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The Social Costs to the U.S. of Monopolization of the World Oil Market, 1972–1991

David L. Greene
Paul N. Leiby

MANAGED BY
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David L. Greene
Center for Transportation Analysis

Paul N. Leiby
Energy and Economic Analysis

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Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831
managed by
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ABSTRACT

The partial monopolization of the world oil market by the OPEC cartel has produced significant economic costs to the economies of the world. This paper reports estimates of the costs of monopolization of oil to the U.S. over the period 1972-1991. Two fundamental assumptions of the analysis are, 1) that OPEC has acted as a monopoly, albeit with limited control, knowledge, and ability to act and, 2) that the U.S. and other consuming nations could, through collective (social) action affect the cartel's ability to act as a monopoly. We measure total costs by comparing actual costs for the 1972-1991 period to a hypothetical "more competitive" world oil market scenario. By measuring past costs we avoid the enormous uncertainties about the future course of the world oil market and leave to the reader's judgment the issue of how much the future will be like the past. We note that total cost numbers cannot be used to determine the value of reducing U.S. oil use by one barrel. They are useful for describing the overall size of the petroleum problem and are one important factor in deciding how much effort should be devoted to solving it. Monopoly pricing of oil transfers wealth from US. oil consumers to foreign oil producers and, by increasing the economic scarcity of oil, reduces the economy's potential to produce. The actions of the OPEC cartel have also produced oil price shocks, both upward and downward, that generate additional costs because of the economy's inherent inability to adjust quickly to a large change in energy prices. Estimated total costs to the United States from these three sources for the 1972-1991 period are put at $4.1 trillion in 1990$ ($1.2 T wealth transfer, $0.8 T macroeconomic adjustment costs, $2.1 T potential GNP losses). The cost of the U.S.'s primary oil supply contingency program is small ($10 B) by comparison.

THE SOCIAL COSTS TO THE U. S. OF MONOPOLIZATION

OF THE WORLD OIL MARKET, 1972-1991

1. INTRODUCTION

Ever since it became apparent in the 1950s that U.S. petroleum reserves could not expand fast enough to keep pace with growing U.S. demand, it has been widely perceived that the economy’s vast consumption of oil is a problem. Opinions have differed greatly, however, over the exact nature and size of the oil problem, and especially what best to do about it. Recently, there have been indications that the oil problem may not have been as big as once thought or will not be as big in the future (e.g., Bohi, 1989; Toman, 1989). This study takes a retrospective look at the U.S. petroleum problem over the past twenty years, a period containing two oil price jumps and one price crash, sandwiched between periods of relative stability. In focussing on the past, we are consistent with Mabro’s (1992) observation:

> “History is perhaps the only discipline open to the study of oil, and here economists may help explain what was.” (Mabro, 1992, p. 16)

Mabro’s point is that future oil markets are subject to such great uncertainty that predictions have dubious analytical value. This sentiment was echoed in a recent attempt to develop social costs per barrel for U.S. oil use, which concluded that estimates of future costs are highly dependent on arguable assumptions about the future state of the world and future actions of key players in the world oil market (Congressional Research Service, 1992). One of our reasons for examining the past is to eliminate the uncertainties associated with the behavior of nation states, technological advancements, and geological discoveries. We do not claim that what has happened
3 will happen again, only that understanding ‘what has happened ‘is useful to understanding what may happen. Certainly, this limits the usefulness of our study to debates over specific oil policies, but probably no more than uncertainties about the future limit the usefulness of analyses based on projections.

A working definition of the oil problem is essential, but is also sure to be controversial. Problems to society generated by oil use range from oil spills to air pollution, and from’oil price shocks to military involvement in the Persian Gulf. This paper, however, focusses on the social‘ costs to the U.S. of the monopolization of the world oil market by the OPEC cartel. Thus,’ our first axiom is that the OPEC cartel exercised monopoly power in the world oil market during the 1972-1991 period.. More specifically, we assert that OPEC acted as an imperfect Von Stackelberg monopolist, but we will elaborate below. We realize that there are some who would dispute this premise, and that they will disagree with our conclusions, as well. Our second axiom is that the U.S., through its own national policy or acting in concert with other oil consuming nations could have reduced the market power of the cartel.’ Whether national and international

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‘In fact, the U.S. and IEA did take actions with this intent.

policy could have restored the status quo ante in the world oil market, and whether this could have been done at a lesser cost, are highly debatable. Whether cost-effective solutions can be found in the future is even more important and equally uncertain. We make no attempt to answer these questions here. Our goal is to describe and quantify the economic costs to the U.S. of world oii monopoly by the OPEC cartel to help define the nature and size of the problem we face. Our hope is that by better understanding the nature and size of the problem, we will be better able to formulate effective policy.

The exercise of monopoly power constitutes a market failure in the sense of being a deviation from a competitive market, Thus, we measure costs compared to a hypothetical "competitive" market.[2] Economic externalities exist in the monopolized oil market, but they are not the central issue, as some have argued (e.g. Toman, 1989). The costs of monopoly behavior are the central issue. Some of these costs can be viewed as external costs, the concept of the monopsony cost of oil is perhaps the best example (see, e.g. Broadman, 1986). The point is that they need not be classical externalities to be considered social costs. Since they result from a market failure and are, at least partially, avoidable through collective action, we consider the costs of world oil monopolization to be social costs.

To what extent the costs of oil market monopolization are avoidable by the U.S. is a very important question. If not at all, then this 'paper is merely an exercise in hand wringing, with no useful implications for energy policy. But, in fact, there are ways to reduce the cartel's market power. That market power depends on three key factors, each of which can be affected by U.S. policy to some extent:

1. the cartel's share of the world oil market,
2. the world price elasticity of oil demand, and
3. the oil supply response of the rest of the world.'

Because the ability of demand and supply to respond is much smaller in the short-run than in the long-run, the cartel may possess enormous short-run market power, but very limited long-run market power. Thus, short-lived oil price shocks are an extremely important component of the costs of oil market monopolization.

The oil problem is multi-faceted. Those focussing on oil price shocks call it the "energy security" problem and view it as the result of uncertainty and instability in world energy markets (e.g., Toman, 1989). Others have seen it as an "oil dependence" problem, resulting from excessive reliance on uncertain foreign suppliers for a basic resource. Still other views emphasize environmental, political, or military aspects. We argue that, with the possible exception of environmental damages, the costs to the U.S. of the exercise of monopoly power by the oil cartel are by far the largest component of the oil problem. We do not mean to imply that other views are not valid or useful. The concentration of oil reserves in the Persian Gulf region, and the politics of the states involved and of their neighbors, are very real problems for the U.S. and

[2] In fact, our basis for comparison is more like a status quo ante 1973.

[3] The supply response is defined as the quantity by which rest-of-world oil supply will increase in response to a 1 bbl/day reduction in OPEC production.

other nations. Environmental and public health effects of the combustion of petroleum also comprise a very serious national and international problem. We focus here on the costs of world oil monopoly because we believe the problem has been relatively poorly understood and because, as it turns out. it has been a very large problem.

This report does not address the question of whether it is possible, through policy, research, or other means, to reduce future costs of oil dependence without creating other, greater costs. The costs of oil use have been high, but the social costs of alternatives may be higher. Our point is that if social costs are likely to be very large, it is sensible to devote considerable effort to trying to find a better alternative. The fact that dependence on monopolistically controlled oil generates enormous social costs is reason enough to look for a better alternative. Whether it also justifies taking policy actions to change oil use or oil production, or whether it justifies massive investments in research and development, depends on whether the costs of alternatives are lower than the costs of continued oil dependence.

By any yardstick, the costs to the U.S. of oil market monopolization have been large: in the vicinity of $4 trillion (T) 1990 dollars for 1972-1991. This is roughly equally divided among three components: loss of potential economic output due to the higher costs of oil, the costs of price shocks to the economy, and the transfer of U.S. wealth to foreign oil producers. Costs this large are of the order of magnitude of total U. S. defense expenditures ($5.2 trillion), or interest payments on the National Debt ($2.1 trillion) over the same period. Monopolization of the world oil market has cost the U.S. economy dearly.

The 1991/1992 National Energy Strategy of the U.S. Department of Energy summarized its national energy goals as follows:

> "achieving a balance among our increasing need for energy at reasonable prices, our commitment to a safer, healthier environment, our determination to maintain an economy second to none, and our goal to reduce dependence by ourselves and our friends and allies on potentially unreliable energy suppliers."
>
> "The goals of a healthy environment and reduced dependence on insecure suppliers represent national security, foreign policy, and social benefits to which markets are unlikely to give adequate weight." (National Energy Strategy, U.S. DOE, 1991, p. 2)

The goal of reducing the market power of the oil cartel and the costs to our economy there-from is, at best, implicit in the NES goals, This is unfortunate because unless we can implement effective policies to avoid them we will very likely face monopoly oil costs again in the near future.

In the following section we define the specific social costs arising from dependence on monopolized oil, and describe the principal components we will attempt to measure. To show how these costs arise, we present a concept of the world oil market in section three that explains how social costs are incurred by oil consumers when monopoly power is exercised by oil producers. Theories of the world oil market are controversial, to say the least, but are also essential to any coherent argument about the economic costs of oil use. The fourth section discusses issues that arise in trying to measure each cost component. Section five attempts to quantify each cost component. In the final section, we discuss the meaning of the results.

2. COMPONENTS OF THE SOCIAL COST OF OIL

Social costs over and above the private costs that result from oil **use are** of two types: 1) classical market externalities, and 2) socially, **but** not individually, avoidable economic costs. An **externality** occurs whenever the action of one entity affects the welfare of another by any means other than by affecting prices **(Varian,** 1978, p. 203). Costs which are reflected in prices, but in which the marginal **cost to** the ‘initiator is less than that to society as a whole, are often called pecuniary externalities. Oil use produces both kinds of externalities. Environmental pollution is a classic externality because there are no or only limited markets for a clean environment and for the rights to pollute **it.**[4] Other examples of externalities are the political, strategic, and military consequences of oil dependence. Oil consumers do not pay these costs in the price of **oil,**[5] nor do they pay the cost incurred when oil price shocks disrupt the economy and slow economic growth. All of these components are classic economic externalities. **Socially avoidable** costs are pecuniary externalities that a society (e.g., a nation or group of nations) bear that they could avoid by practical, collective actions. These costs are not classical externalities, because they generally **are** included in the price of oil. For example, the oil consumption of each individual increases the monopoly power of the oil cartel, permitting prices to be raised for all consumers. **As** a result, the marginal social cost of oil exceeds the individual agent's marginal cost (e.g., Broadman, 1986). The extra costs are external to the individual agent, but not to the market because others pay them. Costs that are a transfer from one individual to another are also usually ignored in economic analyses of costs because there is no net loss to the total economy. Because in this analysis we consider the U.S. economy as a unit, we **do** count wealth transfers from the U.S. economy to foreign nations as direct costs, even though the wealth stays within the world economy. This turns out to be a very large component of costs.

We divide the social costs of oil use into four broad components: 1) the Transfer of U.S. Wealth to Foreign Oil Producers, 2) the Macroeconomic Costs, 3) Military and Political Costs,

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[4]In fact, there are imperfect markets of various sorts. Tradable pollution credits, for example, such as specified in the Clean Air Act Amendments of 1990 for electric utilities, will create a partial market for pollution rights. Also, regulations, such as automobile emissions standards, require polluters to make expenditures to reduce pollution, thereby creating a cost to pollute. While these do not constitute a complete and efficient market for environmental quality, neither can pollution be any longer considered a pure externality.

‘Some have argued that since a significant portion of highway user taxes are collected via taxes on gasoline and diesel fuel (about $0.30/gal., 1992 dollars), these taxes are effectively a surrogate for the cost of externalities associated with oil use. This is partly correct, in that the incidence of the tax falls on the purchase of fuel rather than on highway travel (i.e., vehicle miles), and should affect the demand for fuel in the ‘same manner as if the externalities associated with oil use themselves were priced. However, this view is substantially inaccurate in that the tax may not be of the right magnitude, and in that fully pricing the externality would not eliminate the need for highway user taxes on vehicle travel. Imposing road user taxes on vehicle miles in addition to an externality tax on fuel would further reduce travel, producing a still greater reduction in demand for motor fuel. Thus, unless both are appropriately taxed, the consumption of motor fuel will not be consistent with marginal social cost pricing. In the future it may be possible to directly tax vehicle and highway use, by using advanced electronic technology. The highway user tax could then be shifted to vehicle travel and an appropriate “externality tax” " placed on motor fuel.

and 4) Environmental Costs (Table 1). We include the first two types of costs in our estimates of the cost to the U.S. of monopolization of the world oil market. One could argue that there are significant political and military costs arising from the monopoly behavior of the oil cartel over and above those that derive from the geographical concentration of oil reserves in the Persian Gulf region. Although we believe this view has merit, we do not include political and military costs in our estimates because of the very great difficulties in distinguishing and quantifying the monopoly component. We do show that military expenditures that could be associated with Persian Gulf oil reserves are probably small relative to the economic costs we do try to measure. On the environmental side, one could argue that higher monopoly oil prices serve as a surrogate for a tax on the external environmental costs of oil use. By (unintentionally) internalizing some of the environmental cost, monopoly prices could generate a benefit in the form of a more efficient market. This argument also has some merit, but we leave it to further research to sort it out. In this paper we will concentrate on the transfer of wealth and macroeconomic costs associated with U.S. oil use from 1972-1991.

Macroeconomic costs have two 'major components: 1) the loss of potential economic production (GNP) due to the increased economic scarcity of oil, and 2) costs arising from the economy's inability to adjust quickly to price shocks. The three most important components of economic cost, wealth transfer, loss of potential GNP, and macroeconomic adjustment costs, added together comprise our estimate of the full economic cost to the U.S. of oil monopolization. These cost components do not overlap, but are mutually exclusive. There are other possible economic costs that depend on particular circumstances, such as an inappropriate monetary policy response to higher oil prices, that we do not attempt to quantify. These phenomena may well be important but are certainly secondary to the three major components we measure.

Table 1. Components of the Social Cost of Oil Use

I. ECONOMIC COSTS

Transfer of U.S. Wealth to Foreign Oil Producers ("Monopsony Cost")

Loss of Potential GNP (Permanent producer and consumer surplus losses)

Macroeconomic Costs of Price Shocks

- Macroeconomic Adjustment Costs of Price Shocks
- Other Macroeconomic Costs
  - Aggregate Demand Shortfall (Leakages)
  - Inappropriate Monetary Policy
  - Consumption & Investment Shifts
  - Capital Investment Effects
  - Income Redistribution Costs

Net costs of contingency measures (Strategic Petroleum Reserve)

II. MILITARY AND POLITICAL COSTS

- Conflicts over oil supplies
- Availability of oil to military during a conflict
- Foreign policy costs
- Use of oil rents for militarization

III. ENVIRONMENTAL COSTS

- Emissions from evaporation and combustion
- Spills during transport and leakages from storage

A

3. A VIEW OF THE WORLD OIL MARKET

To quantify the economic costs of dependence on monopolized oil, we need a theory of the world oil market. If there is one thing that petroleum economists agree on, it is that no fully adequate theory of the world oil market has yet been developed (e.g., Gately, 1984; Curlee, 1985; Hogan, 1992). Fortunately, we do not need a full theory capable of predicting price changes. We need an interpretation of the nature of the market that will allow us to roughly estimate the economic costs to the United States, if any, of dependence on a monopolized oil market. Our view of the world oil market depends on two axioms: 1) that the oil market does not behave as if oil were an exhaustible resource in the sense of the Hotelling (1931) economic theory of exhaustible resources, and 2) the OPEC cartel, or at least a core group of OPEC, has acted as a partial monopoly to increase world oil prices. We elaborate on these axioms below.

3.1 STOCK OR INVENTORY: ARE WE RUNNING OUT OF OIL?

For practical purposes, oil is not an exhaustible resource. This statement appears to be obviously false on its face, since everyone knows that the amount of oil in the world is finite. The sense in which it is true is that oil resources are sufficiently large that the market is concerned almost entirely with the marginal cost of developing additional reserves and almost not at all with the eventual depletion of those reserves. We have become so accustomed to thinking of oil as a depletable resource of fixed amount, that we need to spend some time to establish this point.

The brilliant theory of depletable resources, developed by Hotelling (1931), is not particularly useful for oil, because it applies to a fixed resource stock, in effect a tank of oil of known volume and quality. The fundamental implication of Hotelling's depletable resource model is that in a competitive market, economic rent (price minus extraction cost) from the exhaustible resource should rise over time at the discount rate. Thus, we should expect oil prices and rates of profit to oil producers to rise over time as oil reserves are used up. In this model, the problem is that the world is running out of oil. Despite several noteworthy efforts to modify and extend the Hotelling model to capture the reality of the world oil market (e.g., Gilbert, 1978; Alsmiller, et al., 1985; Marshalla and Nesbitt, 1986; Stiglitz, 1976) it remains an unrealistic representation of the nature of oil resources (Watkins, 1992). As Adelman has pointed out many times,

> "Oil reserves are not a one-time stock to be used up, but an inventory, always being consumed and replenished by investment, in new and especially in old fields." (Adelman, 1990, p. 9)

Mabro (1992) has restated this in the context of Hotelling's theory,

> "The geophysical limits may bite one day, but this day of reckoning is so far ahead as to have, on any conceivable assumption about discount rates, no impact on price." (Mabro, 1992, p.3)

Imagine a world in which oil is not a depletable resource. We can find more oil if we go out and look for it! We can return to wells from which we have extracted "all" the oil and "magically" recover more oil (with advanced technology and greater expense)! Things that are not oil, such as oil shale, tar sands, heavy oil, and natural gas, can be "magically" transformed into oil products! We can even do more with the same amount of oil! But this is not an imaginary world. This is the world in which we live.

In 1975, world proven oil reserves stood at just over 700 billion barrels. In the next fifteen years the economies of the world produced and consumed 360 billion barrels of oil and at the end of that period world proven reserves stood at 990 billion barrels, a net increase of reserves of 290 billion barrels. Before we conclude that there isn't an oil problem after all, note that all but 2% of the increase in world oil reserves was in the Persian Gulf. The continual replenishment of reserves is not a new phenomenon; this is the way it has been since the world began using oil. Yergin (1991, pp. 51-52) describes the situation that faced the Standard Oil Trust in the early 1880s.

> "There was always the fear that the oil would run out. . . .And who knew when? Could the industry survive even another decade? . . .Various experts cautioned that the Oil Regions would soon be depleted. In 1885, the State Geologist of Pennsylvania warned that 'the amazing exhibition of oil' was only 'a temporary and vanishing phenomenon - one which young men will live to see come to its natural end.'

And Adelman (1989) has pointed out the same pattern in the United States after WW II:

> "No area in the world is as drilled-up today as this country was (excluding Alaska) in 1945; 'Remaining recoverable reserves' were 20 billion barrels. In the next 42 years, the 'lower 48' produced not 20 but 100 billion, and had 20 billion left. Equally important, there was no increase in real cost before 1973;"
>
> "Was this 100-billion barrels-plus, and stable costs, a miracle, like Moses striking the desert rock to get water? Hardly. The lesson is that oil reserves are not a fixed stock to be allocated over time, but an inventory, constantly consumed and replenished by investment." (Adelman, 1989, p. 19)

The answer to this paradox may lie in the confounding of reserves and resources. Reserves are a reasonably uniform quantity of known size, but they are not finite as Adelman points out. The ultimate petroleum resource of the world is finite, but its size is not known, nor are its characteristics readily definable. Indeed, what is and what is not a resource is chiefly defined by constantly changing technology. The quantities of "oil-like" resources or, more accurately, resources that can be used to produce petroleum products, such as gasoline and distillate fuels, are much larger than petroleum reserves. World proven oil reserves stand at approximately 1 trillion barrels. Known resources of heavy oil are roughly equal in volume, tar or oil sand resources exceed 2 trillion barrels, and oil shale resources exceed 3 trillion barrels, 2 trillion of which are in the U.S. (Greene. Sperling,'and **McNutt**, 1988). The depletable resource theory might classify these as "backstop" resources. resources that would be used when oil resources were exhausted or when the price of oil rises to the level where it is economic to exploit the backstop resources. But this abstraction prevents us from realizing that even oil is not always oil. Crude oils vary widely in density, chemical composition, and viscosity. The less desirable hydrocarbon resources, such as oil shale and tar sands, are toward the end of a continuum of resources with differing recovery and retining costs. Running out of oil is not the problem. The problem is the costs (financial, environmental, political, and military) of using oil and other energy resources.

If oil is not a depletable resource then there is no imperative that oil prices rise over time in a competitive market. It is entirely possible that new discoveries together with advances in the technology of oil recovery could result in constant or even declining oil prices. This point is crucial because if it is not the inexorable economics of exhausting the world's oil resources that causes world prices to rise then it must be something else, and that something else is the exercise of monopoly power.

3.2 MONOPOLY PRICING BY AN OIL CARTEL

The 1987 report to the President of the United States clearly identified the threat of world oil monopoly to the United States.

> "If a small group of leading oil producers can dominate the world's energy markets, this could result in artificially high prices (or just sharp upward and downward price swings), which would necessitate difficult economic adjustments and cause hardships to all consumers." (Energy Security,, U.S. DOE, 1987, p. 3)

The magnitude of hardship depends on the ability of the dominant producers to raise prices in the short run and the long run. The basic theory of monopolistic pricing predicts that a producer having a total monopoly over a market will not price his product at its long-run marginal cost (C), as a competitive firm would, but at a higher price (P) that depends on the price elasticity of demand (η) for his product. The monopoly price mark-up (P/C) is,

$$P/C = 1/[1 + (1/\eta)] \tag{1}$$

Monopoly rent is the difference between price and production cost, (P/C-l)C. Note that the greater the elasticity of demand, the lower the monopoly price mark-up (and the lower the monopoly rent). This is intuitively appealing; the more sensitive buyers are to price, the more difficult it will be to raise prices and extract monopoly rent.

But is OPEC really a monopoly? After all, the majority of the world's oil supply now comes from non-OPEC countries. In reality, absolute monopolies are rare. There are nearly always a few pesky competitors who have to be reckoned with. Even the Standard Oil monopoly at its peak in 1880 controlled **90%**, not **100%**, of U.S. refinery capacity (Yergin, 1991, p. 95).

The OPEC oil producers are, in fact, an imperfect monopolistic cartel of the von Stackelberg type (Mabro, 1992). A von Stackelberg monopolist holds a large enough share of the market to influence prices, but his monopoly influence is limited by a nontrivial amount of competitive supply. von Stackelberg's (1952) theory showed that the price mark-up that yields the greatest profit to a partial monopolist depends not only on the market price elasticity of demand, but on his competitors* response (in terms of quantity supplied) to a change in his output (ν) and on the share (σ) of the market the monopolist holds.[6]

$$P/C = 1/\{1 + [(1/\eta)\bullet\sigma\bullet(\nu + 1)]\} \tag{2}$$

Note that the von Stackelberg monopolist's price mark-up and monopoly rent will be greater the smaller the world price elasticity of demand, the smaller the rest of the world's (ROW) supply response, and the larger the cartel's market share.

A fact of utmost significance for energy markets is that short-run elasticities are much smaller than long-run elasticities. Estimates of short- and long-run elasticities of demand are in the ranges of -0.05 to -0.1, and -0.3 to -0.6, respectively. Short- and long-run elasticity of supply estimates are in the vicinity of 0.03 and 0.6, respectively. As Greene (1991) has pointed out, this implies that the profit maximizing price for the cartel in the short run is far higher than the long-run best monopoly price. As a result, the cartel can, and may wish to, charge a very high price in the short run, but cannot sustain that price over a longer period. As the ROW supply grows and demand contracts, OPEC must yield market share if the short-run price is to be sustained. But with a loss of market share OPEC loses monopoly power and must lower prices or suffer a loss of revenue. Given this situation, the cartel's best strategy might still be to raise prices beyond a sustainable level to reap large rents immediately, even though rents will fall in the long run. When prices have fallen, OPEC can regain lost market share, putting it in a position to start the cycle over again.'

OPEC, or at least a core group of Persian Gulf OPEC countries, fits the description of a von Stackelberg monopolist reasonably well.[8] Dr. Fadihl J. Al-Chalabi Deputy Secretary General Acting for the Secretary General of OPEC described OPEC's position in the world energy market as follows.

> "As the only structured group of sellers in the world energy trade, OPEC can take pricing and production decisions which have a far-reaching impact on the world energy market. Other energy sellers are scattered in separate entities, with no common, coordinated policy action other than the objective of securing and

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[6]The rest-of-world supply response ν is defined as the partial derivative of rest-of-world supply with respect to the monopolist's supply. Note that $\nu < 0$ and a less responsive rest-of-world supply implies ν closer to 0.

Wirl (1990) has explored some aspects of this kind of cyclical price behavior.

[8]Because the pure monopoly is the exception and the von Stackelberg monopoly the more general case, we will refer to the cartel throughout as a monopoly, rather than a von Stackelberg monopoly or an oligopoly. Similarly, we will refer to collusion by consumers as monopsony, rather than oligopsony.

> maintaining a market share at a price high enough to allow them to continue investing in the industry.” (Al-Chalabi, 1988, p. 115)

In other words, the other producers are independent, competitive agents, on their own able to charge no more than the long-run marginal cost of production. It is OPEC that wields monopoly power.

There has been considerable debate about whether OPEC functions effectively as a cartel. Several empirical studies have rejected the hypothesis that OPEC countries behave competitively and tended to support the notion that OPEC functions as a cartel (e.g., Dahl and Yücel, 1991; Jones, 1990; Griffith, 1985). Others, however, have cited evidence that individual OPEC members have undermined official OPEC price structures and violated OPEC production quotas as proof that OPEC is not an effective cartel (e.g., Okogu, 1990). But we note that the very existence of price-setting and production quotas is proof that OPEC is acting as a cartel. It is not necessary that OPEC be a perfect cartel, only that it exert monopoly influence in the world oil market. The instances that prove it to be less than a perfect cartel are literally the exceptions that prove the rule. Adelman has aptly described the situation.

> “Every cartel needs to: (1) to fix the best price-quantity combination to maximize wealth, and (2) to divide up the market. There is no permanent solution to either problem. A temporary agreement lasts a while, breaks down, is patched up, then replaced by a new one. It is endless collusion and conflict, trial and error. But a cartel of sovereigns is a better approximation than any private group to the abstract model of a wealth-maximizing cartel.” (Adelman, 1990, p. 5)

Following the Persian Gulf War of 1991, some have surmised that OPEC may be finished; that there is a new world order in which the interests of the key Persian Gulf producers, Saudi Arabia and Kuwait, are permanently aligned with those of the consuming nations of the West. But there is good reason to doubt this. First, the entire history of the world oil trade has
3 been one of attempts to monopolize (e.g., see Yergin, 1991). Second, the rewards for reestablishing the oil cartel are simply too great. Once again, we quote Adelman.

> “The rewards of monopolizing the world oil industry have been so huge that the OPEC nations will make strenuous violent efforts to maintain it. The Iran-Iraq war was a great help in a difficult decade. So is the Iraqi aggression, which has shut down two major producers. If the cartel collapses it will reappear, perhaps with a partly different membership. Whenever they settle their differences they can cut production, and raise the price.” (Adelman, 1990, p. 12)

Perhaps some of the newly independent states of the former Soviet Union will be among those new members.

The view that the new world order may not be so different from the old is substantiated by Hogan’s (1992) quantitative assessment of capacity production increases OPEC members would have to accomplish to maintain stable world oil prices in the face of growing world petroleum demand. Hogan found that projections of world oil demand for 2000 implied OPEC production levels in the range of 35 to over 50 million barrels per day (MMBD), well in excess of peak production levels during the 1970s. Why should Persian Gulf producers make such unprecedented increases in production that will greatly increase their market share without taking advantage of the opportunity to raise oil prices? With OPEC holding such a large share of world oil reserves, what reason is there to believe that future conditions will be better rather than worse?

It follows from the view of the world oil market as a cartel that the United States and other consuming nations have been and still are paying higher prices for oil than they would in a competitive market. The result is, 1) a transfer **of wealth** from oil consumers to oil producers, **2)** a **loss of economic output** due to the increased economic scarcity of oil, and 3) additional transitory losses of output due to the economy's inability to quickly adjust prices, wages, and capital equipment when oil prices change abruptly and profoundly. We explain these concepts further below.

3.3 MONOPOLY PRICE AND THE TRANSFER OF WEALTH

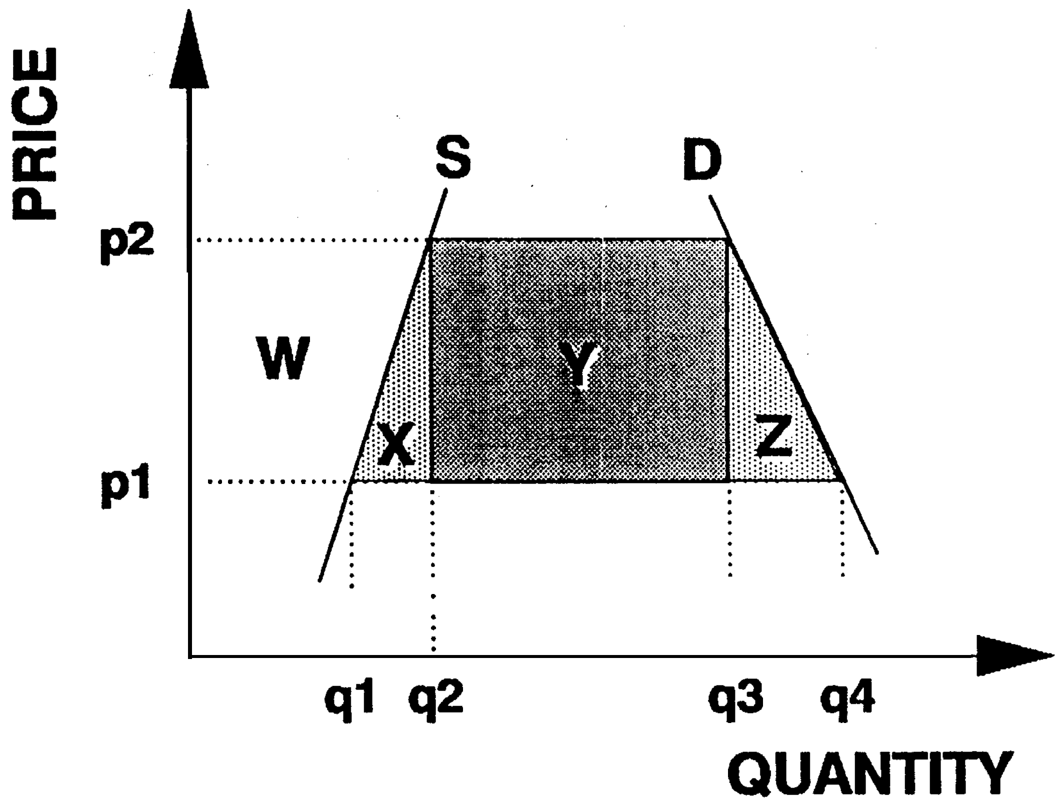
A large component of the cost of oil at monopoly prices is the transfer of wealth from oil consumers to oil producers. Monopoly rent is a large part of this transfer. The situation of an oil importer such as the United States is illustrated in Figure 1. Because the U.S. domestic supply curve "S" does not intersect the domestic demand curve "D" over the range of prices in question, the U.S. imports the difference. At the competitive price p_1, the U.S. produces q_1, consumes q_4, and imports q_4-q_1. At the higher monopoly price, p_2, The U.S. produces a greater quantity, q_2, consumes a smaller amount, q_3, and imports a smaller amount, q_3-q_2. The U.S. must pay much more for the oil it imports, indicated by the area Y. The area Y is a loss, or transfer, of U.S. wealth to all oil producers. Some of this transfer of wealth goes to pay for the cost of increased world oil production but most of it is monopoly rent. Rents are traditionally not considered as economic costs because they are a transfer, not a loss of real resources. We argue that although they are not a cost to the world economy, they are a cost to the U.S. as a nation and should therefore be included in any analysis of national costs.

We count the monopoly rent as a cost but not the economic rent that would be transferred in a competitive market. Consider an oil field in the Middle East with a lower-than-average cost of production per barrel of c dollars. In a competitive market, the owner of the field would get p_1-c dollars of economic rent per barrel of oil produced. At a monopolistic price of p_2, the owner receives p_2-c dollars of rent, p_2-p_1 of which is monopoly rent. Both the economic and monopoly rents are a transfer of wealth from consumer to producer. In a free-market economy, we usually consider the economic rent to be a necessary incentive to insure an efficient market. We usually object to the monopoly rent, on the grounds that it results from a less than competitive market (a market failure), and produces a less than efficient allocation of resources.

Because OPEC producers need not spend additional resources to find and develop oil, they are free to spend their money on other things (e.g., development projects, tanks and missiles, nuclear weapons programs). This point is inconsequential from an economic viewpoint, but may be of great concern from the perspective of U.S. national security.

The situation for ROW competitive producers is somewhat different. They, too reap some monopoly rents whenever the cartel succeeds in raising oil prices. Their rents are reduced,

FIGURE 1. OIL MARKET LOSSES AND TRANSFERS



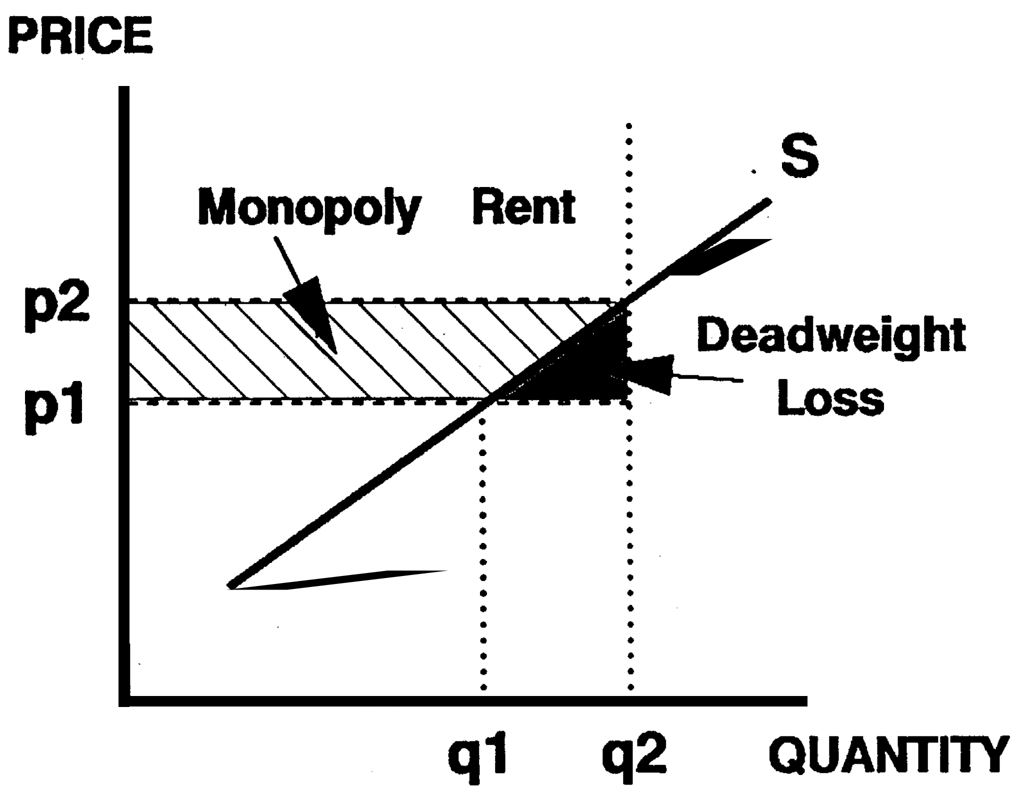
however, by the amounts they spend increasing oil production.’ Figure 2, showing an **upward**-sloping oil supply curve, illustrates this point. When world oil prices increase from p_1 to p_2, supply from this competitive producer increases from q_1 to q_2. The hatched area between the supply curve and the price axis, bounded by p_1 and p_2 is increased producers’ surplus. We call it monopoly rent in Figure 2 to signify that it was brought about by the exercise of monopoly power by the cartel. The shaded triangle below the supply curve represents an increase in resources that must be used to produce the q_2-q_1 increase in oil supply. This increase is a real resource cost and therefore a deadweight loss to the world economy. Both the monopoly rent and dead weight loss are counted as costs to the U.S.

Because of the transfer of wealth. the extent to which the United States. or any individual country. depends on imports does matter, but it is not the whole story. First, if the U.S. imported no oil but OPEC still influenced world oil prices, U.S. consumers would still pay higher prices for oil (in the absence of price or oil export controls).” Some of this higher price would be a transfer payment from U.S. consumers to owners of U.S. oil resources, and a portion would be a deadweight economic loss. No wealth would be transferred to foreign oil producers. To the extent that U.S. petroleum resources were owned by U.S. citizens, the wealth transfer would be internal to the United States. There would be a redistribution of income among U.S. citizens which might or might not be considered a problem. In the 1970s it was considered a problem by the Congress who enacted a windfall profits tax in an attempt to recapture the transfer payments to domestic oil companies.

[9]**Deadweight production losses are costs even if the full social cost of oil is higher than the competitive market** price, **since a tax on oil reflecting its social costs would decrease rather than increase the price oil producers could obtain for their product, thus reducing deadweight supply losses.**

[10]**If there were domestic price controls as there were during the 1970s, U.S. consumers would be at least partially insulated from higher world oil prices. Price controls generate their own problems which we will not go into here.**

FIGURE 2. DEADWEIGHT LOSSES AND MONOPOLY RENT REST-OF-WORLD OIL PRODUCERS



4. MANIFESTATIONS OF THE INCREASED COST OF OIL

The higher cost of oil manifests itself in several, often confusing, ways. In addition, researchers often use different terminology to refer to the same phenomena. In this section we review concepts that have been used to describe the economic effects of higher oil prices, and show how they relate to our three components of economic cost.

4.1 TRANSFER OF WEALTH AND TERMS OF TRADE

All of the extra cost of imports is a loss to the U.S. economy. It is sometimes argued that this outflow of funds need not reduce the growth of U.S. Gross Domestic Product, since the recipients of U.S. wealth may choose 'to buy more U.S. products, or may buy from others who, in turn, may buy more U.S. products. Others may even choose to invest capital in our economy. Regardless, there is always a loss of wealth by U.S. citizens and a gain by foreign owners of oil."

The inevitable loss of wealth to monopolistic oil prices must be reflected in a deterioration in the "terms of trade" between the U.S. and the rest of the world. The mechanism by which this occurs has been well described elsewhere (Broadman, 1986; 'Hogan and Broadman, 1988; Huntington and Eschbach, 1987).

> "To maintain our trade balance in the face of an increase in the total payment for imported'oil, either an increase' in U.S. export earnings 'or a decrease in U.S. import expenditures on non-petroleum products would be required. Accordingly, the dollar exchange rate would adjust, making U.S. exports more competitive on the world market and imports more expensive for U.S. consumers. Since at equilibrium total imports available to the U.S. economy would be reduced and U.S. exports would increase, domestic consumers are made unambiguously worse off." (Hogan and Broadman, 1988, p. 65)

> "An international oil shock also reduces the purchasing power of U.S. national income. When the price of imported oil rises relative to other prices in the economy, the oil-importing economy must produce more exports to buy a barrel of imported oil. With full employment of domestic resources, this deterioration in the terms of trade requires that production be diverted away from goods for internal use in order to purchase a given level of imports. It is important to emphasize that this loss focuses on the shift in claims on production from oil-importing to oil-exporting countries rather than on changes in total output in the

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"The only exception would be if the U.S. could respond to the formation of the oil cartel by creating its own monopoly in another area and extracting comparable monopoly rents from oil producers. As an alternative, the U.S. and other oil consumers could respond by creating a consumer's monopoly and reclaim monopoly rents by exercising monopsony power. This option is discussed below.

oil-importing economies. Even if total U.S. output remains unaltered by the oil shock, the U.S. economy would still be worse off due to the reduction in the purchasing power of its domestic income." (Huntington, and Eschbach, 1987, p. 202)

An adjustment in the relative prices of U.S. exports versus imports, the terms of trade effect is a reflection of the underlying change in economic scarcity caused by the exercise of monopoly power. The cartel, by seizing monopoly control of oil, is able to make itself richer and the oil consuming nations poorer. This is not a cost in addition to the transfer of wealth, it is a manifestation of it.

It is clear from the foregoing that the transfer of wealth due to importing monopolistically priced oil is a cost to the United States, over and above the loss of potential GNP, and in addition to the macroeconomic adjustment losses arising from price shocks. When the oil market is subject to monopoly pricing, it does matter how much oil we import because this determines how great our loss of wealth will be. In estimating the economic losses from oil price shocks, macroeconomic models of the U.S. economy include adjustment costs and the loss of potential GNP because these result from changes in the utilization of factors of production, but they do not include the transfer of wealth. Therefore, in estimating the costs of oil dependency, we must add the transfer of wealth to the macroeconomic adjustment costs and loss of potential GNP in computing the full economic cost of oil.

4.2 MONOPSONY COST AND THE TRANSFER OF WEALTH

The "monopsony cost" of imported oil is the failure of oil consumers to collude and use their market power to recapture monopoly rents from oil exporters (Murphy, Toman, and Weiss, 1986, p. 68). Broadman (1986, p. 243) has described the monopsony cost effect as follows.

> If an increase in the demand for imports leads to a rise in the world price of oil, the increase in price affects all imports, not just the increment that induced the price increase. Although the party responsible for the rise in demand faces a higher price for oil, it does not see the price effect that its contribution to demand has on other importers. In this case, the demand increase by the marginal importer produces an external cost by raising total payments abroad for oil imports by more than the price."

If η_s is the supply elasticity for oil imports, then the marginal social cost (MSC) of an imported barrel of oil is,

$$MSC = P \bullet (1 + 1/\eta_s) \qquad (3)$$

The social cost exceeds the private cost by P/η_s. If the supply of imports to the U.S. is very elastic, the price difference will be very small, and very high if supply is inelastic." A major

[12]The same observations about long-run and short-run supply elasticities made above for the monopoly price mark-up apply here for the monopsony price effect.

question regarding this approach has been the issue of the existence of a supply curve for imports. A large fraction of U.S. imports come from OPEC producers. If we do not have a satisfactory theory of OPEC behavior, how can we have an OPEC supply curve, and if there is no OPEC supply curve how can we have an import supply curve? Viewing OPEC as a von Stackelberg monopolist partially resolves this problem. The price OPEC will charge depends on the quantity of U.S. consumption via the effect of U.S. consumption on OPEC's market share. But which price elasticities (short-run or long-run) should we use in determining the monopoly price of oil (equation 2) and what rules should we use to predict OPEC's behavior as an imperfect cartel? There are no simple nor certain answers. Nonetheless, if the world could somehow reduce OPEC's -market share enough, prices would return, to competitive market levels (or close to them). Thus, in the extreme, the monopsony cost is precisely the failure to reclaim the transfer of wealth caused by monopoly pricing of oil.

If monopsony power can lower monopoly prices, why not use it to lower competitive market prices, as'well? Why not use it in all phases of international trade? There are two good reasons: 1) competitive market prices produce an economically efficient allocation of resources, and 2) indiscriminate exercise of monopsony power would likely shatter painstakingly negotiated free trade agreements. In short, there is too much to lose. If free trade in competitive world markets is the goal, then judicious use of monopsony power against monopoly pricing is a step in the right direction, while indiscriminant use of monopsony power against competitive producers is counterproductive.

4.3 LOSS OF POTENTIAL NATIONAL PRODUCT

Another cost of higher-priced oil is a reduction in the economy's ability to produce (e.g., Pindyck, 1980, or Pakravan, 1984, pp. 1519). Burgess (1984) has described this direct effect as follows.

> "For a net energy-importing economy, an increase in the world relative price of energy confers an immediate real income loss whose magnitude under full employment conditions depends on both imports' share of the economy's energy requirements and energy costs' share in the production of final output. The reduction in real income coincides with a reduction in potential real GNP properly adjusted for terms-of-trade effects.'

The switch to monopoly oil pricing increases the economic scarcity of oil. Whether the cause is geophysical or monopolistic, the economy responds in the same way to the price signal. Because oil is now more scarce, the capability of our economy to produce, and also that of the entire world, is reduced.[13] This effect is long-run in nature and does not decrease over time as the economy adjusts to the higher prices. It is not a result of a loss of aggregate demand, and happens'regardless of whether oil-rich nations buy U.S. products or not. The potential loss of GNP from an increase in oil prices depends on the importance of oil to the economy, and the ability to substitute other energy, capital, and labor for oil. A useful illustration of these

"Put another way, the world's production possibilities frontier has shifted inward (i.e., the world has become poorer). See, e.g., Pindyck (1980) for a discussion of the scarcity effect.

relationships was derived by Bohi (1989, ch. 3). Let Q be the gross output of the economy, including both the final consumption of energy services and the intermediate consumption of energy (E) in the production of GNP. Net output, or GNP, is therefore,

$$GNP = Q - P_E E \tag{4}$$

where P_E is the average price of energy. Noting that Q is a function of factor inputs of capital, K, labor, L, and energy, E, Q = Q(K,L,E), and setting marginal products equal to prices, a change in GNP is related to changes in factor inputs as follows,

$$dGNP = P_K dK + P_L dL - E dP_E \tag{5}$$

Dividing through by GNP and rearranging to form elasticities (β) gives,

$$\beta_{GNP,Pe} = \sigma_K \beta_{K,Pe} + \sigma_L \beta_{L,Pe} - \sigma_E , \tag{6}$$

where σ_x is the cost share of GNP of factor x. The first two terms on the right-hand side are the factor shares for capital and labor multiplied by the respective elasticities with respect to the price of energy. If there is no substitution of either K or L for energy, then the long-run potential GNP loss elasticity with respect to energy price is -a,, the cost share of energy. As Bohi (1989) points out, $\beta_{K,Pe}$ and $\beta_{L,Pe}$ will both be greater than or equal to zero, so that the long-run elasticity of potential GNP with respect to the price of energy will certainly be smaller (in absolute value) than σ_E. We refer to this as the long-run effect of energy prices because it excludes macroeconomic adjustment losses which, in the short-run will prevent the economy from reaching its long-run, full employment, potential output level. Thus, the budget share of energy is a theoretical upper bound on the marginal potential GNP loss elasticity due to an energy price shock.[14] The above argument could also be applied to oil price, with suitable modifications. Thus, a bound on the potential GNP loss due to a marginal increase in oil prices is the oil cost share of GNP.[15]

[14]Note that this does not mean that the observed oil cost share of GNP at any point in the past is an upper bound on the GNP impact of a price increase that incurred in that year. This is because some substitution will already have occurred, pushing up other energy prices but mitigating the oil price rise. As a result, the observed oil price rise will be less than what would have occurred if no substitutions had taken place, as in Bohi's equation above.

[15]Bohi computed "upper bound" estimates of the impact of energy prices on GNP by multiplying the cost shares for 1974 and 1979-80 (0.065, 0.070, and 0.085 for 1974, 1979, and 1980, respectively) by what he termed the relative changes in energy prices in those years. He obtained a maximum impact of 0.7% in 1974 and 0.36% in 1979-80. Wbat he used for relative price changes, however, were the annual percentage change in the price of energy divided by the percentage change in the GDP deflator. These numbers were 11 in 1974 and 4 in 1979-80, but Bohi apparently multiplied the cost shares by 0.11 and 0.04. But the relative price change should have been not the ratio of the percent changes in the price indices (divided by 100), but the percentage change in the deflated price of energy, a very different number (about 8 1% for 1974 and 28 96 for 1980). Had the computations been done this way, the "upper bound" estimate for 1974 would have been 5 % for 1974 and 2.5 % for 1980 (versus 0.7% and 0.36%). As we noted above, these observed shares are not true upper bounds for the impact in their respective years, since they reflect some degree of short-run substitution of factor inputs.

The loss of potential GNP is an inescapable result of the fact that a critical resource has become more difficult to obtain. The economy receives this bad news in the form of a higher price of oil, and responds accordingly. It matters not whether the price increase arises from real physical scarcity of oil or from the exercise of monopoly power. It looks the same to the economy: the price goes up. The result is a chain reaction of producer and consumer surplus losses throughout the economy, in the supply and demand for: 1) oil, 2) other energy and, 3) other factors of production (Ref. Figure 1).[16] In the oil sector, oil consumption falls from q_4 to q_3, with a concomitant loss of consumers' surplus (the triangle **Z**) as a result of the higher price. Because U.S. supply is unable to satisfy domestic demand, imports in the amount of q_3-q_2 are purchased at the monopoly price, p_2. To expand U.S. production to q_2, capital and labor must be spent: this is represented by the shaded triangle labeled X. This extra production cost is a deadweight loss to the U.S., and to the world economy. The area labeled Y represents increased payments for imported oil as discussed above. Y is a loss to the U.S. economy, but it is not a loss to the world economy.[17] The area labeled W is the increase in rent to owners of U.S. oil resources. Note that if we relabeled "imported"' oil as "domestic", the deadweight economic losses (X, **Z**) would remain unchanged. These two components are part of the loss of potential GNP. They represent a real loss in the production possibilities of the U.S. economy. The distinction between W and Y, on the other hand, is a distinction based on who gets to keep the output of the U.S. economy. In this paper we assume that this matters. When wealth leaves the U.S. economy we count it as a loss, even though from the global perspective it is not an economic loss, but rather a pecuniary transfer.

Other types of energy are substitutes for oil. When the price of oil goes up the economy will attempt to use more of them and less 'of oil, tending to drive up their price and dampen the oil price increase. Similarly, nonenergy inputs are substitutes for energy, and when the price of energy rises, demand for nonenergy inputs that are substitutes for energy will rise while demand for those that are complementary to energy use will fall. As a result, there will be surplus losses in markets for substitutes and gains in markets for complements. The total loss of potential GNP is the sum of these components representing the entire economy. That there will be a net loss rather than gain outside of the energy sector is readily demonstrated.[18]

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[16]This discussion draws heavily from Leiby and Lee (1988), pp. 96-97.

[17]There is frequently an argument about whether the money represented by Y will or will not return to'the U.S. economy in the form of increased demand for U.S. exports. If it does not, there will be a loss of aggregate demand for U.S. output, sometimes termed "leakages." If it does, then there will be no loss of aggregate demand. There is no reason, a priori, that it should go either way. From the point of view of the welfare of U.S. citizens the point is, who gets the output of the U.S. economy? Leiby and Lee (1988) have termed this "Domestic Absorption" versus "Foreign Absorption" of U.S. output. It is obvious to us that domestic absorption (how much of our GNP we get to keep) is a better measure of U.S. welfare than gross output (how much we produce).

[18]Consider the cost function for net output Y (demand minus supply), $C(P_e,P_1,Y)$, where P_e is the price of energy, P, the price of an aggregate of other factors, and Y is total net GNP. By Shepard's Lemma, the conditional factor demand function for good x is $\partial C/\partial x$. Thus, the total cost of a new price for energy, P_e', is

$$C(P_e',P_1,Y) - C(P_e,P_1,Y) = \int_{P_e}^{P_e'} x_e(p,P_1,Y)\, dp$$

Huntington and Eschbach (1987) pointed out that wealth losses and macroeconomic (real GNP) oil price shock losses are additive.

> "Specifically, the international wealth losses from an oil price shock can be added to the reductions in output or real gross national product (GNP) measured by models of the aggregate economy." (Huntington and Eschbach, 1987, p. 200)

Their argument that macroeconomic models ignore the oil wealth loss arises from the way GNP is measured and is essentially an accounting problem. Toman (1989) has also argued that GNP, as measured in the national income and product accounts will include neither wealth transfer nor potential GNP loss:

> "Measured GNP in the national income accounts basically is equal to the total income (or product) of labor and capital valued at a base year set of prices. Thus, measured GNP does not reflect the increased real cost of oil used in producing final output when relative oil prices increase. In fact, if total employment of capital and labor services are unchanged after an oil price shock then measured GNP will show no decline, even though potential GNP does decline as described above. In particular, measured GNP losses from an oil price shock will not include the real output loss and wealth transfer from a higher real cost of imports." (Toman, 1989, p. 35)

But, in fact, the total employment of capital and labor services must change when higher oil prices cause a loss of potential output. Recall that the loss of potential output is the sum of producer and consumer surplus losses across the economy. These losses will be reflected in changes in the real resource inputs required to produce outputs and in the consumption patterns of real goods and services. Thus, the loss of potential GNP, <u>will</u> be reflected in measured GNP and in estimates of GNP loss by macroeconomic models. What will <u>not</u> be included, is the transfer of wealth, because the wealth that is transferred is part of the gross 'output. Only the ownership of the output has changed.

4.4 OIL PRICE SHOCKS AND MACROECONOMIC ADJUSTMENT COSTS

Because of the remarkable correlation and apparent causal link between oil price shocks and subsequent economic recessions, oil price shocks and their economic impacts have received the greatest attention from energy economists (Hamilton, 1985). Oil price shocks induce both

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Likewise, the change in total cost that accompanies a change in price from P_1 to P_1' as a result of the change from P_e to P_e', can be shown to be,

$$C(P_e',P_1',Y) - C(P_e,P_1,Y) = \int_{P_1}^{P_1'} x_1(P_e',p,Y)\,dp + \int_{P_e}^{P_e'} x_e(p,P_1,Y)\,dp$$

Because x_1 is an aggregate of other factors by definition, it must be a substitute for energy. Thus, $P_1' > P_1$, and both quantities on the right hand side of the above equation are positive. Not only does an increase in the price of energy produce surplus losses in energy markets, but net losses in the rest of the economy as well. The sum of the two is the loss of potential GNP.

a transfer of wealth and a loss of potential GNP. The difference is that the transfer and **GNP loss** are greater when a price shock occurs because the price increase is greater. [19] But oil price **shocks** also generate what Pindyck (1980) has termed "secondary" effects.

> "Second, rising energy prices contribute directly to inflation, and, by increasing the marginal cost of production they may, if wages are rigid, further reduce GNP and employment. Depending on the macroeconomic policy response to this added inflation and unemployment (that is, whether we 'accommodate' the additional inflation by using an expansionary monetary and fiscal policy to try to move back to full employment quickly, or whether we accept the additional unemployment for some time), and depending on the effectiveness of that policy response, there will be an added cost - namely, the cost of the increased inflation and/or a further reduction in GNP. This might be thought of as an *indirect* cost of higher energy prices." (Pindyck, 1980, p. 2)

Pindyck's concept of indirect costs is similar to what Huntington and Eschbach (1987, p. 201) call "macroeconomic adjustment costs.." **Macroeconomic adjustment** costs arise because imperfect adjustment in the short-run to a major oil price increase will cause the economy to contract more than **is** necessary in the long run (more than the loss of potential GNP). Wages and prices will not adjust immediately to the new price of oil for a variety of reasons, including cost-of-living provisions in labor contracts and entitlement programs. Also, substitutions of other energy sources and other factors of production for oil will take time because of the durability (economic value tied up in) energy-using equipment. Hickman **(1987),** in his superb analysis of oil price shocks, explains this phenomenon as follows.

> "Stability considerations suggest that prices, **and** hence output, will probably overshoot the long-term equilibrium as indicated, however. With the natural unemployment rate and the full employment labor supply unchanged and actual output reduced by the shock, employment should fall at the initial real wage, increasing unemployment and depressing wages and prices." (Hickman, 1987, p. 141)

That is, because the adjustment to the economic scarcity of oil and the loss of income via wealth transfer occur at the "old" prices and wages (and capital stock), the GNP level that can be reached in the short run is necessarily worse than that which could be reached if the economy were able to adjust at the long-run, optimal prices and wages. Figure 3 illustrates how the economy will overshoot its long run loss of production possibilities by moving first to a point that is long-run **inefficient (2),** and then to a point that is on the long-run production possibilities frontier. Another reason that the economy would tend to overshoot its long-run loss of output is that the technology of energy use, reflected in capital stocks of equipment, is long-lived. Energy-using plant and equipment and motor vehicle stocks will take 15 years or more to fully turn over. In the mean time, we 'are stuck with technical substitution rates of energy for other inputs that are not consistent with the new structure of relative prices. **Output** must suffer.

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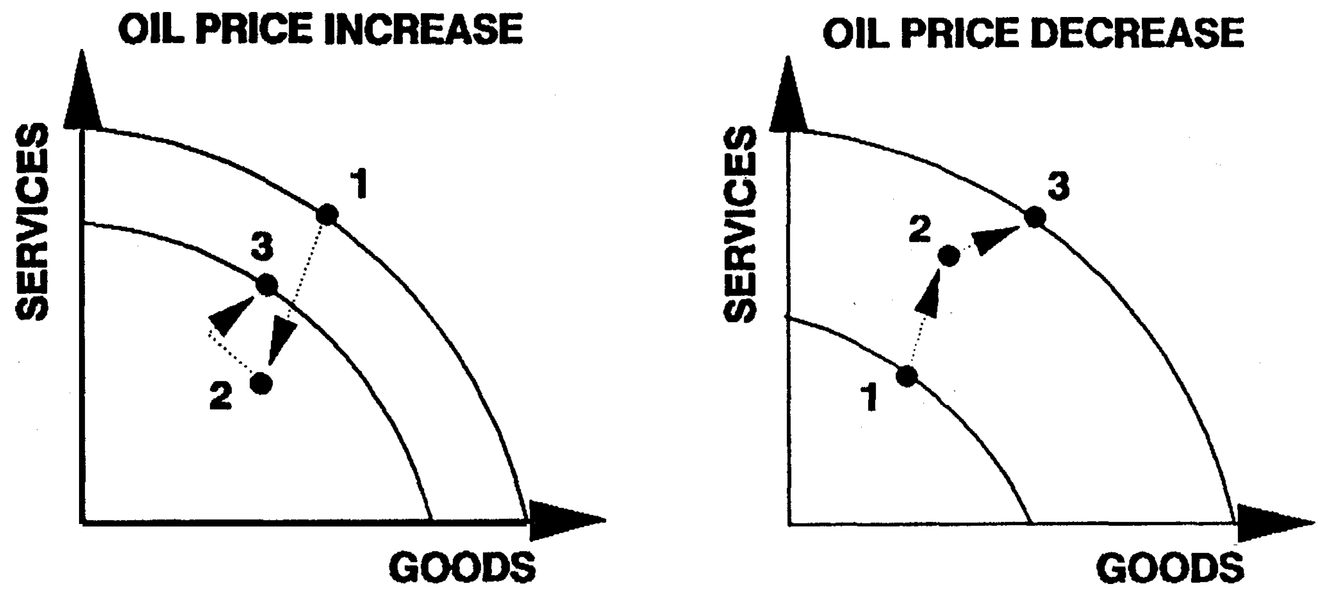
[19]Broadman, 1986 p. 245, makes this same argument in terms of the "monopsony wedge" effect.

FIGURE 3. EFFECTS OF OIL PRICE SHOCK-INDUCED SCARCITY ON SHORT-RUN AND LONG-RUN OUTPUT



1. INITIAL OUTPUT LEVEL
2. OUTPUT AT SUBOPTIMAL USE OF FACTORS
3. OUTPUT AT LONG-RUN OPTIMAL USE OF FACTORS

Macroeconomic adjustment costs are in addition to the loss of potential GNP. Thus the "upper bound" on GNP losses derived by Bohi (1989) and presented above is not an upper bound on the short-run GNP loss. This is because that derivation assumes full employment of factor resources (labor, capital, and energy). Bohi's energy cost share is an upper bound on the long-run loss of GNP due to a price increase. because it does not allow factor substitutions that, in the long run, will mitigate the impact of the price increase. It is not, however, an upper bound on the short-run impact of a price shock, because it assumes full employment of factor resources. Thus, macroeconomic adjustment costs are a temporary (several year) excess loss of GNP, that is suffered in addition to the loss of potential GNP due to the increased economic scarcity of oil. As the economy- approaches congruity with the new cost of oil, macroeconomic adjustment costs wane. The loss in potential GNP, a loss in the economy's ability to produce output as a result of the apparent increase in the scarcity of oil, remains.

Numerous other types of macroeconomic costs can result from an oil price shock.[20] These include "leakages" in trade that may affect the United States' balance of payments, as well as producing a shortfall in aggregate demand. This happens when the extra dollars leaving the U.S. in the form of higher payments for imported oil do not return in the form of increased demand for U.S. exports. The flow of dollars generated by an oil price increase is illustrated in Figure 4. Note that it is not necessary that oil producers directly increase their purchases of U.S. exports. If they increase purchases from a third country that, in turn, increases its purchases of U.S. exports, that will be sufficient to maintain U.S. aggregate demand. Another type of macroeconomic cost can result from consumption-investment shifts due to the international and domestic redistribution of income. To the extent that the new distribution of oil revenues results in a greater or lesser propensity to consume, this too can affect aggregate demand. Price shocks may also affect the willingness of producers to invest in capital equipment, thus affecting the rate of economic growth.

Oil price shocks may also produce governmental policy responses that exacerbate the problem. Bohi (1989) has argued that a significant component of the GNP losses associated with past oil price shocks may be due to inappropriate (anti-inflationary) monetary policy, and to energy price controls. In theory, monetary policy could be used to increase the speed of adjustment to full employment by expanding the supply of money. If a deflationary monetary policy is pursued to deal with the effect of the oil price shock on inflation, rather than an expansionary policy to accommodate the price increase and return the economy as quickly as possible to full employment, one could argue that part of the cost of the price shock should be partly attributed to monetary policy rather than to the price shock itself (e.g., Bohi, 1989, pp. 84-85). This is a very complex question, hinging on trade-offs that must be made in pursuing monetary policy and on the ability of policymakers to respond optimally to future shocks. If Bohi is correct, policymakers may be better able to cope with future price shocks, having learned from the lessons of the past. This does not affect our estimates, however. Since we are attempting to estimate the cost of past shocks, the mistakes of the past, if any, should be included. Attempts to prevent the redistribution of income (e.g., due to "windfall" profits) may also produce excess economic costs. To the extent that these effects are included in the macroeconomic impact estimates of previous studies, we implicitly include them in our analysis, as will be seen in the following section.

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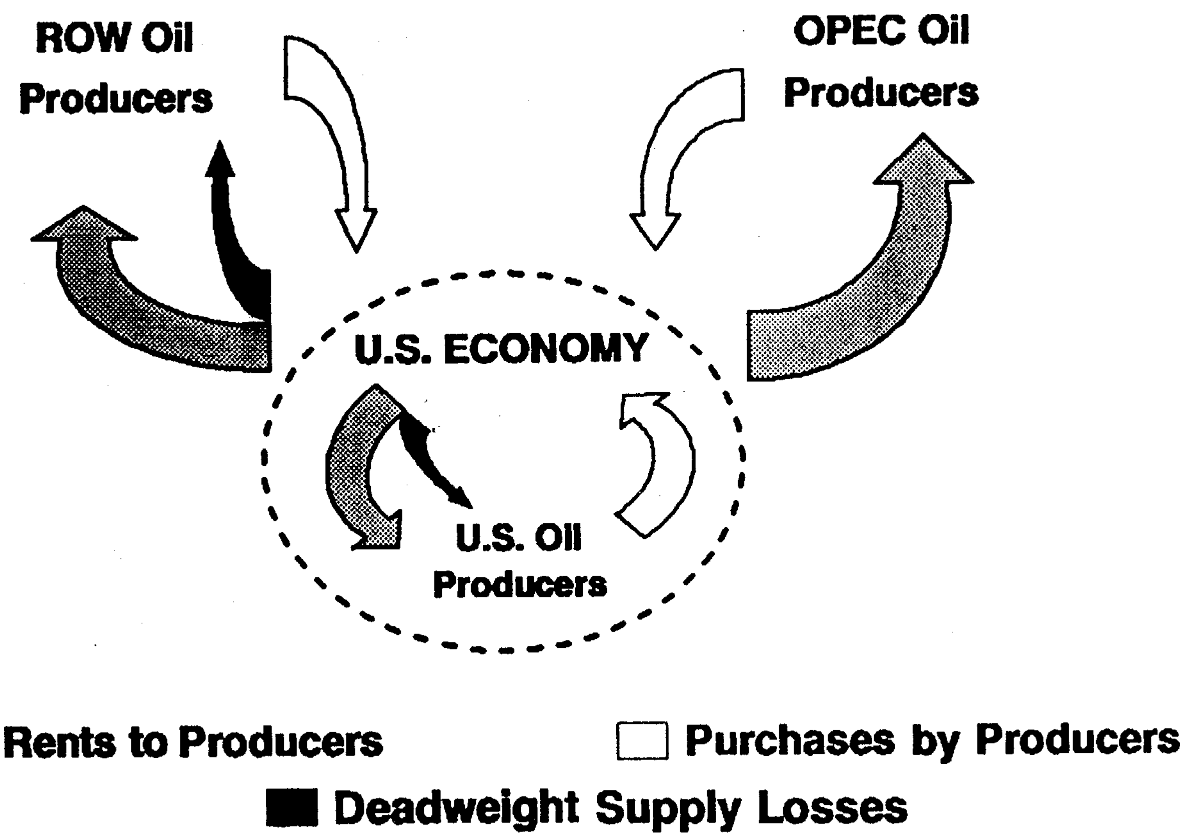
[20]For a discussion see, e.g., Goulder, 1985.

FIGURE 4. MONETARY FLOWS RESULTING FROM THE MONOPOLY PRICING OF OIL



5. MEASURING THE COST COMPONENTS

In this section we consider how to quantify each of the economic cost components discussed in section 4. We also consider some less readily quantifiable costs of increased military and strategic risks, but **only** to get a rough idea of their size relative to the three basic economic cost components. In making these estimates, we compare history to a hypothetical unmonopolized world oil market. To do this we must predict what the. price of oil would have been without the use of monopoly power by OPEC. To the extent this prediction is wrong, our estimates of costs will be in error. We explore the sensitivity of our cost estimates to our hypothetical oil price path.

5.1 ECONOMIC COSTS: THE TRANSFER OF WEALTH

Economic costs to the U.S. are comprised of the **transfer of wealth** to foreign oil producers, **the loss of potential** GNP due to the increased economic scarcity of oil, and **macroeconomic adjustment** costs which arise from the economy's inability to adjust rapidly to oil price shocks. In this section we explain the methods by which we will measure each component.

The transfer of U.S. wealth as a result of higher monopolistic oil prices is comprised of monopoly rents and deadweight losses paid to producers of imported oil. The combined cost can be measured by the difference between prevailing market prices for oil and what the price would have been in a competitive market, multiplied by the quantity of oil the U.S. imports. We assume that OPEC members will accrue the difference between the actual oil price and a competitive world oil market price (P_2-P_1) in the form of pure monopoly rent. This is very likely, since finding and lifting costs in all OPEC countries except Nigeria and Venezuela have been estimated to be $2/bbl or less (1990 $). Venezuela and Nigeria's costs are both below $3.50, and the countries with the largest reserves (Saudi Arabia, Iraq, Kuwait, and Iran) have costs well below $1/bbl.[21] With finding and lifting costs so far below any conceivable competitive market price, OPEC members would receive considerable economic rents even in a competitive world oil market.

What would the price of oil be in a competitive world oil market? This is obviously a difficult question to answer. It is not clear that the world oil market has ever been truly competitive, in the sense of being free from monopolistic influence by states or corporations (see Yergin, 1991). We approach this problem from two directions. The first tack is to find a year or years in which the world oil market may have been approximately competitive and use that

[21]These costs estimates are **based on Adelman and Shahi (1989) and Dahl and Yiicel's (1991) updating of that work. Costs given in these sources in 1982 $ were converted to 1990 $ using the implicit price deflator of the U.S. GNP.**

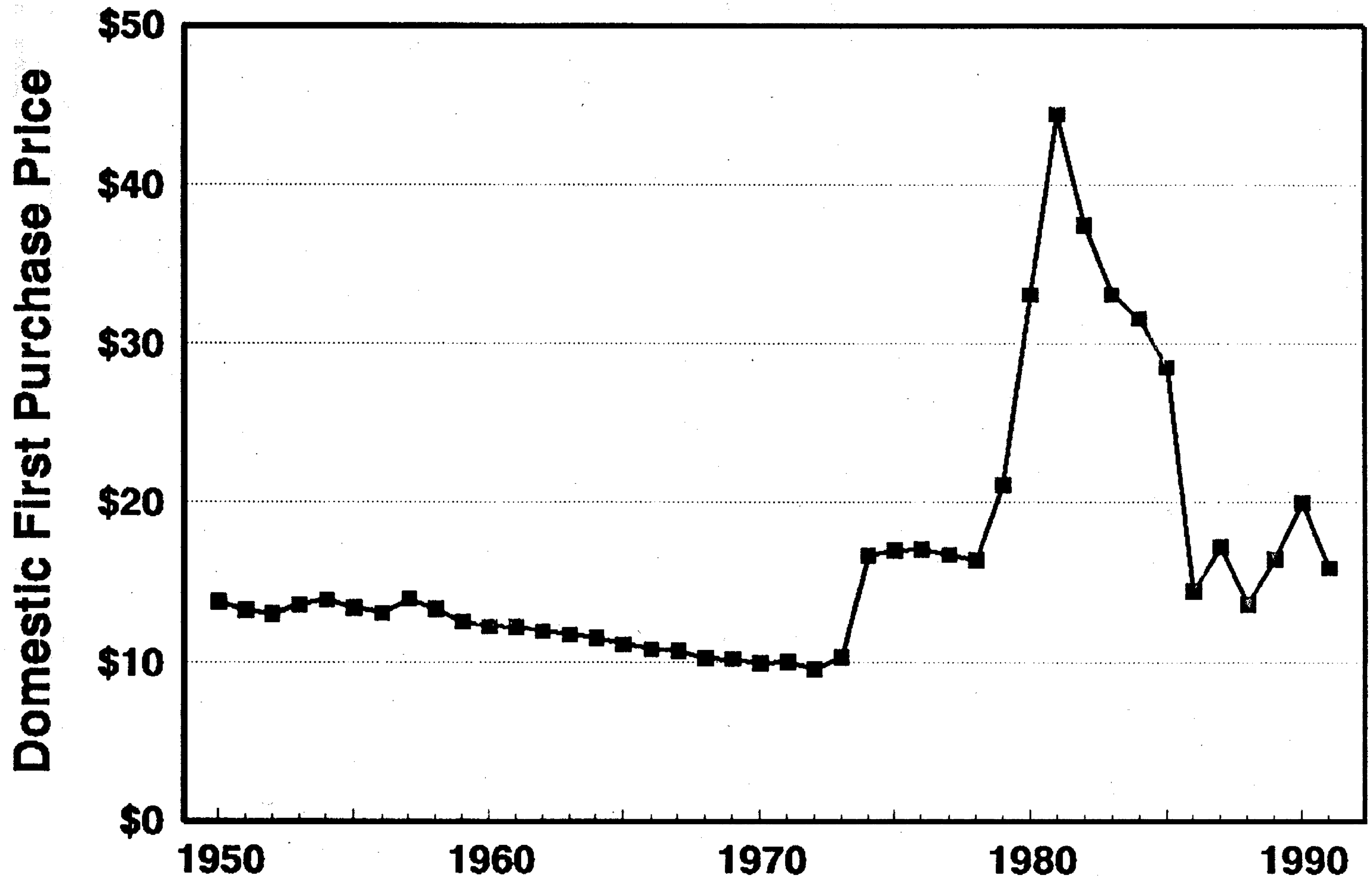
price to estimate competitive prices for succeeding years." The second is to rely on models of the world oil market to predict competitive market prices. If the world oil market was approximately competitive before members. of the OPEC cartel disrupted world oil prices in 1973, then the 1972 price, in real dollars, should be an indication of what the price would be today in a competitive market. In 1972, the refiner acquisition cost of imported oil to U.S. refiners was $3.22/bbl in 1972 dollars, which converts to $9.10/bbl in 1990 dollars (EIA, 1992). This assumes no real price increase due to increasing resource scarcity. The fact that real oil prices in the U.S. had been gradually declining for at least 25 years prior to 1973-74, tends to support the view that oil was not becoming more scarce (Figure 5). However, if real prices would have risen, either due to increasing scarcity or demand, then the lowest recent price might be a better estimate of a competitive market price.

A second approach is to review predictions by modelers and analysts of competitive market world oil prices. These generally range from $5-$10/bbl, 1990$ (Table 2). Estimating what prices would have been had the oil market been competitive is obviously a hypothetical exercise, and answers must be taken with a grain of salt. Fortunately, data on the costs of developing oil reserves are reasonably good, and can be used to check the reasonableness of price estimates. We have pointed out above that finding and lifting costs for the OPEC countries fall in the range of $0.10 to $3.00 per barrel, with the Persian Gulf producers generally below $1.00/bbl (Adelman and Shahi, 1989; Dahl and Yücel, 1991). A recent analysis by Adelman (1991) indicates costs of oil development in the U.S. averaged $3/bbl for 1988-89 (nominal $) and somewhat higher in previous years. In a recent exercise conducted by the Energy Modeling Forum (1992), six models were used to predict future oil prices under competitive market conditions. One model predicted about a $5 per barrel decrease in market prices, three predicted that prices would drop by over $10/bbl, while in two others competitive prices remained in the range of $10-$15/bbl through 2010 (EMF, 1992, p. 103).

These estimates compare reasonably well with historical benchmarks. In 1972, the year before the Arab-OPEC oil embargo, U.S. refiners paid an average price of $3.22/bbl (1972$), or $9/bbl in 1990$. There is little evidence that worldwide costs of oil production have increased significantly since 1972, in real terms. Another benchmark is the lowest annual average price since 1972, about $16/bbl (1990$) which occurred in 1988. This is probably a reasonable upper bound on a competitive world oil price since OPEC was active, if not very effective during this period, in attempting to influence oil prices. However, oil prices in 1986 and 1988 may be more reflective of OPEC's long-run optimal monopoly price, rather than competitive market prices. As Greene (1991) has pointed out, OPEC's optimal monopoly price varies with its market share. We select $9.10/bbl (1990 $) as a reasonable estimate of a competitive world oil market price. Of course, this is an assumption rather than a fact, since we can never know what oil prices would have been had OPEC not acted to restrict supply and influence prices.

[22] This should more accurately be termed a status quo ante market rather than a competitive market.

FIGURE 5. U.S. DOMESTIC CRUDE OIL PRICES, 1950-1991
(1990 $ Per Barrel)



Source: U.S. Dept. of Energy, EIA, Annual Energy Review 1991, Table 68.

Table 2. Estimates of World Oil Prices in a Competitive Market

Source	Oil Price	1990 $/bbl
Model Estimates for Competitive Market		
Adelman (1989) Morison (1987) Brown (1987)	$5/bbl (1986$) $4.8-$5.9 (1985$) $7-$9 (1987$)	$5.7 $5.7-$7.0 $7.8-$10.1
Lowest Annual Prices in Recent History		
1972 u. s. RAC 1988 U. S. RAC	$3.22 (1972$) $14.67 (1988$)	$9.1 $15.9
Optimal OPEC Long-Run Prices		
Powell (1989)	$9.5 (1984$?)	$11.5

The transfer of wealth from the U.S. to foreign oil producers can be divided into three parts:

1. Transfer of Wealth to OPEC Producers
2. Transfer of Wealth to ROW Producers
3. Deadweight Losses by ROW Producers on oil sold to U.S.

Although this division does not effect total costs to the U.S., it is of interest because it affects the distribution of wealth in the world. The transfer of wealth to OPEC producers is simply the prevailing market price minus the assumed competitive market price, multiplied by the volume of oil imported by the U.S. from OPEC. This is similar to the measure recommended by Huntington and Eschbach (1987, p. 206) to measure the real national income loss caused by an oil price shock. The transfer of wealth to nonOPEC, ROW producers is the price difference times nonOPEC U.S. imports, which includes deadweight losses by ROW producers. In terms of the economic cost to the U.S. economy it is unimportant whether the payment to foreign producers is monopoly rent or deadweight loss. In terms of what can be done with the money, however, it may matter a great deal. Whatever is deadweight loss must be spent on finding and developing oil (drilling rigs, crews, etc.). Monopoly rent, however, may be readily converted into social programs and economic development, or it may be spent on tanks, missiles, and fighter planes. It need not be spent in developing oil to continue the flow of income. To the extent that those receiving monopoly rents are hostile to the United States, its allies, or even to their neighbors, the ready availability of cash can escalate military tensions, creating national security problems for the United States. This is not a trivial aspect of the oil problem. Iraq's ability to spend $5-$10 billion between 1981 and 1991 on a massive, secret nuclear weapons program (Davis and Kay, 1992) and to buy enough tanks and planes to challenge, albeit unsuccessfully, the superpowers, was greatly facilitated by the fact that Iraq's oil revenues are predominantly monopoly rent. None of the monopoly revenues had to be spent developing and producing more oil to sell.

Deadweight losses to ROW suppliers are estimated in the usual way as the (shaded) triangular area under the ROW long-run oil supply curve, as shown above in Figure 2. We assume that in the vicinity of a level of supply, q, the supply of oil can be described by the constant price elasticity equation, $q(p) = A^{\alpha}p^{\alpha}$. Deadweight losses, L, are calculated for total output by ROW producers (not just the fraction going to the U.S.) using the 1972 price and quantity as an initial point and a long-run price elasticity of 0.5, according to the following formula.

$$L = [A^{*} (1 + 1/\alpha)]^{-1} \cdot [q_2^{(1+1/\alpha)} - q_1^{(1+1/\alpha)}] - p_1 \cdot (q_2 - q_1)$$

$$= ([A''/ (1+ 1/\alpha)] \cdot [p_2^{(\alpha+1)} - p_1^{(\alpha+1)}]\} - p_1 \cdot A^{\alpha} \cdot (p_2^{\alpha} - p_1^{\alpha}) \quad (7)$$

Short-run supply elasticities are much smaller than the long-run supply elasticity, raising the issue of how to represent the dynamics of the expansion of supply. We assume that ROW suppliers will expand towards a desired long-run output level, according to a dynamic adjustment rule. First, we assume that suppliers base their decision in period t on a simple weighted average of the current and last two years of world prices, p_t^*. The desired level of production in t is $q_t^* = A(p_t^*)^{\alpha}$. We assume that suppliers make a fractional adjustment towards q_t^* in period t, which leads to an actual output level of q_t'. To achieve the desired level of output by moving out along their long-run supply curve, producers must incur an increase in their annual production costs equal to the integral under their long-run supply curve from q_t to q_t^* (Figure 3). We assume that in a given year, suppliers will expand their production costs by a constant fraction, **r**, of the necessary total cost increase required to get to q_t^*. This leads to the following formula for q_t'.

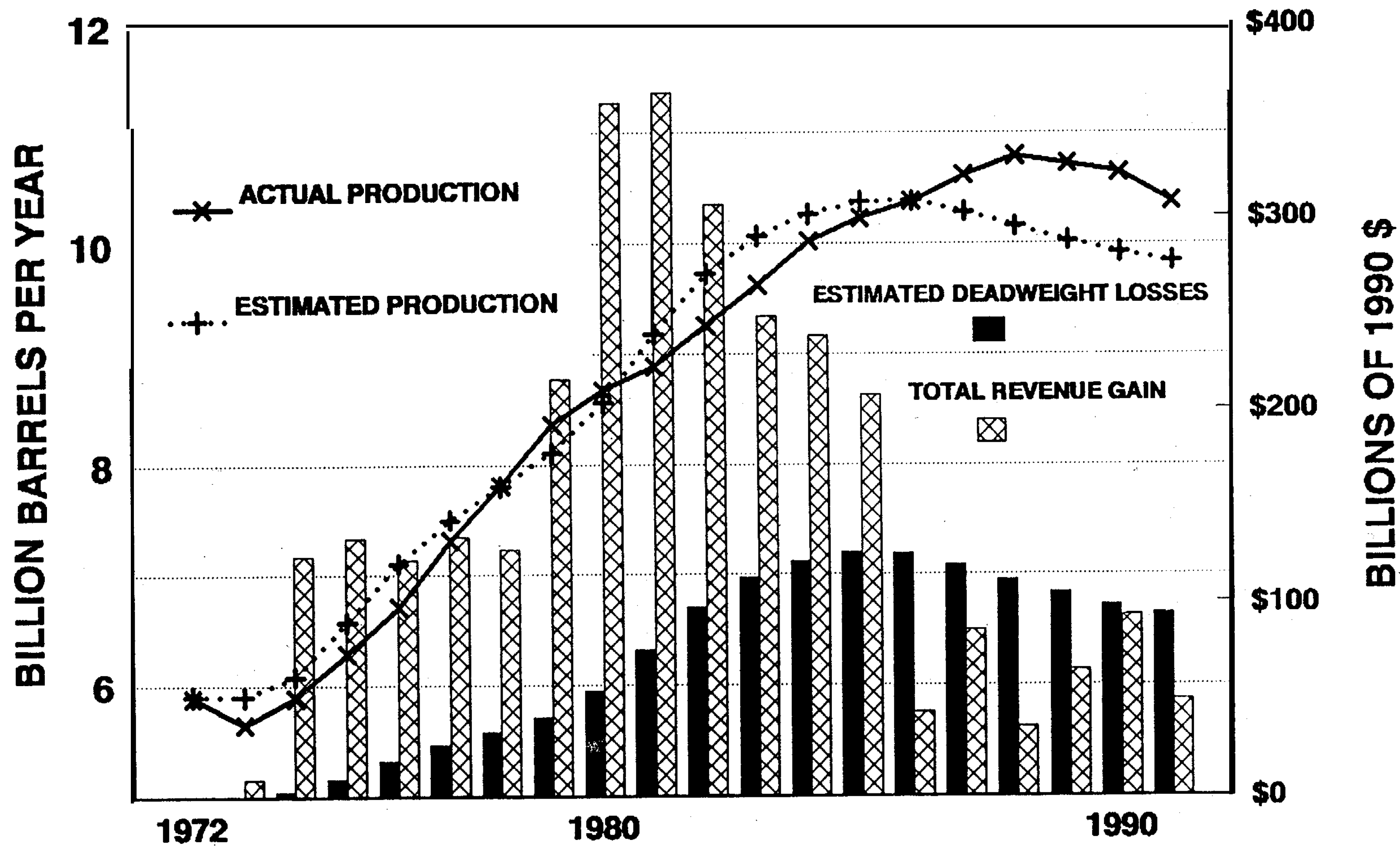
$$q_t' = [r \cdot q_t^{*(1+1/\alpha)} + (1-r) \cdot q_{t-1}'^{(1+1/\alpha)}]^{1/(1+1/\alpha)} \quad (8)$$

To see how the adjustment procedure works, consider the effect of a one-time, sustained price increase. The price increase leads to a new desired long-run output level, q^*. In the first period, ROW producers increase annual expenditures by fraction **r** of the required increase in expenditures necessary to produce q^* on an annual basis, which puts them at q_1'. Because of the triangular shape of the deadweight loss area, however, they will incur far less than fraction **r** of the eventual increase in deadweight losses necessary to produce at q^*. As production increases toward q^*, the share of the total expenditure increase that goes to deadweight losses will increase. The process is intended to be analogous to producing the lowest cost fields first and the highest cost last. Given the production-price point at 1972 and the price elasticity of 0.5, **r** is chosen so as to minimize the sum of squared deviations of actual and estimated annual production by ROW oil suppliers. The resulting time path of supply expansion shown in Figure **5** seems to fit the actual production data reasonably well for such a simple model.

The estimated expansion path seems to lead the actual path by a year or so. This is most marked in 1986 when it starts downward sooner than actual production following the price collapse. This would seem to be consistent with the hypothesis that market dynamics differ in rising and falling price regimes. Total revenues, also shown on Figure 6, jump sharply in 1974, but deadweight losses increase very slowly, suggesting that ROW oil producers reaped a substantial windfall then, and again in 1979-80. Deadweight losses continue to increase, however, and revenues begin to fall after 1981, until the 1986 price collapse. Our model

FIGURE 6. REST OF WORLD OIL SUPPLY AND SURPLUS LOSS ESTIMATES

(BASED ON SUPPLY EXPANSION MODEL)



suggests that ROW producers as a whole were losing money on their expanded output at that point, and have only since been briefly rescued by the oil price spike of 1990.

The transfer of wealth to oil producers from the U.S. economy due to monopoly oil pricing has been substantial. Annual losses have ranged from a low of $6 billion (1990 $) in 1973 to $132 billion in 1980 (Table 3). Over the past **five** years, transfer losses have ranged between $20 billion and $50 billion. The simple sum of annual costs from 1972 ($0) to 1991 amounts to $1.2 trillion. If we compute the present value of that stream of losses using a 5% annual discount rate, the present value comes to $1.9 trillion. The transfer of wealth resulting from payment of monopoly rents will, in itself, have a significant impact on the welfare of U.S. citizens. Unlike the macroeconomic adjustment costs caused by price shocks, the loss of **wealth** due to monopolistic oil prices is a continuing drain. Even in periods of relatively low oil prices, such as followed the oil price crash of 1986, substantial losses were incurred.

Obviously, the size of the estimated wealth transfer depends directly on the assumed competitive market price of oil. Although we are reasonably confident that our estimated price of **$9/bbl** is reasonable, even high, it is instructive to test the sensitivity of cost estimates to alternative assumptions. As an alternative, we assume that from the oil price of **9$/bbl** in 1972, real oil prices would increase at an **annual** rate of 2 % . As a result, 1991 competitive oil prices reach $13 per barrel, The wealth transfer falls to $1.0 trillion, still a considerable sum.

5.2 ECONOMIC COSTS: SHOCKS

Numerous estimates have been made of the impacts of oil price shocks on U.S. GNP. In general, modelers have estimated the total effect only, without dividing it into potential GNP loss and macroeconomic adjustment cost components. For the purpose of estimating historical impacts we should distinguish between the two.

5.2.1 Dividing Empirical Estimates into Potential GNP Loss and Adjustment Costs

In an 18 month study published in 1984, the Energy Modeling Forum employed fourteen major economic models to predict the effect of a sudden 50% oil price increase, sustained indefinitely, on GNP (Hickman, 1984). The implied elasticities of GNP with respect to oil price calculated by Hickman (1987) are shown, together with estimates from other studies in Table 4. Though the EMF study’s estimated elasticities range widely from 2% to almost **10%,** most are in the vicinity of the median estimate of 5.5% (Table 4). Interestingly, 5.5% is approximately equal to the observed oil **cost** share of GNP in,the year 1981 (5.9%). Estimates from earlier or later periods appear to be somewhat smaller (Table 4).

The elasticity estimates shown in Table 4 pertain to the impact in 1984 of a price shock occurring in 1983. For most of the models, the maximum loss of GNP occurred the year following the oil price shock.’ For a sustained oil price shock we should expect the macroeconomic adjustment costs to decline over time as wages, prices, and capital adjust to the new price of oil. Information on the dynamics of the economy’s response to oil prices was also provided by the EMF study (Hickman, 1984). For the same 50% oil price increase occurring in 1983, estimated percent changes in GNP through 1986 are shown in Table 5. The average

3

TABLE 3a. ESTIMATED TRANSFER OF WEALTH FROM UNITED STATES DUE TO MONOPOLY OIL PRICING, 1972–1991

	Estimated Competitive World Oil Price (1982 $)	Estimated Competitive World Oil Price (1990 $)	TRANSFER OF U.S. WEALTH: Wealth Transfer ROW (Billions of 1982 $)	Wealth Transfer to OPEC (Billions of 1982 $)	Wealth Transfer ROW (Billions of 1990 $)	Wealth Transfer to OPEC (Billions of 1990 $)	TOTAL U.S. Wealth Transfer (Billions of 1990 $)	Present Value of Loss of U.S. Wealth (Billions of 1990 $)
1972	$6.92	$9.10	$0	$0	$0	$0		
1973	$6.92	$9.10	$1	$3	$2	$4	$6	$14
1974	$6.92	$9.10	$15	$35	$20	$46	$66	$152
1975	$6.92	$9.10	$14	$35	$18	$47	$64	$141
1976	$6.92	$9.10	$11	$37	$14	$49	$63	$131
1977	$6.92	$9.10	$13	$46	$17	$60	$77	$152
1978	$6.92	$9.10	$11	$39	$14	$51	$65	$123
1979	$6.92	$9.10	$18	$60	$23	$79	$102	$184
1980	$6.92	$9.10	$25	$76	$32	$100	$132	$225
1981	$6.92	$9.10	$25	$64	$32	$84	$117	$190
1982	$6.92	$9.10	$21	$42	$27	$55	$82	$128
1983	$6.92	$9.10	$19	$33	$25	$44	$69	$102
1984	$6.92	$9.10	$19	$34	$26	$45	$71	$99
1985	$6.92	$9.10	$16	$27	$21	$36	$56	$76
1986	$6.92	$9.10	$5	$11	$7	$14	$21	$26
1987	$6.92	$9.10	$9	$18	$12	$24	$36	$44
1988	$6.92	$9.10	$6	$12	$7	$16	$24	$27
1989	$6.92	$9.10	$8	$19	$11	$26	$36	$40
1990	$6.92	$9.10	$10	$25	$13	$33	$46	$49
1991	$6.92	$9.10	$5	$15	$7	$20	$27	$27
			$250	$633	$329	$833	$1,161	$1,931

Rate of Increase
in Real Oil Price
0.0%

Discount Rate
5.0%

TABLE 3b. ESTIMATED TRANSFER OF WEALTH FROM UNITED STATES DUE TO MONOPOLY OIL PRICING, 1972– 1991

	Estimated Competitive World Oil Price (1982 $)	Estimated Competitive World Oil Price (1990 $)	TRANSFER OF U.S. WEALTH				TOTAL U.S. Wealth Transfer	Present Value of Loss of U.S. Wealth
			Wealth Transfer ROW (Billions of 1982 $)	Wealth Transfer to OPEC (Billions of 1982 $)	Wealth Transfer ROW (Billions of 1990 $)	Wealth Transfer to OPEC (Billions of 1990 $)	(Billions of 1990 $)	(Billions of 1990 $)
1972	$6.92	$9.10	$0	$0	$0	$0		
1973	$7.06	$9.28	$1	$3	$2	$3	$5	$12
1974	$7.20	$9.47	$15	$34	$20	$45	$65	$150
1975	$7.34	$9.66	$13	$34	$17	$45	$63	$137
1976	$7.49	$9.85	$10	$36	$13	$47	$61	$126
1977	$7.64	$10.05	$12	$44	$16	$57	$73	$145
1978	$7.79	$10.25	$10	$36	$13	$48	$61	$115
1979	$7.95	$10.45	$17	$57	$22	$75	$97	$175
1980	$8.11	$10.66	$24	$73	$31	$96	$127	$217
1981	$8.27	$10.88	$24	$61	$31	$81	$112	$182
1982	$8.44	$11.09	$20	$39	$26	$52	$78	$121
1983	$8.60	$11.31	$18	$31	$23	$41	$64	$94
1984	$8.78	$11.54	$18	$31	$23	$41	$64	$90
1985	$8.95	$11.77	$14	$24	$18	$32	$50	$67
1986	$9.13	$12.01	$3	$6	$4	$8	$12	$16
1987	$9.31	$12.25	$6	$13	$8	$17	$26	$31
1988	$9.50	$12.49	$3	$6	$4	$8	$12	$13
1989	$9.69	$12.74	$5	$12	$7	$16	$23	$25
1990	$9.88	$13.00	$7	$17	$9	$23	$32	$34
1991	$10.08	$13.26	$3	$8	$4	$11	$15	$15
			$222	$567	$292	$746	$1,038	$1,764

Rate of Increase
In Real Oil Price
2.0%

Discount Rate
5.0%

Table 4. Estimates of the Impact of Oil Price Shocks on GNP

Elasticities of GNP with Respect to Oil Price			
Source	Potential GNP Loss	Adjustment Costs	Total Effect
Pindyck (1980)	-0.01	-0.009	-0.02
Helkie (1991)			
Federal Reserve MCM			-0.03
Federal Reserve MPS			-0.04
Mork and Hall (1980)”			-0.03
Hickman (1987) EMF 7 Study			
LINK			-0.05
Wharton			-0.059
MACE			-0.043
Hubbard-Fry			-0.022
Chase			-0.05 1
Claremont			-0.072
MPS			-0.063
FRB MCM			-0.02
BEA			-0.069
DRI			-0.046
Hickman-Coen			-0.044
St. Louis			-0.057
Mork			-0.095
Michigan			-0.067
Average			-0.055
U. S. DOE Interagency Working Group (1990)			
LOW		-0.020	
MID		-0.025	
HIGH		-0.040	

[a] Based on a predicted -2.8% decline in 1980 GNP for a 93% increase in oil prices in 1980 over 1978

TABLE 5. ESTIMATED EFFECTS OF A 50% OIL PRICE SHOCK ON U.S. GNP
50% Price Shock, Effect on Reai GNP

MODEL	Percent Change in Real GNP 1983	1984	1985	1986
3EA	– 1.754	-3.483	-3.754	-4.012
Chase	-0.438	-2.531	-2.686	– 2.682
DRI	– 1.585	-2.298	-2.398	-2.246
LINK	– 1.767	-2.480	-3.071	-3.339
Michigan	-2.297	-3.340,	-3.106	-2.692
MPS	– 1.606	-3.174	-2.946	– 1.900
Wharton	-2.363	-2.949	-3.518	-3.524
Claremont	– 1.253	-3.638	– 2.289	– 1.589
FRB MCM	-0.981	-1 .001	– 1.252	-1.160
Hickman-Coe	-1 .171	-2.215	– 1.780	– 1.034
Hubbard-Fry	-0.954	– 1.080	-0.957	– 1.058
Mork	-6.243	-4.709	-3.809	-3.406
St. Louis	– 1.224	–2.847	– 1.540	– 1.578
M A C E	-1.192	-2.159	-2.501	– 2.426
Average	-1.77	-2.71	-2.54	-2.33
Ratio to Yr 2	0.66	1 .00	0.94	0.86
Median	-1.42	-2.69	-2.59	-2.34
Ratio to Yr 2	0.53	1.00	0.96	0.87
Lower Quartile	-1.08	-2.19	-1.66	-1.37
Ratio to Yr 2	0.49’	1 .00	0.76	0.63

Source: (Hickman, B.G., 1984, table 8)

estimate for the initial year is -1.8%, increasing to -2.7% by the second year and falling to -2.3% in the fourth year of the price increase. The median estimates are very similar, -1.4%, -2.7%, and -2.3 %. Even the lower quartile estimates are similar in magnitude, but tend to decay more rapidly: -1.1% in the first year, -2-2% in the second, and -1.4% in the fourth.

These studies, however, do not say how to divide the total loss of GNP growth into its two major components 1) the loss of potential GNP and 2) the macroeconomic adjustment costs. There is some evidence that the two components are roughly the same size. Assuming a 10% increase in the price of oil and summing discounted costs over five future years, Pindyck estimated the direct macroeconomic effect at about $25 billion and the indirect effect at about $22 billion for a GNP of $2.4 trillion (elasticities of GNP with respect to oil use of -0.01 and -0.009, respectively). He notes that his estimates assume "an optimal policy response of full accommodation." (Pindyck, 1980, p. 15) The Department of Energy's estimates for the effects of macroeconomic adjustment costs alone are about one half as large as the EMF median estimate. This evidence suggests to us that it is reasonable to divide the EMF median estimate of approximately 5% into 2.5% due to potential GNP loss and 2.5% due to macroeconomic adjustment costs. The macroeconomic adjustment costs will decline over time after a shock while the potential GNP loss component will persist for as long as the price remains above its competitive market level.

5.2.2 What Effect Should a Declining Price Shock Have?

A sudden decline in oil prices should have a mixed but fundamentally positive effect, even in the short run. First, the reduction in the transfer of wealth due to monopoly pricing should be entirely beneficial (recall that this should not necessarily affect GNP). Second, the reduced price of oil expands potential GNP due to the decrease in the economic scarcity of oil. The price shock, however, has the negative effect of preventing the economy from realizing its full potential GNP. Some claim that the shock effect initially dominates the benefits while others assert that beneficial effects dominate (see, e.g., a discussion by Toman, 1989, p. 40). Mork (1989) found strong statistical evidence that the effects of oil price declines are statistically different from those of oil price increases, and may be zero. Whereas in a price increase, adjustment costs push the economy lower than its newly reduced full-employment output level, in a price decrease adjustment costs merely prevent the economy from immediately reaching its new higher potential output level. The direction is still up, but the size of the movement is reduced. Thus the effect of price shocks up and down are inherently asymmetrical. Adjustment costs magnify the downward impact of a price increase, and reduce the upward impact of a price reduction (possibly even to zero in the short run, as Mork, 1989, found).

5.3 A METHOD FOR ESTIMATING MACROECONOMIC COSTS

We estimate the effects of oil price shocks using an elasticity of GNP with respect to the difference between the actual oil price and an estimate of the oil price to which the economy has adjusted by that year. The "adjusted oil price" concept allows us to simulate the dynamic adjustment of the economy to a series of oil price shocks. The starting point for our choice of an oil price elasticity of GNP is the Energy Modeling Forum study whose results are summarized in Table 5 (Hickman, 1984). We pointed out above that these estimates include both the loss of potential GNP, and macroeconomic adjustment costs. The effects of oil prices on these two components will be different, however, depending on whether prices are increasing or decreasing: an oil price drop will produce a gain in potential GNP, but will still generate macroeconomic adjustment losses. Since both increases and decreases of oil price occurred during the 1972-1991 period, we must separate the two effects to correctly estimate the economic impacts.

The EMF GNP impact estimates pertain to a particular time period in which oil prices were near their highest levels. Use of the EMF elasticities for the entire 1972-1991 period would likely overestimate the economic impacts of oil prices, since GNP losses should vary with the cost share of oil in the economy. At the time the EMF study was conducted, the oil price share was near its highest levels (Table 6). This may partly explain why GNP impact elasticities from other periods (Table 4) appear to be somewhat lower that those found by the EMF study. We assume that the EMF elasticity of 5.5% applies to 1982, the year in which the EMF study began. We then compute the elasticities for other years by multiplying 5.5% by the ratio of the oil cost share of GNP in year t to the 1982 oil cost share (Table 6). In the case of macroeconomic adjustment costs, we use the actual oil cost share of GNP for year **t.** For potential GNP loss, however, we use an estimate of the long-run oil cost share of GNP. The reason for this is that the potential GNP loss is a permanent, long-run loss, and will be the same in the long run as in the short run.

First, consider the loss (gain) of potential GNP due to higher (lower) energy prices. The change in potential GNP is a function of the absolute difference of current oil price (p_t) from what it would be in a competitive market (P_c). Thus, even if prices decline, there may still be a net loss of GNP unless they decline to competitive market levels. We measure the loss of potential GNP by the following equation, in which β is an elasticity estimate based on the data in Table **5.**[23]

$$\Delta GNP/GNP = (P_t/P_c)^{(\beta/2)} - 1 \qquad (9)$$

We assume that the potential GNP loss is immediate, and constant for a given percent price increase over the competitive level.

The potential GNP loss component of the impact of a price increase of a given size should be constant over time. Macroeconomic adjustment costs, on the other hand, are inherently dynamic. The EMF project found that all of the models indicated some form of dynamic response to a hypothetical 50% increase in oil price (Table 5). The most typical pattern showed half to two thirds of the maximum GNP loss occurring in **the** first year, followed by the maximum impact in the second year, with impacts gradually decreasing in succeeding years. The average effects of the 50% oil price increase across the 24 models in the first four years were, **1.8%, 2.7%, 2.5%, and 2.3%,** respectively. Themedian impacts were, **1.4%, 2.7%,** 2.596, and 2.3 **%,** respectively (Table 5).

[23]**Note** that by using $\beta/2$ for the two macroeconomic components, we will estimate a slightly smaller GNP impact than if we used β for the elasticity of the combined effect.

TABLE 6. OIL COST SHARE OF GNP AND ELASTICITY OF POTENTIAL GNP LOSS

YEAR	GNP 1990 $B	TOTAL OIL USE (MMBD)	OIL PRICE (1990 $/BBL)	OIL COST ($B 1990)	OIL COST SHARE (% OF GNP)	OIL COST SHARE (LONG RUN)	ADJUSTED ELASTICITY	ADJUSTED ELASTICITY (LONG RUN)
1972	$3,430	13.96	$9.96	$51	1.5%	1.5%	0.015	0.040
1973	$3,608	15.23	$10.98	$61	1.7%	1.6%	0.018	0.043
	$3,589	14.66	$22.71	$122	3.4%	2.0%	0.035	0.053
1975	$3,544	14.22	$23.66	$123	3.5%	2.0%	0.036	0.053
1976	$3,717	15.22	$22.93	$127	3.4%	2.0%	0.036	0.053
1977	$3,891	16.80	$23.62	$145	3.7%	2.1%	0.039	0.057
1978	$4,096	16.71	$22.78	$139	3.4%	2.0%	0.036	0.053
1979	$4,198	16.54	$29.86	$180	4.3%	2.1%	0.045	0.056
1980	$4,191	14.96	$43.48	$237	5.7%	2.2%	0.059	0.058
1981	$4,272	13.97	$49.49	$252	5.9%	2.1%	0.062	0.056
[illegible]	[illegible]	[illegible]	$42.07	$199	4.8%	1.9%	0.05050	0.050
1983	$4,312	13.00	$36.72	$174	4.0%	1.7%	0.042	0.046
1984	$4,604	13.60	$34.98	$174	3.8%	1.7%	0.039	0.045
1985	$4,759	13.26	$31.74	$154	3.2%	1.5%	0.034	0.041
1986	$4,889	14.12	$16.74	$86	1.8%	1.3%	0.018	0.034
1987	$5,057	14.26	$20.06	$104	2.1%	1.3%	0.022	0.035
1988	$5,282	14.73	$15.89	$85	1.6%	1.2%	0.017	0.032
1989	$5,415	14.81	$18.72	$101	1.9%	1.2%	0.020	0.033
1990	$5,467	14.52	$22.18	$118	22%	1.3%	0.023	0.034
1991	$5,467	13.65	$18.38	$92	1.7%	1.1%	0.018	0.030

Long−Run Oil Cost Share Adjustment Parameters
Long−run Share(t) = Share(t)[{Price(t)/Price(1972)} ^{A*B}]
Oil demand dynamic adjustment rate, A = 0.933
Long−run elasticity of oil demand, B = −0.7

For the second and following **years,** the process of dynamic adjustment can be approximated by a constant annual reduction, **λ,** in the percent GNP loss (we use the ^ symbol to indicate a second level superscript).

$$\Delta GNP_t/GNP = (P_1/P_o)^{(\beta/2)\cdot(1-\lambda)\hat{}t-1} - 1 \tag{10}$$

for t > 1.

We solve equation (10) for a time path of adjusted prices, P,, that gives the same GNP impact as equation (10) when the elasticity **(β/2)** is applied to the adjusted price change **$(P_1-P_t)/P_o$.**

$$(P_1/P_o)^{(\beta/2)\cdot(1-\lambda)\hat{}t-1} = (P_1/P_t)^{(\beta/2)} \tag{11}$$

Solving for P_t we get,

$$P_t = P_1\cdot(P_o/P_1)^{(1-\lambda)\hat{}t-1} \tag{12}$$

P_t represents the price to which the economy has adjusted in year t. It starts out close to P_o and approaches P,, so **that the** price difference (shock), **ΔP,** approaches zero over time. The advantage of this approach is that it can deal with the fact **that** the oil price is changing all the time. Thus, if the oil price falls in the **third** year after an initial price shock so that the market price is very close to the adjusted price, the residual GNP impact of the initial shock will be greatly diminished.

A **difficulty** with this **method** is **that** it fits the EMF model predictions for only the second and later years of a price shock. To get around the problem, we assume that the full effect of the price shock **is** felt in the first year, but we reduce the parameters **β/2** and **λ** such that the sum of effects over four years is the same as if we used the median estimates from Hickman (1984) for the first four years (see Table 5). Recall that the elasticity for potential GNP is assumed to be constant. It is the macroeconomic adjustment cost portion (we assume half) that is declining over time. By choosing **β** = -0.05 (-2.5% for a 50% price shock, and **β/2** = -0.025.) and **λ** = 0.15, we obtain a sum of effects for the first four years nearly identical to the sum of the median effects.

If half of the estimated elasticity of GNP with respect to a price shock is due to the potential loss of GNP, and if that is constant over time for a given -price increase over competitive levels, then it must be the other half, the macroeconomic adjustment half, that decreases' over time. 'This is **important for** estimating the decay rate. Let f be the fraction of the oil price shock elasticity that we attribute to macroeconomic adjustment costs, and let η_t be the oil price shock elasticity in year t. We estimate the rate of decay of the macroeconomic adjustment cost portion of the oil price elasticity effect as,

$$\lambda = SQRT\{(\eta_{t+3}/f\eta_{t+1}) - 1\} \tag{13}$$

If f is 0.5, then **λ** turns out to be about 0.85, using the median of the EMF model estimates. If f = **2/3,** then **λ** is approximately 0.9. Since **(1-λ)** is the rate of adjustment of the economy to an oil price shock, the estimated oil price shock costs are sensitive to it. If prices adjust rapidly **(λ** is small) then oil shock costs decrease rapidly and cumulative costs over time tend-to be less.

Total estimated costs, however, tend not to be very sensitive to assumptions about f, because the larger f is, the larger λ is. That is, the greater share of the elasticity we attribute to transitory adjustment costs, the less transitory those costs must be. As a result, combined GNP losses from the two components are not very sensitive to assumptions about the division of costs between them.

Macroeconomic adjustment costs occur whether prices are falling or rising. When prices fall, the potential GNP loss component we estimate represents the long-run gain in potential output. But adjustment costs will prevent us from achieving this improvement right away. Over time, as the equilibrium price adjusts to the actual price, more and more of the potential gain will be realized as the adjustment cost component dies away. Thus, we define ΔP in terms of the absolute value of the price difference. As a result, any price shock, up or down, will have a negative macroeconomic adjustment cost impact on GNP (since $\beta < 0$).

In summary, we determine the adjusted price of oil by the equation,

$$P_t = \exp[(1-\lambda)\cdot \ln\{P_{t-1}\} + \lambda\cdot \ln\{p_t\}], \quad (14)$$

where p_t is the actual world oil price (refinery acquisition cost) and $P_t = p_t$ at t=O (ln{} indicates natural logarithms and exp[] exponentiation). The GNP impact of macroeconomic adjustment costs over time is then determined by,

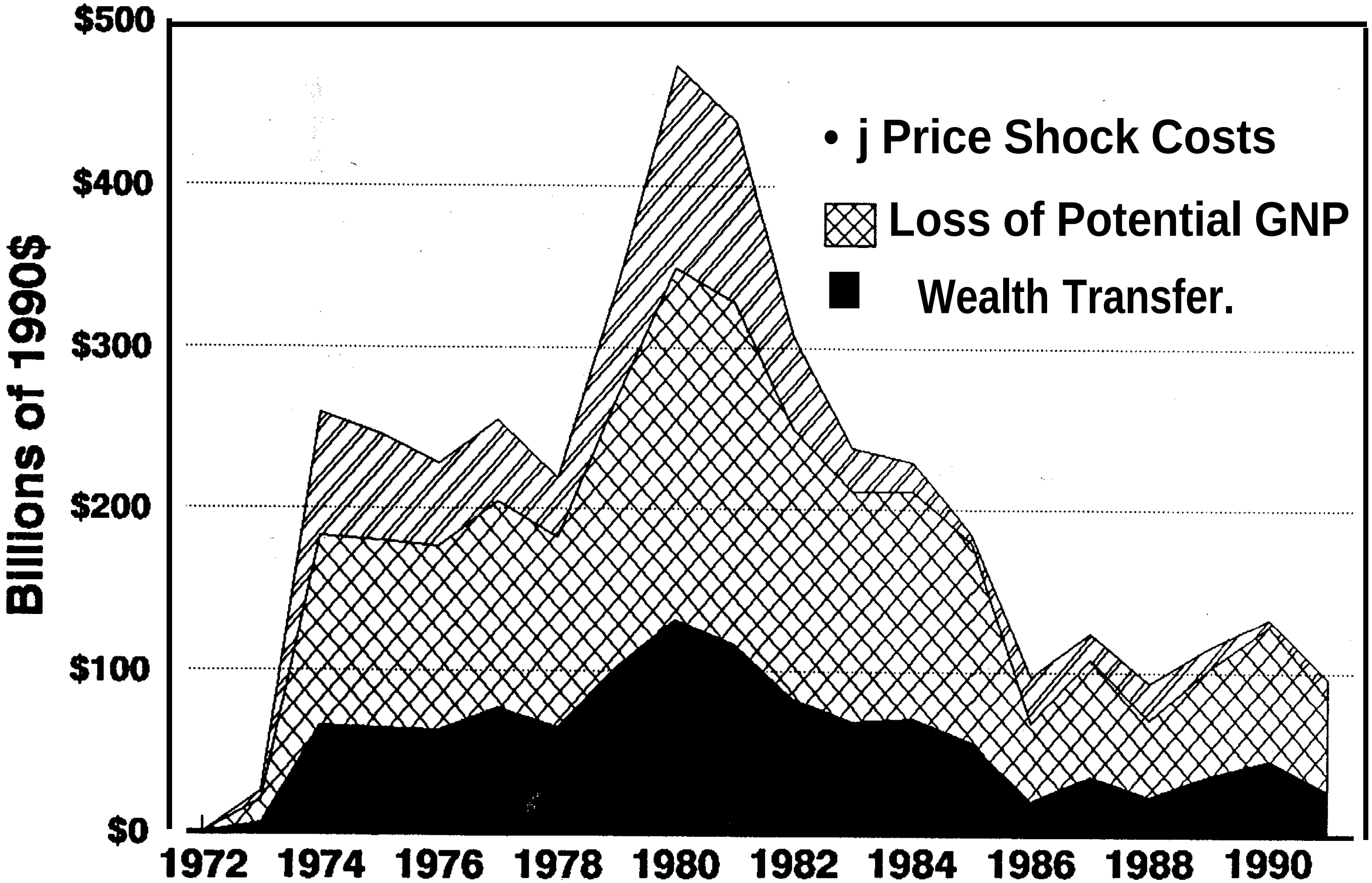
$$\Delta GNP_t/GNP_o = -(ABS(1-(p_t-P_t)^{(\beta/2)})). \quad (15)$$

5.4 MACROECONOMIC COST ESTIMATES

Loss of potential GNP begins at $13 billion in 1973, but jumps to over $100 billion in the second year of the first oil crisis (all in constant 1990 $). In 1979 and 1980 it jumps again, this time to over $200 billion per year. From that point, potential GNP losses gradually decline with the price of oil to just under $100 billion in 1985 (Figure 7). The oil price collapse of 1986 reduced the potential GNP loss to under $50 billion. Since then the estimates indicate annual losses between $40 billion and $100 billion. The sum of the estimated losses of output over the twenty year period comes to nearly $2.1 trillion dollars. The vast majority of losses, of course, occurred during the decade of peak oil prices from 1974 to 1984. The estimated present value of total losses (assuming a 5% annual inflation of past costs) is over $3 trillion. These estimates assume that half of the 1982 elasticity of GNP with respect to oil price is loss of potential GNP, and half is macroeconomic adjustment costs. If one assumes that only one third of the elasticity pertains to potential GNP losses, and that oil prices would have increased at a 2% annual rate, the total for the period falls to $1.2 trillion (Figure 8). This implies greater macroeconomic adjustment (or price shock) losses as will be seen below.

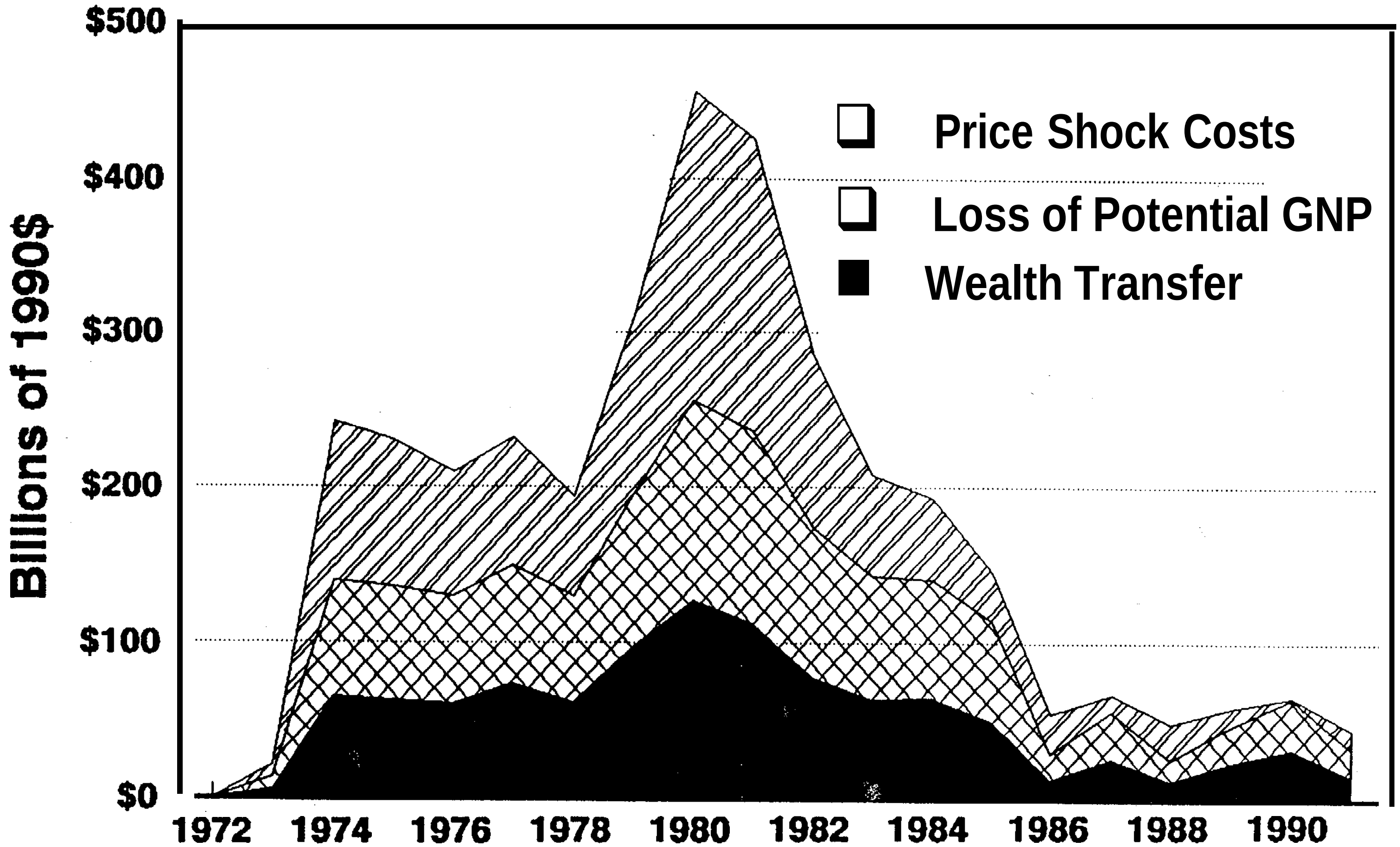
Macroeconomic adjustment costs are inherently transitory. As the economy adjusts to higher oil prices, they fade away. Assuming the 50/50 split of total macroeconomic impacts implies a fairly rapid adjustment parameter of 0.85 (15% adjustment each year). Under these assumptions, the macroeconomic costs first peaked at $76 billion in 1974, declined to $36 billion by 1978, and peaked again at $124 billion in 1980. In no year are they as large as potential GNP losses, even though their elasticity parameter is the same. This is because potential GNP losses

FIGURE 7. LOSSES TO THE U.S. ECONOMY FROM MONOPOLY PRICING OF OIL, 19724991



Macroeconomic Adjustment Cost Share 50%, Rate Parameter 0.85, Annual Price Increase 0%.

FIGURE 8. LOSSES TO THE U.S. ECONOMY FROM MONOPOLY PRICING OF OIL, 1972-1991



Macroeconomic Adjustment Cost Share 67%, Rate Parameter 0.9, Annual Price Increase 2%.

are measured relative to a constant "competitive price", while adjustment costs are measured relative to an "adjusted price", the price to which the economy has adjusted in the year in question. In 1982, for example, the competitive price is still $9/bbl. but the economy has substantially adjusted to the early oil price shocks, so that the adjusted price is $25/bbl., compared to a market price of $44/bbl. (1990 $). Total macroeconomic adjustment costs come to $800 billion for the 1972-1991 period, or $1.4 trillion inflated to present value. If we assume that two thirds of the total 1982 GNP elasticity is macroeconomic adjustment costs, the adjustment parameter must increase to 0.9 to be consistent with the EMF study results. This implies that adjustment costs are much larger both because the effect of a given price difference is larger and because the adjusted price will adjust more slowly, implying larger price differences in any given year. The total adjustment costs estimate rises to $1.3 trillion, with a peak annual loss of $200 billion in 1980. Because the potential GNP loss and macroeconomic adjustment cost estimates move in opposite directions depending on which assumption is made, their sum changes very little. Assuming a 50/50 split, total estimated GNP losses amounted to $2.9 trillion over two decades. The one-third/two-thirds split results in an estimate of $2.7 trillion.

These estimates, as well as the estimated wealth transfer, are sensitive to the assumption that the competitive oil price would remain constant at $9.10 over the entire 20-year period. Of course, in reality it would be reasonable to expect prices to fluctuate somewhat about that level (see Figure 5). But even if we assume that real prices will increase continuously at a rate of 2% per year, the estimated economic costs remain very high (Table 7). Under the assumption of a constant 2%/yr. price increase, the wealth transfer component declines from $1.16 trillion to $1.04 trillion. The loss of potential GNP falls from $2.15 trillion to $1.78 trillion.

Table 7. Sensitivity of Estimated GNP Losses to Macroeconomic Adjustment Cost Share of Total GNP Oil Price Elasticity and Increases in the "Competitive" World Oil Price

	Macroeconomic Adjustment (1990 $Trillion)	Potential GNP Loss (1990 $Trillion)	Total
50%/50% Split			
0%/yr. Price Increase	0.8	2.1	2.9
2%/yr. Price Increase	0.8	1.8	2.6
67%/33% Split			
0%/yr. Price Increase	1.3	1.4	2.7
2%/yr. Price Increase	1.3	1.2	2.5

The combined estimate of wealth transfer, potential GNP losses, and macroeconomic adjustment costs for the 1972-1991 period amounts to $4.1 trillion (1990 $). Sums of money this large are difficult to comprehend. The entire GNP of the United States in 1991 was $5.5 trillion. The sum of all defense expenditures from 1972 to 1991 was $5.2 trillion. Total interest payments on the national debt over the same period came to $2.1 trillion. Total economic losses to the

United States due to monopolistic oil pricing and price shocks appears to have been on the order of one entire year's Gross National Product over the past 20 years.

5.5 THE ECONOMIC COSTS OF POLICY RESPONSES

In response to the oil crises of the past two decades, the U.S. took several policy actions which themselves required significant expenditures. One might argue that these policy costs were optional and should not be counted. But since this is a historical analysis, and since whatever benefits these policies produced have been implicitly included as reduced economic costs, we see no reason, in principle,. not to count them. In practice it is difficult and ambiguous, however. A wide range of policy actions could potentially be included from expenditures on R& D to the indirect costs of regulation." Acknowledging this, we explicitly consider only two policy actions: the Strategic Petroleum Reserve, and military expenditures. The first is easy to attribute, the second nearly impossible.

5.5.1 The Strategic Petroleum Reserve

The strategic petroleum reserve (SPR), a 569 million barrel stock of crude oil in May of 1992 (EIA, 1992), is intended to reduce the risk of oil price shocks and dampen their impact should they occur. As such, it should have substantial potential benefits as well as costs. Estimating the value of benefits is difficult and uncertain (see, e.g., Leiby and Lee, 1988). Historic costs, however, are a matter of public record. It is inescapable that whatever benefits the SPR may have had in the past are reflected in the history of oil prices and supply disruptions. Thus, for our purposes we may simply add up the costs. The benefits are implicit in our estimates of other oil costs. By drawing the line at 199 1, we are ignoring possible future benefits that may accrue from having made the initial investment in SPR. That is, future expenditures could be reduced to just those necessary to maintain the current SPR at its present size so that, presumably, the same benefits could be obtained in the future at a lower cost. We represent this by subtracting the market value of oil in the ground at the end of 1991 from the total expenditures on the SPR.

The cost estimates shown in Table 8 come from the Department of Energy's, Office of Petroleum Reserves' annual report, and represent government expenditures on oil purchases, capital, and holding costs, in current year dollars. We convert these to constant 1990 dollars using the implicit price deflator of GNP, and inflate to present value using a 5% annual discount rate. The total cost (1990$) of the SPR since 1972 has been $26 billion (1990 $). Inflating to present value at 5%, gives a total present value of expenditures on the SPR of $41 billion. At the end of 1991 there were 569 million barrels of oil held in the SPR (EIA, 1992, Table 3.2b). At an average refiner acquisition cost of $18.38/bbl (1990 $), the value of SPR oil amounted to $10.5 billion. Neglecting the costs of retrieving the oil, the cost of SPR net of the oil asset value

[24]For example, Greene and Liu (1988) suggested that fuel economy regulations may have increased the cost of an average car by as much as $500 in 1985 (1985$), but that consumers' surplus benefits (largely in the form of reduced fuel costs) probably outweighed the costs. At annual sales of 10 million passenger cars, fuel economy regulation would have cost $5B in 1985. Since the benefits of reduced fuel use are "included" in our estimates, the costs should be also.

amounted to $15.4 B **(1990$)**, or $30.3 BPV at the end of 1991. The SPR is clearly a relatively minor cost component.

5.5.2 Military, Expenditures Related to the Persian Gulf

The term "energy security" has occasionally been mistakenly applied to only the threat of oil price shocks. For example, Montgomery and Sweeney (1992, p. 25) assert,

> "Energy security, or more accurately, its converse, energy vulnerability, can be measured as the expected value of losses to the U.S. economy associated with energy supply disruptions, particularly world oil supply disruptions."

In fact, energy security is multifaceted and inherently **difficult** to reduce to dollars and cents. It includes, military, strategic; and political **difficulties**, some obvious, some more subtle. Although we will end up counting dollar costs of military operations, one should not be mislead by this into believing that these costs capture the full importance of energy security to the United States. The 1987 Report to the President of the United States summarized national security concerns over oil dependence as follows:

> "This risk affects national security and the conduct of U.S. foreign policy to the extent that (1) the foreign policy actions of our allies are affected as they respond to perceived vulnerabilities and rivalries for "scarce" supplies undermine allied solidarity; (2) the U.S. loses some flexibility in responding to disruptions, so that it becomes more difficult to reach peaceful resolutions of disputes; or (3) oil supply disruptions coincide with a major defense emergency, complicating an already troublesome situation." (**Energy Security**, U.S. DOE, 1987, pp. 7-8)

> "Increased dependence on insecure oil supplies reduces flexibility in the conduct of U.S. foreign policy." (U.S. DOE, 1987, p. '68)

Other foreign policy constraints that have been cited include strained relations **with** allies who would benefit if the U.S. reduced its oil imports, the need to avoid triggering world supply disruptions, and a stronger position for countries openly hostile to the United States, such as Iran, Iraq, and Libya (API, 1988, pp. 28-29). Military and strategic costs are perhaps the most complicated of all the costs of oil dependence because the costs to the United States depend in complex ways on the actions and intentions of other nations. It is likely that even if the U.S. consumed no oil at all, the Persian Gulf region would be of strategic importance 'because of the oil dependency of friends and potential foes..

TABLE 8. COSTS OF SPR OIL PRICE SHOCK CONTINGENCY PROGRAM

STRATEGIC PETROLEUM RESERVE

	TOTAL ($M)	TOTAL (1990 $M)	TOTAL PV (1990 $M)
1972	$0	$0	$0
1973	$0	$0	$0
1974	$0	$0	$0
	$0	$0	$0
1976	$314	$413	$858
1977	$448	$589	$1,166
1978	$3,182	$4,184	$7,890
1979	$3,007	$3,954	$7,101
1980	($2,000)	($2,630)	($4,498)
1981	$3,333	$4,382	$7,139
1982	$3,875	$5,096	$7,906
1983	$2,316	$3,046	$4,500
1984	$809	$1,064	$1,496
1985	$2,509	$3,299	$4,421
1986	$108	$141	$180
1987	$147	$194	$236
1988	$603	$793	$918
1989	$415	$546	$602
1990	$628	$826	$868
1991			
	$19,694	$25,898	$40,784
Value of Oil Held in 1991 (Millions bbls) (1990 $/bbl)			
569	$18.38	$10,460	$10,460
Cost, Net of Stocks		$15,439	$30,324

Sources: US. Department of Energy, Office of Petroleum Reserves, "Strategic Petroleum Reserve Annual/Quarterly Report," DOE/FE-0165, Washington, D.C., February 15, 1990. Energy Information Administration, "Monthly Energy Review," DOE/EIA–0035(92/06), Tables 3.2b, and 9.1, Washington, D.C., June 1992.

Even in the absence of an OPEC cartel, however, oil would have been a serious strategic concern for the U.S. Since World War I, oil has been considered a strategic resource by developed economies, and nations have sought ways to insure its availability to their military in times of conflict. In 1914 the United Kingdom purchased a 51% share of the Anglo-Persian Oil Company to insure adequate supplies to support the Royal Navy's decision to convert from steam to diesel engines. At the same time the United States established the Naval Petroleum Reserve for the a similar purpose (Yergin, 1991, p. 161). Ever since warships converted from coal to diesel power and land forces became mechanized, the availability of oil to the armed forces has been a strategic concern. Many consider the lack of adequate oil supplies a critical factor in the defeats of Nazi Germany and Japan in World War II. In 1989, the United States military used 385 thousand barrels of oil per day (Davis and Morris, 1992, table 2.9). In a major worldwide crisis, petroleum demand by the U.S. military and defense industrial base could increase by over 2.5 million barrels per day (Lee, Das, and Leiby, 1991, table 1). Insuring supplies around the world of adequate quantity and quality for modem ships, vehicles, and warplanes is a major concern of the U.S. Defense Department.

An important energy security consideration is the fact that the oil fields of the Persian Gulf Region have the potential to create a new superpower, and one potentially hostile to the United States. Two thirds of the world's proven oil reserves are concentrated in the Persian Gulf Region. Such a singular concentration in a small geographic area, and in countries with relatively small populations and limited military strength makes oil fields attractive targets for aggression. Consider that if Iraq had succeeded in conquering Saudi Arabia, as well as Kuwait, much smaller states like Oman, Qatar, and the United Arab Emirates could not have rdisted. The combined reserves of such an empire would amount to over 550 billion barrels, over half of the world's proven oil reserves. Such a state would have the ability to extract enormous monopoly rents from the rest of the world. Since the vast majority of the revenue collected would not be needed to produce more oil, it could be used to develop advanced weapons, and expand military strength. Such a state could quickly become a world superpower. There should be no doubt that this is precisely what Saddam Hussein had in mind when he invaded Kuwait and threatened Saudi Arabia.

Finally, there are the specific military expenditures that the United States has incurred to protect U.S. interests in the Persian Gulf Region. The U.S. General Accounting Office (1991, p. 1) recently published estimates of ". ..the cost of activities related to the protection of U.S. interests in the Southwest Asia area." Costs from 1980 to 1990, approximately half of the time period we are considering, amounted to $366.2 billion. These costs included, (1) U.S. military programs and activities, (2) bilateral military and economic assistance to countries of strategic importance, (3) multilateral economic assistance, and (4) bilateral and multilateral nonmilitary assistance to any petroleum-producing country for activities related to oil production. The GAO estimates are summarized in table 6. Some of the activities shown in table 6 would have been conducted at some level, even if the United States were not dependent on oil, or put another way, even if the world's oil resources were not concentrated in the Persian Gulf Region. Surely, most would have been incurred even if OPEC did not exist. The largest single item, "other contingency and mobility," clearly falls in this area. Of the $273 billion total, $220 is for forces available to the U.S. Central Command which already existed when the command was created in 1983 and which are available for use in other areas as well. Were there no oil problem, a large fraction but not all of these forces would still be needed. The same reasoning also applies to other categories.

The problem of attributing military costs to oil has recently been addressed in a study by the Congressional Research Service (CRS, 1992). Based on statements made by the Department of Defense to the General Accounting Office, CRS divided the $366.2 billion into Southwest Asia specific, and Persian Gulf specific costs. CRS judged that only $70.9 billion of the total were Southwest Asia specific; the rest they believed would have been done anyway for other global regions. They judged that less than $11.8 billion was Persian gulf specific. CRS excluded the costs of the Persian Gulf War because they fell outside the 1980-1990 period they considered. We include them, but subtract the $52.4 billion we have received from allies from the $61 billion we spent. Concerning the largest single cost component, "Contingencies and Mobility," CRS' reasoning was as follows,

> "Costs of the 'other contingencies and mobility programs' totalled $272.6 billion for the 1980-1990 period. Of that total, $49.5 billion was for strategic airlift, and $220.3 billion funded forces available to the U.S. Central Command. Central Command is the military command responsible for protecting U.S. interests in Southwest Asia. DoD told GAO that all of these programs, although useful in meeting contingencies in Southwest Asia, were motivated by requirements outside the region, and would be funded even if the Southwest Asia mission were eliminated." (CRS, 1992, p. 25)

Attribution of costs to an activity with multiple objectives is always a difficult and ambiguous task. If one attributes zero costs to one of the reasons for supporting military readiness because it is not the sole reason, then none of the individual reasons can be held responsible, leading to the conclusion that there is no reason why the costs were incurred. The CRS's argument is more sophisticated, in that they claim that the entire force would have been maintained anyway for other reasons, presumably to counter the Soviet Union. We doubt this, especially since some of the threat from the Soviet Union was surely to the oil fields of such great strategic importance to the West. Since forces were, in fact, used in the recent Persian Gulf War, we can see no justification for not attributing at least some of their readiness costs to the United States' and world's dependence on Persian Gulf oil. The same reasoning applies to Southwest Asia Military expenditures, as well as military and economic assistance programs. We suggest that half to one third of the costs of these forces should be attributed to oil dependence. But most of this would probably have been spent in the absence of monopolization of oil by OPEC, in order to defend a geographically concentrated strategic resource.

Finally, it is reasonable to attribute some fraction of the total readiness cost of the entire U.S. military to each and every threat we face. Would we have fewer National Guardsmen if Persian Gulf oil were not a problem? Would we need fewer fighters, cargo planes, tanks, bullets, rations? Probably, we would, to a limited degree. Two attempts by prominent defense experts to estimate total costs in this way are reported in the CRS (1992) study. One arrived at an estimate of $50 billion for defending the Middle East in the year 1992 (Ravenal, 1991). The other put the cost at $64.5 billion in 1990 (Kaufmann, and Steinbruner, 1991). Estimates such as these suggest that total costs since 1972 have been higher than even the GAO's estimates.

Our total military cost estimate for oil dependence amounts to $157 billion for the 1980-1991 period. We expand this estimate to the 1973-1979 period by assuming that average annual costs were the same as the 1980-1991 period (see Table 9). The extrapolated estimate amounts to $270 billion. To discount this to present value, we must know the rate of expenditure by year, information not provided in the GAO or CRS studies. Assuming a constant rate of expenditure yields a present value of $447 billion. Clearly, these are soft estimates and should interpreted as indicative only of the order of magnitude of U.S. military costs associated with U.S. and world oil dependence. We argue that only a small fraction of this can be reasonably attributed to oil market monopolization. Thus, the military component of the cost of monopolized oil is also probably small in relation to the economic costs.

TABLE 9. MILITARY COSTS OF PROTECTING U.S. OIL-RELATED INTERESTS IN SOUTHWEST ASIA
(Billions of 1990 Dollars)

CATEGORY	EXPENDITURES FOR FYs 1980-90, PLUS PERSIAN GULF WAR: Total Cost GAO, 1991	SW Asia Specific CRS, 1992	Persian Gulf Specific CRS, 1992	Attribution Factor (%)	Estimated Oil Dependence Costs
Military Activities (SW Asia Dedicated)	$21.4	$4.5	$4.5	100%	$21.4
Military Activities (SW Asia Oriented)	$5.8	$0.0	$0.0	100%	$5.8
Other Contingency & Mobility	$272.6	$0.0	$0.0	33%	$90.9
Kuwaiti Reflagging	$0.2	$0.2	$0.2	100%	$0.2
Operations Desert Shield and Storm	$61.0	NA	NA	14%	$8.6
Military Assistance to Strategic SW Asia	$30.8	$30.8	$0.0	50%	$15.4
Economic Assist. to Strategic SW Asia	$28.3	$28.3	$0.0	50%	$14.2
Multilateral Financial Aid	$6.6	$6.6	$6.6	0%	$0.0
U.S. Aid for Energy Programs	$0.1	NA	NA	50%	$0.1
Multilateral Aid for Energy Activities	$0.5	$0.5	$0.5	0%	$0.0
TOTAL, 1980-1990	$427	$71	$12		$157
				Present Value	$259
EXTRAPOLATED TOTAL, 1973-1991	$736	$123	$20		$270
				Present Value	$447

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6. CONCLUSIONS

The economic costs of monopoly behavior in the world oil market have been a major problem for the United States over the past twenty years. Though our methods of estimation are rough, and one may argue with many of our assumptions, there is no doubt that the use of oil has caused significant economic distress over the past twenty years. With total costs in the vicinity of one year's GNP, the economic component of the oil problem must be counted as one of the United States' biggest economic problems of the past two decades. Even in good years, economic costs were in the vicinity of $100 billion per year, and in the worst year costs may have exceeded $400 billion (Table 7). The total economic cost from 1972 to the present is in the range of $4 trillion. Quantifiable economic costs appear to be nearly equally divided among 1) the transfer of U.S. wealth to foreign oil producers, 2) the loss of potential output due to the increased economic scarcity of oil, and 3) macroeconomic adjustment costs precipitated by oil price shocks. On a very gross scale, the three components appear to have been of about the same magnitude, Though costs expand greatly during periods of price shocks, they continue even during periods of price stability, so long as prices exceed competitive market levels.

The Strategic Petroleum Reserve has been a comparatively minor expense of about $1 billion per year and $15 billion net of assets since 1972. Military costs arising from oil dependence may be as little as a few billion dollars or as large as $50 billion annually. Total military and strategic costs since 1972 induced by dependence on oil almost surely exceeded $100 billion, and may even have been as much as $500 billion, or more. Not easily monetizable political and foreign policy costs add to this total. It is not clear, however, what part of military cost would have been required had the OPEC cartel not exercised monopoly influence on the world oil market. The concentration of reserves in the Persian Gulf region would still have been a substantial strategic concern during this period of Cold War conflict between East and West.

Will the costs of oil monopoly be as great in the future as they have been over the past twenty years? Certainly economic costs have been lower over the last five years of the 1972-1991 period. But OPEC's share of the world oil market is growing, as are U.S. oil imports. Since the market power of a monopolist grows with its market share, we can expect rising prices in the future, and probably even renewed price shocks. U.S. imports are growing, and as U.S. imports grow; so will the transfer of wealth to foreign oil producers. Thus, it appears that the recent history of reduced economic costs may be drawing to a close.

The question, of course, is what can and should we do about it? To act, we must have alternatives, and unless the costs of the alternatives are less than the oil costs they avoid, then there is no better strategy than to grin and bear it. But if there is a better way, the rewards may be great. Just as more oil can be found by exploration and development, so also can alternatives be produced through research and development. At the very least, this study indicates that it is important to keep searching for a better way. The social cost of oil use, including energy security, has been an enormous problem for the United States and will likely continue to be until, through policy and innovation, we solve it.

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APPENDIX

DETAILED ESTIMATES OF MACROECONOMIC COSTS

OIL SUPPLY AND OIL PRICES. 1972– 1991

	WORLD CRUDE OIL PRODUCTION				Barrels of Oil Supplied to U.S.			Refiners' Acquisition Cost per Barrel		1982=100 Implicit Price
	OPEC	U.S.	ROW	WORLD	Domestic Crude Oil	Net Imports Crude+Prod.	Imports From OPEC	Domestic	Imported	Deflator
	(Thousands of Barrels per Day)				(Millions of Barrels per Day)			(1982 $)		(1982=100)
1970								$8.24	$7.05	44.1
1971								$8.29	$7.14	44.6
1972	27090	7880	16160	51130	9.44	4.52	2.06	$7.89	$6.92	48.3
1973	30988	9208	15488	55684	9.21	6.02	2.99	$8.42	$8.24	51.1
1974	30729	8774	16157	55660	8.77	5.89	3.28	$13.30	$23.19	55.6
1975	27154	8375	17248	52777	8.37	5.85	3.60	$14.15	$23.49	60.7
1978	30737	8132	18400	57269	8.13	7.09	5.07	$14.01	$21.36	63.9
1977	31299	8245	20045	59589	8.24	8.56	6.19	$14.19	$21.59	67.6
1978	29875	8707	21421	60003	8.71	8.00	5.75	$14.70	$20.18	72.6
1979	30998	8552	22927	62477	8.55	7.99	5.64	$18.16	$27.57	78.9
1980	26985	8597	23771	59353	8.60	6.36	4.30	$28.27	$39.54	86.1
1981	22843	8572	24363	55778	8.57	5.40	3.32	$36.52	$39.41	94.4
1982	19145	8649	25390	53184	8.65	4.30	2.15	$31.22	$33.55	100.0
1983	17891	8688	26388	52967	8.69	4.31	1.86	$27.79	$28.20	104.0
1984	17857	8879	27467	54203	8.88	4.72	2.05	$26.49	$26.82	108.2
1985	16634	8971	28041	53646	8.97	4.29	1.83	$24.04	$24.34	111.8
1988	18734	8680	28458	55872	8.68	5.44	2.84	$13.01	$12.29	114.5
1987	18846	8349	29111	56306	8.35	5.91	3.06	$15.13	$15.44	117.5
1988	20785	8140	29582	58507	8.14	6.59	3.52	$12.15	$12.00	121.7
1989	22558	7613	29397	59568	7.61	7.20	4.14	$14.16	$14.31	126.3
1990	23828	7355	28178	60361	7.36	7.16	4.30	$17.18	$16.55	131.5
1991	23983	7417	28442	59842	7.42	6.23	4.09	$14.18	$13.72	136.3

Domestic is crude oil and lease condensate, excluding natural gas plant liquids.
Imports include both crude oil and petroleum products.

Sources: Data for 1991, EIA, "International Petroleum Statistics Report," DOE/EIA–0520(92/06), June 1992 Table 1.1: EIA, "Monthly Energy Review," DOE/EIA–0035(92/06), Table 9.1.

ESTIMATION OF EFFECTS OF MONOPOLY PRICES AND PRCE SHOCKS ON U.S. GROSS NATIONAL PRODUCT

					POTENTIAL GNP LOSSES				MACROECONOMIC ADJUSTMENT COSTS				
	U.S. GNP (BILLIONS) (1982 $)	U.S. GNP (BILLIONS) (1990 $)	ACTUAL CHANGE IN GNP (1990 $)	PRICE OF IMPORTED OIL TO U.S. 982 $)	INCREASE OVER COMPETITIVE PRICE (1982 $)	LOSS OF POTENTIAL GNP (1990 $)	PRES. VALUE LOSS OF POTENTIAL GNP (1990 $)	ADJUSTED PRICE (1990 $)	RATIO OF ADJUSTED/ ACTUAL PRICE	MACRO ADJUSTMT. GNP LOSS (1990 $)	PRES. VALUE MACRO ADJUSTMT. GNPLOSS (1990 $)	TOTAL QNPLOSS (1990 $)	TOTAL GNP LOSS PRESENT VALUE
1972	$2,609	$3,430		$6.92	$0.00	$0	$0	$6.92	1.000	$0	$0	$0	$0
1973	$2,744	$3,608	$178	$8.24	$1.32	$13	$32	$6.92	1.191	$6	$13	$19	$46
1974	$2,729	$3,589	($19)	$23.19	$16.27	$117	$268	$7.10	3.265	$76	$174	$193	$442
1975	$2,695	$3,544	($45)	$23.49	$16.57	$116	$254	$8.48	2.769	$66	$144	$182	$398
1976	$2,827	$3,717	$173	$21.36	$14.44	$113	$236	$9.88	2.161	$52	$108	$165	$343
1977	$2,959	$3,891	$173	$21.59	$14.97	$128	$253	$11.09	1.940	$51	$101	$179	$354
1978	$3,115	$4,096	$206	$20.18	$13.26	$118	$222	$12.26	1.646	$36	$69	$154	$291
1979	$3,192	$4,196	$102	$27.57	$20.65	$166	$299	$13.21	2.067	$70	$126	$236	$424
1980	$3,187	$4,191	($7)	$39.54	$32.62	$217	$372	$14.75	2.680	$124	$213	$342	$584
1981	$3,249	$4,272	$81	$39.41	$32.49	$212	$345	$17.10	2.304	$112	$182	$323	$527
1982	$3,166	$4,163	($109)	$33.55	$26.63	$168	$260	$19.39	1.731	$57	$89	$225	$349
1963	$3,279	$4,312	$149	$28.20	$21.28	$142	$210	$21.05	1.340	$27	$40	$169	$250
1904	$3,501	$4,604	$292	$26.82	$19.90	$141	$198	$21.99	1.220	$18	$25	$159	$224
1985	$3,619	$4,759	$154	$24.34	$17.42	9123	$165	$22.66	1.074	$6	$8	$129	$173
1986	$3,718	$4,889	$130	$12.29	$5.37	$48	$61	$22.90	0.537	$28	[illegible]	$76	$97
1987	$3,845	$5,057	$168	$15.44	$8.52	$72	$87	$20.86	0.740	$16	[illegible]	$88	$107
1988	$4,017	$5,282	$226	$12.00	$5.06	$47	$54	$19.94	0.602	$23	$26	$69	$80
1989	$4,118	$5,415	$133	$14.31	$7.39	$66	$72	$18.48	0.774	$14	$15	$79	$87
1990	94,157	$5,467	$52	$16.55	$9.63	$82	$86	$17.78	0.931	$4	$5	$87	$91
1991	$4,157	$5,467	$0	$13.72	$6.80	$57	$57	$17.59	0.700	$12	$12	$69	$69
TOTK			$2,037			$2,146	$3,532			$798	$1,404	$2,943	$4,936

ASSUMPTIONS:

TOTAL GNP LOSSES ELASTICITY	0.050
MACRO ADJUSTMENT COST SHARE	50%
ADJUSTMENT RATE PARAMETER	0.85
RATE OF REAL OIL PRICE INCREASE	0.0%

Note: Estimated potential GNP loss and Macroeconomic Adjustment cost elasticities are proportional to estimated bng-run and short-run oil cost shares of GNP, respectively.

ESTIMATION OF EFFECTS OF MONOPOLY PRICES AND PRCE SHOCKS Of4 U.S. GROSS NATIONAL PRODUCT

	U.S. GNP (BILLIONS) (1982 $)	U.S. GNP (BILLIONS) (1990 $)	ACTUAL CHANGE IN GNP (1990 $)	PRICE OF IMPORTED OIL TO U.S. (1982 $)	POTENTIAL GNP LOSSES: IN OVER COMPETITIVE PRICE (1982 $)	POTENTIAL GNP LOSSES: LOSS OF POTENTIAL GNP (1990 $)	POTENTIAL GNP LOSSES: PRES. VALUE LOSS OF POTENTIAL GNP (1990 $)	MACROECONOMIC ADJUSTMENT COSTS: ADJUSTED PRICE (1990 $)	MACROECONOMIC ADJUSTMENT COSTS: RATIO OF ADJUSTED/ ACTUAL PRICE	MACROECONOMIC ADJUSTMENT COSTS: MACRO ADJUSTMT. QNPLOSS (1990 $)	MACROECONOMIC ADJUSTMENT COSTS: PRES. VALUE MACRO ADJUSTMT. GNPLOSS (1990 $)	MACROECONOMIC ADJUSTMENT COSTS: TOTAL GNPLOSS (1990 $)	TOTAL GNP LOSS PRESENT VALUE
1972	$2,609	$3,430		$6.92	$0.00	$0	$0	$6.92	1.000	$0	$0	$0	$0
1973	$2,744	$3,608	$178	$8.24	$1.18	$12	$29	$6.92	1.191	$6	$13	$17	$42
1974	$2,729	$3,589	($19)	$23.19	$15.99	$113	$259	$7.10	3.265	$76	$174	$189	$433
1975	$2,695	$3,544	($45)	$23.49	$16.15	$111	$241	$8.48	2.769	$66	$144	$177	$386
1976	$2,827	$3,717	$173	$21.36	$13.87	$105	$219	$9.88	2.161	$52	$108	$157	$326
1977	$2,959	$3,891	$173	$21.59	$13.95	$117	$231	$11.09	1.946	$51	$101	$167	$331
1978	$3,115	$4,096	$206	$20.18	$12.39	$105	$197	$12.26	1.646	$36	$69	$141	$266
1979	$3,192	$4,198	$102	$27.57	$19.62	$149	$268	$13.21	2.087	$70	$126	$219	$394
1980	$3,187	$4,191	($7)	$39.54	$31.43	$197	$337	$14.75	2.680	$124	$213	$321	$550
1981	$3,249	$4,272	$81	$39.41	$31.14	$190	$309	$17.10	2.304	$112	$182	$301	$491
1982	$3,166	$4,163	($109)	$33.55	$25.11	$146	$227	$19.39	1.731	$57	$89	$204	$316
1983	$3,279	$4,312	$149	$28.20	$19.60	$120	$177	$21.05	1.340	$27	$40	$147	$217
1984	$3,501	$4,604	$292	$26.82	$18.04	$116	$163	$21.99	1.220	$18	$25	$134	$189
1985	$3,619	$4,759	$154	$24.34	$15.39	$98	$131	$22.66	1.074	$6	$8	$103	$139
1986	$3,718	$4,889	$130	$12.29	$3.16	$25	$31	$22.90	0.537	$28	$36	$53	$67
1987	$3,845	$5,057	$168	$15.44	$6.13	$45	$55	$20.86	0.740	$16	$20	$61	$75
1988	$4,017	$5,282	$226	$12.00	$2.50	$20	$23	$19.94	0.602	$23	$26	$42	$49
1989	$4,118	$5,415	$133	$14.31	$4.62	$35	$39	$18.48	0.774	$14	$15	$49	$54
1990	$4,157	$5,467	$52	$16.55	$6.66	$48	$51	$17.78	0.931	$4	$5	$53	$55
1991	$4,157	$5,467	$0	$13.72	$3.64	$25	$25	$17.59	0.780	$12	$12	$37	$37
TOTAL			$2,037			$1,776	$3,012			$798	$1,404	$2,574	$4,417

ASSUMPTIONS:

TOTAL GNP LOSSES ELASTICITY	0.050
MACRO ADJUSTMENT COST SHARE	50%
ADJUSTMENT RATE PARAMETER	0.85
RATE OF REAL OIL PRICE INCREASE	2.0%

Note: Estimated potential GNP loss and Macroeconomic Adjustment cost elasticities are proportional lo estimated bng-run md short-run oil cost shares of GNP, respectively.

ESTIMATION OF EFFECTS OF MONOPOLY PRICES AND PRCE SHOCKS ON U.S. GROSS NATIONAL PRODUCT

	U.S. GNP (BILLIONS) (1982 $)	U.S. GNP (BILLIONS) (1990 $)	ACTUAL CHANGE IN GNP (1990 $)	PRICE OF IMPORTED OIL TO U.S. (1982 $)	POTENTIAL GNP LOSSES: INCREASE OVER COMPETITIVE PRICE (1982 $)	LOSS OF POTENTIAL GNP (1990 $)	PRES. VALUE LOSS OF POTENTIAL GNP (1990 $)	MACROECONOMIC ADJUSTMENT COSTS: ADJUSTED PRICE (1990 $)	RATIO OF ADJUSTED/ ACTUAL PRICE	MACRO ADJUSTMT. GNP LOSS 990 $)	PRES. VALUE MACRO ADJUSTMT. GNP LOSS (1990 $)	TOTAL GNPLOSS (1990 $)	TOTAL GNP LOSS PRESENT VALUE
1972	$2,609	$3,430		$6.92	$0.00	$0	$0	$6.92	1.000	$0	$0	$0	$0
1973	$2,744	$3,608	$178	$8.24	$1.32	$9	$22	$6.92	1.191	$7	$18	$16	$39
1974	$2,729	$3,589	($19)	623.19	$16.27	$78	$178	$7.04	3.263	$103	$235	$180	$413
1975	$2,695	$3,544	($45)	$23.49	$16.57	$77	$168	$7.63	2.961	$94	$206	$171	$374
1676	$2,827	$3,717	$173	$21.36	$14.44	$75	$156	$8.84	2.416	$79	$165	$154	$321
1977	$2,959	$3,891	6173	$21.59	$14.67	$85	$168	$9.66	2.236	$82	$163	$167	$330
1978	$3,115	$4,096	$206	$20.18	$13.26	$78	6147	$10.47	1.928	$64	$121	$142	$268
1676	$3,192	$4,198	$102	$27.57	$20.65	$110	$198	$11.18	2.467	$115	$207	$225	$405
1980	$3,187	$4,191	($7)	$39.54	$32.62	$144	$246	$12.23	3.232	$199	$340	$343	$586
1661	$3,249	$4,272	$81	$39.41	$32.49	$140	$228	$13.76	2.865	$189	$309	$329	$537
1982	$3,166	$4,163	($109)	$33.55	$26.63	6111	$172	$15.28	2.1%	$111	$172	$222	$344
1863	$3,279	$4,312	$149	$28.20	$21.28	$94	$139	$16.53	1.706	$65	$97	$160	$236
1984	$3,501	$4,604	$292	$26.82	$19.90	$94	$132	$17.44	1.538	$52	$74	$146	$205
1985	$3,619	$4,759	$154	$24.34	$17.42	$82	$110	$18.21	1.337	$31	$42	$113	$151
16%	$3,718	$4,889	$130	$12.29	$5.37	$32	$40	$18.74	0.6%	$25	$32	$57	$73
1987	$3,845	$5,057	$168	$15.44	$8.52	$48	$58	$17.97	0.659	$11	$13	$59	$71
1988	$4,017	$5,282	$226	$12.00	$5.08	$31	$36	$17.70	0.676	$23	$27	$54	$63
1989	$4,118	$5,415	$133	$14.31	$7.39	$44	$48	$17.02	0.841	$12	$14	$56	$62
1990	64,167	$5,467	$52	$16.55	$9.63	$55	$57	$16.73	0.989	$1	$1	$56	$58
1991	64,167	$5,467	$0	$13.72	$6.80	$38	$38	$10.71	0.821	$13	$13	$50	$50
TOTK			$2,037			$1,423	$2,341			$1,278	$2,246	$2701	$4,587

ASSUMPTIONS:

TOTAL GNP LOSSES ELASTICITY	0.050
MACRO ADJUSTMENT COST SHARE	67%
ADJUSTMENT RATE PARAMETER	0.9
RATE OF REAL OIL PRICE INCREASE	0.0%

Note: Estimated potential GNP loss and Macroeconomic Adjustment cost elasticities are proportional to estimated long-run and short-run oil cost shares of GNP, respectively.

ESTIMATION OF EFFECTS OF MONOPOLY PRICES AND PRICE SHOCKS ON U.S. GROSS NATIONAL PRODUCT

					POTENTIAL GNP LOSSES				MACROECONOMIC ADJUSTMENT COSTS					
	U.S. GNP (BILLIONS) (1982 $)	U.S. GNP (BILLIONS) (1990 $)	ACTUAL CHANGE IN GNP (1990 $)	PRICE OF IMPORTED OIL TO U.S. (1982 $)	INCREASE OVER COMPETITIVE PRICE (1982 $)	LOSS OF POTENTIAL GNP (1990 $)	PRES. VALUE LOSS OF POTENTIAL GNP (1990 $)	ADJUSTED PRICE (1990 $)	RATIO OF ADJUSTED/ ACTUAL PRICE	MACRO ADJUSTMT. GNP LOSS (1990 $)	PRES.VALUE MACRO ADJUSTMT. GNP LOSS (1990 $)	TOTAL GNPLOSS (1990 $)	TOTAL GNP LOSS PRESENT VALUE
1672	$2,609	$3,430		$6.92	$0.00	so	$0	$6.92	1.000	$0	$0	$0	$0
1673	$2,744	$3,608	$176	$8.24	$1.16	$8	$19	$6.92	1.161	$7	$18	$15	$37
1674	$2,729	$3,589	($19)	$23.19	$15.66	$75	$172	$7.04	3.263	$103	$235	$176	$407
1675	$2,695	$3,544	($45)	$23.49	$16.15	$73	$160	$7.63	2.981	$94	$206	$168	$366
1676	$2,827	$3,717	$173	$21.36	$13.67	$70	$145	$8.84	2.416	$79	$165	$149	$310
1677	$2,959	$3,891	$173	$21.59	$13.95	$77	$163	$9.66	2.236	$82	$163	$159	$316
1978	$3,115	$4,096	$206	$20.18	$12.39	$69	6131	310.47	1.928	$64	$121	$134	$252
1676	$3,192	$4,196	$102	$27.57	$19.62	$99	$176	$11.16	2.467	$116	$207	$214	$385
1980	$3,187	$4,191	($7)	$39.54	$31.43	$130	$223	$12.23	3.232	$199	$340	$329	$563
1661	$3,249	$4,272	$81	$39.41	$31.14	$126	$204	$13.76	2.865	$189	$309	$315	$513
1982	$3,166	$4,163	($109)	$33.55	$25.11	$97	$150	$15.28	2.195	$111	$172	$207	$322
1983	$3,279	$4,312	$149	$28.20	$19.60	$80	6116	$16.53	1.706	$65	$97	$145	$214
1664	$3,501	$4,604	$292	$26.82	$18.04	$77	$108	$17.44	1.538	$52	$74	$129	$182
1985	$3,619	$4,759	$154	$24.34	$15.39	$65	$87	$18.21	1.337	$31	$42	$96	$129
1986	$3,718	$4,889	$130	$12.26	$3.16	$16	$21	$18.74	0.656	$25	$32	$42	$53
1987	$3,845	$5,057	$168	$15.44	$6.13	$30	$36	$17.97	0.859	$11	$13	$41	$50
1988	$4,017	$5,282	$226	$12.00	$2.50	$13	$15	$17.70	0.678	$23	$27	$36	$42
1989	$4,118	$5,415	$133	$14.31	$4.62	$23	$26	$17.02	0.641	$12	$14	$36	$39
1990	$4,157	$5,467	$52	$16.66	$6.66	$32	$34	616.73	0.989	$1	$1	$33	$35
1991	64,167	$5,467	$0	$13.72	$3.64	$17	$17	$16.71	0.821	$13	$13	$30	$30
TOTAL			$2,037			$1,176	$1,998			$1,276	$2,246	$2,456	$4,244

ASSUMPTIONS:

TOTAL GNP LOSSES ELASTICITY	0.050
MACRO ADJUSTMENT COST SHARE	67%
ADJUSTMENT RATE PARAMETER	0.0
RATE OF REAL OIL PRICE INCREASE	2.0%

Note: Estimated potential GNP loss and Macroeconomic Adjustment cost elasticities am proportional to estimated bng- run md short–run oil cost shares of GNP, respectively.

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