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Issues in Domestic Petroleum Pricing in Oil-Producing Countries

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Abstract

This paper discusses issues relating to the domestic pricing of petroleum in oil-producing countries. It finds that in most major oil-exporting countries, government policies keep domestic prices below free-market levels, resulting in implicit subsidies that equaled 3.0 percent of GDP, on average, in 1999. Moreover, the paper argues, these petroleum subsidies are inefficient and inequitable—entailing substantial opportunity costs in terms of forgone revenue or productive spending—and also procyclical, complicating macroeconomic management. Nonetheless, the elimination of petroleum subsidies is often politically difficult, although countervailing measures and publicity campaigns can help engender support for reform.

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I. Introduction

Petroleum product prices are often heavily regulated. Domestic price controls are prevalent, especially in countries that are net exporters of oil. Governments often keep prices well below international levels, resulting in the implicit subsidization of oil consumption. However, as these subsidies are typically not recorded in government budgets as expenditures, their economic cost, as well as the incidence on different income classes, is often poorly understood. The lack of readily available estimates of the size of these implicit subsidies has thus precluded a fuller discussion of their costs and benefits. Good fiscal policy management requires that the cost of all government activities, including such quasi-fiscal ones, be made transparent.[2]

The purpose of this paper is to shed light on subsidies for oil consumption in oil-producing countries. The paper first assesses the magnitude of the costs stemming from such subsidization. In addition, the discussion addresses the consequences of these subsidies for economic efficiency, income distribution, and fiscal policy.

The paper is organized as follows. Section II describes petroleum-pricing policies in oil-producing countries, and estimates the implicit subsidy on petroleum products in a wide sample of countries. Section III then discusses the effects of pricing policies, including economic efficiency, equity, and macroeconomic performance, with a view to characterizing optimal pricing policy. Section IV then discusses issues in reforming pricing policies and eliminating implicit subsidies, including the preconditions for successful reform, the appropriate pace of reform, and the use and development of countervailing measures. Section V concludes.

II. Current Petroleum Pricing Policies

A. Description of Current Pricing Polices

Currently, a broad range of petroleum pricing policies exists across the world. In most Organization for Economic Cooperation and Development (OECD) countries, prices are market determined, although high excise taxes are usually levied on petroleum consumption. For example, total taxes on gasoline among the G7 countries range from US$0.10 per liter in the United States to US$0.81 per liter in the United Kingdom.[3]

In developing countries that are *net importers* of oil, prices are in some cases fixed by the government or by state-owned enterprises. In these cases, as well as in countries that have market-determined prices, excise taxes on petroleum are common; thus, the after-tax

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[2] For a general discussion of quasi-fiscal activities, see Mackenzie and Stella (1996). For a discussion of quasi-fiscal activities in the energy sector specifically, see Petri, Taube, and Tsyvinski (2002).

[3] Data refer to November 2001, *Monthly Price Statistics* (International Energy Agency 2001). As a comparison, the tax exclusive price of gasoline in the United States was US$0.21 per liter.

retail prices of petroleum products are typically higher than they would be in the absence of any taxes or government intervention.

In developing countries that are *net exporters* of oil, however, governments typically maintain domestic petroleum prices well below the free market level. In most of these countries, the petroleum sector is dominated by a few large, state-owned enterprises, and the government typically controls both the wholesale and retail prices of petroleum products, either directly or indirectly, through export restrictions or other such measures. For example, in Saudi Arabia in 1997, the after-tax price of gasoline was set at only US$0.16 per liter.[4] These below-market prices result in the implicit subsidization of petroleum consumption; by selling petroleum domestically at a lower price than could be obtained abroad, the government forgoes revenue.

B. Quantifying the Implicit Subsidies/Taxes

Several studies have attempted to quantify the magnitude and importance of implicit petroleum subsidies in oil-producing and other countries (Rajkumar, 1996; International Energy Agency, 1999; Metschies, 1999; and Gürer and Ban, 2000). However, these studies either focus on only selected countries or petroleum products, or are dated. In this study, we attempt to provide an update on petroleum subsidies for a wide spectrum of countries and products. In addition, we propose a methodological improvement over most earlier estimates by including implicit tax subsidies that might be granted in the form of exemptions from VAT or other consumption taxes.

Subsidies can be defined broadly as the difference between the reduced cost of a good with government support and the cost of the good in the absence of such support (World Bank, 1997; Schwartz and Clements, 1999; and Gupta and others, 2000). Implicit subsidy for petroleum product i in country j in time period t ($S_{i,j,t}$) can then be defined as the difference between the "free market price" ($M_{i,j,t}$) and the after-tax retail price ($P_{i,j,t}$), times the volume of consumption ($C_{i,j,t}$):

$$S_{i,j,t} = (M_{i,j,t} - P_{i,j,t})C_{i,j,t} \tag{1}$$

The free-market price is defined as the price that would prevail if there were no government interventions to affect the relative price of the product in question. In other words, the free market price is the competitive market price plus the level of taxation typically leveled on consumption goods. For net oil-importing countries, this free market price should equal the cost of importing another unit of petroleum. This is calculated as the world wholesale spot price for the refined product ($W_{i,j,t}$) plus transportation, distribution, and marketing costs ($D_{i,j,t}$), plus all general consumption taxes ($T_{i,j,t}$—general sales taxes, VAT, etc.). General consumption taxes are included because, as a first approximation, these taxes do not distort

[4] Energy Information Administration (various years).

most relative prices[5] and so should be included if the objective is to determine what the price of a petroleum product would be if it were given the same treatment by government policies as any other good. Thus, the free market price is as follows:

$$M_{i,j,t} = W_{i,j,t} + D_{i,j,t} + T_{i,j,t} \tag{2}$$

For net oil-exporting countries, the free-market price is calculated in the same manner as for net oil importers, except that the transportation cost of shipping petroleum from one country to another is subtracted from the free market price in equation (2) (since net oil exporters often do not import petroleum from other countries).

Data on all of the components in equation (1) for 86 countries were gathered for 1995–2000 from different data sources, including the Energy Information Administration and *Datastream*, and subsidies for major petroleum product types were calculated. The detailed methodology for these calculations is described in the Appendix. Once the subsidy for each subproduct was calculated, the total petroleum subsidy was simply calculated as the sum.

Several caveats to this methodology should be noted. First, the estimates only measure the subsidy due to underpricing. Substantial subsidies may also arise from nonpayment of bills by consumers to state-owned oil producing or supplying enterprises, a practice that is especially prevalent in transition economies. The subsidy estimates in this paper do not include these nonpayments, and thus they may in some cases understate the total petroleum subsidy. Second, the domestic prices on which the subsidy estimates are based are in some cases the average for only a month or quarter rather than the entire year. Thus, the subsidy estimates in these cases should be viewed as a "snapshot" measure of the subsidy that is then annualized over the year.[6] Finally, due to data limitations and in order to simplify the calculations, a constant, average amount for marketing, distribution, and transport costs for all destinations is taken. This introduces some measurement error since these costs will vary across time and country. However, previous studies have estimated that marketing and distribution costs in developing countries are remarkably similar, on average, to marketing and distribution costs in developed countries (Bacon 2001), so the assumption of constant costs should not introduce a significant bias. The assumption of constant transport costs should not in general bias the results since these costs represent only about 2 percent of the retail price of petroleum products. However, it could understate the bottlenecks faced by some oil exporters in supplying additional petroleum output. For example, ice-blocked ports and pipeline capacity constraints can significantly increase marginal transport costs of some oil producers.

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[5] Because some goods, notably leisure, are often excluded from consumption taxes, some distortion of relative prices is still likely to occur, especially to the degree that goods are complements to or substitutes for the excluded goods.

[6] This may be relevant, for example, in Ecuador in 2000. In this case, the domestic price was measured in January 2000 but prices were adjusted significantly later in the year. Thus, the large subsidy estimate for Ecuador shown in Table 1 represents the annualized subsidy in January 2000, which may be different from the actual subsidy for 2000 as a whole.

Nonetheless, it should be noted that, using this methodology, the average estimate for net oil taxes in non-major oil exporting countries is 1.6 percent of GDP for developing countries and 2.7 percent of GDP for OECD countries. These estimates are similar to other, directly measured estimates of petroleum taxation (Gupta and Mahler 1995), again indicating that the methodology in this paper uses broadly correct reference prices in estimating net taxes/subsidies.

Table 1 shows the average calculated subsidies for 1999[7] for various groups of countries. The results indicate that major oil-exporting countries are typically net subsidizers of petroleum products, whereas oil-importing countries are net taxers (negative subsidies). Moreover, the subsidies in major oil-exporting countries tend to be large, relative both to GDP and to government spending recorded in the budget.[8] In 1999, the average subsidy in major oil-exporting countries was 3.0 percent of GDP and 15.2 percent of government expenditure.

The degree of subsidization in oil-exporting countries varies significantly across products, countries, and time. As Table 1 shows, residential fuel oil and diesel fuel are subsidized more heavily than gasoline. Across countries, positive subsidies vary from 16.6 percent of GDP in Azerbaijan in 2000 to less than one percent of GDP in Libya in 1999 (Table 2). Across time, average petroleum product subsidies tend to rise when world crude oil prices are high and fall when crude oil prices are low. This occurs because governments tend to adjust domestic prices slowly in response to changes in world prices. For example, between January 1998 and January 2000, the spot price of refined gasoline rose by over 40 percent, yet the after-tax retail price of gasoline in the República Bolivariana de Venezuela (RB Venezuela) increased by less than 5 percent.[9]

III. Economic Effects of Petroleum Subsidies and Taxes

Is this subsidization appropriate? This depends on the effects of subsidies on economic efficiency and equity, the fiscal costs of these subsidies, and whether they contribute to or dampen cyclical fluctuations in economic activity.

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[7] 1999 is the latest available year for most countries; the world oil price in this year was also near the average for recent years (US$18/barrel).

[8] Much of the subsidy here does not appear in government expenditure—only in the case that an explicit government subsidy was provided to an oil producer would these outlays be reflected in total government spending.

[9] Energy Information Administration (various years).

Table 1. Domestic Petroleum Price Subsidies, 1999
(Median values in parentheses)

	Average Oil Subsidies 1/			
	(In percent of GDP)		(In percent of government expenditure)	
Major oil exporters 2/ 3/	3.0	(2.5)	15.2	(8.6)
Of which:				
Subsidizing oil exporters 4/	3.8	(3.7)	18.8	(10.8)
Other oil exporters 5/	-1.9	(-1.8)	-7.0	(-7.0)
Net oil importers 6/	-2.2	(-2.1)	-8.3	(-8.6)
Of which:				
Countries not producing oil 7/	-1.7	(-1.6)	-7.0	(-6.4)
Memo items:				
Subsidy rate by type of product (in percent) for Subsidizing oil exporters				
Gasoline	9	(8)		
Diesel	48	(46)		
Residential light fuel oil	71	(78)		
Number of countries per category:				
Major oil exporters 2/ 3/	15		15	
Of which:				
Subsidizing oil exporters 4/	13		13	
Other oil exporters 5/	6		6	
Net oil importers 6/	41		40	
Of which:				
Countries not producing oil 7/	20		19	

Source: IMF staff estimates. Based on exchange rates taken from IMF, *International Finance Statistics* (Washington: International Monetary Fund

1/ Negative figure indicates net taxation of petroleum.

2/ Based on a comparison of domestic production and consumption volumes.

3/ Includes Algeria, Ecuador, Indonesia, Iran, Kazakhstan, Kuwait, Libya, Mexico, Nigeria, Norway, Qatar, Russia, Saudi Arabia, the United Arab Emirates, and República Bolivariana de Venezuela.

4/ Comprises 13 countries with positive subsidies - all countries included in footnote 3 except Mexico and Norway.

5/ Includes Argentina, Bolivia, Canada, Colombia, Denmark, and the United Kingdom.

6/ Includes Austria, Barbados, Brazil, Chile, France, Germany, Greece, Guatemala, Hungary, India, Italy, Japan, the Netherlands, New Zealand, Peru, Poland, Romania, Spain, Suriname, Turkey, the United States, Belgium, Costa Rica, the Czech Republic, Dominican Republic, El Salvador Finland, Grenada, Guyana, Haïti, Honduras, Ireland, Jamaica, Luxembourg, Nicaragua, Panama, Paraguay, Portugal, Sweden, Switzerland, and Uruguay.

7/ Includes Belgium, Costa Rica, the Czech Republic, Dominican Republic, El Salvador, Finland, Grenada, Guyana, Haiti, Honduras, Ireland, Jamaica, Luxembourg, Nicaragua, Panama, Paraguay, Portugal, Sweden, Switzerland, and Uruguay.

Table 2. Domestic Petroleum Price Subsidies in Main Oil-Exporting Countries, 1996–2000
(In percent of GDP)

Country	1996	1997	1998	1999	2000
Algeria	3.0	2.2	..	2.5	..
Azerbaijan 1/	..	..	..	..	16.6
Ecuador	..	3.3	1.4	-1.5	12.6
Indonesia	..	..	7.7	6.5	..
Iran, Islamic Republic of: Official exchange rate	10.0	..	..	4.2	..
Market exchange rate 2/	10.3			5.7	
Kazakhstan	..	4.3	..	6.8	..
Kuwait	5.1	5.1	..	4.8	..
Libya	..	5.8	..	0.7	..
Mexico	..	1.0	-0.9	-0.9	-0.4
Nigeria	..	..	..	2.5	..
Norway	-4.5	..	-4.8	-3.9	-4.5
Qatar	3.9	3.2	..	2.4	..
Russian Federation	..	5.0	-5.0	8.0	..
Saudi Arabia	7.4	7.0	..	5.9	..
United Arab Emirates	1.9	1.4	..	1.7	..
Venezuela, República Bolivariana de	..	5.9	2.9	3.7	4.9
Average subsidy	3.8	4.0	0.2	2.9	7.9
Sample size	7	11	6	15	5
Memo item:					
Average price of crude oil (US$ per barrel, U.K. Brent)	20.5	19.1	12.7	17.7	28.3

Sources: Energy Information Administration (various years); IMF, *International Financial Statistics* (Washington: International Monetary Fund); and authors' estimates.
1/ Based on IMF staff estimates using a different methodology (Wakeman-Linn and others, 2002). The figure includes only the subsidy due to underpricing; if the effects of nonpayment are also included, the effective subsidy in 2000 is estimated at 21.3 percent of GDP.
2/ Based on a weighted average exchange rate in 1996 and the Tehran Stock Exchange Rate for 1999.

A. Efficiency

In general, economic efficiency requires marginal cost pricing. This implies that, in the absence of market imperfections and other price distortions, it will be most efficient to set the domestic price of petroleum equal to the net price that could be received on the world market.[10] The latter equals the sum of the wholesale spot price for the refined petroleum product plus the marketing and distribution costs that are saved by not consuming the good domestically. This is also the price that would result from a perfectly competitive free market, as it would eliminate arbitrage between domestic and world prices.

In reality there are several imperfections in this market. First, governments impose taxes in order to raise revenue. Taxation of petroleum may help minimize the efficiency losses of taxation in general, since the revenue collected allows taxes on other products to be lower. While the theoretically optimal rate of taxation on petroleum depends on many factors, a neutral hypothesis would be to assume that petroleum should be taxed at the same rate as other products.[11] Under this taxation rule, the most economically efficient policy would be to set the price of petroleum equal to the opportunity cost of selling the product on the world market plus any general consumption tax, which is the "free-market price" in equation (2).

Second, petroleum consumption is typically associated with several negative externalities, including air pollution and traffic congestion. These externalities generally argue for higher taxation of petroleum products in order to ensure that the price reflects these extra costs to society. How high should these taxes be? This of course depends on how large the externalities are, which is a subject of significant debate and uncertainty. However, a recent review of the research on this issue has estimated that the total environmental and congestion cost of gasoline consumption in the United Kingdom is between US$0.25 and US$0.40 per liter (Parry, 2001), an amount that would imply taxation equal to at least 100 percent of the free-market price. For developing countries, it is likely that the externality costs will be somewhat lower, since incomes are lower and people are therefore less willing to pay as much to reduce the environmental and congestion costs. Nonetheless, the externalities in these countries are still likely to be significant.

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[10] A similar result holds in an intertemporal context where the first order condition for optimization requires that the marginal revenue from exporting today be equal to the discounted marginal revenue from exporting tomorrow. Thus, the domestic price would be set equal to the marginal revenue from exports in each time period.

[11] It has been shown that, under some conditions, it is most efficient to tax all commodities at the same rate (e.g., Atkinson and Stiglitz, 1976). A more general rule would be to tax goods so that the percentage tax-induced change in the quantity demanded (measured along the compensated demand curve) is the same for each taxed good (Ramsey, 1927).

Finally, the domestic price of petroleum in some countries is likely to be influenced by their monopoly pricing power in world oil markets. In this case, the marginal revenue lost from not selling another unit of petroleum on the world market is not simply the free market price; it also depends on the resulting change in the world price and the effect this has on the country's existing oil export revenues.

To see this, note that the revenue from exporting refined petroleum, R, is equal to the world wholesale spot price of petroleum, W, plus the distribution and marketing costs saved, D, times the quantity of exports, X:

$$R = (W+D)X \tag{3}$$

Thus, the marginal revenue from exporting another unit of petroleum is the following:

$$\frac{dR}{dX} = W + \frac{dW}{dX}X + D = W\left(1 + \left(\frac{1}{\eta_{X,P}}\right)\left(\frac{X}{X_W}\right)\right) + D \tag{4}$$

where $\eta_{X,P}$ = the price elasticity of demand for world petroleum and X_W = the total demand for petroleum on the world market.

For countries with a small share of the world market, the second term in brackets in (4) will be insignificant. For these countries, the opportunity cost of not exporting is simply equal to the world wholesale spot price plus the saved marketing and distribution costs, as noted above. However, for countries that have a sizable share of the world market, the latter term is likely to be significantly negative so that the opportunity cost of not exporting would be lower than the world price. All other things equal, this implies that it will be economically efficient to sell petroleum domestically at a lower price.[12]

How important might this consideration be in reality? Table 3 calculates the marginal revenue from exporting another unit of petroleum for the largest oil producers, using equation (4). Different long-run oil price demand elasticities are assumed,[13] and each country's oil exports as a share of world consumption is taken. It is further assumed that distribution and marketing costs equal 75 percent of the wholesale price (D=.75W).[14] Table 3

[12] The argument for creating a wedge between export and domestic prices is essentially identical to the classic terms of trade rationale for protectionism.

[13] Golembek, Hagem, and Hoel (1994) estimate price demand elasticities of around –0.9 for OECD countries and –0.75 for non-OECD countries. Hwang and Yang (2001) find somewhat lower elasticities (around -.25) in their study of US data.

[14] This number represents an average of distribution and marketing costs in the US and OPEC observed over a period of time. If these costs were lower, the marginal revenue estimates would be somewhat lower. For

(continued)

also presents marginal revenue for the Organization of Petroleum Exporting Countries (OPEC) as a whole under the assumption that the cartel could make pricing and production decisions collectively and enforce a single domestic pricing rule among all members. The marginal revenue is expressed as a fraction of marginal revenue in the no-market-power (small exporter) case.

If each country determines its prices independently, marginal revenue is significantly less than the no-market-power case only for the largest exporter, Saudi Arabia; in the case of that country, marginal revenue is still 75 percent of the no-market-power case even assuming a demand elasticity as low as –0.25. If, however, OPEC is able to successfully coordinate pricing and export decisions across all members, then the marginal revenue from exporting may be as low as 25 percent of the no-market-power case, which, all other things equal, would argue for lower domestic prices in these countries.

Table 3. Marginal Revenue from Exporting for Largest Oil Exporters

	Exports as Share of World Consumption 1/	Marginal Revenue 2/		
		(η = -0.25)	(η = -0.50)	(η = -0.75)
All OPEC	32.7	0.25	0.63	0.75
Saudi Arabia	10.8	0.75	0.88	0.92
Russia	5.1	0.88	0.94	0.96
Norway	4.3	0.90	0.95	0.97
Venezuela, República Bolivariana de	4.0	0.91	0.95	0.97

Sources: Energy Information Administration (various years); and authors' estimates.
1/ For 1998 (Energy Information Administration 2001).
2/ As fraction of small exporter (no-market-power) case; assumes distribution and marketing costs are 75 percent of wholesale price.

Some caveats to this monopolistic pricing/terms of trade argument for lower domestic pricing should be noted. First, this monopoly pricing is only optimal from the viewpoint of the oil-exporting country. From a worldwide viewpoint, welfare is maximized by eliminating differences in prices between countries. Second, the calculations in Table 3 ignore the reactions of large oil-importing countries that may have monopsonistic power in world markets. These countries may have a symmetric incentive to influence the world price of oil by taxing consumption in their domestic markets. If monopolistic pricing behavior by large oil exporters encourages large oil importers to engage in retaliatory monopsonistic behavior, this will reduce the incentive to price in a monopolistic manner.

In sum, various considerations enter into the efficient pricing of petroleum products.[15] Precise calculations are therefore difficult, as there is significant uncertainty regarding key parameters such as the environmental effects of oil consumption and the long-run elasticity

example, if distribution and marketing costs were 50 percent of the wholesale price, then marginal revenue for Saudi Arabia would be 86 percent (rather than 88 percent) of the small exporter case when η = -0.50.

[15] Gupta and Mahler (1995) survey the reasons behind petroleum taxation policies.

of oil demand. However, for countries with no market power, the negative externalities and the need for government revenue clearly indicate it is most efficient to tax petroleum at a rate that is *at least* equal to that imposed on other consumption goods. For the very largest oil exporters, the most efficient rate of taxation (from the country's viewpoint) may be slightly lower than in other countries, but it is likely to still be significantly positive, as the estimates discussed earlier indicate that the factors favoring taxation (negative externalities and the need for government revenue) will still outweigh the factors favoring subsidization (market power/terms of trade arguments for protection). For example, Table 4 presents optimal subsidy/tax rates for major oil exporters, based on assumed environmental externalities of US$0.10 per liter, an optimal uniform consumption tax of 10 percent, and a price elasticity of demand of -0.5. One can see that net taxation is optimal under these assumptions even if one considers OPEC as a unified producer and seller.[16]

Most oil-exporting countries do not tax domestic petroleum consumption, resulting in significant economic losses annually. Rather, as Table 1 indicates, they typically subsidize consumption. This deviation from efficient pricing results in a deadweight welfare loss. This can be seen in Figure 1, where the loss in government/exporter revenue from the subsidization (area ABC) is greater than the increase in domestic consumers' surplus (area AB). Table 4 presents estimates for the magnitude of this deadweight loss (area C in Figure 1) as a percent of GDP for several major petroleum exporters. For 1999, these losses range from 0.4 percent of GDP in Ecuador to 1.6 percent of GDP in Kazakhstan and the Russian Federation. High levels of domestic consumption resulting from these price distortions can even turn net exporters into net importers, as some analysts forecast may eventually happen in Iran.[17]

B. Equity

Subsidies are not the most efficient means of redistributing income or of improving the poor's access to energy. The impact of subsidies on equity can be evaluated by their relative efficacy—whether they reach those for whom they are intended—and the ease of administration, particularly given the incentives for smuggling and corruption. This section attempts to assess subsidies in each of these respects.

The available evidence shows that higher-income households consume larger quantities of petroleum products and electricity in oil-producing countries, and thus benefit relatively more from subsidies.[18] For example, in Mexico and Ecuador, over 30 percent of

[16] Domestic oil consumption would also fall in oil-exporting countries if prices were increased, leading to pressures to increase exports. Given the small share of world oil consumption accounted for by these countries, the impact on world prices would be small.

[17] See Dinmore (2002).

[18] Oil is a major input for electricity production.

Figure 1. Deadweight Loss from a Subsidy

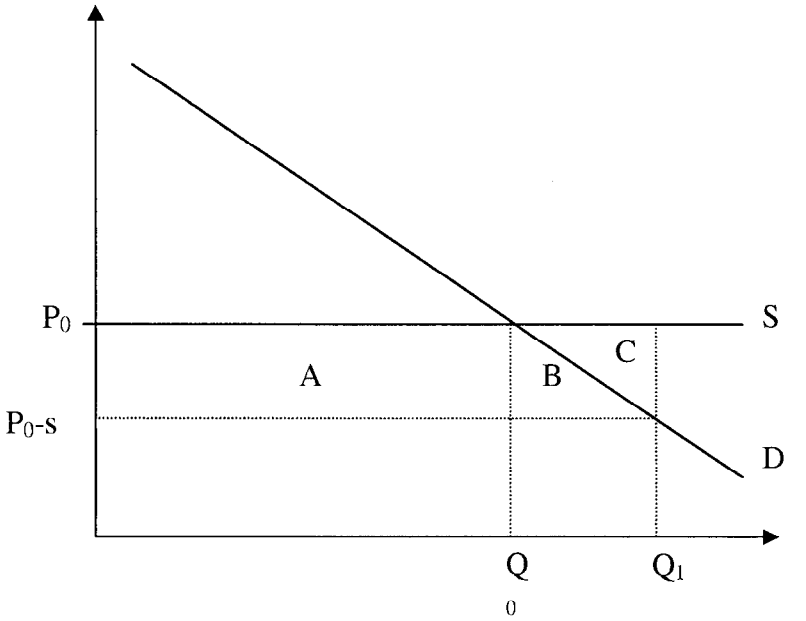

Table 4. Deadweight Loss from Subsidies in Selected Countries, 1999

Country	Optimal subsidy (tax) rate 1/ (In percent)	Actual subsidy rate (In percent)	Deadweight loss 2/ (Percent of GDP)
Algeria	-57	37	0.6
Ecuador	-65	-14	0.4
Indonesia	-62	78	0.9
Iran, Islamic Rep. of	-64	69	0.7
Kazakhstan	-65	46	1.6
Kuwait	-71	95	0.4
Libya	-65	10	0.4
Nigeria	-61	22	0.9
Qatar	-57	32	0.6
Russia	-58	51	1.6
Saudi Arabia	-44	53	1.0
United Arab Emirates	-81	30	0.6
Venezuela, República Bolivariana de	-55	72	0.6
OPEC as a unit	-22	63	0.6

Sources: Energy Information Administration (various years); and authors' estimates.
1/ Assumes environmental externalities of US$0.10 per liter, an optimal uniform consumption tax of 10 percent, and $\eta = -0.5$. Negative numbers imply optimal net taxation.
2/ Based on the traditional Harberger (1964) approximation for deadweight loss under perfectly elastic supply ($DWL = -\frac{1}{2}\eta s^2 PQ$, where η is the compensated elasticity of demand). This approximation is precisely accurate only in the case of small deviations from the Pareto optimum, which would be the case if the 10 percent consumption tax were nondistortionary.

household electricity consumption is accounted for by the top decile (Table 5). Outside of Latin America, Saboohi (2001) finds that in the Islamic Republic of Iran the energy consumption of a poor household is 44 percent of that of a rich household. Similarly, in the RB Venezuela, the richest 20 percent of the population receive 6½ times more in subsidies per person than the poorest 33 percent of the population. Similarly, 38 percent of electricity subsidies go to the top 20 percent of the population, while only 16 percent accrue to the bottom third (World Bank, 1995). In Ecuador, the more expensive energy (electricity and LPG) receive the highest subsidies, while household kerosene (kerex), which poor households considered convenient and versatile, is not subsidized (UNDP/World Bank, 1994).

Table 5. Mexico and Ecuador: Share of Total Expenditures by Quintile
(In percent of total spending)

Quintile	Electricity	Gasoline 1/	Gas/ LPG	Petrol / Kerex	Others 2/
Mexico					
1	5.4	0.9	6.7	15.1	26.1
2	10.2	3.9	13.8	18.3	24.0
3	15.9	9.3	18.5	20.2	20.4
4	21.6	19.4	25.1	21.7	17.4
5	46.8	66.5	35.9	24.8	12.1
Ecuador					
1	9.2	...	15.2	43.2	...
2	15.3	...	23.2	20.6	...
3	16.2	...	20.1	13.8	...
4	26.4	...	22.1	7.6	...
5	32.9	...	19.4	14.8	...

Sources: UNDP/World Bank (1998); and IMF staff calculations based on the 1996 Mexican Income and Expenditure Household Survey (INEGI 1996).
1/ Gasoline refers to gasoline, diesel, or gas purchased as fuel for vehicles.
2/ Includes coal, firewood, heating oil, candles, and other items such as paper or cardboard.

Relatively better-off groups also benefit more when quantities well above what the poor need are subsidized. In Yemen, for example, the lifeline electricity rate was set at a level of consumption that covered more than 75 percent of the population (Barnes and Halpern, 2000).

The pro-rich bias for subsidies is further compounded by smuggling and corruption. Subsidies create the incentive for smuggling petroleum products to markets where prices reflect market conditions. In Nigeria, for example, petroleum prices are a third of the levels prevailing in neighboring Niger or Cameroon, leading to widespread smuggling and chronic fuel shortages in many parts of the country.

Despite their pro-rich bias, removing subsidies suddenly can have adverse social effects in the short run. This is particularly the case when a country lacks adequate mechanisms for shielding poor households from the resulting higher prices. Poor households may spend a

significant share of their income on energy, and in the absence of compensating mechanisms, the ensuing loss in their consumption could be large. For example, in Ghana kerosene, diesel, and gasoline prices rose in real terms by 161, 214, and 156 percent, respectively from 1983 through 1987. Since kerosene was a major fuel for the poor (as shown by the expenditure shares), estimates of the loss in consumer surplus for different magnitudes of price elasticity show that households in the bottom two quintiles lost the most.

C. Fiscal Costs

Subsidies also have substantial fiscal costs for oil-producing countries. In many such countries, the cost of subsidies exceeds the overall fiscal deficit, which averaged 2.1 percent of GDP in the second half of the 1990s in subsidizing oil-exporting countries. Given high levels of public debt in these countries (61 percent of GDP, for the four countries for which data are available), the potential gains (in terms of reduced fiscal vulnerability) from further fiscal consolidation could be sizeable.[19]

If fiscal consolidation is not required, the revenue foregone by governments through the subsidization of petroleum consumption could be used to reduce tax rates or increase more productive spending, such as that for infrastructure and human capital formation.[20] For example, if subsidizing oil-exporting countries eliminated petroleum subsidies, they could increase spending on health, which is low in relation to the average in middle-income countries (Figure 2 and Table 6). This should contribute to boosting indicators of health status in oil-producing countries, which in some cases are below those in other countries with similar or lower per capita income.[21] In the República Bolivariana de Venezuela, for example, immunization rates are below the level achieved by lower middle-income countries, despite per capita income that is about double the average for this group. Education spending is also low in some oil-producing countries (e.g., Nigeria).

D. Cyclicality

The policy of maintaining below-world-market prices for petroleum products has important implications for macroeconomic management. As noted earlier, many oil-exporting countries tend not to adjust domestic prices fully in response to changes in world prices. For net oil exporters, this means that implicit subsidies will be procyclical—subsidies will increase when world oil prices increase, which also tend to be periods of economic

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[19] To the extent that subsidies are implicit, removing them may not automatically increase government revenue. Changes in tax policy may be required to capture higher profits of domestic oil supplying or producing enterprises. In addition, corruption in state oil companies (SOCs) may result in the government effectively having less than a 100 percent claim on the SOC's profit, thus reducing the fiscal benefits of subsidy reform.

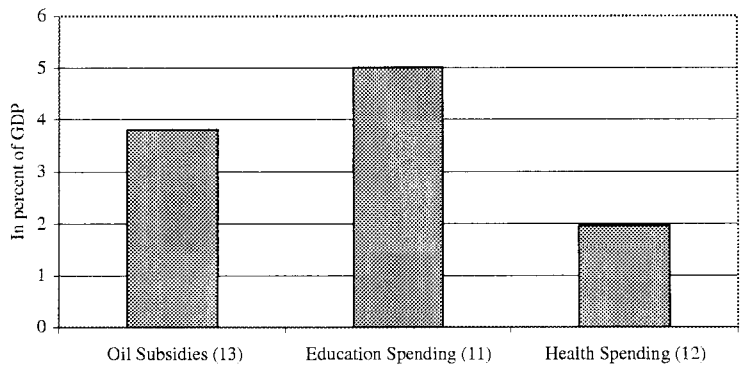
[20] For a related discussion of unproductive spending, see Chu and others (1995).

[21] See Gupta, Verhoeven, and Tiongson (2001) for an examination of the impact of public spending on health care and the health status of the poor.

expansion for these countries. The procyclicality of subsidies will thus exacerbate the effects of oil price shocks on economic volatility.

Available data suggests that subsidies have a substantial procyclical bias. Figure 3 plots the changes in subsidies against real GDP growth per capita across countries. The coefficient implies that a one percentage point increase in per capita GDP growth is associated with an increase in oil subsidies of 0.6 percent of GDP.

Figure 2. Composition of Government Expenditure in Major Subsidizing Oil-Exporting Countries 1/



1/ Unweighted averages for subsidizing oil-exporting countries. Oil subsidies are for 1999; expenditure data reflect averages over the period 1997–99. Number of countries in parentheses.

One way to eliminate the procyclicality of oil subsidies is to tie domestic petroleum prices to fluctuations in international markets. This can, however, lead to wide swings in domestic prices, thereby increasing uncertainty about government revenue and investment decisions. Under these circumstances, governments could adopt partial pass-through for temporary shocks and use financial hedging instruments.[22]

Partial pass-through rules can help smooth out the path of domestic petroleum prices. These include moving average rules (which base retail prices on a moving average of past spot prices), trigger rules (which update only if spot prices change by a predetermined trigger amount), or max-min rules (which place a ceiling and a floor on the level of retail petroleum prices). For example, Chile has a max-min price stabilization law under which reference prices are updated weekly.

Hedging instruments can also mitigate oil price fluctuations. For example, the state of Texas hedges its heavy reliance on oil revenue by buying and selling options in order to narrow the range within which its revenue stream fluctuates. Oil-producing countries do not

[22] See Federico, Daniel, and Bingham (2001); and Daniel (2001) for a more extensive discussion.

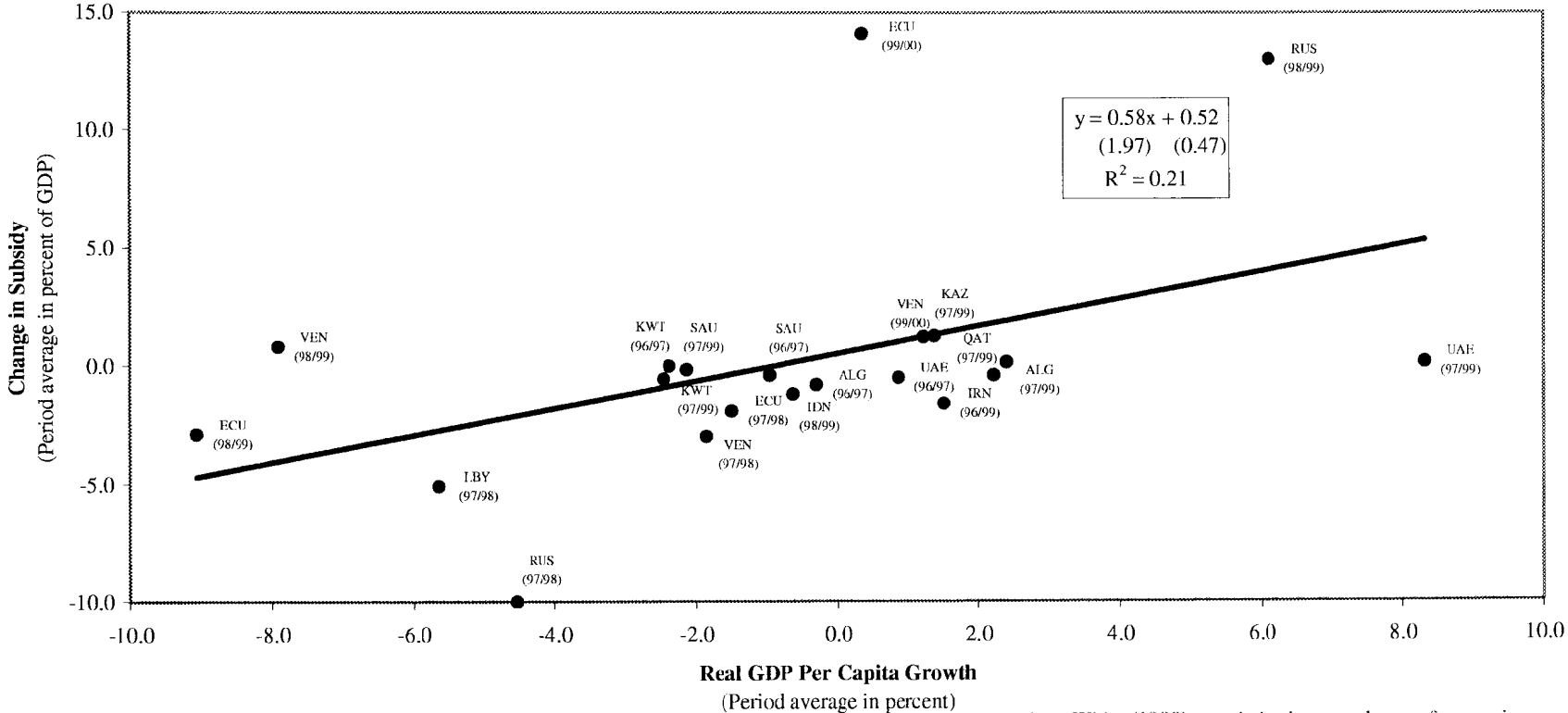
Table 6. Social Indicators and Social Spending in Subsidizing Oil-Exporting and Other Countries, 1997–99

							Education Spending		Health Spending	
	Life Expectancy	Illiteracy Rate (percent of adult population)	Infant Mortality Rate (per 1,000 live births)	Under 5 Mortality Rate (per 1,000 live births)	Immunization Rate against Measles (percent of children aged less than 12 months)	GDP Per Capita (constant 1995 US$)	(percent of GDP)	(percent of total expenditure)	(percent of GDP)	(percent of total expenditure)
Subsidizing oil-exporting countries (13) 1/	69	20	26	36	88	3,259	5.0	15.7	2.0	5.8
Of which:										
Algeria	71	35	35	39	76	1,534	8.8	28.0	1.5	4.9
Ecuador	69	9	29	37	87	1,521	3.1	15.6	0.9	4.8
Indonesia	65	14	43	54	80	1,025	..	..	0.6	3.3
Nigeria	49	39	82	149	48	253	1.4	7.6	0.7	3.8
Saudi Arabia	72	25	19	26	92	6,841	8.8	23.1	2.9	7.6
Venezuela, República Bolivariana de	73	8	21	24	79	3,451	3.8	19.7	1.4	7.0
Low-income countries (56)	55	41	75	126	67	423	4.0	15.0	2.0	6.8
Lower-middle-income countries (42)	68	16	33	44	86	1,642	4.8	16.6	2.3	7.5
Upper-middle-income countries (26)	71	11	18	26	90	5,306	4.7	14.4	3.3	9.7

Sources: World Bank, 2001, *World Development Indicators* (Washington). Expenditure data from IMF staff reports.

1/ Numbers in parentheses refer to the numbers of countries in the different income groups in 1999.

Figure 3. Change in Subsidy and Real GDP Per Capita Growth 1/ 2/



1/ Excludes one outlying observation when real GDP growth per capita was in excess of 20 percent. Robust White (1980) t-statistics in parentheses of regression.
2/ Dates provided in parenthesis indicate the period over which the change in subsidy was calculated.

disclose whether they use hedging instruments because this is market-sensitive information; however, it is believed to be a common practice in a number of countries. Since risk management activities require considerable knowledge of financial instruments and an appropriate institutional framework, the human and institutional requirements to implement and monitor hedging operations are significant.[23] In particular, if institutions in a country are weak, there may be scope for rent-seeking. It is important that the government officials are held accountable for their hedging decisions. For example, Ecuadorian officials were recently forced to explain to their Congress why they hedged at a price that ended up being lower than the spot market price.

IV. Reforming Petroleum Pricing Policies

Petroleum price subsidy reform entails reducing generalized subsidies by raising prices and targeting subsidies to the poor and vulnerable population groups. Subsidy reform has not been easy for most countries because of the opposition from losers of subsidization, the likely impact of higher prices on the poor and on production costs, and the inability of the government to protect the poor because of weak administrative capacity.

What lessons does the past provide for successful subsidy reform? In particular, what are the preconditions for successful reform and what is the appropriate timing and sequencing of reforms? What countervailing measures could be adopted to address any adverse distributive consequences of reform, and how might poverty and social impact analysis be useful? This section addresses each of these questions in turn.

A. Preconditions for Reform

The decision to liberalize the petroleum market, if met with strong protest and social unrest, can undermine reform efforts. For example, in June 2000 Nigeria increased petroleum prices by 50 percent, leading to a general strike and riots, followed by subsequent reversal of government policy. In Indonesia, an attempt to limit the fuel subsidy in 1998 was met with violent protests, forcing the government to partially roll back planned price increases. Similar protests have occurred in the República Bolivariana de Venezuela and Ecuador.

The risk of political disruption is highest when rapid reform is attempted without credible social protection mechanisms in place and without adequate attention to building political consensus on the need for reform. To assess the political risks associated with price-subsidy reform and inform its design, policymakers could, to the extent feasible:

[23] See Davis and others (2001) for a more extensive discussion.

- *Identify winners and losers in price-subsidy reforms.* This can be done by examining the benefits of existing subsidies for different income classes and then identifying the characteristics of winners and losers.[24]

- *Assess the political strength and the magnitude of the losses or gains of each group.*

- *Assess the feasibility and cost of alternative measures to protect the consumption of the poor or politically vocal groups.*

- *Generate political support.*

Subsidy reductions should be embedded in a reform program that engenders broad support and yields widespread benefits. This stakeholder approach (Graham, 1998) implies that governments should avoid reforms that impose an unfair burden on a narrow group of socioeconomic or ethnic categories. Compensatory measures for the poor can help to gain the support of an important constituency. For example, Indonesia was able to reduce the fuel subsidies in October 2000 and April 2001 after earlier failed attempts by compensating poor consumers through a combination of public works programs, microcredit, and cash assistance. This process was helped in part by a growing acceptance among the population that the fuel subsidies were not well targeted. In the longer term, sustained support for reforms should be crafted in a consultative process, with adequate poverty and social impact analysis (PSIA) to inform policy choices (see below).

Finally, publicity campaigns to discuss the trade-offs involved in providing subsidies can be useful in fostering support for reform. Successful reforms have often been accompanied by effective government communication to the population regarding the trade-offs and rationale for reform. This includes presenting the cost of subsidies in concrete terms and/or explaining how the reform package affects real household incomes.[25] For example, in Egypt the budgetary burden of subsidies was compared with revenues from the Suez Canal.

B. Timing and Sequencing of Petroleum Pricing Reforms

The optimal speed of subsidy reform depends on several factors. First, the government must take into account fiscal considerations. There is a trade-off between rapidly cutting budget-financed subsidies and avoiding an adverse impact on the poor. Although a one-time adjustment of prices to eliminate subsidies can yield immediate budget savings and quickly correct distortions in resource allocation, it can also result in a sudden and significant decline in household consumption, especially for low-income households. Although there may be a

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[24] See Gupta and others (2000).

[25] In this respect, increased transparency in the management of public finances is critical for gaining public support for higher petroleum prices. It would demonstrate that resources realized from reducing or eliminating implicit price subsidies would be used for the benefit of the population in need.

potential for rapid budgetary savings from the elimination of implicit subsidies, a sustainable reform will also require substantial outlays to protect the poor.

A second consideration regarding the speed of reform is the availability of social protection instruments. Such instruments require not only resources, but also a system to deliver compensation to those who need it. In general, if existing social protection instruments can be adapted to the needs of the poor during reform, then reform can be rapid. However, if new social safety net instruments need to be established, then the speed of reform will be affected by the administrative capacity to design and implement adequate and well-targeted social protection. In this regard, gradual adjustment may minimize the adjustment costs faced by businesses and individuals. A sudden increase in prices of petroleum products can affect the viability of businesses, potentially leading to job losses.

Third, governments must consider their political constraints. Rapid reform is feasible only when governments are politically strong and social disruption from implementing reforms is unlikely. Gradual adjustment has the benefit of giving the government time to assess and react to unintended consequences, including adverse political repercussions. Furthermore, insufficient institutional and administrative capacity to protect the poor can weaken political support for reforms.

Finally, the external environment may also affect the pace of reform. Specifically, more rapid reform may be possible under favorable external circumstances, such as low international prices. For example in Guinea, prior to the adoption of an automatic adjustment mechanism for the retail prices of petroleum products, the price of gasoline at the pump was reduced in 2001 to reflect the decline in international oil prices.

Despite these advantages, a gradual pace of reform also has drawbacks. First, it extends the time frame for reaping budgetary gains and, by slowing the adjustment of prices, it diminishes the incentive for the private sector to rapidly switch to energy-efficient technology. It may also lead to policy reversals, especially if it is adopted to postpone politically difficult reforms.

In the absence of a formal price-setting mechanism, subsidies can quickly reemerge regardless of whether reform is rapid or gradual. For example, in Ecuador one-time adjustments were undertaken, but no automatic adjustment mechanism was put in place, leading to the reemergence of subsidies (Box 1). Exchange rate changes can also lead to the reemergence of subsidies when domestic prices are fixed. For example, in Indonesia, the resurgence of massive fuel subsidies was due to the large depreciation of the exchange rate coupled with the lack of an automatic price-setting mechanism.

The problem of policy reversal with gradual reform can be overcome by adopting and making public a detailed timetable of reform measures. For example, in Cameroon the authorities have decided to phase out the petroleum subsidy by cutting it in half in 2001/02, and completely eliminating it in 2002/03.

Box 1. Ecuador: Experience with Energy Price Subsidy Reform

Ecuador provides a good case study of how the lack of a formal price-setting mechanism can hinder the implementation of lasting reforms of petroleum subsidies. Traditionally, Ecuador has granted subsidies to consumers for cooking gas, electricity, and some other commodities (mainly fuels and other utilities), and is a case where subsidies have continued to reemerge. The government grants these subsidies by fixing consumer prices below the opportunity cost—sometimes even below the cost of production—of these goods and services. In September 1998, the government decreed an increase of more than 400 percent in the price of cooking gas, thereby eliminating the existing subsidy. However, the new price was fixed in sucres and the subsidy quickly reappeared as the price of petroleum increased with exchange rate depreciation. In May 2000, the government introduced price increases of 65–92 percent for diesel and gasoline and of 90–333 percent for other derivatives. This sharply lowered the subsidy on fuels from an average of 35 U.S. cents per gallon to an average of 8 U.S. cents per gallon, but it left unchanged the subsidy on cooking gas. The government also implemented several increases in electricity prices: in September 1998, in January 1999, and, most recently, in May 2000, when prices were raised by an average of 70 percent (combined with 4 percent monthly adjustments thereafter). The direct subsidy to small consumers was replaced with a system of cross-subsidies between large and small consumers. This latest increase would allow electricity companies to cover their own operating costs, but prices would still be significantly below long-term marginal cost. More recently, a decree doubling the price of cooking gas and increasing petroleum prices was reversed—following massive protests in February of 2001—and instead the government agreed to freeze petroleum prices for a year and cut cooking gas prices.

Source: Offerdal and others (2000).

C. Distributive Considerations and Countervailing Measures

The adverse social effects of reforming energy subsidies earlier noted can be mitigated through appropriate social protection mechanisms. Poverty and social impact analysis (PSIA)—which aims to assess the ex ante, during, and ex post consequences of policy interventions on the well-being of the poor—can help to weigh the costs and benefits of alternative strategies prior to implementation, and therefore inform the design of the reform program itself.[26] Such an analysis could help to evaluate the timing and the sequencing of reforms as well as the need for countervailing measures.

For example, an *ex ante* social impact study for the Islamic Republic of Iran (Saboohi, 2001) estimated that an increase in energy prices with the aim of eliminating energy subsidies would have a serious impact on household consumption and inflation. However, estimates showed that if part of the additional resources obtained through the elimination of energy subsidies were allocated to strengthen the budgetary balance (thus containing inflation) and the rest of the resources allocated to targeted programs for the poor, then rural populations and the poorest three deciles of urban households would be better off.[27]

[26] See PSIA concept note (http://www.imf.org/external/np/exr/facts/sia.htm) and the recent PRGF review (http://www.imf.org/External/NP/prgf/2002/031502.htm) for an assessment of recent experience on PSIA.

[27] As another example, an *ex post* social impact analysis for an oil consuming country—Armenia—showed that reforms in the energy sector had led to a more reliable electricity supply, improved the financial viability of energy companies, reduced cross-subsidization, and improved payment discipline. However, the poor cut

(continued)

Countervailing measures that can be implemented to minimize poverty and social impacts include cash transfers or limiting subsidies to a subgroup of the population. Cash compensation, in some cases, has taken the form of a separate benefit in lieu of the subsidy. In 1998, for example, Ecuador eliminated the cooking-gas subsidy and instituted a cash transfer program for poor families and the elderly. In the wake of the 1999 financial crisis, this cash transfer program became the backbone of the government's safety-net strategy. In other cases, cash benefits have been merged with existing social benefits.

Cash transfers have several advantages: they allow for consumer choice, their cost to the budget is explicit and known with greater certainty than generalized subsidies, and they can be targeted to the poor. However, their real value may erode quickly during periods of high inflation and they are prone to corruption. For example, although the safety-net program in Ecuador has been quite successful in providing relief to a large segment of the poor population, more than a quarter of the current recipients are not eligible (World Bank, 2000a). In addition, since these transfers are disbursed through the banking system, which is far better developed in cities and urban areas than in rural areas, the distribution tends to favor the urban population. The coverage of these transfers is, therefore, well below target in rural areas.

Other countervailing measures include limiting price subsidies to a subgroup of the population. For example, in Ecuador, the cash transfer program was complemented by targeted electricity subsidies to poorer consumers financed through higher prices charged to wealthier consumers. A more common approach among oil producers is to tax the relatively inelastic products such as gasoline and subsidize so called "social products" such as kerosene and diesel. This practice is common in Algeria, Iraq, Egypt and Syria (Al-Faris, 1997). In Yemen for example, gasoline prices were increased every year from 1996 through 1999 so that by 1998 they were 80 percent above world market prices. This allowed for cross-subsidies for diesel and, to a lesser extent, for fuel oil and kerosene. This policy, however, added to the discrepancy between domestic and border prices, and suffered from the efficiency problems discussed earlier; furthermore, it provided incentives for industries and the nonpoor to shift their consumption to the subsidized products.

V. Conclusion

This paper finds that major oil-exporting countries tend to be net subsidizers of petroleum, while oil-importing countries tend to be net taxers. Implicit subsidies in major oil-exporting countries are large, equaling 3.0 percent of GDP and 15.2 percent of explicit government expenditure, on average, in 1999. Subsidies in major oil-exporting countries vary over time, with a marked procyclical bias. With respect to variation by product, residential fuel oil and diesel are subsidized more heavily than gasoline.

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consumption more (relative to the nonpoor), partly because the elimination of the increasing block tariff raised the average price of electricity more than expected (Lampietti and others, 2001).

Subsidization does not appear to be a wise use of resources. From an efficiency point of view, it would be best for oil exporting-countries to set the domestic price of petroleum equal to the world market price (assuming no market imperfections). Taking into account market imperfections complicates the analysis but generally supports the notion that prices should be no lower than world market levels. From an equity point of view, subsidies tend to be an undesirable method of redistribution, either because they benefit all users (including the rich) or because they are indiscriminate, allowing for consumption well above that needed by the poor. The pro-rich bias of subsidies can be further compounded by smuggling and corruption. From a fiscal perspective, the opportunity costs of these subsidies are substantial.

Despite the substantial costs of implicit petroleum subsidies, reform is difficult, as there is strong popular opposition to their elimination. Subsidy reform should be embedded in a reform program that engenders broad support and yields widespread benefits. This could include the use of countervailing measures and vigorous publicity campaigns, which educate the population on the trade-offs involved in providing subsidies versus other social services. The speed of subsidy reform will depend on the required size of fiscal adjustment, the availability of social protection instruments, the strength of government, and the administrative capacity to implement reforms. The adverse social and political effects of reforming energy subsidies can be mitigated by undertaking poverty and social impact analyses and establishing safety nets. These safety nets can include cash compensation for the most vulnerable, limiting price subsidies to a subgroup of the population, or tax exemptions for the poor. To inform the design, pace, and implementation of reform, PSIA should be undertaken prior to, during, and after a reform to ensure that appropriate mitigating measures are in place.

Calculation of Implicit Subsidies

This appendix explains how the implicit subsidies are calculated. Conceptually, the implicit subsidy for petroleum product i in country j in time period t ($S_{i,j,t}$), is defined as the difference between the "free market price" ($M_{i,j,t}$) and the after-tax retail price ($P_{i,j,t}$), times the volume of consumption ($C_{i,j,t}$):

$$S_{i,j,t} = (M_{i,j,t} - P_{i,j,t})C_{i,j,t} \qquad \text{(A.1)}$$

To calculate this subsidy, data on each of these three variables is calculated as follows. Data on the after-tax retail prices of major petroleum products are obtained from various editions of the *International Energy Annual* (Energy Information Administration, various years). Data are obtained for gasoline,[28] motor diesel, residential light fuel oil, kerosene, residential liquefied petroleum gas (LPG),[29] industrial light fuel oil, and industrial heavy fuel oil.[30] Data are collected for the years 1995-2000. For most countries, however, data are available for only some years. Prices for each year come in various forms (either from a particular month, a quarter, or an annual average). There are 86 countries in the sample and all prices are expressed in U.S. dollars.

The data on consumption are obtained from the Energy Information Administration website.[31] These data are divided into gasoline, jet fuel, kerosene, distillate fuel oil, heavy fuel oil, LPG, and other. For most countries, data are available for 1995–98. For some countries, data are also available for 1999. Missing consumption data for 1999 and 2000 are imputed by assuming that consumption grows at the rate of real GDP, measured in domestic currency. All GDP and exchange rate information are from *International Financial Statistics* (International Monetary Fund, various years).

The free market price is defined as the price that would prevail if there were no government interventions to affect the relative price of the product in question. For net oil-importing countries, this free market price should be equal to the cost of importing another unit of the good. This is calculated as the world wholesale spot price for the refined product ($W_{i,j,t}$) plus transportation, distribution, and marketing costs ($D_{i,j,t}$) plus all general consumption taxes ($T_{i,j,t}$—general sales taxes, VAT, etc.). General consumption taxes are included because, as a

[28] For most countries, prices are for premium gasoline; for a few, however, prices are reported for regular gasoline instead.

[29] LPG includes primarily residential propane or a mixture of propane and butane.

[30] Heavy fuel is also sometimes referred to as residual fuel oil.

[31] The website is http://www.eia.doe.gov/emeu/world/main1.html. This same information is published in the *International Energy Annual* (Energy Information Administration, various years).

first approximation, these taxes do not distort most relative prices[32] and so should be included if the objective is to determine what the price of a petroleum product would be if it were given the same treatment by government policies as any other good. Thus, the free market price is as follows:

$$M_{i,j,t} = W_{i,j,t} + D_{i,j,t} + T_{i,j,t} \qquad \text{(A.2)}$$

Data on world wholesale spot prices are obtained from *Datastream*. For each of the following retail prices, the corresponding wholesale spot price is used: (1) premium gasoline—New York premium unleaded nonoxygen gasoline; (2) regular gasoline—New York regular unleaded nonoxygen gasoline; (3) motor diesel—New York low sulfur (0.5 percent) diesel fuel; (4) light fuel oil (both residential and industrial)—New York No. 2 fuel oil; (5) kerosene—Singapore jet kerosene; (6) LPG—Mount Belvieu propane; and (7) heavy fuel oil—Northwest Europe heavy fuel oil (3.5 percent sulfur). There are four or five major world markets for each type of product (mainly New York harbor, the U.S. Gulf Coast, Los Angeles, Singapore, and Rotterdam). The choice of market is based on data availability from *Datastream*. However, prices in these markets usually do not differ widely for long periods of time, so the use of only one market should not introduce significant bias into the estimates. For each observation, the frequency of the wholesale price (i.e. whether it is a monthly, quarterly, or annual average) is chosen so as to match the frequency in which the corresponding retail price is reported. All prices are in U.S. dollars.

For gasoline, motor diesel, light fuel oil, and heavy fuel oil, transportation, distribution, and marketing costs are measured as the difference between the average before-tax retail price across eight OECD countries taken from *Monthly Price Statistics* (International Energy Agency 2001b)[33] and the wholesale price of each of these products in November 2001. For kerosene and LPG, costs are calculated as the difference between the average before-tax retail price to end users in the U.S. from the *Annual Energy Review* (Energy Information Administration 2000) and the average annual wholesale price for 2000. The resulting estimates for transportation, distribution, and marketing costs in US cents per gallon are 36.4, 44.3, 35.6, 19.8, 59.1, and 15.2 for gasoline, motor diesel, light fuel oil, jet kerosene, propane, and heavy fuel oil, respectively.

To simplify the calculations, these transportation, marketing, and distribution costs are kept constant over time and country for each product. This introduces some measurement error since these costs will vary across time and country. However, previous studies have estimated that marketing and distribution costs in developing countries are remarkably similar, on

[32] Because some goods, notably leisure, are often excluded from consumption taxes, some distortion of relative prices is still likely to occur, especially to the degree that goods are complements or substitutes to the excluded goods.

[33] The eight countries are Canada, France, Germany, Italy, Japan, Spain, the United Kingdom, and the United States. Data is missing for Canada for light and heavy fuel oil and for the United States for heavy fuel oil.

average, to marketing and distribution costs in developed countries (Bacon 2001), so the assumption of constant costs should not introduce a significant bias. The assumption of constant transport costs should not in general bias the results since these costs represent only about 2 percent of the retail price of petroleum products. These transportation costs are estimated as US$9.71 per metric ton, which was the average for all routes between 1996–2000, based on data from the *OPEC Annual Statistical Bulletin 2000* (Organization of Petroleum Exporting Countries 2001). In some countries and under some conditions, however, they may be substantially higher. In the former Soviet Union, for example, ice-blocked ports and pipeline capacity constraints may significantly increase marginal transport costs.

Data on general consumption taxes is obtained for each country from *Corporate Taxes: Worldwide Summaries* (Price Waterhouse Coopers, various years) and internal IMF databases. The taxes include the standard rate of any VAT or general sales tax that is applied at the central government level.

For net oil-exporting countries, the free market price is calculated in the same manner as for net oil importers, except that the transportation cost of shipping petroleum from one country to another is subtracted from the free market price since oil exporters need not import petroleum from other countries.[34]

Another complication that arises in calculating the subsidies is that available consumption data are divided into somewhat different categories than the price data. This problem is most pronounced for distillate fuels, which are lumped into one group in the consumption data but for which three different retail prices exist (motor diesel, residential light fuel oil, and industrial light fuel oil). For most OECD countries, however, the breakdown of distillate fuel consumption into the various subproducts does exist in the *Energy Statistics of Non-OECD Countries 1997–98* (International Energy Agency 2001a).[35] Thus, it is assumed that all countries divide their consumption of distillate fuels into the three categories in the same proportions as the OECD average for 1998. Similarly, jet fuel and kerosene are provided as separate categories in the consumption data, whereas only data on kerosene are provided in the retail price data, and only data on jet fuel are provided in the spot price data. Thus, kerosene and jet fuel are lumped together as one consumption category, and the retail price for kerosene is compared to the market price for jet fuel. In addition, retail prices for some products are missing for many countries. In these cases, it is assumed that the subsidy rate on missing prices is equal to the subsidy rate on motor diesel. If the retail price of motor diesel is missing, it is assumed that the subsidy rate on missing prices equals the subsidy rate on residential light fuel oil.

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[34] Note that insurance costs are not taken into account, which could lead to an underestimation of the subsidy. However, these costs are likely to be very small and would not substantially change the results.

[35] Data taken from the table on page II. 11.

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