THE DOLLAR AND THE WORLD OIL MARKET

Hillard G. Huntington*

Forthcoming in Energy Policy

EMF OP20

December 1985
(revised)

*Executive Director, Energy Modeling Forum, Stanford University. This paper was presented at the Seventh Annual North American Conference of the International Association of Energy Economists, Philadelphia, Pennsylvania, December 10-13, 1985. I have benefitted from discussions with Bill Hermann and Bob Oglesby, who have also found significant exchange rate effects in their work, as well as with Tom Kaufmann, James McNabb, Howard Mueller, and James Shaw. However, I retain sole responsibility for the paper's contents.

Energy Modeling Forum
Terman Engineering Center
Stanford University
Stanford, California 94305

ACKNOWLEDGMENTS

The activities of the Energy Modeling Forum are funded by gifts from corporate affiliates and by grants from or contracts with the U.S. Department of Energy and the Electric Power Research Institute. Corporate affiliates are :

Alberta Energy and Natural Resources
Chevron U.S.A. Inc.
Conoco Inc.
Exxon Company, U.S.A.
Gas Research Institute
General Motors Corporation
Interstate Natural Gas Association of America
Ontario Hydro
Pacific Gas and Electric Company
Pembina Resources Limited
Rocky Mountain Energy Company
Royal Bank of Canada
Shell Oil Company
Southern California Edison Company

ABSTRACT

Due to the increasing value of the dollar, world oil prices rose rather than fell relative to the price of OECD exports between 1980 and 1984. The real crude oil price for OECD countries increased approximately 30 percent more than its counterpart for the U.S. If OECD oil prices had not risen but followed the trend for U.S. prices, world oil demand in 1984 would have been about 3.0 million barrels per day (6.6%) higher than otherwise, according to estimates presented in this paper.

Different projections for the future value of the dollar can introduce substantial uncertainty for world oil market trends. The paper considers two plausible scenarios, which assume the same nominal oil price, U.S. inflation rate, and OECD growth rate. World oil consumption by 1990 could vary by 4 MMBD, depending upon shifts in the exchange rates and the value of the dollar. This variation is comparable to the range associated with significant differences in the economic growth rate between now and 1990.

These developments could also eventually influence the dollar-denominated crude oil price. We show that shifts in exchange rates could produce changes in oil prices in 1990 that are comparable to the effects of gradually removing 5 million barrels per day from total oil production by 1990.

Introduction

Despite record levels of excess capacity, oil producers have adopted an extremely aggressive pricing strategy during most of the 1980s. This development has contributed importantly to the excess supply that is placing downward pressure on crude oil prices in late 1985.

This aggressive pricing stance has sometimes been obscured, particularly in the United States, by a 7 percent decline in nominal oil prices and a 26 percent reduction in dollar-based oil prices adjusted for U.S. inflation since 1980 (as of 1984).[1] However, oil is an internationally traded commodity and its price should be compared to other such goods. Relative to the price of OECD exports (in dollars), world crude oil prices increased by about 6 percent in the 1980-84 period.

World oil producers faced the same situation as U.S. exporters of goods. They were trying to compete in a world with an appreciating dollar without dropping their price in dollars. For many countries this rise in the dollar's value exceeded the inflation rate in local currencies, causing real oil prices to increase even if the nominal price did not. This aggressive pricing strategy by oil producers, in combination with slack world economic conditions, resulted in sharp reductions in oil consumption. The weakening of the dollar beginning in early 1985 has helped to reduce these pressures, and if they continue, will create new uncertainties in this market.

This paper probes the implications of a changing value of the dollar for the world crude oil market. Specifically, we ask what would world crude oil demand be under different regimes of international exchange rates.[2] In order to simplify the discussion and focus on the possible

biases introduced by this factor, we simplify the problem considerably. In particular, we assume that world oil prices in dollars will not be influenced by shifts in exchange rates. We then judgmentally assess the likelihood of OPEC's ability to follow this pricing strategy, given the resulting world oil consumption from assumptions about economic growth and shifts in exchange rates.

While technically it is incorrect to exclude the causes of the exchange rate shifts from our analysis, this simplification focuses the analysis on the key point we wish to consider: the direct effects of changing oil prices (through exchange rate shifts) on oil demand. We exclude any possible macroeconomic impacts and their ramifications on the oil market, because it is less clear how exchange rates affect economic activity. The analysis also ignores potential interfuel substitution issues, particularly the increased competition between oil and gas resulting from the gas surpluses in the North America and Europe. We assume that gas prices will move with oil prices, so that relative fuel prices do not shift during the period of analysis.

After describing our methodology, we examine the effect of a strong dollar on the world oil market during the 1980-84 period. Next, we evaluate the uncertainty associated with several possible conditions involving changes in exchange rates over the rest of the decade. And finally, we summarize the key implications of this issue for understanding future trends in this market.

Methodology

The demand for crude oil will be governed by the demand for petroleum products in countries displaying vastly different climates, economic activity, and other determinants of energy end use. A comprehensive model of these decisions would probably be disaggregated, at a minimum, by region and product. However, we have adopted a much simpler approach here because many projections of world oil are often conducted on a highly aggregate level;[3] detailed econometric equations are only infrequently used.

We apply a simple historical regression analysis for OECD total oil consumption for the 1969-84 period to estimate aggregate oil demand. In our specification the oil-GNP ratio (expressed in logarithms) adjusts gradually to changing levels of real oil prices. Thus, this response of demand to price grows over time. In addition, the price elasticity is assumed to increase with the crude oil price level, which is the price variable in the model because a consistent data series on product prices for the OECD was not available for the full historical period.

This specification appears reasonable from several perspectives. First, economic theory strongly implies that demand becomes more responsive to price increases as a commodity becomes more important in the overall budget. Given the limited degree of substitution between oil and other inputs that is often considered possible, higher oil prices will cause oil's importance in the overall budget to rise, thereby increasing its price elasticity.[4]

And second, oil demand is a function of petroleum product rather than crude oil prices. If refiner margins and taxes remain more or less constant, rising crude oil prices will increasingly have a larger

proportional effect on product prices. The elasticity with respect to the crude oil price would gradually rise towards the elasticity with respect to the petroleum product price, even if there were a constant-elasticity rule relating demand and price at the end-use level.[5]

Our preferred measure of real oil prices for the OECD is the current-dollar price divided by the average price of OECD exports in dollars.[6] The implications of using this variable rather than real oil prices measured relative to the U.S. inflation experience (as tracked by the implicit GNP price deflator) are revealed in Table 1.

Since 1980 the U.S.-based oil price will understate the increase in the real oil price as measured by the OECD-based series. Thus, one would expect that the demand response to oil price changes will be overestimated if the U.S.-base price is used in the regression. The initial impact on oil demand is actually larger with the OECD-based oil prices. However, the adjustment to higher prices is quicker so that the long-run effect after many years is less. This result means that the response during the first several years will be greater with this specification, although the price coefficient is not significantly different in the top two equations.

The third equation uses the logarithm of real OECD oil prices, thereby imposing a constant price elasticity at all prices. It shows a noticeably smaller first-year reduction in demand as prices rise, although the long-term response is only slightly less. This implies a slower adjustment process.

The last equation is noticeably inferior on several grounds. Most importantly, the estimated long-run price elasticity is very sensitive to the sample period used in the regression equation. For example, truncating

Table 1

Estimated Short- and Long-Run Price Elasticities
For Aggregate OECD Demand

Oil Price Variable	Price Elasticity at 1983 Price Level		$\bar{R}^2$[c]	No. of Runs[d]
	Short Run	Long Run		
(1) Real OECD Price[a]	-0.137	-0.750	.980	9
(2) Real U.S. Price[b]	-0.096	-0.953	.981	6
(3) Log (Real OECD Price)	-0.048	-0.649	.946	7

[a]Nominal oil price deflated by unit value ($) of OECD exports

[b]Nominal oil price deflated by U.S. GNP price deflator.

[c]When fitted values replace lagged dependent variable.

[d]Strings of over or underpredictions during backcast.

the sample to end in 1982 raises this estimated parameter from -0.649 to -2.04 because the shorter period reduces the estimated rate of adjustment to previous price changes. By contrast, the parameters in the top two equations in Table 1 are quite robust across sample periods.

The constant-elasticity equation is also inferior for backcasting the historical period (column 3). In this step the fitted value for a period's demand level replaces the lagged demand variable in producing the next year's demand level. The lagged demand variable represents the slow adjustment in the oil-GNP ratio in response to oil price changes.

The equation using the OECD-based oil price is preferable to the others when the residuals are examined for their tendency to produce runs, or strings of over- or under-predictions, as highlighted in column 4. Fewer runs imply that the model consistently underestimates the demand levels in some periods and overpredicts them in other periods. The first equation produced 9 different runs for the 14-year sample, compared to 7 for the double-log specification and 6 for the equation using the level of oil prices deflated by the U.S. GNP deflator. Most disturbing was the fact that the latter overpredicted the actual demand level during four of the last five years (1980-84).

The 1980-84 Experience

Before considering possible future scenarios, we will briefly review the recent past. The trends of the last several years can be interpreted in two different ways.

First, movements in the exchange rates could have been fully incorporated in the price of oil in dollars. If so, real oil prices and

world oil consumption would have been left unchanged, although the price of oil in dollars would clearly have been lower than otherwise.

The mechanics of this process would be as follows. Producers would be encouraged by the high prices caused by a strong dollar to place more oil on the market. At the same time, consumers would reduce their purchases of oil. Surplus capacity would grow, placing downward pressure on the price of oil in dollars, as occurred in 1983.

Even in this case, it is important to recognize the effects of exchange rate shifts. Many oil analysts have interpreted the falling dollar price for oil as a weak OPEC during the early 1980s.

Many oil analysts would dismiss the suggestion that the decline in oil prices during 1980-84 was attributable entirely to exchange rate movements. Another interpretation would be that key producers like Saudi Arabia had both the political incentive and the capability to prevent declines in the dollar-denominated price during this period. In this case the dollar-denominated oil price would be inflexible to exchange rate movements. World oil prices in real terms would be higher with a stronger dollar than if its value had held steady. As a result, world oil consumption would have been lower than otherwise.

In the remainder of this section, we consider the second case in which real oil prices outside the United States are influenced by the dollar's appreciation. It should be emphasized that the transmission of exchange rate shifts on commodity markets is an empircally difficult and tricky issue in international economics. Our knowledge about the speed of adjustment and its magnitude is limited. Moreover, as with any market experiencing substantial unused capacity, official prices may disguise

widespread price discounting. Hence, transaction prices may be lower, although we do not know by how much. Of course, this situation poses a problem for any analysis of world oil markets, whether or not the exchange rate issue is explicitly considered. Despite these problems, however, this issue can be fruitfully probed using a relatively rudimentary framework.

The estimated demand relationship based upon real OECD prices from the previous section was used to simulate world oil consumption under two different sets of conditions.[7] First, the actual historical experience was backcasted using the actual real oil prices of the 1980-84 period, i.e., the nominal price deflated by the observed price of OECD exports. And second, a new historical backcast was prepared by assuming that the price of OECD exports rose with the price of U.S. exports during this period. This alternative hypothesis implies that the dollar does not appreciate relative to other currencies, once differences in inflation rates are accounted for.

Table 2 shows that world oil consumption (WOCA) would be some 3.0 million barrels per day (MMBD) higher by 1984 in the alternative backcast representing a constant value for the dollar through the 1980-84 period. Had world oil consumption been 6.6 percent greater, as suggested by this analysis, much of the current pressure on world oil prices today might have been abated.[8]

This estimate represents the decline in oil consumption caused by energy price shocks outside of the U.S. resulting from a sharply stronger dollar. Its magnitude is determined principally by the fact that the real oil price for all OECD countries increased by about 30 percent more than the price trend for real U.S. price during this period. Oil demand is not

Table 2

Actual and Simulated World Oil Demand (MMBD)
Using OECD and U.S. Real Oil Prices

Year	Actual	Simulated Based Upon: OECD Prices	U.S. Prices	Difference
1981	46.7	46.7	47.5	+0.7
1982	45.2	44.7	46.2	+1.5
1983	44.7	44.6	46.8	+2.2
1984	45.7	45.8	48.8	+3.0

Source: Actual demand levels are those reported by British Petroleum [12]. First simulation is based upon oil price deflated by the unit value ($) of OECD exports. Second simulation is based upon oil price deflated by the U.S. export price.

overly responsive to price in this analysis; the price elasticity after 4 years is about -0.3 for the equation explaining WOCA oil consumption. It measures the change in oil use as the economy shifts away from more expensive energy; interfuel substitution and macroeconomic effects on oil demand are excluded. There are no a priori reasons for expecting that exchange rate shifts would alter the relative gas/oil price ratio.

Similarly, the effects of exchange rates on economic activity, and hence world oil consumption, are not obvious and could either raise or lower world economic growth. While the rising dollar has made U.S. exports less competitive, it has improved U.S. economic performance by lowering inflation. The rising dollar reverses these effects for European countries, encouraging exports but either worsening inflation or encouraging more restrictive monetary policy. As a result, OECD economic activity could be either higher or lower, depending upon the macroeconomic relationship between the markets for goods and money in the individual countries. The higher dollar also shifts purchasing power towards the U.S. and oil-producing countries, but the strength and direction of this effect depends upon the propensities to spend in the different regions. As a result, these more complicated effects are best left to examination by a comprehensive analysis of global economic activity and fluctuating exchange rates.

Projections for 1990

World oil demand adjusts gradually to oil price changes. This dynamic response means that future oil demand projections will become increasingly sensitive to the exchange rate movements of the last several years, unless

these international currency trends are reversed in subsequent years. Additionally, further exchange rate movements could introduce another level of uncertainty into future oil market conditions.

This point can be made most forcefully by considering a hypothetical scenario (not a forecast) in which the crude oil price rises with the U.S. inflation rate. The scenario also assumes a steady economic growth rate of 3 percent per year from 1984. What would be a reasonable range of WOCA oil demand by 1990 with different assumptions about the value of the dollar, given these conditions?

Two alternative and highly stylized assumptions about OECD prices in dollars are made in order to probe the consequences of different exchange rate trends during the 1984-90 period.[9] The first case assumes that exchange rate movements adjust only for differences in inflation rates between countries. Any inflation above the U.S. rate is offset by a depreciation of that currency relative to the dollar. As a result, the price of a country's exports, in dollars, rises with the average U.S. inflation rate. By assumption, crude oil prices rise by the same rate. Therefore, the real crude oil price in terms of OECD purchasing power remains constant through 1990 in this initial scenario ("no real appreciation").

In a second case ("depreciation"), the dollar is assumed to decline in value, causing OECD prices in dollars to rise by 5 percent per year more than U.S. inflation. This assumption essentially reverses by 1990 the real gains experienced by the dollar during 1980-84. Since nominal oil prices are assumed to increase only with U.S. inflation, real oil prices in terms of OECD purchasing power falls through 1990, by approximately 5 percent per

year.

The range of oil demand projections shown in Table 3 is strikingly large, even though both cases use the same oil price (in dollars), U.S. inflation rate, and economic growth trajectories. By 1990, there emerges a 4 million barrels per day (MMBD) difference between the two demand projections.[10] These effects are comparable to those resulting from modest but reasonable changes in the underlying economic growth trends. For example, the analysis reveals a 6.1 MMBD difference (from 49.2 to 55.3 MMBD) for the no appreciation scenario when the underlying economic growth rate is separately raised and then lowered by 1 percent per annum during the 1984-90 period. These assumptions about economic growth represent significant differences in the level of economic activity.

The oil demand projections in Table 3 show that oil demand could recover and by 1990 exceed its 1980 level (48.5 MMBD) in the absence of any further changes in real exchange rates. The results in this scenario are driven by the continued economic growth assumed in all scenarios. This recovery in oil demand will be more dramatic if these conditions are accompanied by a falling real oil price for the OECD. This could occur even with no decline in the real U.S. oil price, if OECD prices, in dollars, rose more rapidly than the crude oil price due to a depreciation of the dollar.[11]

These demand projections are based upon an assumed crude oil price path and could be inconsistent with estimates of available crude oil supplies developed by others. However, this does not appear to be the case judging from the range of estimates in Table 4 reported to the International Energy Workshop conducted by Manne and Schrattenholzer

Table 3

Projected 1990 World Oil Demand Based Upon Different Exchange-Rate and Economic Assumptions[a]

3% Economic Growth, 1984-1990	
No Real Appreciation[b]	52.2
Depreciation	56.2
No Real Appreciation[b]	
2% Economic Growth	49.2
3% Economic Growth	52.2
4% Economic Growth	55.3

[a]Projections assume a constant oil price ($/bbl) and the same U.S. inflation rate.

[b]Any appreciation (depreciation) of dollar offsets greater (less) inflation outside the U.S.

Table 4

Projections of World Oil Consumption
Reported in IEW Poll

	IEW Index (1980=100)	Approximate MMBD
Highest	114	55.5
Median	100	48.5
Lowest	87	42.4

Source: Manne and Schrattenholzer [9]

(1984b). That project compares the energy market forecasts of some 200 international analysts and agencies for the years 1990, 2000, and 2010. The participating forecasters include those using formal models as well as judgmental estimates.[12]

The estimates in Table 4 refer to oil consumption rather than to the available supply at a given price. However, they have been generated by analysts considering both the supply and demand conditions of the oil market. Thus, as a group, the IEW participants can envision a set of world oil market conditions that would lead to a range of crude oil supplies between 42 and 55 MMBD by 1990. The range of real oil prices reported by this group is not substantially different from that developed in this paper.[13]

Price Uncertainty

The preceding analysis has assumed that oil producers maintain a steady oil price path denominated in dollars. In fact, however, the dollar-denominated price itself may ultimately be influenced by exchange rate shifts. For any given dollar-denominated oil price, a weaker dollar would reduce the real price, thereby discouraging oil production and conservation efforts and placing greater upward pressure on the dollar-denominated oil price.

This issue can be probed by allowing the oil market to clear, using our demand estimates in conjunction with external judgments about world oil supply. For example, if productive capacity allowed world oil production to increase by 3 percent per year between 1984 and 1990, oil supply would reach about 55 MMBD by 1990. If petroleum supply is fixed at this level

for 1990 and economic growth maintained at 3 percent per year, the oil price would be somewhat lower than its 1984 level ($28.70), at $25 per barrel (1984 dollars). This estimate assumes no further dollar appreciation in real terms. However, if the dollar depreciates as outlined in the second scenario above, the dollar-denominated price for clearing the market would increase to about $34 per barrel.

This range is quite substantial. It would require a removal of 5 MMBD from the 1990 level of production to support the $34 per barrel price under the conditions assumed for the no appreciation case. Thus, differences in exchange rate assumptions have world oil market effects comparable to significant changes in crude oil supply.

Implications

Many oil analysts may be suffering from "money illusion" by focusing on recent oil price trends in terms of dollars (either nominal or adjusted for U.S. inflation). Our analysis has important implications for understanding both recent trends as well as possible mid-term futures (through the decade) for the world oil market.

It appears that the oil producers' decision to hold nominal prices nearly constant (with only a single break, through 1983) actually represented an aggressive pricing strategy given the surplus capacity conditions of the oil market. Between 1980 and 1984, this behavior resulted in oil prices rising faster than OECD's purchasing power as measured by the unit value of its exports. In contrast to the 1973 oil price shock,[14] real oil prices, OECD-wide, did not decline with the ensuing soft market conditions. These observations suggest that nominal

oil price rigidity might be the rule in other circumstances of lower world oil demand, e.g., when oil-consuming nations adopt oil-saving strategies to reduce the world oil price.

Aggressive pricing of crude oil contributed importantly to declining world oil demand. If oil producers had maintained the nominal oil price path observed during 1980-84, but the dollar had not appreciated from its 1980 level, total world oil demand would not have fallen. This higher level of demand would have mitigated to a considerable degree the pressure on OPEC to lower its price in dollars.

Clearly, the flexibility in fuel substitution, combined with deregulated energy markets in the U.S., have been important contributors to the current soft conditions in the world oil market. However, the effects of such developments can be easily overestimated in reviewing recent oil market trends if the experience with exchange rates over the last several years is not explicitly recognized.[15]

Planners have learned to live with uncertainty when evaluating oil projections. The relationship between economic growth and oil demand is widely recognized to be critical for understanding oil's future.[16] The hypothetical scenarios developed in this paper suggest that comparable uncertainty resides in the phenomenon of shifting exchange rates. While oil forecasters may not be able to anticipate such swings, they will probably understate the range of oil demand, and hence the price in dollars, if these considerations are ignored altogether.

Notes

[1]We confine these remarks to the period through 1984 due to the availability of annual data on OECD export prices. The dollar continued to rise above its average 1984 value during the third and fourth quarters but began to weaken in early 1985. In addition, as of late 1985, oil prices were beginning to show severe softness. While both developments could significantly alter the projections discussed in this paper, they do not obviate the importance of the exchange rate effect highlighted here.

[2]As will be seen shortly, we are concerned with changes in real or inflation-adjusted exchange rates rather than the popularly discussed nominal ones. An appreciation of the dollar could be offset by greater inflation outside the U.S. If this happened, the appreciation would not affect the price of goods denominated in dollars relative to foreign prices.

[3]For example, see the Energy Modeling Forum [1] and Manne and Schrattenholzer [2].

[4]If oil is used with non-energy inputs in a Constant-Elasticity-of-Substitution (CES) production function, its price elasticity will be equal to $\sigma/(1-\theta)$, where σ is the elasticity of substitution and θ is oil's value share of total output. When $\sigma < 1$, then θ and the price elasticity both increase as the oil price rises. See Hogan and Manne [3].

[5]Decompose the product price (P) into crude costs (C) and non-crude costs. Then, the demand elasticity with respect to the price of crude oil will be equal to:

$$(\partial Q/Q)/(\partial C/C) = (C/P)[(\partial Q/Q)/(\partial P/P)]$$

The elasticity rises as the ratio of crude to product prices increases. The use of crude rather than product prices will tend to result in larger percentage price increases but lower estimated demand elasticities. The real price increases for different petroleum products in Europe ranged from about 0 to 10 percent between 1980 and 1983, which appears to be reasonably similar to the crude oil experience (Commission of the European Communities [4]). The bias introduced by using crude oil prices does not appear to be great, as was the case for the 1980-82 period (Huntington [5]).

[6]The International Monetary Fund reports this price as the average unit price (in dollars) of aggregate OECD exports. It is a quantity-weighted index in which the prices of exports from member OECD countries are converted to dollars using official exchange rates. This price series is routinely reported and incorporates broad movements of the dollar against other currencies without requiring detailed exchange-rate computations by the energy analyst. It has distinct advantages over the use of the U.S.

inflation rate often used by oil analysts in discussing global trends in the world oil market. Where the analyst has the resources to conduct disaggregated modeling by country, using petroleum product rather than crude oil prices, other more exact measures such as the Purchasing Power Parity used by Hogan and Leiby [6] may be appropriate.

[7]The previous section's results were estimated on aggregate OECD demand, whereas the projections in this section are based on an equation for WOCA demand, including the demands of the less developed countries (LDCs). Although the fit is marginally poorer, all of the previous conclusions pertain to this second equation as well. As expected, a separate estimate of aggregate LDC demand did not produce encouraging results. Such a specification has several serious deficiencies that are particularly severe for this group of countries. (1) Foreign exchange rate restrictions and subsidized domestic energy prices obfuscate the measure of oil prices in terms of real purchasing power. (2) The relationship between commercial energy use (oil) and economic activity can be expected to vary greatly across countries at widely different levels of development.

[8]This estimate appears consistent with some disaggregated estimates by country conducted by Brown and Phillips [7]. It is larger than a previous estimate conducted by the author (Huntington, op.cit.). My previous study was conducted through 1982 and assumed that there was no further appreciation of the dollar in 1983. In fact, however, there has been a continuing appreciation of the dollar over the 1983-84 period, causing the difference between the U.S.- and OECD-based prices to widen further. My previous analysis was also based upon a parametric demand equation developed by Rowen and Weyant [8] that did not specifically incorporate exchange rate effects. Their equation was characterized by a smaller immediate reduction and a longer adjustment in energy demand due to rising oil prices. As a result, the price response after about three years was noticeably smaller than that estimated here.

[9]We discuss our scenarios in terms of the effect on OECD prices in dollars because that is the variable that enters our demand model. The real price of oil (R) for a country can be written as: $H/(P \times F)$, where H is the nominal price in dollars, P is the aggregate price level for goods and services, and F is the exchange rate (dollars per unit of foreign currency). Then, the percent change in real oil prices (denoted by small letters) can be expressed as $r=h-(p+f)$. Or $r=h-(p^*+p'+f)$, where p^* is the U.S. inflation rate and $p'=p-p^*$. Since $h=p^*$ by assumption, $r=0$ when changes in exchange rates offset differential inflation rates ($p'=f$). This expression may be helpful for understanding the discussion in this and the following paragraph.

[10]A third scenario was also considered to show the effects of a continued appreciation in the dollar, lowering OECD prices in dollars by 5 percent per year. These assumptions constrain oil demand to 47.2 MMBD by 1990.

[11]This point raises the issue of demand reversibility, i.e., will the response to oil price reductions be similar to the estimated response to oil price increases in the past. If market participants expect that sharp oil price reductions will be followed by an increasing trend for future

prices, the demand response will not appear reversible with respect to today's prices. This was not a problem for our previous analysis of the 1980-84 period because we were estimating the effect of higher non-U.S. prices on reducing oil consumption. For the 1984-90 projections, however, we are explicitly considering oil price reductions as exchange rates decrease the non-U.S. oil price. However, even if one arbitrarily adjusts the estimated effects downward, they remain important. The principal driver of this estimate is the size of the price change due to exchange rate shifts; the price elasticities for demand in this analysis are relatively moderate.

[12]The objectives and approach of the International Energy Workshop are extensively discussed by Manne and Schrattenholzer [2].

[13]The concept of a real oil price becomes troublesome at this point. The IEW poll asks modelers to report oil prices in real purchasing power (1980=100). However, it is unclear whether participants are reporting real oil prices in terms of U.S. or OECD purchasing power. For example, our 1983 real oil price would be 78 in terms of U.S. purchasing power but 105 in terms of OECD purchasing power. The confusion stemming from past appreciation of the dollar could be overcome in future polls if participants were asked to benchmark their oil price index in terms of the 1983 or some other recent price. Of course, this procedure would not address ambiguities introduced by future appreciation or depreciation.

[14]See Dunkerly and Jankowski [10] for the trend in real oil prices in individual countries following the first oil price shock.

[15]For example, Ott and Tatom [11] attribute much of the decline of oil prices in dollars to the deregulation of domestic crude oil in the U.S.

[16]This result is dramatically illustrated in the Energy Modeling Forum, op.cit.

References

[1] Energy Modeling Forum (1982). World Oil. Stanford University, Energy Modeling Forum Report 6. Stanford, Calif. (February).

[2] Manne, Alan S., and Leo Schrattenholzer (1984a). "International Energy Workshop: A Summary of the 1983 Poll Responses." The Energy Journal 5, No. 1 (January).

[3] Hogan, William W., and Alan S. Manne (1977). "Energy-Economic Interactions: The Fable of the Elephant and the Rabbit?", in Energy and the Economy, Volume 2, Energy Modeling Forum Report 1, September 1977, Stanford University, Stanford, CA. Also in Modeling Energy-Economy Interactions: Five Approaches, C. Hitch (ed.).

[4] Commission of the European Communities, (1984) Energy in Europe: Energy Policies and Trends in the European Community. Bruxelles-Luxembourg.

[5] Huntington, Hillard G. (1984). "Real Oil Prices from 1980 to 1982." The Energy Journal 5, No. 3 (July).

[6] Hogan, William W. and Paul N. Leiby (1985), "Oil Market Risk Analysis," Discussion Paper Series, Kennedy School of Government, Harvard University (December), #H-85-03.

[7] Brown, Stephen P.A. and Keith R. Phillips (1984), "The Effects of Oil Prices and Exchange Rates on World Oil Consumption," Economic Review, Dallas Federal Reserve Bank (July).

[8] Rowen, Henry S., and John P. Weyant (1981). "A Possible 'Collapse' in Oil Prices: Implications for U.S. Industry and Government." Mimeographed, Stanford University (July).

[9] Manne, Alan S., and Leo Schrattenholzer (1984b). "International Energy Workshop." Mimeographed, International Energy Project, Stanford University, Calif. (July).

[10] Dunkerly, Joy and John E. Jankowski, Jr. (1982). "The Real Price of Imported Oil," Energy Journal 1, No. 3 (July).

[11] Ott, Mack, and John A. Tatom (1982). "Are There Adverse Inflation Effects Associated with Natural Gas Decontrol?" Contemporary Policy Issues, No. 1 (October).

[12] British Petroleum (1985). Statistical Review of World Energy. London (June).

[13] Central Intelligence Agency (1985). Energy and Economic Indicators. Washington, D.C. (July).

[14] Council of Economic Advisors (1983, 1984). Economic Report of the President. Washington, D.C.: U.S. Government Printing Office (February).

[15] International Monetary Fund (1984). International Financial Statistics. Washington, D.C. (September). Supplement on Trade Statistics, 1982, for previous years.

[16] Organization for Economic Cooperation and Development (1975, 1980, 1984). Main Economic Indicators. Paris (July).

[17] International Monetary Fund (1972, 1975). Annual Report. Washington, D.C.

Appendix

The backcasts and projections were based upon rudimentary equations that regressed the oil-GDP ratio for the developed economies and for the world (outside the Communist area) as functions of their lagged values and the real price of oil. Equation parameters for the price and lagged demand variables for the developed countries are summarized in Table A.1. The counterpart equations for the world are very similar.

These equations are based upon historical data from the following sources:

Variable	Units	Source
Oil consumption	Thousand barrels per day	British Petroleum [12]
Crude oil price	Dollars per barrel	Central Intelligence Agency [13]
GNP price deflator for U.S.	Index 1980=100	Council of Economic Advisors [14]
Unit value of exports in $	Index 1980=100	International Monetary Fund [15]
Gross Domestic Product	1975 prices and exchange rates	Organization for Economic Cooperation and Development [16]

Notes:

Oil consumption in developed areas includes North American, Western Europe, Japan, and Australasia, while that in developing areas includes total Non-Communist World (NCW) minus developed areas.

Oil price is average crude oil official sales price (not posted price).

Unit export values for industrial countries and for oil-importing developing countries are used in separate estimates of OECD and developing countries' oil demand.

GDP for OECD countries are estimated for 1984, using growth rates reported in Council of Economic Advisors, op.cit.

Comparable GDP estimates for the LDCs had to be estimated from 1981 GNP levels for developed and less developed countries (Council of Economic Advisors, 1983, op.cit.) and 1981 GDP level for the developed countries. Other years were estimated from the reported LDC growth rates: 1973-83 from the Council of Economic Advisors, op.cit., and 1968-72 from the International Monetary Fund [17]. This step does not appear to be critical, judging from the similarity between equations for oil-GDP ratios for the developed countries and the world.

Table A.1

Estimated Parameters for Oil Demand-GNP Ratios
in Developed Countries

Price Variable in Equation	Coefficient[a] for: Oil Price	Lagged Oil-GNP Ratio[b]	Constant	Adjusted[c] R^2
(1) Real OECD Price	-.0043	.804	.486	.980
	(-9.06)	(17.23)	(4.52)	
(2) Real U.S. Price	-.0042	.899	.268	.981
	(-9.87)	(24.58)	(3.22)	
(3) Log (Real OECD Price)	-.048	.926	.274	.946
	(-5.96)	(17.01)	(2.08)	

[a]T-statistics are in parentheses.

[b]Current and lagged dependent variables are in logarithms.

[c]Fitted Oil-GNP ratio for current year is based upon fitted, not actual, oil-GNP ratio from preceding year.