FOR
AGENDA



0451

EBS/91/129

CONFIDENTIAL

August 2, 1991

To: Members of the Executive Board

From: The Secretary

Subject: Issues in Energy Pricing Policy

Attached for consideration by the Executive Directors is a paper on issues in energy pricing policy which will be brought to the agenda for discussion on a date to be agreed. Issues for discussion appear on pages 26-28.

Mr. Wickham (ext. 4792) or Mr. Kumar (ext. 7730) is available to answer technical or factual questions relating to this paper prior to the Board discussion.

Att: (1)

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INTERNATIONAL MONETARY FUND

# Issues in Energy Pricing Policy

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Approved by Bijan B. Aghevli

July 31, 1991

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## I. Introduction

During the last two decades, prices of energy products have exhibited considerable volatility. 1/ For instance, domestic energy prices in the industrial countries increased by more than 30 percent (in constant 1990 U.S. dollars) during 1978-1984, but declined by an almost equal amount in the following five years. During 1990, energy prices increased again by nearly 10 percent. World crude oil prices, a major element determining domestic energy prices, have shown similar variability. Oil prices dropped from an average of $43 a barrel (in constant 1990 U.S. dollars) in 1980 to $17 a barrel in 1986. During 1990, the average monthly nominal price varied between $14 and $33 a barrel.

The variability in international prices has important implications for the formulation of appropriate policies related to pricing and taxation of energy products. Furthermore, in the context of the recently introduced oil element of the CCFF, one of the preconditions for lending under this element has been that the member pursues appropriate energy policies. More specifically, the focus of a number of discussions at the Executive Board has been on the "pass-through" into domestic prices of changes in the international prices of crude oil, petroleum products, and natural gas. Several Executive Directors have suggested that the Fund advice on energy pricing and the issue of pass-through merited further investigation. 2/ The recent decline in the oil prices has brought to the fore the issue of symmetry in countries' response to changes in the world price of energy and the likely impact on efficiency of energy use.

This paper discusses a number of issues related to energy pricing policies, with particular emphasis on pricing of domestic oil products. It does not address the broader issue of how to achieve greater stability in world oil prices through closer cooperation between oil producing and oil consuming countries. 3/ The discussion below is organized as follows: Section II briefly describes the structure of the energy sector in industrial and developing countries, provides an international comparison of the level of domestic energy prices and taxes, and presents some evidence on the volatility of international energy prices; Section III examines the methodology for setting domestic prices of energy products on efficiency grounds when there are no externalities, the criteria for pass-through, and the desirability and implications of price smoothing; Section IV considers

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1/ Energy products include oil products, coal, natural gas and electricity.

2/ See Supplements 3 and 4 of EBS/90/179 which set out the details of the oil import element in the CCFF. For an illustration of the application of the energy policy tests, see, for instance, the staff reports on Bulgaria (EBS/91/22), Czechoslovakia (EBS/90/215), Hungary (EBS/91/2), India (EBS/91/4), Philippines (EBS/91/17) and Romania (EBS/91/37).

3/ This issue has been the focus of discussion in a number of recent international meetings.

various externalities associated with energy use and develops a framework for analyzing the role of taxes in dealing with these externalities; Section V examines the budgetary importance of energy taxes and the extent to which they have been adjusted in response to changes in the international price of oil; Section VI examines the welfare consequences of an adjustment of domestic energy prices on low-income groups; and finally, Section VII provides a summary of the key issues that emerge from the paper.

## II. Energy Sector, Prices and Taxes, and Volatility

### 1. The structure of energy sector

Energy is a critical input in both household and productive sectors. It is not surprising therefore that production and distribution of energy products constitutes one of the largest industries in both the developed and the developing countries alike. 1/ Given that the minimum efficient size for energy operations is quite large, the industrial structure is often highly concentrated, with a single or a handful of companies dominating the sector. Furthermore, despite recent moves towards privatization, in most developing countries and in many developed ones, energy companies are in the public sector, and governments exercise direct control over their pricing, output and investment policies. Precisely because of this close integration of the energy sector with the public sector, the impact on general government revenues of changes in energy prices can be direct and significant.

There is considerable variation in the use of energy by sector and by product, both across and within the developing and industrial countries. Nevertheless, some "stylized facts" do emerge. The household sector consumes from 15 to 25 percent of total energy in the form of fuels for cooking, heating etc., with a sizable proportion of this use in the developing countries accounted for by non-commercial sources of energy, such as fuel-wood. 2/ The agricultural, industrial, and commercial sectors account for another 35 to 45 percent, with agriculture accounting for a much higher share in the developing countries. The remaining use of energy is accounted for by the transportation sector. With regard to specific fuels, more than half of the consumption of petroleum products is by the transportation sector, with the rest used by industry (including, for instance, use of fuel oil for furnaces) and by households. Solid fuels, such as coal, are used largely in electricity generation and in industry, but in a number of developing countries they are also used in railway transportation. A

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1/ Energy here refers to the commercial fuels which are traded in more or less organized markets. The paper is concerned only with this type of energy; in many of the developing countries, non-commercial sources of energy such as fuel-wood are also of considerable importance, especially in the household sector.

2/ For details, see, for example, Petroleum Finance Company (1988).

significant proportion of electricity is generated using hydro-electric power or nuclear fuels, but oil and gas also play an important role for peak-load (or marginal) generation. Electricity, in turn, is used mainly in the commercial and the household sectors, although its use in the agricultural sectors has been increasing in the developing countries.

The significance of these stylized facts is that pricing of different fuels will affect various sectors differently, depending on the intensity of fuel use in the specific sector. Furthermore, although in the short run the elasticities of substitution between fuels are low, over the medium and long run, pricing policies are likely to have a considerable impact on the structure of fuel use throughout the economy.

2. Domestic energy prices and taxes

Data relating to a range of petroleum and other energy products for the industrial and developing countries are presented in Tables 1 to 3. Table 1 shows the average of retail prices, the pre-tax (or net-of-tax) prices, and taxes as a percentage of both retail and pre-tax prices in industrial countries; these data are provided for the five most important oil products, which account for some 80 percent of the total oil consumption in these countries, for five bench-mark years, 1978, 1982, 1986, 1989 and 1990. 1/ This table exhibits a number of features. First, in any given year, there is a significant difference in the retail prices of different oil products, reflecting in large part the differences in tax rates; taxes as a percentage of the pre-tax price range from over 160 percent for gasoline to under 20 percent for heavy fuel oil used by industry. Second, there is a considerable variation across countries in the tax rates, as indicated by the coefficient of variation; as illustrated for gasoline in Chart 1, the United States is at one extreme with taxes accounting for 24 percent of retail price, while France and Italy are at the other extreme with a tax ratio of nearly 71 percent. Third, there is a significant variation in the tax ratios over time. In general, for most products, tax ratios declined sharply after the rise in world oil prices in 1979-81, but increased considerably after the fall in oil prices in 1985-86. This pattern, however, has not been followed after the increase in world oil prices in 1990, in large part because the world price rise was short-lived.

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1/ See Appendix 1 for details of the sample and data. The sample for industrial countries includes all the countries in that category identified in International Financial Statistics. The taxes include those paid by the consumer as part of the transaction and which are not refundable, but excludes the value added tax paid in many European countries by industry (including electric utilities) and commercial end-users for all goods and services, which is refunded to the customer, usually in the form of a tax credit. (See OECD (1991)). Appendix 2 provides additional data for "energy-equivalent" prices of different products; these data do not change the conclusions discussed here.

Table 1. Oil Product Prices and Taxes in Industrial Countries

(<u>In U.S. dollars per gallon</u>)

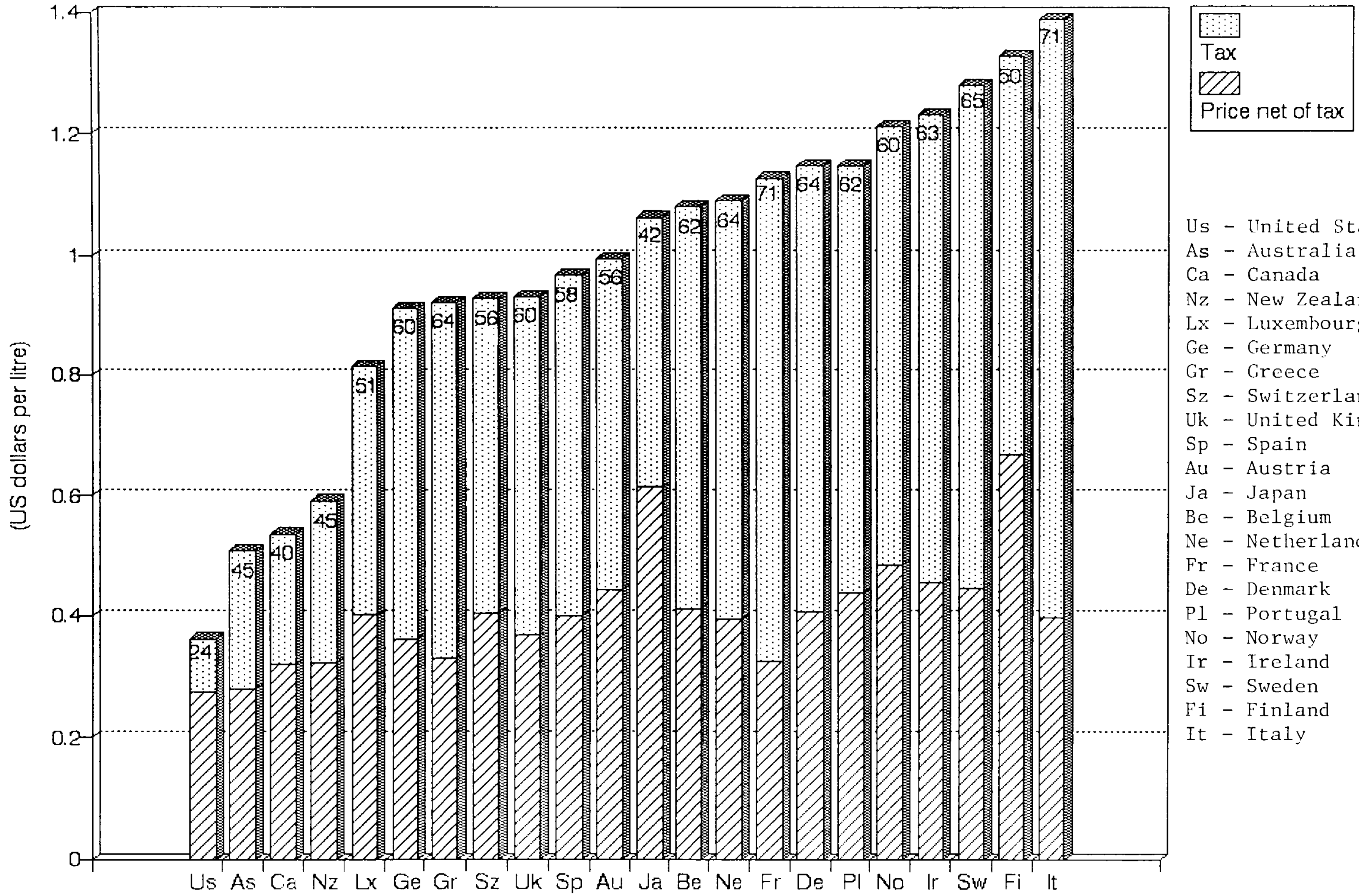
| | | 1978 | | 1982 | | 1986 | | 1989 | | 1990 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation |
| 1. Gasoline | Price (retail) | 1.67 | 0.28 | 2.35 | 0.19 | 2.23 | 0.26 | 2.65 | 0.26 | 3.21 | 0.26 |
| | Price (net) | 0.76 | 0.25 | 1.32 | 0.17 | 0.87 | 0.26 | 1.02 | 0.22 | 1.23 | 0.21 |
| | Tax (% of retail price) | 51.16 | 0.29 | 41.33 | 0.33 | 57.72 | 0.24 | 59.31 | 0.19 | 59.19 | 0.19 |
| | Tax (% of net price) | 122.37 | 0.50 | 78.91 | 0.48 | 160.88 | 0.49 | 164.22 | 0.43 | 162.35 | 0.40 |
| 2. Auto diesel | Price (retail) | 0.91 | 0.33 | 1.55 | 0.20 | 1.40 | 0.26 | 1.59 | 0.25 | 2.03 | 0.26 |
| | Price (net) | 0.61 | 0.19 | 1.17 | 0.10 | 0.83 | 0.23 | 0.91 | 0.21 | 1.11 | 0.23 |
| | Tax (% of retail price) | 28.48 | 0.60 | 21.68 | 0.59 | 37.80 | 0.41 | 40.89 | 0.39 | 43.36 | 0.28 |
| | Tax (% of net price) | 48.72 | 0.78 | 31.24 | 0.71 | 69.46 | 0.51 | 79.53 | 0.50 | 84.27 | 0.43 |
| 3. Light fuel oil (industry) | Price (retail) | 0.52 | 0.18 | 1.14 | 0.13 | 0.87 | 0.30 | 0.92 | 0.39 | 1.20 | 0.42 |
| | Price (net) | 0.48 | 0.15 | 1.05 | 0.09 | 0.68 | 0.14 | 0.69 | 0.12 | 0.89 | 0.14 |
| | Tax (% of retail price) | 7.74 | 0.91 | 6.94 | 0.97 | 17.32 | 1.07 | 17.88 | 1.08 | 18.24 | 1.06 |
| | Tax (% of net price) | 9.06 | 0.97 | 8.06 | 1.03 | 28.83 | 1.24 | 31.76 | 1.38 | 33.15 | 1.44 |
| 4. Light fuel oil (residential) | Price (retail) | 0.58 | 0.16 | 1.26 | 0.13 | 1.04 | 0.29 | 1.16 | 0.37 | 1.53 | 0.38 |
| | Price (net) | 0.51 | 0.13 | 1.11 | 0.11 | 0.74 | 0.22 | 0.77 | 0.15 | 0.99 | 0.12 |
| | Tax (% of retail price) | 11.86 | 0.73 | 11.78 | 0.70 | 25.10 | 0.73 | 27.34 | 0.71 | 27.99 | 0.71 |
| | Tax (% of net price) | 14.57 | 0.78 | 14.37 | 0.77 | 43.73 | 0.97 | 51.38 | 1.06 | 54.10 | 1.09 |
| 5. Heavy fuel oil (industry) | Price (retail) | 0.38 | 0.20 | 0.72 | 0.16 | 0.49 | 0.23 | 0.53 | 0.36 | 0.61 | 0.40 |
| | Price (net) | 0.34 | 0.11 | 0.68 | 0.11 | 0.42 | 0.27 | 0.42 | 0.18 | 0.50 | 0.19 |
| | Tax (% of retail price) | 3.96 | 1.04 | 5.03 | 1.27 | 12.65 | 1.19 | 12.62 | 1.13 | 13.98 | 1.05 |
| | Tax (% of net price) | 4.32 | 1.08 | 5.85 | 1.39 | 19.03 | 1.41 | 19.02 | 1.54 | 20.83 | 1.32 |

Sources: Computed from OECD'S <u>Energy Prices and Taxes</u> (various issues). Data are for 22 industrial countries as classified in International Financial Statistics. See Appendix for details.

## Chart 1.

### Gasoline Prices and Taxes in Industrial Countries [1/]

(Q4 1990)




Us - United States
As - Australia
Ca - Canada
Nz - New Zealand
Lx - Luxembourg
Ge - Germany
Gr - Greece
Sz - Switzerland
Uk - United Kingdom
Sp - Spain
Au - Austria
Ja - Japan
Be - Belgium
Ne - Netherlands
Fr - France
De - Denmark
Pl - Portugal
No - Norway
Ir - Ireland
Sw - Sweden
Fi - Finland
It - Italy

1/ Numbers indicate taxes as a percentage of the retail price.
Source: OECD 1991.

Table 2 provides similar information for two other energy products--electricity and natural gas--for both residential and industrial users in the industrial countries (for these products, comparable data were not available for 1990). Taxes on these energy products have been considerably lower than those on petroleum products; for instance, in 1989 the average tax rate on electricity as a percentage of its pre-tax price was only around 17 percent. Also, taxes on electricity and gas were substantially higher for residential consumers than for industrial users. In general, pre-tax prices were also higher for residential consumers; for instance, natural gas prices for residential consumers were more than twice those for industrial users. To a considerable extent, these differences may be accounted for by differing distribution costs and profit margins in supplying residential and industrial consumers. There is again a significant variation across countries in both pre-tax prices and taxes, with the variation in taxes for industrial consumers particularly marked.

Table 3 provides the information for oil product prices and taxes in a sample of 25 developing countries. 1/ The composition of products is somewhat different from that provided for industrial countries. The table includes, for instance, kerosene which is an important fuel for cooking and lighting in the household sector in developing countries. As in the case of the industrial countries, there is a significant variation in the pre-tax prices of different oil products in the developing countries, with gasoline being the most expensive and fuel oil the least. Taxes on gasoline are again the highest, amounting on average to some 60 percent of the pre-tax price.

There are also a number of notable differences between the industrial and the developing countries. For all products except fuel oil for industry, tax ratios are (on average) lower in the developing countries; the variability over time in the tax ratios is also lower in these countries. While there are no systematic data available on prices of other energy products in the developing countries, there is evidence of a significant subsidization of electricity and of coal in a large number of these countries. The degree of subsidization has varied considerably over time and in general was the highest during the early 1980s. 2/

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1/ Conclusions drawn from the analysis of developing countries should be treated with caution, given the limited size and geographic concentration of the sample (data were available mainly for the Latin American and Asian countries); for details see Appendix 1. Data were also obtained for a somewhat different sample of countries for January 1990 and January 1991. These data are provided in Appendix Table 4.

2/ See World Bank (1990).

Table 2. Non-Oil Product Prices and Taxes in Industrial Countries

(In U. S. dollars per gallon)

| | | 1978 | | 1982 | | 1986 | | 1989 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation |
| 1. Electricity 1/ (industrial) | Price (retail) | 0.04 | 0.25 | 0.05 | 0.25 | 0.06 | 0.37 | 0.07 | 0.35 |
| | Price (net) | 0.04 | 0.26 | 0.05 | 0.26 | 0.06 | 0.37 | 0.06 | 0.34 |
| | Tax (% of retail price) | 2.34 | 1.78 | 2.52 | 1.77 | 3.50 | 1.50 | 3.94 | 1.47 |
| | Tax (% of net price) | 2.60 | 1.87 | 2.82 | 1.88 | 3.97 | 1.61 | 4.52 | 1.54 |
| 2. Electricity 1/ (residential) | Price (retail) | 0.07 | 0.33 | 0.09 | 0.26 | 0.10 | 0.31 | 0.11 | 0.29 |
| | Price (net) | 0.06 | 0.32 | 0.08 | 0.28 | 0.09 | 0.35 | 0.10 | 0.32 |
| | Tax (% of retail price) | 9.30 | 0.88 | 10.36 | 0.71 | 12.94 | 0.54 | 14.34 | 0.43 |
| | Tax (% of net price) | 11.22 | 0.97 | 12.32 | 0.76 | 15.58 | 0.58 | 17.31 | 0.46 |
| 3. Natural gas 2/ (industrial) | Price (retail) | 137.69 | 0.71 | 237.63 | 0.44 | 212.47 | 0.54 | 175.28 | 0.57 |
| | Price (net) | 136.72 | 0.70 | 233.22 | 0.46 | 211.23 | 0.54 | 172.40 | 0.56 |
| | Tax (% of retail price) | 0.48 | 1.50 | 2.98 | 2.45 | 0.42 | 1.36 | 1.41 | 2.24 |
| | Tax (% of net price) | 0.49 | 1.50 | 3.82 | 2.59 | 0.42 | 1.36 | 1.54 | 2.30 |
| 4. Natural gas 2/ (residential) | Price (retail) | 278.46 | 0.73 | 385.93 | 0.51 | 437.83 | 0.58 | 443.07 | 0.68 |
| | Price (net) | 266.51 | 0.76 | 361.32 | 0.56 | 407.20 | 0.64 | 412.12 | 0.74 |
| | Tax (% of retail price) | 5.03 | 1.08 | 8.13 | 0.88 | 7.94 | 0.84 | 9.37 | 0.78 |
| | Tax (% of net price) | 5.66 | 1.12 | 9.52 | 0.90 | 9.19 | 0.85 | 11.05 | 0.79 |

Sources: See Table 1. Data are for 17 industrial countries. See Appendix for details.

1/ Electricity prices are in U.S. dollars per kilo-watt hour.

2/ Natural gas prices are in U.S. dollars/$10^7$ kilo-calories.

Table 3. Oil Product Prices and Taxes in Developing Countries

(In U.S. dollars per gallon)

| | | 1978 | | 1982 | | 1986 | | 1989 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation |
| 1. Premium gasoline | Price (retail) | 1.15 | 0.43 | 1.77 | 0.47 | 1.75 | 0.42 | 1.38 | 0.46 |
| | Price (net) | 0.84 | 0.50 | 1.29 | 0.50 | 1.27 | 0.48 | 0.87 | 0.44 |
| | Tax (% of retail price) | 27.90 | 0.58 | 28.34 | 0.58 | 26.68 | 0.67 | 32.30 | 0.53 |
| | Tax (% of net price) | 47.10 | 0.82 | 48.00 | 0.78 | 47.18 | 0.98 | 58.39 | 0.75 |
| 2. Regular gasoline | Price (retail) | 0.91 | 0.50 | 1.53 | 0.51 | 1.60 | 0.58 | 1.14 | 0.50 |
| | Price (net) | 0.64 | 0.56 | 1.08 | 0.59 | 1.08 | 0.48 | 0.74 | 0.55 |
| | Tax (% of retail price) | 29.06 | 0.53 | 30.08 | 0.70 | 27.87 | 0.69 | 32.85 | 0.58 |
| | Tax (% of net price) | 48.59 | 0.75 | 59.43 | 0.94 | 52.84 | 1.05 | 64.90 | 0.91 |
| 3. Auto diesel | Price (retail) | 0.65 | 0.44 | 1.24 | 0.44 | 1.22 | 0.47 | 1.03 | 0.47 |
| | Price (net) | 0.56 | 0.52 | 1.01 | 0.45 | 0.94 | 0.41 | 0.79 | 0.46 |
| | Tax (% of retail price) | 14.59 | 1.17 | 18.55 | 0.72 | 21.69 | 0.77 | 20.77 | 0.64 |
| | Tax (% of net price) | 25.29 | 1.69 | 26.62 | 0.89 | 35.22 | 1.03 | 30.27 | 0.81 |
| 4. Kerosene | Price (retail) | 0.57 | 0.53 | 1.10 | 0.37 | 1.10 | 0.40 | 0.95 | 0.41 |
| | Price (net) | 0.45 | 0.66 | 0.99 | 0.37 | 0.96 | 0.42 | 0.77 | 0.40 |
| | Tax (% of retail price) | 16.26 | 0.59 | 9.75 | 0.95 | 13.64 | 0.83 | 16.70 | 0.82 |
| | Tax (% of net price) | 21.33 | 0.79 | 12.22 | 1.13 | 18.54 | 1.14 | 24.05 | 1.02 |
| 5. Heavy fuel oil (industry) | Price (retail) | 0.31 | 0.56 | 0.57 | 0.49 | 0.63 | 0.45 | 0.45 | 0.50 |
| | Price (net) | 0.25 | 0.63 | 0.49 | 0.53 | 0.54 | 0.56 | 0.39 | 0.60 |
| | Tax (% of retail price) | 18.18 | 0.77 | 13.71 | 0.95 | 15.38 | 1.15 | 16.68 | 1.16 |
| | Tax (% of net price) | 27.05 | 1.07 | 19.29 | 1.18 | 27.18 | 1.65 | 36.68 | 2.05 |

Sources: Estimates based on Energy Detente (various issues) and Energy Annual (various issues). Data are for 25 developing countries. See Appendix for details.

### 3. Volatility of international energy prices

A principal component of domestic energy prices is the international price of oil. 1/ Table 4 provides an indication of short-term volatility in the international price of oil and oil products, as well as in primary commodity prices and manufactures unit values (see also Chart 2). It seems clear that monthly volatility in nominal price of oil and oil products has increased sharply during the 1980s. Volatility of prices adjusted for inflation was also more marked in the 1980s, although it has declined somewhat during the most recent period. It is also noticeable that prices of oil and oil products have been considerably more volatile than either the average of the non-oil commodity prices, or the export unit values of manufactures of industrial countries. Of course, a comparison of the volatility of an index of commodity prices or of manufactures unit values, with a specific product such as oil may be misleading, because variations in the prices of commodities or goods constituting an index may offset each other. A more appropriate comparison would be between the price of oil and prices of individual commodities. As the data in the Appendix show, while there is considerable degree of variation in individual commodity prices, in general, most of these prices have been less volatile than oil prices.

While prices of oil and oil products have moved broadly in tandem over a run of years, they have diverged considerably over shorter periods of time. Table 5 illustrates this divergence by showing average quarterly changes in nominal prices for crude oil and four oil products for the world's two largest oil product markets in Singapore and Rotterdam (see also Chart 3). As the table shows, there are marked divergences between changes in product prices in the two markets as well as changes between the crude oil price and product prices. In general, it appears that changes in oil prices only partially affect the product prices in any given quarter. For instance, during the last quarter of 1990, while crude oil prices increased by over 15 percent, gasoline prices fell in both markets. 2/ The main reason for this divergence lies in the constantly changing conditions in the global supply and demand balance for individual oil products as well as changes in the crude oil mix used in refinery operations.

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1/ While the notion of a world price of oil is fairly unambiguous, that of the world price of energy is much less so. The main reason for that is that oil is by far the most important of the traded energy fuels. Given the high transportation costs, trade in coal is a very small proportion of the total consumption of coal. Similarly, although trade in natural gas is on the increase, it still accounts for a small proportion of gas consumption. Electricity is traded but the volume and the geographic extent of this trade is again very limited.

2/ Furthermore, these divergent movements in prices can persist for fairly lengthy periods of time. For instance, as Appendix Table 6 shows, for the last three years changes in ex-refinery price of gasoline have differed markedly from changes in crude oil prices.

Table 4. Price Volatility of Oil and Non-Oil Commodity Prices

(In U.S. dollars; 1985=100)

| | 1974-78 | | 1979-82 | | 1983-86 | | 1987-90 | | 1974-90 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation |
| 1. Oil prices | | | | | | | | | | |
| Nominal | 48.40 | 0.099 | 128.16 | 0.138 | 91.90 | 0.259 | 69.08 | 0.280 | 82.27 | 0.420 |
| Real | 65.75 | 0.145 | 120.00 | 0.120 | 89.51 | 0.300 | 48.76 | 0.230 | 80.11 | 0.387 |
| a. Gasoline | | | | | | | | | | |
| Nominal | 52.89 | 0.166 | 134.33 | 0.098 | 92.21 | 0.242 | 75.98 | 0.260 | 86.74 | 0.396 |
| Real | 71.72 | 0.177 | 126.28 | 0.096 | 89.77 | 0.282 | 53.75 | 0.212 | 84.57 | 0.364 |
| b. Diesel | | | | | | | | | | |
| Nominal | 46.11 | 0.138 | 125.73 | 0.100 | 90.57 | 0.223 | 70.36 | 0.258 | 81.01 | 0.410 |
| Real | 62.32 | 0.117 | 118.33 | 0.104 | 88.13 | 0.264 | 49.80 | 0.207 | 78.62 | 0.375 |
| c. Fuel oil | | | | | | | | | | |
| Nominal | 46.69 | 0.114 | 108.02 | 0.180 | 93.93 | 0.304 | 59.17 | 0.231 | 75.17 | 0.414 |
| Real | 63.15 | 0.159 | 100.59 | 0.156 | 91.50 | 0.348 | 41.90 | 0.219 | 73.63 | 0.398 |
| 2. Average non-oil commodity prices | | | | | | | | | | |
| Nominal | 95.76 | 0.090 | 119.99 | 0.091 | 105.93 | 0.090 | 120.05 | 0.099 | 109.57 | 0.134 |
| Real | 130.14 | 0.147 | 112.46 | 0.083 | 101.80 | 0.144 | 85.30 | 0.096 | 108.76 | 0.200 |
| 3. Dollar unit value of manufacturing exports | 74.26 | 0.126 | 106.29 | 0.045 | 104.68 | 0.081 | 140.32 | 0.057 | 104.50 | 0.241 |

Sources: Data based on Platt's Oil Price Handbook (various issues), WEO Databank, and IMF Commodities Division Price Databank.

Note: Oil prices are for U.K. Brent and product prices are for Rotterdam market. Real prices use dollar unit value of manufacturing exports.

Table 5. Petroleum Products and Crude Oil Prices

(Quarterly percentage changes)

A. Singapore market

| | 1988 | | | | 1989 | | | | 1990 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Products | | | | | | | | | | | | |
| 1. Gasoline | -7.4 | 10.2 | -14.6 | -1.2 | 17.1 | 10.2 | -10.3 | -0.1 | 22.7 | -7.0 | 59.5 | -1.2 |
| 2. Diesel | -4.3 | 3.4 | -19.7 | 1.3 | 35.5 | -4.6 | 0.9 | 15.1 | -3.9 | -10.9 | 48.6 | 24.9 |
| 3. Heavy fuel oil | -15.7 | 11.0 | -17.5 | -6.5 | 18.8 | 25.4 | -7.4 | 10.4 | -3.4 | -20.0 | 55.5 | 21.5 |
| 4. Light fuel oil | -11.2 | -2.0 | -9.3 | -11.1 | 29.1 | 24.7 | -16.5 | 7.5 | 25.8 | -32.1 | 52.3 | 35.7 |
| Crude oil 1/ | -10.8 | -0.6 | -13.3 | -11.6 | 34.7 | 6.6 | -3.9 | 7.2 | 1.3 | -15.8 | 67.5 | 17.2 |

1/ Dubai crude oil price.

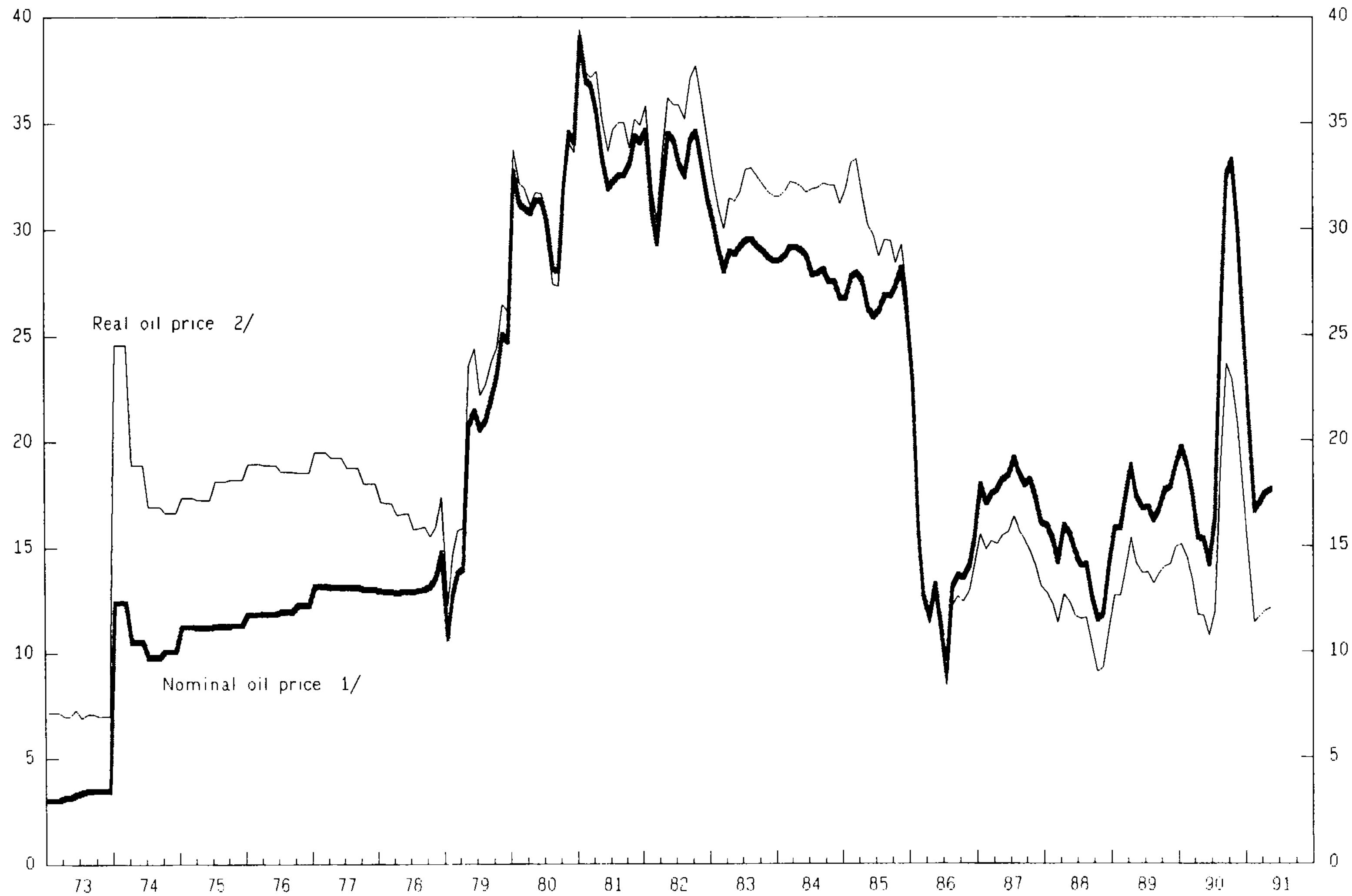
B. Rotterdam Market

| | 1988 | | | | 1989 | | | | 1990 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Products | | | | | | | | | | | | |
| 1. Gasoline | -8.5 | 16.1 | -7.2 | -0.6 | 8.6 | 33.9 | -20.5 | -2.8 | 12.6 | 1.5 | 48.3 | -0.7 |
| 2. Diesel | -14.0 | 2.1 | -10.6 | 3.2 | 13.8 | -0.2 | 4.5 | 23.1 | -10.3 | -11.6 | 47.1 | 30.2 |
| 3. Heavy fuel oil | -20.1 | 8.8 | -13.9 | -4.2 | 21.4 | 16.4 | -4.8 | 19.4 | -14.8 | -21.5 | 49.7 | 34.7 |
| 4. Light fuel oil | -15.4 | 1.7 | -8.5 | 1.7 | 17.5 | 14.9 | -10.3 | 18.3 | -3.2 | -25.8 | 39.7 | 24.0 |
| Crude oil 2/ | -11.8 | 2.5 | -11.1 | -5.9 | 28.9 | 6.2 | -5.3 | 10.3 | 2.4 | -19.3 | 73.7 | 16.6 |

2/ U.K. Brent crude oil price.

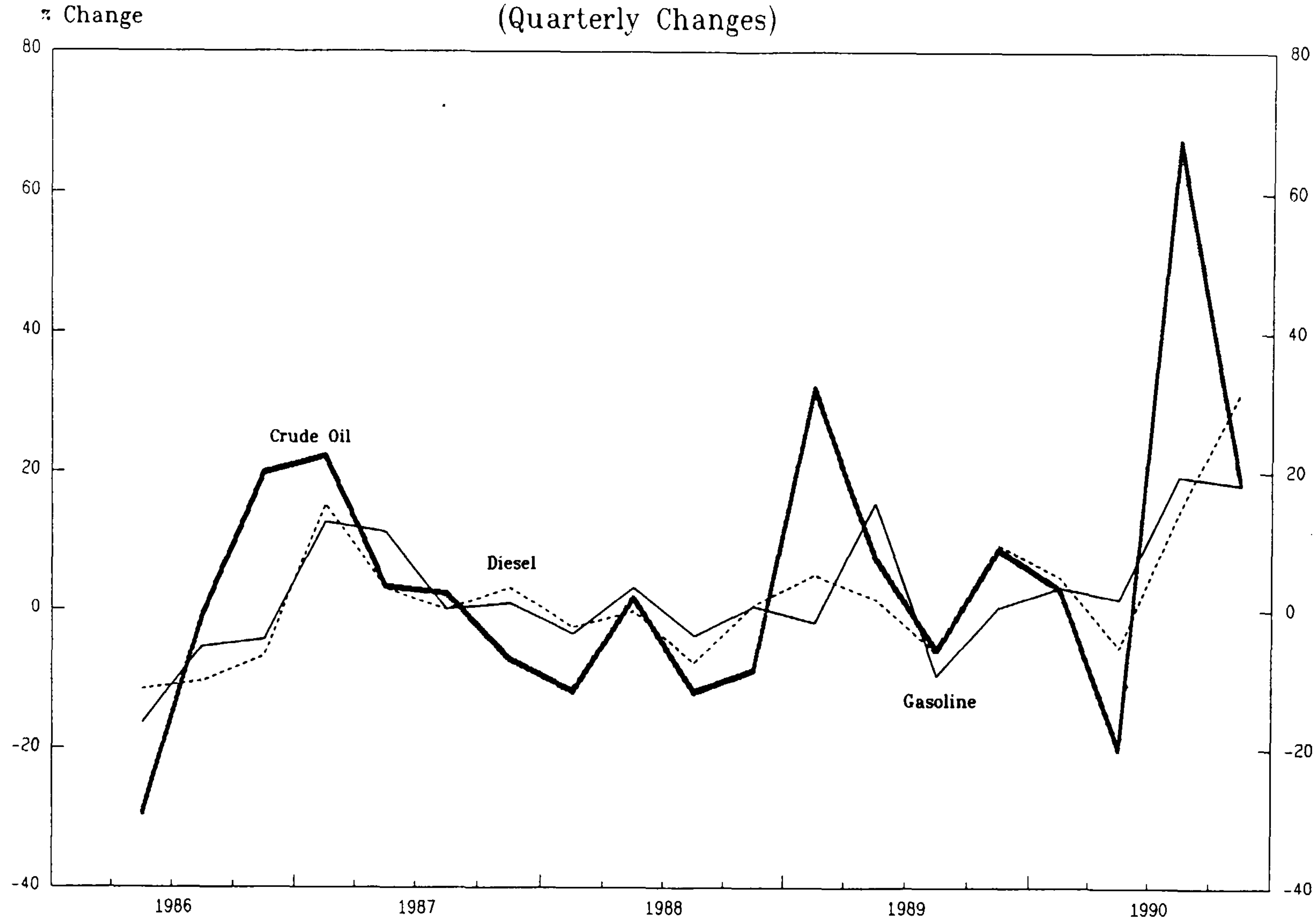
# Chart 2. Nominal and Real Oil Prices.

(U.S. dollars per barrel)




1/ Nominal oil price is the "APSP" (Average Petroleum Spot Price) -- an average of U.K. Brent, Dubai and Alaska North Slope prices
2/ Real price is obtained by deflating nominal price with unit value of manufactured goods exports.

# Chart 3.
# Crude Oil and Product Prices[1/]
(Quarterly Changes)




Sources: OECD (1991) and IMF Commodities Division.

1/ Crude oil price is the "APSP" (Average Petroleum Spot Price) -- an average of U.K. Brent, Dubai and Alaska North Slope Prices. Product prices are average pre-tax domestic prices for the G-7 countries.

While some short-term volatility in prices of oil and oil products is unavoidable, the recent development of futures markets has provided an effective means for both oil consumers and producers to safeguard against such volatility through hedging transactions. However, periodic supply shocks (or expectations of such shocks) can lead to abrupt shifts in prices and have significant economic consequences. As an illustration, it is instructive to examine the impact of the last three shifts in oil prices on the world economy. 1/ For instance, the more than doubling of the world oil prices in 1979-80 led to an increase of nearly 5 percent in the general price level in the world economy. There were also large indirect effects on prices resulting from higher wage demands, prompted by higher oil costs and an increase in the prices of non-oil energy products.

Higher oil prices also had a sizable impact on world economic activity, with a deflationary effect equivalent to nearly 2 percent of world GNP and on the external current accounts of both the oil exporting and oil-importing countries. The current account position of oil importers worsened by about $150 billion during 1979-80, virtually mirroring an improvement in the position of the oil exporting countries .

The sharp decline in prices in 1986 led to a decline in world inflation of nearly 2 percent. But notwithstanding the favorable impact of lower oil prices on domestic demand in the industrial countries, the withdrawal of external demand from the oil exporting and other developing countries reinforced the cyclical downturn in these countries and contributed to a slight decline in the growth of world output in 1986.

In the most recent episode, the surge in oil prices lasted only about three months. Even so, the temporary increase in prices raised the level of consumer prices in the industrial countries by 1/2 a percent and lowered real GNP by a 1/4 of a percent in 1990. Similarly, the real GNP of the oil-importing developing countries was lowered by about 1/2 a percent in 1990.

In addition to the above estimates of the impact of abrupt shifts in oil prices on macroeconomic aggregates, there can be significant underlying costs associated with the adjustment process. For instance, sharp oil price increases result in large capital losses for oil importing countries, as parts of their capital stock become economically inefficient under the new pattern of relative prices. Oil price declines also result in adjustment costs, the most obvious of which are associated with investments in oil exploration and extraction, as well as in new or alternative energy sources. Many of these investments become unviable as energy prices decline precipitously. In this context, it has been noted that uncertainty in the world oil markets has led large energy consumers in many industrial countries to invest in more flexible plant and equipment to increase fuel switching capability. However, for medium and small consumers in industrial

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1/ See Camdessus (1991).

countries, and most of the consumers in developing countries, it has not been feasible to incur the higher capital costs of investments required to promote greater fuel flexibility. 1/ More generally, sharp changes in relative prices induce large-scale and costly reallocations of resources.

The above discussion suggests that in view of the importance of the energy sector, and the costs of volatility in world energy prices, the approach taken to determining domestic energy prices can have a crucial bearing on overall macroeconomic management. The extent to which domestic energy prices should reflect world prices is examined in the next section.

## III. Determination of Domestic Energy Prices

### 1. Efficiency prices

In the absence of externalities and distortions in the economy, "efficient" pricing of fuel--that is, the price which is optimal from the point of view of resource allocation--requires that both the final consumer and the productive sector face the opportunity cost of obtaining the energy products. If energy products are traded, such as oil products, the efficiency price would be the import (or export) parity price which would be well defined and readily observable. 2/

If energy products are nontraded, two alternative approaches can be considered. In cases in which domestic fuel displaces some imported fuel, the marginal cost of imported fuel would provide the efficiency price. For instance, if at the margin, domestic gas is substituted for imported oil, then the efficiency price for gas would be the c.i.f. price of oil. In other cases, the price can be set equal to the marginal cost of producing energy, including the cost of increments to capacity, that is, the long-run marginal cost. This approach is applied frequently in the case of electricity pricing. In addition to the cost of capacity expansion,

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1/ See, for instance, Saunders (1988).

2/ The opportunity cost is assumed to reflect the long-run marginal cost of fuel; thus the discussion assumes that this cost includes an element reflecting the 'user-cost' or a 'premium' for an exhaustible resource. (There is a considerable literature in this area, going back to Hotelling (1931). For recent surveys, see Dasgupta and Heal (1979) and Fisher (1981)). For an oil importing country, which also has some domestic supplies of oil, the world price of oil is taken as given and assumed to include the user-cost element.

efficiency pricing of, say, thermal electricity, would have to take into account the opportunity cost of fuels such as coal or oil. 1/

In the case where non-energy product and factor prices are distorted, setting the optimal price of fuels could be quite complicated. The theory of "second-best" suggests that fuel prices should be set in such a way as to offset inefficiencies elsewhere in the economy. However, as a number of studies have pointed out, 2/ in practice, it is better to deal with economy-wide distortions directly, rather than by adjusting only the price of energy.

2. Criteria for pass-through

In the case where a country imports only refined oil products, efficiency requires that the domestic prices for these products reflect their c.i.f. cost in domestic currency plus the domestic distribution costs. Assuming no externalities, assessing the extent of the pass-through following a change in the international price would be quite straightforward. If domestic distribution costs do not change, full pass-through requires that domestic product prices change by the same absolute amount as the change in the c.i.f. domestic currency prices of imported products, implying a less than proportionate change in domestic prices. The c.i.f. prices can be computed from ex-refinery prices in major refining centers, which are readily available, plus transportation and insurance costs which can be estimated with reasonable accuracy.

To the extent that a government levies tariffs on imported refined products or imposes implicit or explicit taxes on consumption, there may be departures from efficient pricing; but as long as there is information available on the tariff rates and tax wedges, then confirming that full pass-through has occurred in the aftermath of a change in international prices should be feasible.

In the above criterion for the pass-through, the magnitude of the change in the price of crude oil is irrelevant, and only the import price of the refined products is considered. Furthermore, pass-through as defined above is independent of the existing level of taxes on oil products. The rationale for separating pass-through from tax considerations is based on conceptual and operational grounds. Conceptually, if taxes are assumed to be optimal before the international price change, they may, at least in the

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1/ When economies of scale in production are such that investment takes place in large discrete amounts, the supply curve based on strict adherence to short-run marginal cost will show sharp discontinuities. A solution to this problem is to price at long-run marginal cost (LRMC) where the consumer faces a smooth price path and each price over time includes a contribution toward future investment calculated along the LRMC price path. (See Vedavalli (1989)).

2/ See, for instance, Dixit and Newbery (1985).

first instance, be considered to be so after a price change. Operationally, if externalities and fiscal factors are taken into account at the same time as efficiency considerations, it would be very complicated to assess whether or not the pass-through has occurred. The assumption of optimal taxes is, of course, a very strong one, but all that is being suggested is that in the first instance, it is likely to be appropriate to separate fiscal and efficiency considerations in the analysis of pass-through.

Next consider the case where a country has its own refining capacity and imports crude oil. Prices of domestically refined products would in general differ from those of imported refined products, with the differences depending on crude oil prices, transportation and refinery costs, and profit margins. The refinery margins are likely to be a particularly important variable since import prices would reflect the international supply-demand balance for the various refined products, while domestic prices would reflect mainly the domestic market conditions. Despite this consideration, the criterion for assessing the pass-through should again be the c.i.f price of products, rather than the import price of crude oil or the relative costs and margins of domestic refinery operations. The rationale for maintaining this criterion is that the import prices of refined products provide the sole measure of opportunity cost. If the costs of domestic refining exceed those of international operations, the country would be better off importing. If the domestic costs are less, then the country has a comparative advantage in refining but the domestic consumers should still be faced with the opportunity cost given by the import price.

Finally, consider the case of a country which has some domestic production of crude oil but also imports additional oil as well as oil products. If the domestic oil companies are fully integrated, as is the case in many developing countries, the pricing of domestic crude would only entail a bookkeeping operation. 1/ If they are not, domestic crude should be priced at the international prices with the appropriate differentials for quality and transportation. But as in the above two cases, the relevant factor for assessing the pass-through is again the import price of refined products.

### 3. Price smoothing

The above discussion clearly suggests that there should be a full pass-through of changes in world prices into domestic prices. A complex issue, however, relates to the speed of pass-through, that is, whether it should be immediate or whether there should be some smoothing of price changes. In general, from a resource allocation point of view, it would be inefficient to try to prevent short-term volatility in world oil prices from being

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1/ Nevertheless, if crude is priced too cheaply relative to the international price, it could lead to an inefficient use of crude and also excessive refinery profits if product prices are fixed according to import prices.

reflected in domestic prices. To the extent that the price of a commodity is subject to volatility, immediate pass-through forces consumers to take into account the risks associated with such volatility, and the uncertainty which it generates.

Nevertheless, it is often suggested that both consumers and producers face considerable adjustment costs due to sharp, abrupt changes in prices. In such a situation, some smoothing of prices may reduce adjustment costs. The development of international forward and futures markets for oil and oil products during the last decade has provided market instruments to bring about precisely such smoothing. In countries with fully developed domestic markets, additional hedging instruments have also been developing rapidly. The result has been that in the industrial countries, oil companies as well as major consumers of oil products routinely engage in price smoothing through the use of a wide range of market hedging instruments.

In most developing countries, prices of oil products are determined directly by governments or state-owned oil companies. A number of these countries are also increasingly using the international markets to hedge risks. For instance, in recent months, several oil importing countries in Latin America (including Chile and Brazil) have used the futures markets to lock-in prices. If the time-profile and volume of products secured through futures contracts is such that a significant proportion of the future needs of the country could be met through the futures purchases, then the reference price for pass-through considerations should give greater weight to prices reflected in the futures contracts, rather than using only spot prices. Of course, if the future spot price were to fall sharply, and the country remains locked-in to the contracts, domestic prices should remain high to reflect the higher reference price.

A number of developing countries, in the absence of adequate information or expertise for using market instruments, have continued to undertake price smoothing directly by using budgetary resources. Where such a course of action is undertaken, it is critical to ensure that it does not result in any net losses to the budget over time. Consider, for example, an abrupt increase in world energy prices which is passed on to domestic consumers in a staggered manner. To the extent that the increase in the world price is transitory, any impact on government budget would be short-lived. This is because budgetary costs of smoothing operations when the world prices rise temporarily would be offset by budgetary profits of symmetric smoothing operations when prices revert to their original levels. However, if the price increase turns out to be permanent, the government will have to be able to charge higher than world market prices in the future to offset the earlier budgetary losses.

The extent of price smoothing may also depend on expectations of the government and the consumers as to the future course of oil prices. If there is any appreciable divergence of expectations, say due to asymmetric information, then it is no longer straightforward to decide on the optimum response. For instance, a government may regard an increase in world prices as transitory and hence not allow a full pass-through immediately into domestic prices. However, the private sector, correctly or otherwise, may regard the world price rise to be permanent and therefore expect the domestic prices also to rise in the near future. Indeed, even if the world price increase is seen as temporary, the private sector may expect a further increase in domestic prices if the government is seen to be engaged only in a smoothing operation. In such a case, there may be speculative buying, and, at least in the industrial sector, substantial stock hoarding that would be inefficient from resource allocation perspective.

The above discussion clearly suggests that smoothing operations financed through the budget are risky and should not be undertaken when the budgetary position is weak. The risks of smoothing are amply borne out by the experiences of the special "compensatory funds", instituted by a number of developing countries for smoothing of oil product prices over the last decade. 1/ While some of these funds have been effective in reducing abrupt changes in prices to domestic consumers, in many cases the budgetary drain has been large. The problems have essentially arisen due to the sharp increase in resources required by the funds, as political considerations have inhibited governments from implementing the required price changes.

## IV. Energy Pricing in the Presence of Externalities

This section first discusses various externalities associated with energy use. It then develops a simple framework for the use of taxes to deal with these externalities, and examines how such taxes should be changed in response to changes in international energy prices.

### 1. Energy externalities

Externalities are costs or benefits of market transactions not reflected in prices. In the case of energy, the market price may not fully reflect the marginal social cost of consumption (or production) because of a number of negative externalities including the effect on the environment, such as air and water pollution and acid deposition; the associated clean-up costs; the related health costs; and so on. The externalities related to the environment have received particular attention in recent years with some evidence that the production and use of energy is an important cause of global warming. 2/ Concern about water pollution, especially due to the

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1/ These funds have been set up in several Asian countries including Thailand and the Philippines and in several Central American countries.

2/ While the precise significance of global warming is somewhat controversial, there is little disagreement that energy production and use is the single largest source of carbon dioxide emissions. See, for instance, Cox (1991), IEA (1991) and Sathaye and Ketoff (1991).

industrial use of energy and the sharply increasing clean-up costs has also been mounting.

In addition to the direct energy externalities, there are also indirect costs associated with the danger of supply disruption and of price volatility. A disruption in the supply of an imported energy source is likely to impose significant welfare costs, beyond those resulting from the terms of trade losses. These costs arise from the dislocation in domestic productive activities, and are reflected in worsening domestic macroeconomic performance. Furthermore, as discussed in Section II.3, large shifts in oil prices have substantial negative effects on the economies of the oil producing and consuming countries alike. The costs associated with supply disruptions and shifts in prices are part of a much broader "national security" argument which has been frequently discussed in the context of several of the large European countries and the United States, and has received additional impetus in the wake of the recent Middle East crisis. 1/ It has been suggested that, to the extent these costs are not reflected in market prices prevailing before the supply disruption, they may be regarded as similar to the externalities noted earlier.

## 2. Taxation to deal with externalities

The two main methods which a government can employ to deal with the above externalities include the imposition of direct regulations and taxes. For instance, the government may set emission standards for vehicles or it may require firms using, say, coal as an energy source, to employ scrubbers and other pollution abatement devices; alternatively, it may impose a tax, that is, a pollution charge, related to the level of pollution. As is generally accepted, using the price mechanism, corresponding to the use of taxes, to deal with externalities leads to a more efficient outcome than the use of direct controls. 2/ In addition, direct controls often require greater information for their implementation and are more susceptible to arbitrariness and to political manipulation. The discussion below therefore focusses on the use of taxes to deal with the energy externalities.

The main case for using taxes would be to increase the private cost of consuming energy products so that it equals the social cost. Taxes may also be used to deal with the social costs of energy consumption, say, health or clean-up costs. In both these cases, there are two key questions--first, how are the tax rates to be determined, and second, how should they be adjusted following any change in the prices of energy products.

Consider first taxes which are levied for the purpose of equalizing private and social costs. If the objective is, say, to reduce the cost to the environment of carbon dioxide and other green-house gas emissions, the

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1/ See, for instance, IEA (1991). For the United States, the case has been discussed in detail by Broadman and Hogan (1988).

2/ See, for example, Stiglitz (1988).

purpose of taxation will be to curb consumption of hydrocarbons by raising private costs. The necessary rise in private costs would depend on the reduction required in the emissions and the price elasticity of demand. For any required reduction in emission, the more inelastic the demand, the higher the tax rate. But more importantly, given that consumption of different fuels has differing effects on the environment, the tax rates should vary according to the carbon emission characteristics of specific fuels. For instance, carbon emissions from the use of coal are more than twice those from oil products and around three times those from natural gas. Tax rates on these products should therefore reflect their polluting characteristics accordingly. 1/ In principle, the variation in tax rates should be made on the basis of the emissions after the installation of any cleaning devices, which reduce or remove carbon emissions, although in practice, it is often technically difficult to monitor pollution continuously and to tax polluters optimally.

Furthermore, the potential effects on the environment of alternative fuels should also be taken into account. For instance, the possibility of a mishap in a nuclear power plant, or problems associated with the disposal of waste products, as well as the proliferation of nuclear materials, should be taken into account when determining the relative magnitudes of taxes on fossil fuels and on nuclear energy.

It should also be emphasized that given the limited information on the environmental costs and on the way carbon emissions affect these, a precise quantification of these taxes may not be possible. For instance, the International Energy Agency does not provide any firm estimates for such taxes; the best which can be done at this stage is to evaluate the likely impact of a range of different tax rates on different fuels. 2/ The carbon taxes would, of course, yield substantial revenues but, from the point of view of dealing with the externalities, this would not be the relevant consideration.

Energy taxes have also been advocated as means to reduce excessive dependence on any specific energy source through improving the efficiency of energy use, encouraging conservation, and promoting substitution of alternative energy sources. A quantification of social benefits of reducing dependence on any given energy source is extremely difficult as it entails

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1/ According to calculations made by the International Energy Agency, the carbon emission factors are as follows: Coal, 1.88 T-C/TOE; oil, 0.864 T-C/TOE; and natural gas 0.616 T-C/TOE where T-C/TOE is tons of carbon equivalent per ton of oil equivalent, which takes account of the net calorific value of each fuel.

2/ See, for instance, IEA (1991) and Whalley and Wigle (1991). The estimates are also quite sensitive to the assumptions concerning the effect which taxes in any one country would have on the regional and global environment.

complex strategic considerations. In the case of oil, for instance, depending on the costs imputed to its supply disruption or to the impact of volatile prices, it is estimated that taxes on oil products can range from a few cents to several dollars a barrel. 1/

Finally, taxes may also be levied to meet the costs of energy consumption, say, water pollution, the effect of pollution on public health, on buildings, etc.. From an efficiency perspective, past costs of energy consumption should be regarded as "sunk" costs, that is, they have been already incurred and there is no reason why they should be borne by current consumers of energy. But if the government has to provide additional health services or has to incur extra expenditure for cleaning-up due to the current use of energy, it may then levy taxes specifically on energy products to deal with this externality. The tax rates would be set to yield sufficient revenues to cover the costs being incurred and would depend on the elasticity of demand and the amount of expenditures required to deal with the costs.

Next, consider how tax rates should be changed in response to, say, an increase in the world price of oil which is regarded as permanent. If the tax rate is kept constant, and there is a full pass-through in the sense defined in the preceding section, then regardless of the type of tax (specific or proportional), there would be an increase in the price facing the domestic consumer. In the case of a proportional tax, price would increase more than in the case of a specific tax. If the marginal social cost of consumption has not increased, the consumer would now be paying in excess of the social cost. In other words, if the quantity of energy consumed, and therefore carbon emission, was optimal before, it would not be so now. On efficiency grounds, therefore, the tax rate should be reduced, with the magnitude of the reduction depending both on the type of tax and on the increase in international prices of energy products. 2/

With regard to the conservation objective, if the current domestic price is such that this objective is regarded as being met, then any increase in the world price should not be passed on in the form of yet higher domestic prices. However, if there is no "trigger" price per se according to which the conservation objective might be considered attainable, then an increase in the world price may be regarded as having increased the opportunity cost of consuming the oil products. In that case, at a minimum, there should be a corresponding increase in domestic prices, which would imply that the tax rates remain unchanged.

A different type of argument has been made in terms of a welfare-improving tariff on imports. If the market for an imported energy source is not competitive, it may be in the interest of the consuming nations to

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1/ See, for instance, IEA(1991).

2/ Note that this argument assumes taxation is only for the purpose of conservation, rather than a measure to compensate for externalities.

impose a tariff on energy products. The major elements in determining the size of such a tariff include the extent to which the price which a large country pays for oil on the world market is affected by the level of home country demand and its price elasticity. In other words, the effectiveness of the import tariff, as of any other tax measure in dealing with the externalities, depends critically on the extent to which oil consumption responds to changes in oil prices, and on the parameters of supply. Here, as noted earlier, there is a considerable difference in the demand patterns between the industrial and developing countries and between different sectors in each of these two groups of countries. However, in general, it appears that the demand for oil products is relatively inelastic in the short run, say, within the first six months or so of any price change. In the medium and long run, the demand is relatively elastic and an import tariff may have the desired effect on consumption. 1/ But even if such an effect is realized, it is far from clear that such a tariff, which would alter relative prices in the world economy, would be desirable from a global resource allocation perspective.

Finally, whether or not to change taxes levied to meet the costs of energy consumption would again depend on the structure of taxes and on the change in world prices. For instance, in the case of a proportional tax, an increase in prices of oil products for which demand is relatively inelastic would lead to an increase in revenues in excess of those needed for the provision of, say, additional health services. Thus, in this case a reduction in tax rates would be warranted. In the case of a specific tax, a decline in energy use, following an increase in its domestic price, would lead to a decline in revenues. But if health costs declined proportionately, the tax rate should be left unchanged.

The main conclusion of this section is that there are significant direct and indirect externalities in the consumption and production of energy. The tax system can be used to deal with these externalities, and when deciding on the extent to which changes in world prices should be passed-through into domestic prices, both the nature of externalities, and the rationale for imposing these taxes should be taken into account. In general, the required adjustment in taxes should take place in a symmetric manner. However, in cases in which the structure of energy taxes had not been at an appropriate level, advantage should be taken of changes in world

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1/ For a detailed discussion in this area, see OECD(1983). Estimates of elasticities vary very considerably across countries and across sectors within individual countries. Even for overall energy demand, there is significant variation. For instance, overall short run price elasticity for Japan is -0.09 and the long run elasticity is -0.35; the long-run elasticity in the transportation sector is -0.53 while in the residential sector it is only -0.02. In contrast, for Belgium the overall long-run elasticity is estimated to be -1.05; elasticities in the residential and transport sectors are -0.92 and -1.33 respectively.

prices to correct this structure. In such cases, adjustment to changes in international energy prices should be asymmetric.

## V. Budgetary Considerations

In most countries, taxes and subsidies on energy products play a significant role from a government's budgetary perspective. The pervasive use of energy products in the economy provides a wide base for revenue purposes. Taxes on energy products are also relatively easy to administer, and offer considerable flexibility in responding to changed economic circumstances. In addition, as discussed in Section IV above, to the extent that there are externalities in the economy, energy taxes can be used to improve the efficiency of resource allocation. However, in the absence of such externalities, any tax itself would give rise to distortions and entail a loss in welfare.

### 1. Energy taxes and subsidies

Oil products have traditionally provided the largest share of government revenues from energy products. In most countries, there is a variety of such taxes imposed on different types of products. These include ad valorem taxes, such as general sales taxes and the value added taxes, which are proportional to the price of the product, and specific duties which are fixed per unit of product and are invariant to the product's price. Both proportional and specific taxes are often levied on the same oil product. In addition, there are frequently import duties on both crude oil and oil products as well as taxes on profits of refineries and distribution companies.

During the last two decades, the importance of oil product taxes in government revenues has varied considerably among both industrial and developing countries. For instance, during the early 1970s, energy taxes, consisting largely of oil product taxes, accounted for nearly a third of total tax revenues, in the largest developing countries. 1/ The share of oil taxes dropped to around a quarter of all tax revenues by the end of the 1970's and further to under 20 percent by 1982. However, after the sharp oil price declines in 1986, the share increased again to around 25 percent. In the largest industrial countries, the share of energy taxes was considerably smaller--about 10 percent in 1987--but this share varied over time in a similar manner as that in the major developing countries.

The main factor responsible for changes in the relative share of energy taxes was the change in the effective tax rates following changes in the world price of oil. Before the first oil shock, the ratio of domestic oil

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1/ These are estimates based on Cnossen (1977), Due (1988), Imran and Barnes (1990), and data provided in the International Finance Statistics. For sample and definitions, see Appendix 2.

product prices to international prices was 2.7 for the oil importing developing countries, and 3.3 for the industrial countries. 1/ Following the first world oil price increase in 1973-74, governments cushioned the impact of oil price increases by reducing the effective tax rates. That meant that by 1978, the ratio of domestic to world prices for the developing countries had fallen to 1.8, while for the industrial countries it had declined to 2.0. Following the second oil price increase in 1979-80, the ratios fell further to 1.4 for the developing countries and 1.6 for the industrial countries. After the world oil price declines in 1986, however, there was an increase in the effective tax incidence, leading to an increase in the ratio for both sets of countries to close to levels in the late 1970s.

A cross-country comparison of petroleum tax revenues reveals a number of other features. It appears, for instance, that small countries collect less than average from these taxes, in large part because of relatively lower transportation costs. In most industrial countries, the taxes are largely collected on motor fuel (gasoline and/or diesel fuel); in developing countries, on the other hand, a substantial part of the taxes derives from diesel oil used for industrial or agricultural purposes, and from kerosene or fuel oil. In India, for instance, the largest share of the petroleum excise is collected on diesel fuel used by the industrial sector. 2/

In addition to energy taxes, the fiscal position is also affected by both subsidies provided on several of the petroleum products and investments in the oil sector. In general, it appears that non-oil energy products are subsidized significantly, in contrast to the high taxes on oil products. For instance, a number of recent studies have emphasized that the very low tariffs for electricity in developing countries has led to large subsidization of the power sector. 3/ At the same time, the power sector is the recipient of very substantial public investment funds, accounting on average for a fifth to a quarter of all public sector investment in developing countries in recent years. As noted earlier, the demand for energy is continuing to increase sharply in these countries and hence the supply has to keep pace. However, the financing of these increased supplies

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1/ See World Bank (1981). As discussed in Section III, the difference in the domestic and world prices is due to a range of factors, of which taxes are but one. However, what is of interest is the relative change in these ratios over time where taxes play a large role.

2/ In both industrial and developing countries, other road user charges, such as taxes on motor vehicles, registration fees, and passenger and freight charges and tolls also bring in substantial revenues.

3/ See World Bank (1990). This study concluded that during the 1980s the average level of electricity tariffs in developing countries was only half of the average level in the industrial countries, and was only about half the level required to cover the average incremental costs of the planned expansion of power systems.

is being seriously hampered by inadequate returns, especially from the power sector.

Meanwhile, the high level of taxes on oil products can have adverse effects on consumer welfare and on the economy generally. The "excess burden" or the "deadweight" loss in welfare from these taxes may be substantial, especially since the welfare loss increases more than proportionately with increases in tax rates. Such a consideration suggests that it is desirable to have a more uniform structure for energy taxes than a single large tax on a specific petroleum product. 1/

2. Tax revenues

It is, of course, not only changes in tax rates on energy products which affect budgetary revenues, but also such factors as the type of tax and the underlying elasticities of demand. The impact of such factors is illustrated in Table 6. The first half of the table shows, for any given proportional tax, the percentage change in revenues, resulting from a given world price change and a full pass-through; the second half of the table shows the revenue change for any given specific tax. 2/ For both types of taxes, price is assumed to increase by two steps of 20 percent and then by 10 percent, and also to decrease by similar magnitudes.

In the case of a proportional tax, if demand is relatively inelastic, as would be the case in the short run, a full pass-through of an increase in world prices would lead to a marked increase in revenues; in the case of very low elasticity, there is an almost proportional increase in revenues. For instance, with elasticity of demand of -0.3, a price increase of 50 percent increases revenues by 35 percent. However, with higher elasticities, revenues would increase much less or even decline. With elasticity of -1.5, a similar price increase leads to a decline in revenues of 25 percent. This effect is, of course, symmetrical; when the price falls revenues decline sharply if elasticities are low, while at higher elasticities revenues increase.

With regard to the specific tax, the revenue impact of price change is markedly different. For a given decline in prices. the more elastic the demand, the greater the increase in quantity consumed and the greater the increase in revenues. Conversely, in the case of a price increase, the greater the elasticity of demand, the greater the decline in revenues.

The above illustration has focussed only on the direct effect of price changes on government revenues. Any change in the world price of oil would,

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1/ The structure of taxes should, of course, take into account the elasticities of demand and supply for the different energy products.

2/ For the sake of simplicity, it is assumed, not unrealistically, that the elasticity of supply is large so that the impact of the price change is borne fully by the final consumer.

Table 6. Percentage Change in Revenue for a Given Price Change: Proportional and Specific Tax

A. Proportional Tax

| | Price Change in Percent | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Elasticity | -50 | -40 | -20 | 0.0 | 20 | 40 | 50 | 60 |
| 0 | -50 | -40 | -20 | 0 | 20 | 40 | 50 | 60 |
| -0.3 | -35 | -28 | -14 | 0 | 14 | 28 | 35 | 42 |
| -0.8 | -10 | -8 | -4 | 0 | 4 | 8 | 10 | 12 |
| -1.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -1.5 | 25 | 20 | 10 | 0 | -10 | -20 | -25 | -30 |

B. Specific Tax

| | Price Change in Percent | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Elasticity | -50 | -40 | -20 | 0.0 | 20 | 40 | 50 | 60 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -0.3 | 15 | 12 | 6 | 0 | -6 | -12 | -15 | -18 |
| -0.8 | 40 | 32 | 16 | 0 | -16 | -32 | -40 | -48 |
| -1.0 | 50 | 40 | 20 | 0 | -20 | -40 | -50 | -60 |
| -1.5 | 75 | 60 | 30 | 0 | -30 | -60 | -75 | -90 |

of course, also have substantial indirect effects. Suppose, for instance, that a fall in the world price is fully passed-through to domestic prices; with tax rates unchanged, there will be an increase in demand for oil products, and hence an increase in revenues from specific duties on these products. Depending on the price elasticities, this could be offset by a fall in receipts from any proportional tax levied on these products. If lower oil prices feed through to lower prices more generally, then receipts from general sales taxes will be also be reduced. In addition, if lower inflation causes some moderation of wage increases, taxes on income may also yield less than anticipated. The quantification of these effects again hinges mainly on the values of demand elasticities and on the wage bargaining process, but the effects can clearly be significant.

## VI. *Equity Considerations*

This section examines equity issues related to energy costs. The argument for the regressive impact of rising fuel prices on low-income groups is essentially based on evidence from the "Family Expenditure Surveys," which show that the share of energy expenditure in the total is significantly higher for low-income groups than for high-income groups. The regressive impact of higher energy prices on lower-income groups, however, should take account of the indirect as well as the direct effects. Households consume energy indirectly when they purchase any commodity or service such as public transport. There is some evidence that, at least in the industrial countries, the ratio of households' indirect energy consumption to direct energy consumption rises with household income. 1/ Thus, it appears that indirect energy costs tend to moderate the sharply regressive impact of direct energy costs.

It has often been advocated that the fuels used directly by the low-income households should be subsidized. In considering the issue of subsidization, three types of factors need to be taken into account:

(1) When the fuels are subsidized, is it possible to ensure that the benefits do reach the low-income groups? In many developing countries, for instance, the price paid by the consumers, especially in rural areas, frequently exceeds the apparently fixed price, with the traders who would frequently have a local monopoly, receiving the difference. 2/ Nevertheless, if the subsidy is not provided, the price would be higher still.

(2) Are there any unintended consequences? For instance, expensive fuels may be adulterated by the subsidized ones, such as diesel by kerosene, leading to inefficient and wasteful use of energy.

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1/ For some evidence in this area, see, for example, Webb and Ricketts (1980), Common (1985), and Kumar (1987).
2/ See, for example, Bhatia (1985).

(3) Are the potential benefits limited to the low-income households, or do the benefits in fact accrue to higher-income groups? Subsidization of electricity to rural areas provides an example of these benefits being claimed by the relatively better off households.

The above considerations suggest that, in general, direct help to the low-income groups would be more appropriate. Furthermore, any subsidies on fuels need to be financed by general taxes on commodities. Thus, the regressive consequences of such taxes should also be taken into account. Low-income households that consume little electricity and few petroleum products could end up contributing proportionately more. Cross subsidization within the energy sector is often offered as an alternative; for example, taxing gasoline or diesel to subsidize kerosene. If only richer people use gasoline for private transport, this approach may appear satisfactory, but large price differentials inevitably promote adulteration of diesel, and even gasoline, with kerosene. Further, if poorer people use public transport, higher diesel prices may be reflected in increased fares. In any case, if a subsidy is to be provided for some products, it is not clear why such subsidies should be provided by consumers of other oil products, rather than the community at large.

## VII. Issues for Discussion

This section summarizes some of the key issues that have emerged in the preceding discussion, and on which Executive Directors may wish to focus in the course of their deliberations:

(1) In a majority of countries, taxes on oil products account for a sizable proportion of retail prices, with the tax rates varying considerably across products and over time. Taxes on other energy products have been in general much lower, and, in developing countries especially, there appears to be marked subsidization of coal and electricity.

(2) There has been a considerable degree of volatility in world energy prices during the last decade. Due to the pricing and tax policies in individual countries, however, this volatility has been transmitted in differing degrees within individual countries. For the world economy as a whole, it has, however, entailed a large cost.

(3) In the absence of externalities, prices confronting the domestic users of energy should correspond to the international price of energy or, in the absence of significant trade, to its long-run marginal cost.

(4) From the point of view of resource allocation, it would be inefficient for governments in developing countries to try to prevent short-term volatility in world oil prices from being reflected in domestic prices. A timely pass-through of world prices would help ensure that consumers learn

to cope with volatility by taking into account the risks associated with price uncertainty.

(5) In this context, the development of international futures markets for oil products has provided a market-based means for buyers and sellers to hedge against risks and in effect bring about the smoothing of final product prices. For instance, in industrial countries, a substantial degree of price smoothing is undertaken by the private sector through the use of inventory adjustments as well as through forward and futures contracts.

(6) Many developing countries, in which prices are determined directly by governments or state-owned oil companies, have also relied increasingly on the international markets to hedge price risks. However, a number of these countries, in the absence of adequate information and expertise for using market instruments, have continued to undertake price smoothing directly by using budgetary resources.

(7) It is critical, however, that any such smoothing not result in net losses to the budget over time (or force such losses onto public or private enterprises). To the extent that a change in the world prices is transitory, as prices revert to their original levels, a symmetric delay in fully adjusting domestic prices would be necessary in order to allow the expenditures previously made to be recouped.

(8) In general, however, it is difficult to determine, ex ante, whether a shift in prices is transitory or permanent. It is essential that, if there is evidence that the world price change is likely to be permanent, it is fully passed through to domestic prices in a timely manner. Indeed, domestic prices will, at some stage, have to actually overshoot world prices in order to compensate for the budgetary impact (or the impact on state or private enterprises) of any initial smoothing operations. Budgetary financed smoothing operations are risky and should be undertaken only when there is evidence that the change in prices is transitory, the budgetary position is sufficiently strong, and it will be possible to recoup any losses through offsetting price adjustments in the future.

(9) There are a number of externalities associated with the consumption and production of energy. The tax system can play a major role in internalizing these externalities, even though it is difficult to be precise in determining the optimum structure of tax rates.

(10) In setting taxes to deal with the externalities, care should be taken to ensure that unintended distortions are not created. In particular, when deciding on tax rates, the energy sector as a whole should be considered rather than any specific energy product. A failure to do this could adversely affect resource allocation, rather than improve it.

(11) Taxes on oil products make a major contribution to government revenues, while subsidies on some energy products, such as electricity, have

been the cause of budgetary drain. In both developed and developing countries, governments have changed effective tax rates markedly following changes in the world price of oil, with tax rates being reduced when international oil prices increased, and raised when international prices fell.

(12) The pass-through of changes in international prices into domestic prices can have a profound effect on budgetary revenues. The magnitude of this effect depends crucially on both the type of tax and tax rates, as well as on the elasticity of demand and the change in price. In addition to the direct revenue effects, there can be significant indirect effects due to the impact of domestic energy price changes on the economy.

(13) The impact of higher domestic energy prices on the low income groups has been an important concern of governments. In general, it is preferable to deal with this concern by providing direct help to the low income groups, rather than subsidizing the price of fuels.

## Data Sources

1. The data on energy prices and taxes, provided in Section 1 of the text, were obtained from the following sources:

a. For industrial countries, averages were computed from data provided in the OECD publication Energy Prices and Taxes (1984, 1986, and 1991, all fist quarters), supplemented by data from IMF's countries' "Recent Economic Developments" memoranda. For petroleum products, the averages reported in the text are for the following countries: Australia, Austria, Beligum, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States. The exceptions are auto diesel, for which data were not available for Canada, New Zealand, and Switzerland, and light fuel oil for industry, for which data were not available for Australia, Austria, Netherlands, and New Zealand.

For electricity and natural gas, the averages are based on the same countries as all petroleum products, except Finland, Luxembourg, New Zealand, Norway, and Portugal.

All data for industrial countries are monthly averages for each of the four benchmark years.

b. For developing countries, data were obtained from three main resources: (a) Energy Détente, a monthly publication which provides data on a large sample of developing and industrial countries; (b) Energy Annual, published by the Energy Information Agency, (USA); and (c) IMF's "Recent Economic Developments" memoranda.

For premium and leaded gasoline, and kerosene, the data are for the following countries: Argentina, Barbados, Bolivia, Brazil, Colombia, Ecuador, El Salvador, Ethiopia, Grenada, Guatemala, Honduras, India, Indonesia, Israel, Kenya, Malaysia, Panama, Paraguay, Peru, Philippines, South Africa, Thailand, Turkey, Uruguay, and Venezuela. For the other two fuels, data are for these countries except Argentina, Colombia, Guatemala, Honduras, Panama, and Uruguay.

The measures of volatility were computed form data obtained from the following sources: (a) oil: Platt's Oil Price Handbook (various issues); (b) manufactures unit values: WEO databank; (c) commodity prices: Commodities Division databank.

2. Data on energy intensity, noted in Section II, were obtained from the Annual Report of the Petroleum Finance Company Ltd.

3. Data on revenues from petroleum product taxes were obtained as follows:

a. Developing countries: Data were obtained for the following eight countries from Cnossen (1977), Imran and Barnes (1990), and Government Finance Statistics: Brazil, China, India, Indonesia, Malaysia, Pakistan, Philippines, and Thailand. Data provided by Cnossen (1977) are used for averages for 1972-73 and other sources for 1979-80, 1982, and 1987.

b. Industrial countries: Data were compiled for the seven largest industrial countries from data provided by the OECD and Government Finance Statistics.

c. Data on the ratio of domestic petroleum product prices to international prices were obtained from World Bank (1981) for 1973, 1978, and 1979-80. Data are for a large sample of industrial and developing countries. For 1987, data were estimated for the eight largest developing countries and the seven largest countries from data provided in Platt's Handbook (op. cit.) and Government Finance Statistics.

## Additional Results

This Appendix provides four sets of additional results which complement the results noted in text:

1. Appendix Tables 1 to 3 correspond to Tables 1 to 3 in the text, but with prices converted to U.S. dollars per BTU. Given that fuels differ in their heat or energy content, such a conversion allows a somewhat better comparison of prices across fuels. The tax ratios are, of course, unchanged by this conversion.

2. Appendix Table 4 provides price and tax data for a sample of 35 developing countries for January 1990 and January 1991. Thus the sample is larger than that discussed in the text for which a longer time series is available. The additional countries are as follows: Bangladesh, Bhutan, Burundi, Cameroon, Côte d'Ivoire, Malawi, Sierra Leone, Sri Lanka, Sudan, and Tanzania.

3. Appendix Table 5 provides some data on volatility in the nominal prices of individual commodities; the commodities chosen are a cross-section of primary commodities. The results show that for 1974-90, volatility in individual commodity prices was generally considerably lower than that in world oil prices.

4. Appendix Table 6 corresponds to Table 5 in the text and provides data on semi-annual and annual changes in crude oil and products prices.

Appendix Table 1. Oil Product Prices and Taxes in Industrial Countries 1/

(In U.S. dollars per BTU)

| | | 1978 | | 1982 | | 1986 | | 1989 | | 1990 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation |
| 1. Gasoline | Price (retail) | 15.21 | 0.28 | 21.34 | 0.19 | 20.39 | 0.26 | 24.19 | 0.26 | 29.38 | 0.26 |
| | Price (net) | 6.91 | 0.25 | 12.10 | 0.17 | 7.95 | 0.26 | 9.33 | 0.22 | 11.41 | 0.21 |
| | Tax (% of retail price) | 51.16 | 0.29 | 41.33 | 0.33 | 57.72 | 0.24 | 59.31 | 0.19 | 59.19 | 0.19 |
| | Tax (% of net price) | 122.37 | 0.50 | 78.91 | 0.48 | 160.88 | 0.49 | 164.22 | 0.43 | 162.35 | 0.40 |
| 2. Auto diesel | Price (retail) | 5.09 | 0.33 | 8.69 | 0.20 | 7.84 | 0.26 | 8.90 | 0.25 | 11.45 | 0.26 |
| | Price (net) | 3.39 | 0.19 | 6.57 | 0.10 | 4.66 | 0.23 | 5.09 | 0.21 | 6.15 | 0.24 |
| | Tax (% of retail price) | 28.48 | 0.60 | 21.68 | 0.59 | 37.80 | 0.41 | 40.89 | 0.39 | 43.36 | 0.28 |
| | Tax (% of net price) | 48.72 | 0.78 | 31.24 | 0.71 | 69.46 | 0.51 | 79.53 | 0.50 | 84.27 | 0.43 |
| 3. Light fuel oil (industry) | Price (retail) | 3.55 | 0.18 | 7.70 | 0.13 | 5.87 | 0.30 | 6.23 | 0.39 | 8.11 | 0.42 |
| | Price (net) | 3.25 | 0.15 | 7.12 | 0.09 | 4.58 | 0.14 | 4.69 | 0.12 | 6.00 | 1.36 |
| | Tax (% of retail price) | 7.74 | 0.91 | 6.94 | 0.97 | 17.32 | 1.07 | 17.88 | 1.08 | 18.24 | 1.06 |
| | Tax (% of net price) | 9.06 | 0.97 | 8.06 | 1.03 | 28.83 | 1.24 | 31.76 | 1.38 | 33.15 | 1.44 |
| 4. Light fuel oil (residential) | Price (retail) | 3.96 | 0.16 | 8.55 | 0.13 | 7.02 | 0.29 | 7.85 | 0.37 | 10.33 | 0.38 |
| | Price (net) | 3.45 | 0.13 | 7.49 | 0.11 | 4.99 | 0.22 | 5.21 | 0.15 | 6.73 | 1.16 |
| | Tax (% of retail price) | 11.86 | 0.73 | 11.78 | 0.70 | 25.10 | 0.73 | 27.34 | 0.71 | 27.99 | 0.71 |
| | Tax (% of net price) | 14.57 | 0.78 | 14.37 | 0.77 | 43.73 | 0.97 | 51.38 | 1.06 | 54.10 | 1.09 |
| 5. Heavy fuel oil (industry) | Price (retail) | 2.52 | 0.20 | 4.79 | 0.16 | 3.28 | 0.23 | 3.53 | 0.36 | 4.04 | 0.38 |
| | Price (net) | 2.27 | 0.11 | 4.54 | 0.11 | 2.78 | 0.27 | 2.78 | 0.18 | 3.28 | 0.15 |
| | Tax (% of retail price) | 3.96 | 1.04 | 5.03 | 1.27 | 12.65 | 1.19 | 12.62 | 1.13 | 13.98 | 1.05 |
| | Tax (% of net price) | 4.32 | 1.08 | 5.85 | 1.39 | 19.03 | 1.41 | 19.02 | 1.54 | 20.83 | 1.32 |

1/ This table corresponds to Table 1 in the text and shows prices and taxes normalized according to BTUs.

Appendix Table 2. Non-Oil Product Prices and Taxes in Industrial Countries 1/

(In U.S. dollars per BTU)

| | | 1978 | | 1982 | | 1986 | | 1989 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation |
| 1. Electricity 2/ | Price (retail) | 136.49 | 0.25 | 170.61 | 0.20 | 204.73 | 0.33 | 238.85 | 2.57 |
| (industrial) | Price (net) | 136.49 | 0.25 | 170.61 | 0.20 | 204.73 | 0.33 | 204.73 | 3.00 |
| | Tax (% of retail price) | 2.34 | 1.78 | 2.52 | 1.77 | 3.50 | 1.50 | 3.94 | 1.47 |
| | Tax (% of net price) | 2.60 | 1.87 | 2.82 | 1.88 | 3.97 | 1.61 | 4.52 | 1.54 |
| 2. Electricity 2/ | Price (retail) | 238.85 | 0.29 | 307.09 | 0.22 | 341.21 | 0.30 | 375.34 | 0.27 |
| (residential) | Price (net) | 204.73 | 0.33 | 272.97 | 0.25 | 307.09 | 0.33 | 341.21 | 0.30 |
| | Tax (% of retail price) | 9.30 | 0.88 | 10.36 | 0.71 | 12.94 | 0.54 | 14.34 | 0.43 |
| | Tax (% of net price) | 11.22 | 0.97 | 12.32 | 0.75 | 15.58 | 0.58 | 17.31 | 0.46 |
| 3. Natural gas 3/ | Price (retail) | 0.55 | 0.71 | 0.94 | 0.44 | 0.84 | 0.54 | 0.70 | 0.57 |
| (industrial) | Price (net) | 0.54 | 0.70 | 0.93 | 0.46 | 0.84 | 0.54 | 0.68 | 0.56 |
| | Tax (% of retail price) | 0.48 | 1.50 | 2.98 | 2.46 | 0.42 | 1.36 | 1.41 | 2.24 |
| | Tax (% of net price) | 0.49 | 1.49 | 3.82 | 2.58 | 0.42 | 1.38 | 1.54 | 2.31 |
| 4. Natural gas 3/ | Price (retail) | 1.11 | 0.73 | 1.53 | 0.51 | 1.74 | 0.58 | 1.76 | 0.68 |
| (residential) | Price (net) | 1.06 | 0.76 | 1.43 | 0.56 | 1.62 | 0.64 | 1.64 | 0.74 |
| | Tax (% of retail price) | 5.03 | 1.08 | 8.13 | 0.88 | 7.94 | 0.84 | 9.37 | 0.78 |
| | Tax (% of net price) | 5.66 | 1.11 | 9.52 | 0.90 | 9.19 | 0.85 | 11.05 | 0.79 |

1/ This table corresponds to Table 2 in the text.

2/ Electricity prices are in U.S. dollars per BTU.

3/ Natural gas prices are in U.S. dollars/$10^7$ BTU.

Appendix Table 3. Oil Product Prices and Taxes in Developing Countries 1/

(In U.S. dollars per BTU)

| | | 1978 | | 1982 | | 1986 | | 1989 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean | Coefficient of Variation |
| 1. Premium gasoline | Price (retail) | 10.50 | 0.43 | 16.16 | 0.47 | 15.98 | 0.42 | 12.60 | 0.46 |
| | Price (net) | 7.67 | 0.50 | 11.78 | 0.50 | 11.60 | 0.49 | 7.94 | 0.44 |
| | Tax (% of retail price) | 27.90 | 0.58 | 28.34 | 0.58 | 26.68 | 0.67 | 32.30 | 0.53 |
| | Tax (% of net price) | 47.10 | 0.82 | 48.00 | 0.78 | 47.18 | 0.98 | 58.39 | 0.75 |
| 2. Regular gasoline | Price (retail) | 8.31 | 0.51 | 13.97 | 0.51 | 14.61 | 0.58 | 10.41 | 0.51 |
| | Price (net) | 5.84 | 0.56 | 9.86 | 0.59 | 9.86 | 0.48 | 6.76 | 0.54 |
| | Tax (% of retail price) | 29.06 | 0.53 | 30.08 | 0.70 | 27.87 | 0.69 | 32.85 | 0.58 |
| | Tax (% of net price) | 48.59 | 0.75 | 59.43 | 0.94 | 52.84 | 1.05 | 64.90 | 0.91 |
| 3. Auto diesel | Price (retail) | 3.64 | 0.45 | 6.94 | 0.44 | 6.83 | 0.47 | 5.77 | 0.48 |
| | Price (net) | 3.14 | 0.52 | 5.66 | 0.46 | 5.26 | 0.41 | 4.42 | 0.46 |
| | Tax (% of retail price) | 14.59 | 1.17 | 18.55 | 0.72 | 21.69 | 0.77 | 20.77 | 0.64 |
| | Tax (% of net price) | 25.29 | 1.69 | 26.62 | 0.89 | 35.22 | 1.03 | 30.27 | 0.81 |
| 4. Kerosene | Price (retail) | 4.20 | 0.53 | 8.11 | 0.37 | 8.11 | 0.40 | 7.00 | 0.41 |
| | Price (net) | 3.32 | 0.67 | 7.29 | 0.37 | 7.07 | 0.42 | 5.67 | 0.40 |
| | Tax (% of retail price) | 16.26 | 0.59 | 9.75 | 0.95 | 13.64 | 0.83 | 16.70 | 0.82 |
| | Tax (% of net price) | 21.33 | 0.79 | 12.22 | 1.13 | 18.54 | 1.14 | 24.05 | 1.02 |
| 5. Heavy fuel oil (industry) | Price (retail) | 2.07 | 0.55 | 3.80 | 0.47 | 4.20 | 0.44 | 3.00 | 0.51 |
| | Price (net) | 1.67 | 0.64 | 3.27 | 0.53 | 3.60 | 0.56 | 2.60 | 0.59 |
| | Tax (% of retail price) | 18.18 | 0.77 | 13.71 | 0.95 | 15.38 | 1.15 | 16.68 | 1.16 |
| | Tax (% of net price) | 27.05 | 1.07 | 19.29 | 1.18 | 27.18 | 1.64 | 36.68 | 2.05 |

1/ This table corresponds to Table 3 in the text.

Appendix Table 4. Oil Product Prices and Taxes in Developing Countries, 1990-1991

(In U.S. dollars per gallon)

| | | January 1990 | | January 1991 | | Percentage Change |
|---|---|---|---|---|---|---|
| | | Mean | Coefficient of Variation | Mean | Coefficient of Variation | Mean |
| 1. Premium gasoline | Price (retail) | 1.58 | 0.42 | 1.91 | 0.52 | 20.89 |
| | Price (net) | 0.97 | 0.39 | 1.18 | 0.44 | 21.65 |
| | Tax (% of retail price) | 34.43 | 0.49 | 32.05 | 0.52 | -6.91 |
| | Tax (% of net price) | 63.85 | 0.72 | 57.33 | 0.75 | -10.21 |
| 2. Regular gasoline | Price (retail) | 1.39 | 0.39 | 1.80 | 0.49 | 29.50 |
| | Price (net) | 0.89 | 0.41 | 1.12 | 0.45 | 25.84 |
| | Tax (% of retail price) | 29.06 | 0.53 | 32.49 | 0.53 | 11.80 |
| | Tax (% of net price) | 48.59 | 0.75 | 60.07 | 0.80 | 23.63 |
| 3. Auto diesel | Price (retail) | 1.07 | 0.41 | 1.33 | 0.50 | 24.30 |
| | Price (net) | 0.80 | 0.42 | 0.98 | 0.48 | 22.50 |
| | Tax (% of retail price) | 24.89 | 0.69 | 22.74 | 0.67 | -8.64 |
| | Tax (% of net price) | 43.50 | 1.12 | 35.81 | 0.93 | -17.68 |

Sources: Estimates based on Energy Detente (Vol. XII, No. 4). See Appendix for details.

Appendix Table 5. Price Volatility of Non-Oil Commodity Prices

(Prices in U.S. dollars; 1985=100)

| | 1974-78 | | | 1979-82 | | | 1983-86 | | | 1987-90 | | | 1974-90 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AVG. | S.D. | C.V. | AVG. | S.D. | C.V. | AVG. | S.D. | C.V. | AVG. | S.D. | C.V. | AVG. | S.D. | C.V. |
| Commodity | | | | | | | | | | | | | | | |
| Wheat | 101.99 | 21.603 | 0.212 | 123.01 | 10.079 | 0.082 | 103.16 | 13.888 | 0.135 | 103.60 | 18.008 | 0.175 | 107.59 | 18.801 | 0.175 |
| Coffee | 96.42 | 51.554 | 0.535 | 104.96 | 21.602 | 0.206 | 107.26 | 16.680 | 0.156 | 72.55 | 16.183 | 0.223 | 95.37 | 34.414 | 0.361 |
| Cotton | 107.77 | 17.208 | 0.160 | 127.18 | 14.358 | 0.113 | 110.19 | 22.030 | 0.200 | 127.96 | 15.534 | 0.121 | 117.66 | 19.765 | 0.168 |
| Natural rubber | 102.45 | 22.319 | 0.218 | 153.78 | 30.384 | 0.198 | 118.20 | 19.377 | 0.164 | 131.94 | 19.668 | 0.149 | 125.17 | 30.059 | 0.240 |
| Copper | 104.01 | 28.941 | 0.278 | 130.23 | 22.203 | 0.170 | 101.54 | 8.595 | 0.085 | 174.45 | 38.562 | 0.221 | 126.17 | 39.530 | 0.313 |
| Nickel | 94.65 | 10.362 | 0.109 | 118.82 | 18.276 | 0.154 | 92.94 | 10.564 | 0.114 | 208.34 | 88.858 | 0.426 | 126.69 | 64.236 | 0.507 |

Sources: Data based on Commodities Division Price Databank.

Appendix Table 6. Petroleum Products and Crude Oil Prices

(Semi-annual and annual percentage changes)

A. Singapore market

| | 1988 | | 1989 | | 1990 | | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|
| | I | II | I | II | I | II | | | |
| Products | | | | | | | | | |
| 1. Gasoline | -5.3 | -10.9 | 22.3 | -6.0 | -2.8 | 57.4 | -14.5 | 11.8 | 45.0 |
| 2. Diesel | -4.7 | -17.9 | 33.2 | 5.9 | -2.8 | 57.4 | -12.3 | 23.7 | 28.7 |
| 3. Heavy fuel oil | -20.1 | -16.0 | 29.4 | 8.5 | -8.8 | 53.1 | -27.0 | 23.2 | 20.1 |
| 4. Light fuel oil | -16.4 | -15.1 | 36.6 | -3.8 | 9.4 | 45.2 | -21.1 | 23.0 | 31.6 |
| Crude oil 1/ | -13.6 | -18.6 | 30.6 | 2.7 | -3.5 | 66.3 | -21.9 | 18.8 | 30.3 |

B. Rotterdam market

| | 1988 | | 1989 | | 1990 | | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|
| | I | II | I | II | I | II | | | |
| Products | | | | | | | | | |
| 1. Gasoline | -4.5 | -0.6 | 26.7 | -10.3 | 11.8 | 49.0 | -5.8 | 19.8 | 31.6 |
| 2. Diesel | -12.5 | -8.3 | 15.4 | 17.4 | -6.8 | 58.8 | -13.5 | 19.6 | 29.8 |
| 3. Heavy fuel oil | -23.2 | -12.2 | 28.6 | 12.4 | -17.3 | 54.5 | -29.8 | 27.7 | 11.4 |
| 4. Light fuel oil | -20.1 | -7.0 | 27.2 | 4.7 | -8.6 | 33.3 | -24.4 | 25.5 | 9.1 |
| Crude oil 2/ | -13.5 | -12.7 | 28.9 | 2.6 | -3.0 | 68.0 | -18.4 | 21.7 | 31.7 |

1/ Dubai crude oil price.
2/ U.K. Brent crude oil price.

Note: Changes in prices are averages for the period relative to the preceding period. For instance, 1988 I refers to average of prices in the first half of 1988 relative to the average of prices in the preceding six months.

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