With projected total exports of $51 billion, the additional $5 billion represents a 10% increase. This could be nearly sufficient to eliminate a projected $7 billion payments deficit. While these projections all must be regarded as mainly illustrative of future possibilities, they do suggest that the removal of the energy subsidy would improve the trade outlook substantially.

Policy Implications

7.26 With an increase in exports as the subsidy is removed, there are three main lines of response for balance-of-payments policy. The exchange rate can be appreciated in a general attempt to reduce non-oil exports and increase imports. An alternative would be to maintain the exchange rate and direct the additional foreign exchange earnings toward imports that are important in the development plan. A third alternative would be to invest abroad or add to reserves. Each of these alternatives is considered in turn.

7.27 Appreciation of the exchange rate will serve to eliminate a surplus in an industrial country with extensive possibilities of substitution between

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1/ This is calculated from CEM, 1982, op. cit., using 1980 market shares.

2/ This is calculated from CEM, 1982 op. cit., using 1980 market shares.

3/ All the data are obtained from CEM, 1982, op. cit.

Table 7.3: EFFECT OF SUBSIDY REMOVAL ON EXPORTABLE SUPPLIES OF OIL, 1990-91

(1)	Weighted subsidy, Jan. (Table 2.3)	0.6
(2)	Price elasticity of domestic demand (Annex 1, Table 3)	-0.3
(3)	Percentage effect on consumption (1) . (2)	-0.18
(4)	Consumption with subsidy (Table 4.2) (million barrels)	401
(5)	Increase in exportable surplus (3) . (4)	72
(6)	Projected price of oil in base case (Table 4.1) ($ per barrel)	70
(7)	Effect on value of oil exports (5) . (6) ($ billion)	5
(8)	Projected total exports with subsidy (Table 4.3) ($ billion)	51
(9)	Payments balance with subsidy (Table 6.6)	-7
(10)	Net official reserves with subsidy (Table 6.6) (US $billion)	6

Source: CEM, 1982. The source for the numbers in rows (9) and (10) is the January 27, 1982 version (yellow cover) of the CEM, 1982.

consumption of home goods and imports, or production for home consumption or for export. In Indonesia, as in many developing countries, these possibilities for substitution are limited. The more usual pattern in developing countries is import of capital goods and intermediate inputs, of which little is produced at home, and export of non-manufactured final goods, of which little is consumed at home. This pattern holds in Indonesia, as is shown in Table 7.4.

7.28 Only 3.1% of Indonesian exports in 1981-82 are manufacturers, with a signficiant margin of substitution between home consumption and export. The rest is the output of oil and other raw materials, industries and agriculture and forestry. On the import side some 52% in 1981-82 is capital goods and intermediate inputs, and another 35% is input into the oil sector. Thus, in its trade, Indonesia mainly imports inputs into production and exports the final product of resource sectors. What would be the consequence of an appreciation in this situation?

7.29 The sectors producing tradeable goods would experience downward pressure in the domestic prices of output and imported inputs, with no likely net effect on profits. But the sectors producing non-traded goods would see a reduction in imported input costs, but no initial downward pressure on outputs. Thus, an appreciation would tend to reduce the costs of all sectors' inputs, and to reduce the price of output in the traded goods sector relative to the price of non-traded goods.

7.30 The result would be anti-inflationary overall, but also to favor initially profits in the non-traded sector relative to the traded goods one. This would shift resources at the margin from the traded to non-traded goods sector. However, as the exportable oil surpluses decline, the exchange rate would begin to depreciate and resources at the margin would move in the reverse direction, viz., from the non-traded to the traded goods sector. Efficient resource allocation would support such a policy. However, a developing country, such as Indonesia that has an explicit policy to nurture the manufacturing (and therefore traded goods) industry, this is not likely to be an acceptable option by the Government. Thus, the appreciation option will probably not be a feasible one in Indonesia as the Government would view the initial reduction of relative profits in the traded goods sector as not being compatible with its overall development program.

7.31 An alternative option, therefore, may be to direct the additional export revenues to the import of capital goods that are essential to the development program. The details of trade policy are not the subject for this report, but appropriate imports could be encouraged by tariff reduction which would also be anti-inflationary. Directly increasing imports has the added advantage of preserving over-all macroeconomic balance as the subsidy to energy prices is removed. If the reduction in domestic subsidy expenditure is met by an increase in domestic government expenditure or a cut in taxes, and the increase in export revenues is directed to additional imports, both internal and external macroeconomic balance will be preserved.

7.32 The third option is investment abroad or reserve accumulation relative to the levels that would be achieved otherwise. This would imply that the rate of return abroad exceeds that in domestic investment, an unusual assumption for a resource-rich developing country such as Indonesia.

Table 7.4: STRUCTURE OF INDONESIAN TRADE, 1981-82

Exports (Table 6.3)			Imports (Table 6.4)		
	US $ billion	%		US $ billion	%
Agriculture and forestry	2.9	12.9	Consumer goods	2.9	13.0
Metals and minerals	0.8	3.6	Capital goods	4.5	20.2
Manufactures	0.7	3.1	Intermediate goods	7.2	32.3
Oil sector	18.0	80.4	Oil sector	7.7	34.5
Total	22.4	100	Total	22.3	100

Source: CEM, 1982.

7.33 In summary, if the appreciation option is ruled out by the Government, then directing the additional export earnings to imports in the context of the development program will avoid the initial relative profit squeeze on the tradeable goods sector, transform the oil resources into domestic investment, and preserve both internal and external macroeconomic balance. As articulated in previous Bank reports, these features all likely make this an option preferable to the Government to appreciation or foreign investment to maintain external balance.

8. THE ANALYTICS OF ALTERNATE PRICING POLICY OPTIONS

Introduction

8.01 In Indonesia, as in many other energy-exporting developing countries, domestic energy prices have been suppressed in the period up to 1982 due, in part, to implicit concerns about the effects of a sudden price increase on producers and consumers who have difficulty in adjusting to rapid price changes. 1/ Since there is no particular reason to single out the energy price as an efficient instrument for income redistribution in the long run, this difficulty in adjusting to large changes in the short run lies behind the pervasive tendency in many countries to restrict the rise of domestic energy prices to world market levels. As expected, after domestic prices have been supressed for an interval of time, the problem of domestic "overconsumption" of energy appears, and the policy problem arises as to how to adjust domestic energy prices to a level which reflects their scarcity value or opportunity cost? The instinctive answer to this question seems to be gradually. 2/ The report so far has concentrated on the economic implications of increasing energy prices. Now, this chapter focuses on the adjustment path of energy prices and analyzes three alternate policy options faced by policy makers in Indonesia to adjust domestic energy prices to levels that reflect the true scarcity value of energy to the country. It first presents the case for gradual adjustment and the problems it poses; it then discusses an alternative to this approach; viz., a series of unannounced discrete jumps in prices - a policy approach followed to date by the Indonesian Government; and finally, a third policy option of moving prices immediately to world levels. The analytics of each policy option is discussed and the benefits and costs are outlined to aid the policy makers in shaping the best feasible policy suitable to Indonesian conditions. It should be emphasized here that given the amount of data and information available, it was not possible to arrive at any conclusion regarding the superiority of one option over another; this report remains deliberately agnostic on that issue. That is a determination that can only be made by the Government after a careful analysis and taking into account the specifics of the situation in Indonesia. The intention here is to outline the analytics (the pros and cons) that need to be considered prior to reaching a final judgement.

The Rationale for Gradual Price Increases

8.02 The basic rationale for gradual price increases is the instinctive idea that this will minimize adjustment costs. If the path of the energy price is announced in advance, producers and consumers can adjust their stocks of energy-using durable goods gradually. In this section, the case for gradual price adjustment is presented. We begin by showing the capital or real-income losses with no adjustment costs, and then show the additional

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1/ Chapter 2 discusses the specific concerns of the Government of Indonesia.

2/ For example, in his speech of November 1978, President Carter of the United States proposed a schedule of energy price increases that would reach world price levels over a period of three years. In this speech he did not recognize the incentive this plan provided for investment in energy hoarding. This is but one example of the problems posed by a policy of gradual adjustment of energy prices after a period of control.

losses when there are costs of adjusting inputs in the short run. This analysis establishes the case for some amelioration of the effects of a sudden jump in energy prices.

8.03 The income effects of an energy price increase on the energy consuming sectors (industry, household and transport) have been discussed in previous chapters. Briefly, the effect on the industrial sector is an increase in total costs ranging from 2% - 4% depending on the magnitude of the energy price increase (see Chapter 4). A rise in the price of energy appears as a reduction in profits on the fixed capital stock excluding all adjustment costs. This reduction in profits can be interpreted as a capital loss on the initial capital stock. The income effect on consumers of the energy price increase have also been analyzed. The increase in income needed to compensate for the rise in the energy price, i.e., to allow consumers to be able to consume the same bundle of goods as before the price rise was shown, on the average to be 10% the energy price increase. These profits and income effects on producers and consumers assume no adjustment costs. These effects, however, do not provide a rationale for a gradual adjustment of energy prices; the rationale for gradual change has to be based on adjustment costs, so that a slow adjustment of energy prices eases the transition from the short run to the long run.

8.04 The effects of short-run rigidity in consumption and the resulting, if implicit, adjustment costs are well-known. If energy consumption for households is fixed initially, the effect of an energy price increase will impose a short-run loss to these consumers. For example, if a household uses a kerosene stove using a fixed amount of kerosene for its daily cooking, it will be forced to pay more for kerosene until it can replace the stove with a heating unit that is more energy efficient. The short-run loss could be avoided if it were announced that the energy price would rise to the world level gradually over a period equal to average life of the consumers' energy-using durable goods. This would permit consumers to replace existing durable goods with units appropriate to higher energy prices, gradually adjusting their consumption behavior and avoiding abrupt changes. As an example, if the energy price is to rise by 100% and the average life of the consumers' energy-using durable goods is 10 years, an annual increase of 7% in the price would permit such a smooth adjustment by consumers.

8.05 A similar analysis can be applied to the case of producers' adjustment costs. Consider the case of a (competitive) producer with capital that requires a fixed amount of energy to operate. A significant increase in the energy price will make this capital instantaneously obsolete; its value will fall to scrap value. Whether a particular firm continues to operate will depend on whether the price still covers variable cost after the total cost has increased. Firms that cannot cover variable cost become bankrupt. As firms close down, the industry supply shrinks and the price rises until a new short-run equilibrium is reached where existing firms can cover variable costs. 1/ The key point in the adjustment process is the closing down of firms by bankruptcy due to the sudden energy price increase.

1/ This is a fixed-coefficients version of the macro-adjustment analysis of Chapter 6.

8.06 If the energy price were increased gradually and predictably, firms could turn over capital stock into more energy-efficient units as it becomes obsolete. Some firms would find that they cannot compete with the new higher costs; they would withdraw their capital from the industry gradually by not replacing it. The long-run result would be the same as with a jump in energy prices to world levels, but the transition would be made by gradual exit instead of a sudden wave of bankruptcies. The calculation of the optimal rate of the price increase would be the same as in the case of consumers. The energy price would rise smoothly to its new level over the period given by the average life of energy-using capital goods. 1/

8.07 Thus, an announced gradual rate of increase in the energy price would permit gradual adjustment by both producers and consumers, eliminating the need for sudden losses to consumers and bankruptcy among producers. This is the basic economic rationale for gradual adjustment of energy prices, once they have initially been suppressed.

The Necessary Conditions for a Gradual Price-Adjustment Path

8.08 Once the domestic price energy has been suppressed, a policy of subsidy removal, intending to raise the internal price to the world level, necessarily implies that the domestic price must rise relative to the world price during the adjustment period. This simple observation places a surprisingly strong restriction on the rate of increase of the domestic energy price: it must exceed the domestic rate of interest. 2/

8.09 This is demonstrated in Figure 8.1. The solid line gives the path of the world energy price in terms of rupiah. From equations (1) and (2) in the footnote, on the preceding page, its slope is given by the sum of the international interest rate and the rate of depreciation of the rupiah, $r^* + \hat{e}$, which exceeds the domestic interest rate r. At time t(0), when the domestic energy price begins to move toward the world price, it is below the solid path. The adjustment path of the domestic price could be gradual, as shown in the dashed path A, or come in discrete jumps, as shown in path B. Either path, or any path moving from $PE^{(0)}$ to join the solid path, must have an average slope greater than that of the solid path, whose slope, in turn, is at least equal to the domestic interest rate, r. Thus, the path of the adjustment of the domestic energy price is necessarily steeper than the domestic interest rate, 3/ if the domestic price is to converge to the world price of energy.

1/ The general formula is given by

$$g = \ln (X_{t}/X0)t,$$

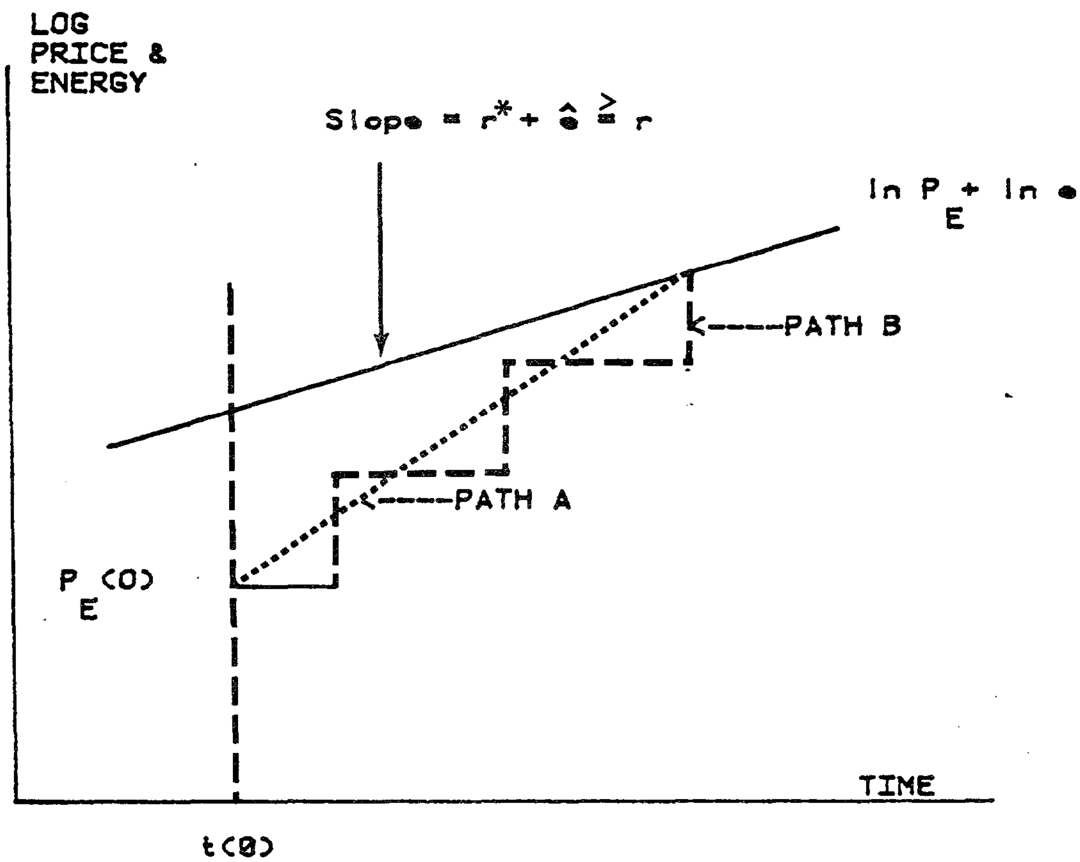
where $Xt/X0$

is the ratio of final price to initial price, t is the number of years in the adjustment period, and g is the annual rate of price increase. The formula comes from the growth equation $X_t = X0egt$.

2/ See footnote on p. 146.

3/ As shown by Equation (4) in footnote 2, p. 146.

FIGURE 8.1: PATH OF ENERGY PRICE



The Different Paths for Energy Prices

8.10 In Indonesia, after energy prices were increased in January 1982, differences remained between subsidy rates across energy sources. The first three columns of numbers in Table 8.1 summarize the situation as of the end of January 1982. The first column gives the subsidy-inclusive domestic rupiah price per liter; the second column gives the "world" price translated into rupiah; and the third column is the ratio of the first to the second. Kerosene remained, in January 1982, the most heavily subsidized fuel with the domestic price equal to 30% of world market price. Fuel oil is the least subsidized, with a price/opportunity cost ratio of 0.51.

Footnote 2 from p. 144:

2/ This restriction can be derived as follows.

The world energy price P_E^* is likely to rise, on average, at a rate equal to the world rate of interest r*:

(1) $\hat{P}_E^* \approx r^*$, where $\hat{P}_E^*$ is the percentage change in the world energy price.

This is the fundamental result from the theory of optimal resource extraction. Obviously there will be fluctuations around the trend in the world energy market, but the above equation describes the long-run trend. Thus the domestic energy price must rise to catch up with a world rising energy price. If the domestic energy price in rupiah, $\hat{P}_E$, is to increase relative to the world energy price translated into rupiah, then we have

(2) $\hat{P}_E > \hat{P}_E^* + \hat{e}$,

where e is the rupiah effective exchange rate and $\hat{e}$ is its rate of depreciation. The domestic interest rate with open capital markets will be approximately given by the world interest rate plus the rate of depreciation. If capital markets are not open, domestic credit-rationing will exist in order to hold the domestic interest rate below this level. So the interest rate relationships can be summarized by

(3) $r \leq r^* + \hat{e}$,

where r is the domestic interest rate. Equations (1) and (2), together, imply that $\hat{P}_E > r^* + \hat{e}$, so (1) - (3) yield the basic restriction that

(4) $\hat{P}_E > r$

during the period of adjustment.

Table 8.1: ENERGY PRICES AND POTENTIAL GROWTH RATIO

Product	Price (1/82) Rp/ltr (P_0)	Opportunity Cost (1982) Rp/ltr (P_0*) 1/	P_0/P_0*	Average Annual Growth Rate (%) 2/		
				3 Years	5 Years	8 Years
Kerosene	60	203	0.30	48.6	32.4	23.0
Motor Diesel	85	185	0.46	33.9	23.5	17.7
Industrial Diesel	75	185	0.41	38.1	26.1	19.1
Fuel Oil	75	146	0.51	30.2	21.3	16.4

Notes: 1/ Singapore price plus 5%.

2/ This is the compound annual growth rate that would raise price to opportunity cost over the time indicated, assuming opportunity cost (world market price) grows at 8% and the effective exchange rate remains constant. These growth rates are calculated as follows. Let the growth rate be n, the initial price be P_0, and P_0* be the initial opportunity cost. Then,

$$n = g - [\ln (P_0/P_0^*)/t]$$

where g is the assumed growth rate of P_0*.

Source: Table 2.1.

8.11 The last two columns of Table 8.1 show the growth rates of domestic energy prices that would be required to bring them to world market levels over periods of three, five or eight years, respectively. These calculations assume that the world prices all rise at 8% per year and that the rupiah effective nominal exchange rate remains constant. 1/ To the extent that this assumption of world price increase is incorrect the appropriate adjustments in the growth rate can be made. However, what must be borne in mind by policy-makers is that any respite in the increase of world energy prices, such as the current one, provides Indonesia with an opportunity to close the gap between domestic and international prices. Otherwise, as the recent past has indicated, the large discrete jumps in domestic energy prices will continue to "lag behind" the international price increases, thus, leaving Indonesia only marginally better off, if at all, than before the domestic price increase. The average annual growth rates of Table 8.1 represent smooth price adjustment paths such as those illustrated by Path A in Figure 8.1. For heavily subsidized kerosene, a three-year adjustment would require an annual price increase of 48.6%, a five-year adjustment would imply an annual price increase of 32.4%, and an eight-year adjustment (i.e., by the end of this decade) would imply a 23% price increase. The price adjustment paths for fuel oil would require average annual growth rates of 30.2%, 21.3% and 17.7%, respectively.

8.12 Convergence of all energy prices to the world level over the same time period, as discussed above, obviously requires differing growth rates for each energy source. This would, however, lead to interfuel substitution in the various sectors as changing relative prices would encourage firms to search for the least-cost mix of fuels during the transition period. An alternative policy would be to move all prices at the same growth rate, but for periods of differing lengths. 2/ Such a policy would imply no change in the relative pricing of fuels during the transition phase and there would be no interfuel substitution until fuel prices relfected their true opportunity cost (see Table 8.2). For example, suppose a uniform rate of energy price increase of 25% per year were imposed, then the length of the adjustment periods would be as follows: kerosene, 7 years; motor diesel, 4.5 years; industrial diesel 2.1 years; fuel oil, 1.6 years. Table 8.2 also shows the length of adjustment period for a uniform rate of an energy price increase of 50% per year. As might be expected, the adjustment price for kerosene and motor diesel shorten considerably, with no change for industrial diesel and fuel oil.

The Problems of Gradual Price Adjustment

8.13 A program of gradual removal of energy subsidies, allowing the domestic price to rise to the world market price along a path such as path A in Figure 8.1, faces two main economic problems. First, since the rate of

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1/ If the rupiah appreciates/depreciates, the percentage rate of appreciation/depreciation would have to be subtracted/added.

2/ The formula of footnote 2 to Table 8.1 can be used to compute the length of the adjustment period t that will give convergence at any growth rate n that is higher than the growth rate of the world price g, given the initial PO/PO^* ratio in Table 8.1.

Table 8.2: ADJUSTMENT PERIODS FOR ENERGY PRICES
(Years)

Product	Uniform Price Increase 25%	50%
Kerosene	7	2.9
Motor Diesel	4.5	1.8
Industrial Diesel	2.1	2.1
Fuel Oil	1.6	1.6

increase of the energy price necessarily exceeds the domestic interest rate, the program presents a strong incentive for hoarding in the private sector. Second, investment undertaken while energy prices are still below world market prices will still be energy-inefficient. The inefficiency will end only after a full generation of replacement of capital equipment and consumer durables after the domestic price reaches the world level. These two potential problems are considered in turn.

8.14 The first problem of energy hoarding is evident so long as the increase in the domestic price of energy exceeds the domestic interest rate. This provides a safe profit for any agent who can buy and store energy (kerosene, diesel fuel, etc.), financing this activity at the interest rate or incurring that opportunity cost. In theory, the effect could be indefinitely large. As long as the margin between the energy price increase and the interest rate is certain and financing is available, the entire inventory could shift from the public sector into private stocks. As long as the activity is legal, it would be limited by the lack of financing, lack of storage facilities, and possible uncertainty about the government's resolve to continue the price along its announced path. The economic effects of this "speculation" would be windfall profits for agents who control or produce storage facilities, and a shortage of energy for use during the adjustment period. This could have an adverse effect on the economy.

8.15 One obvious policy to combat hoarding could be to make it illegal with a credibly stiff penalty to prevent it. This approach, however, would raise problems of implementation and administration and the need to define a "normal" level of inventories. It would also open a new field for corruption, since clear profits are available in the illegal activity. It is impossible without further detailed study to estimate the size or seriousness of this problem. Energy sources are easily storable, the potential profits would be clear, and there is experience in similar situations with energy and other commodities in other countries to suggest that the problem could be potentially serious in Indonesia. One example is the movement of grain between private and public inventories when buffer stock and price control programs are initiated. Therefore, a policy program of gradual removal of the price subsidy should not be undertaken without serious consideration of potential disruptions and profit redistribution from hoarding during the periods of adjustment.

8.16 The second problem relates to continued energy inefficiency. Rational agents making investments during the period of adjustment will reduce their energy requirements only gradually. Capital or consumer durables purchased during the period will be consistent with expected energy prices over the expected lifetime of the investment. These will be below world energy prices until the end of the adjustment period; therefore, the average energy price relevant for an economic evaluation of the investment will be below its world price. It is only after the energy price has reached the industrial level that investment projects will fully reflect the new long-run level of energy costs.

8.17 This implies that long-run energy efficiency will be reached only after a full generation of capital and consumer durables has been installed after the end of the adjustment period. This could prolong the life of the capital equipment using excessive energy for several years after the adjustment program is finished. Thus, if an adjustment period of five to eight years is contemplated, it could be up to almost 15 to 20 years before nearly all capital equipment is energy efficient and is suited to the new long-run path of energy prices.

8.18 The two problems discussed here are inherent in any program of gradual adjustment of energy prices that have been suppressed for long periods. During the period when the price is moving to the higher levels, there will be expected capital gains due to "speculative" hoarding. And during the period, user-cost calculations will reflect the path of rising energy prices resulting in an even more gradual adjustment of the capital stock (including consumer durables) to the efficient level of energy-intensity. The quantitative importance of these problems is not clear, but they are worrisome aspects of a gradual adjustment package that should be studied with care.

A Second Policy Option: Discrete Price Jumps

8.19 An alternative policy option that would seem to reduce the hoarding problem would be to remove the energy subsidy in unannounced discrete jumps in the price, following a path like path B in Figure 8.1.; over the last decade, this has been the approach of the Indonesian Government. This would seem to reduce the certainty attached to the margin between the energy price increase and the domestic interest rate thus, reducing the incentive to hoard. The gains of this policy are mainly illusory, however, and it would pose additional problems relative to the gradual adjustment option.

8.20 If the general objectives of policy to remove energy subsidies over a certain period is known, as may be the case in Indonesia, then the gains from buying energy sources and holding them until the price approaches the world market level exist more or less independently of the precise timing of the price movements. So the fundamental incentive to hoard is not removed. In addition, the policy would create speculative bubbles around times when the private sector expects a discrete price increase; this expectation would be based on past official behavior. For example, we can expect private agents to consider the fact that energy prices were increased significantly in May 1980 and January 1982, and to speculate on the possibility of a repeat sometime in 1983 or 1984.

8.21 Thus, a policy of discrete jumps induces two components of speculation which may already exist in the Indonesian energy system. First, since the policy objective is already known, hoarding may exist in the form of inventories in excess of "normal". This could inflate the energy consumption data and make the problem seem worse than it actually is. Similarly, after an increase in energy prices is implemented, as the stocks of inventories are released on the market, the energy consumption data could be understated thus, indicating an illusory decline in consumption growth. Preliminary evidence indicates that this may in fact be happening in Indonesia. Government officials, however, feel that hoarding does not take place on a large scale. Second, one could expect a wave of speculative demand before the expected date of the next price jump, with the demand increasing as time passes. 1/ This kind of speculative behavior, induced by a policy of discrete price jumps, can only serve to disrupt the flow of productive economic activity as agents turn their attention to attempts to predict the timing of price jumps and to accumulate energy sources before these price increases take place.

8.22 In addition to speculative problems associated with energy sources as a storable durable asset, a program of discrete unannounced jumps makes the path of energy prices to capital investors uncertain. This makes the marginal productivity of waiting, until the price situation becomes clear before investing, very high and thus leading to delays in investment. Therefore, an implicit policy of occasional discrete price jumps could create a disruption of investment in the private sector by maximizing uncertainty and the return from waiting.

8.23 Thus, compared with a program of announced gradual elimination of the energy subsidies, the economic effects of an implicit program of unannounced price jumps could be quite adverse. These include the addition of speculative bubbles to the underlying incentive to hoard and a short-run disincentive to investment during the period of price uncertainty. The non-economic gains of this adjustment policy would have to be substantial to outweigh these economic losses to the development program.

A Third Policy Option

8.24 The main reason why gradual price adjustment appears to be preferable to an unannounced jump of energy prices to world market levels is the perception that producers and consumers are "locked into" existing energy intensities in capital equipment and consumer durables. This has been interpreted previously as high short-run adjustment costs. Thus a sudden rise in energy prices would impose substantial capital losses, and perhaps even a wave of bankruptcies. As discussed, this has been the rationale for a gradual and predictable adjustment which, on the face of it seems preferable.

8.25 A policy alternative that is worth some exploration would be to move domestic prices instantaneously to world market levels, and simultaneously to recycle the revenues to energy consumers in the form of a temporary subsidy to income proportional to the initial energy consumption. The income subsidy could then be phased out gradually along a path keyed to the ability of producers and consumers to adjust capital and durable inputs. The policy would be essentially to jump energy prices to international levels and to phase out the income subsidy along the mirror image of the path contemplated for gradual price escalation -- Path A in Figure 8.1.

8.26 There are several gains from this policy package. First, the immediate jump to world market levels would provide an immediate incentive to replace capital stock and durables with energy efficient units. So the move to energy efficiency would be completed after one turnover of the capital stock beginning from the time when the policy is begun. This would be approximately half the time it would take to move to energy efficiency under a

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1/ Such an increase in demand toward the end of 1982 would not be surprising.

careful plan of gradual price adjustments. Furthermore, the immediate jump would forestall any further speculation on energy prices and release any existing energy hoards into productive use. Second, as discussed above (paras. 8.03-8.05), the initial losses to "locked in" consumers and producers will be proportional to their existing energy consumption. So an initial subsidy to income also proportional to the initial consumption level could eliminate the initial capital losses. Third, a gradual phasing out of the subsidy as consumers and producers are able to replace existing capital into energy efficient units would serve exactly the same purpose as gradual price adjustment, permitting a smooth transition from the short run to the long run. The final result would be the same without the incentives to hoard energy or delay adjustments to energy efficiency.

8.27 Finally, the policy package would be more than self-financing. The initial income subsidy would be at most equal to the additional revenue gained by eliminating the energy price subsidy and moving to world market levels. The income subsidy would then be phased out over a period of time, perhaps five to eight years; i.e. the subsidy would last until the end of this decade. This would leave consumers with the non-adjustment-cost income effects and a shrinkage in the size of energy-intensive producing sectors, the intended long-run effects of the policy. The result would be a net social gain from the move towards energy efficiency, with a zero budgetary effect in the first year, and a tendency toward production of net revenues thereafter. Thus, if it were feasible to administer, this policy package would have the same benefits as a gradual removal of the energy price subsidy without incurring the costs.

8.28 The feasibility of the package is of crucial importance and remains to be considered; it may negate this third policy option in favor of gradualism. Estimates of initial consumption would be needed. The income subsidy would be phased out along the same path that prices would follow with gradual elimination of the subsidy, so the information needs would be essentially the same in both cases. Thus, the economic balance seems to be between the additional administrative costs of a temporary income subsidy and the hoarding and inefficiency costs of gradual elimination of the price subsidy. Furthermore, some realistic assessment also needs to be made about the speed at which the industrial structure would be permitted to adjust by the industrial policy environment. If the latter remains a constraint, then a strategy of gradual price increases may dominate any sudden price changes. These topics are, however, outside the boundary of this report, but are presented for further consideration and study by the Government.

Announced versus Unannounced Price Changes and Price Stabilization

8.29 The Government also has the option of either announcing or not announcing future price increases. The behavior of the firms and households would depend upon their expectations of the timing and level of future prices; i.e. whether, from their point of view, these price changes were anticipated correctly or were completely unanticipated. Given past price increases, it is likely that there will be expectations of future price rises. If the Government follows a policy of announcing the trajectory of future prices, and actually implements that strategy, firms and households will undertake their adjustments and new investments with full certainty of future prices. So will individuals and firms with a capacity to hoard; they will now have the incentive to buy and store energy while the prices are low and release these stocks when prices are high. The extent to which this will actually take place will depend on the investments required to store alternate forms of energy. If, however, price changes are unannounced, an element of uncertainty will enter into the decision-making of firms and households regarding their investment behavior. Firms investing in new capital equipment will not do so in capital that reflects the long-term price level; rather, they will make some judgement about the timing and level of future energy prices, compare them to the useful life of different forms of capital and after weighing the costs and benefits in this uncertain environment, reach some judgement. If future prices are correctly anticipated, then socially efficient investment decisions will be made. If the anticipations are, however, incorrect, then socially inefficient decisions will be made; the extent of this inefficiency will depend upon the error in anticipation. This element of uncertainty will also enter the "hoarding decision" and less hoarding, than under conditions of certainty, will take place. This debate about announced versus unannounced policy changes has taken place quite extensively in Latin America with respect to the price of foreign exchange (the exchange rate). No conclusions have emerged as to which approach is preferable as this involves questions of behavior in an uncertain environment and the manner in which individual form their expectations about future events.

8.30 Whatever strategy is undertaken, the conclusion that energy prices must eventually reflect their opportunity costs remains valid. For non-tradeable forms of energy, such as electricity, the opportunity cost would be the long-run marginal cost of production and distribution. For tradeable forms, i.e. those that can be exported or imported, the relevant opportunity cost would be the world price (f.o.b. or c.i.f. depending on whether the energy form is an exportable or an importable). The crucial question that policy-makers will face once domestic prices approximate international prices, is whether to continue administering prices and make periodic adjustments to reflect a changing world environment or decontrol prices and permit the market to adjust these prices. It is not possible to address this question fully here, but the general principles can be outlined. The answer to this issue would depend very much on expectations of future energy prices. If the expectations are that international prices will be essentially stable over the long run (though there may be short-term fluctuations) then decontrolling prices eventually may be the better solution. If on the other hand, international energy prices are expected to have very wide fluctuations over the long run, then administered prices to stabilize them domestically and insulate the economy from the large international gyrations, but still letting them reflect the long-run opportunity cost, may be the answer. This is clearly an important and a very complicated policy issue that the Government will have to face eventually -- once the domestic prices have been raised sufficiently in the context of this report. Consequently, in the meantime, the Government may wish to establish the analytical framework so that when a decision needs to be made, the mechanism to arrive at that decision is in place.