

**REAL OIL PRICES DURING 1980-82**

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## ABSTRACT

Real crude oil and petroleum product prices rose rather than fell relative to the prices of other internationally traded commodities during the 1980-82 period of slack market conditions. Although the oil price in dollars was relatively stable during this period, the value of the dollar was rising sharply against other national currencies. This trend reinforced the effect of the world recession on reducing total oil consumption, thus contributing to the eventual price break observed in the oil markets. When adjusted for the changing value of the dollar, real oil prices today (about \$29 in 1983) appear comparable to their 1980 level.

It is important to recognize these developments when analyzing the current oil market. The response of world oil consumption to oil price changes will be overestimated if one uses a price measure (e.g., constant U.S. dollars) that understates the price increment globally. Since oil demand is dynamic, this demand bias can be expected to grow over time as long as this price disparity prevails.

## Introduction

In the early 1980s, soft world oil markets were accompanied by two important and unforeseen world economic developments: stagnant economic growth and an appreciating dollar. The virtual standstill in economic growth during 1980-82 was well off the 3%-plus growth path that many analysts had anticipated. This experience, coupled with large shifts in oil inventory holdings by consumers and perhaps increased consumer responses to oil prices, has led to a steady accumulation of unused productive capacity in the world oil market.

In most markets widespread excess capacity would place significant downward pressure on the price. While the oil price in dollars per barrel has increased more slowly than the U.S. inflation rate since 1980, this by itself is not indicative of falling real oil prices worldwide. A constant oil price denominated in dollars per barrel during 1980-82 could represent an increasing real cost for many countries if the appreciation of the dollar, the second important economic development, rose more rapidly than the prices of other goods and services. Under these conditions, OPEC's insistence on a relatively constant price in dollars during the 1980-82 period would represent an aggressive pricing strategy for the existing slack conditions. Moreover, this strategy could be directly linked to the sharp decline in consumption that has exacerbated the depressed oil market conditions.

For this reason, it is important to consider the effect of past appreciation of the dollar on real world oil prices. An important first step consists of documenting the trend in real crude oil prices for the 1980-82 period. These trends, which are discussed in the next section, are strikingly different from the earlier 1974-78 period reviewed by Dunkerly and Jankowski [5]. Real crude oil prices for the U.S. substantially understated

the increase in the average OECD price, which rose about 12 percent above its 1980 level during this period. The implications of these trends for oil consumption are then considered. Here, the available evidence on OECD petroleum product prices suggests that they too rose in real terms, but somewhat less than crude oil in the case of gasoline. And finally, we highlight the problem of interpreting and developing oil price forecasts in light of these recent trends.

### Real Crude Oil Prices

Supply and demand decisions in the oil market should be governed by the real private cost of oil, i.e. the value of goods and services that decision-makers yield or receive in exchange for a barrel of oil. The measurement of this concept immediately raises some problems because there are many heterogeneous goods exchanged in the world economy. The oil price might be compared with some index of producer or wholesale prices, with consumer prices, or with the price of exports. The measurement of real oil prices may be sensitive to this decision because prices are being measured at different levels and for different commodities.

One measure of real oil prices would be the ratio of the crude oil price (in dollars) to the price of exports (also in dollars). This ratio measures directly the ability of OPEC to maintain the value of its principal export relative to that of other commodities traded internationally. Moreover, when this index rises, oil-importing economies are shifting domestic production from goods used internally to exports. These economies are yielding more in the form of greater exports to purchase the same level of oil imports as before. This concept most closely approximates the direct or terms-of-trade

losses used in the analysis of world oil price increases.<sup>1</sup>

Table 1 reviews the major trends in the dollar-denominated oil price relative to export prices for different groups of countries, expressed as an index where the 1980 price = 100. Despite almost no change in the real U.S. oil price, significant increases exceeding 10 percent can be observed by 1982 (relative to 1980) for the non-OPEC countries, the industrial countries, and the seven major, OECD countries as a group. Most of this increase occurred during 1980-81 when oil price shocks of about 20% and more were observed for the four European economies.

The unit value of exports in dollars for industrial countries declined by about 4 percent in 1981, resulting in a 14 percent increase in the real price of oil measured in this way. Moreover, the decline in export prices between 1981 and 1982 was sufficiently great to prevent the real oil price from declining, even though the dollar price of oil was falling. This experience was a close approximation to that for the world excluding OPEC.<sup>2</sup>

These aggregate indices weight the experiences of the individual countries by trade volume rather than by their dependence upon imported oil. If the real oil price index for each of the seven major OECD countries is weighted by its oil imports in 1980, the 1981 real oil price for the group is 11.3% greater than its 1980 level while the 1982 price is 11.8% greater. Within this group, most of the increase can be attributed to the experiences of the four European countries.

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<sup>1</sup>The approach of using the relative prices of exports and imports is sometimes used to adjust GNP to reflect the terms of trade losses resulting from the increased cost of imports. See Denison [3].

<sup>2</sup>There may be a reason for focusing on the experience of the industrial countries. Many less developed countries (LDCs) have restrictions on foreign exchange, thereby causing prices based upon official exchange rates to underestimate the true costs of importing goods.

TABLE 1

REAL CRUDE OIL PRICE (1980=100) MEASURED RELATIVE TO  
UNIT VALUE OF EXPORTS, 1981 and 1982

	<u>1981</u>	<u>1982</u>
<u>Average Nominal Oil Price</u>	110.6	105.9
<u>Real Oil Price by Area</u>		
Non-OPEC <sup>a</sup>	114.3	114.0
Industrial Countries	115.2	115.2
Major Seven OECD <sup>b</sup>	111.3	111.8
United States	101.4	96.3
Canada	106.3	103.9
Japan	104.3	105.9
France	125.6	127.7
Germany	127.1	124.6
Italy	120.2	134.1
United Kingdom	118.9	123.2

<sup>a</sup>Calculated by removing OPEC from total world exports.

<sup>b</sup>Weighted by 1980 crude oil imports.

Source: Department of Energy [4] for the average price of international oil sales and International Monetary Fund [9] for export prices. See appendix for further information.

The quarterly trends for the non-OPEC, industrial, and major OECD countries are compared with those for the nominal and real U.S. oil prices in Figure 1. Both real and nominal oil prices generally rose through 1980 and jumped noticeably in the first quarter of 1981. While the real U.S. price declined and never returned to this level, the real price for the world maintained this higher level through 1982 with some fluctuations in intervening quarters. By the end of 1982, before the 1983 break in nominal prices, the U.S. price had returned to its level at the beginning of 1980. The real world price, however, remained substantially above this level because the price of world exports fell in dollars.

These trends have important implications for interpreting producer behavior. It would appear that until the recent price break, the price of oil remained remarkably resistant to downward pressures in the face of a worldwide recession. By maintaining the nominal dollar price of oil relatively stable, the world oil producers were actually raising that price relative to other traded goods, whether manufactured products or raw inputs. The appreciation of the dollar was escalating oil prices more rapidly than internal costs were pushing up the prices of exports in other countries.

These results contrast sharply with the 1974-78 period following the first oil shock. As Dunkerly and Jankowski [5] have documented, real crude oil prices declined in many countries, particularly in the developed ones. Increases in the nominal dollar oil price were more than offset by inflation. Moreover, this effect was reinforced in the major economies by the depreciation of the dollar relative to other major currencies.<sup>3</sup>

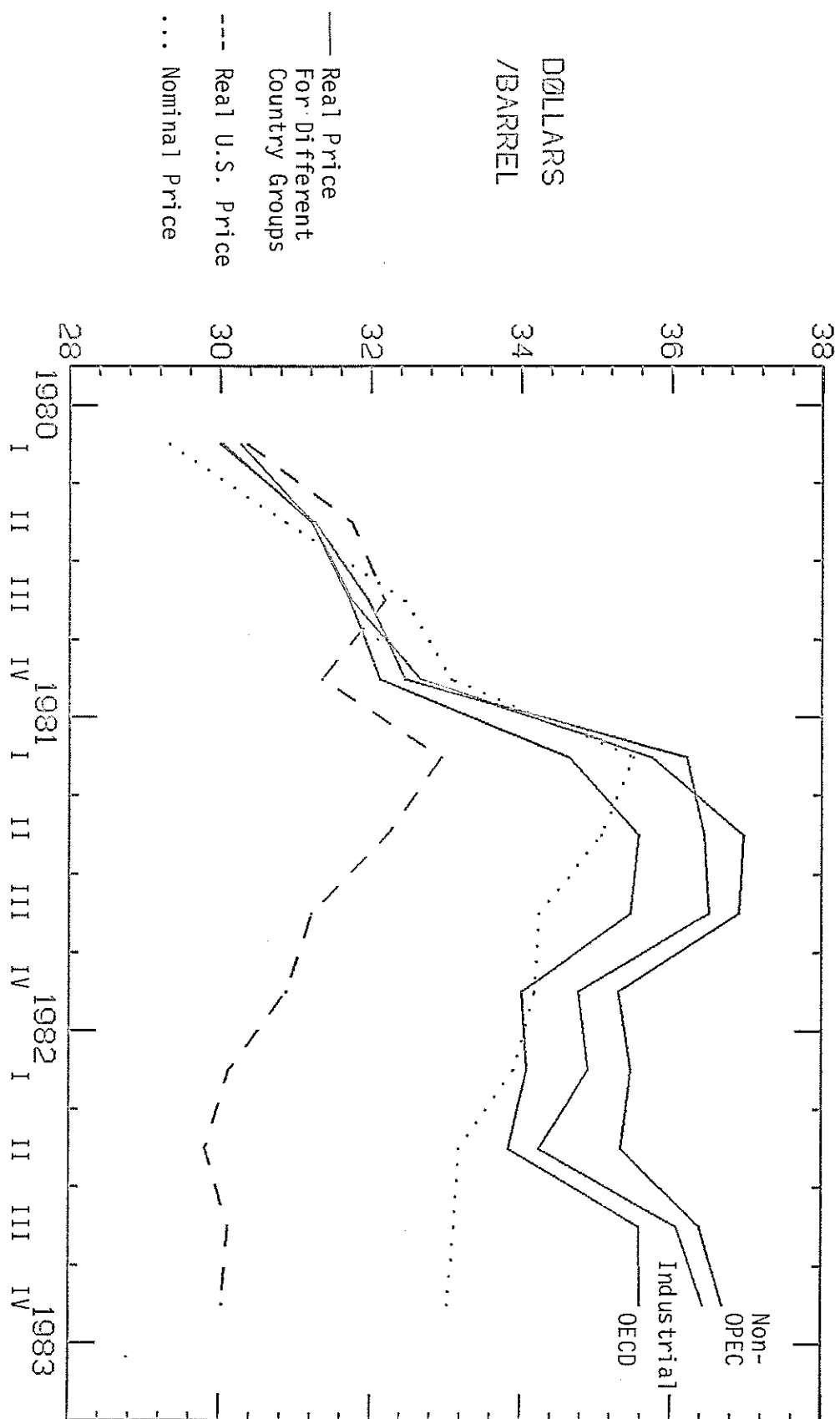
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<sup>3</sup> Although Dunkerly and Jankowski [5] use consumer prices as a deflator, similar trends can be observed for export-deflated oil prices reported by the OECD [9]. Except when the dollar experienced some appreciation in 1976, oil prices declined relative to the price of OECD exports from 1974 to 1978.



FIGURE 1

WORLD CRUDE OIL PRICES  
USING DIFFERENT DEFLATORS



Real prices are deflated by the unit value of exports (\$) where 1980 = 1.

These recent trends conflict with the popular view that world crude oil prices were weakening after 1981 in the presence of considerable excess productive capacity. OPEC was not meekly relinquishing real purchasing power on each barrel of oil during 1980-82, although it was suffering from reduced volume. Even the 1981 decontrol of domestic U.S. oil prices did not reverse this trend within the 1980-82 period under study here.

Real Petroleum Product Prices. Rowen and Weyant [11] have noted the wide variation in consumer response to the dollar-denominated crude oil price during 1972-80. The response to the second price shock appeared to be more than twice that to the first OPEC price hike. They offered several explanations for this, including the fact that the dollar was depreciating after the first shock. The results of the previous section suggest that this exchange rate problem could be an important contributor to this phenomenon.

Although this particular issue would be more appropriately addressed by analyzing petroleum product rather than crude oil prices, the former are not usually available on a timely basis. This was a problem faced by Dunkerly and Jankowski [5], who had to rely upon crude oil rather than petroleum product price trends. Recently, however, Weisman [12] has reported end-use energy prices in the major OECD countries for 1978-1982 (second quarter). From this data set, real end-use petroleum prices can be developed by first converting product prices in dollars to ones in foreign currencies and then deflating by an inflation indicator such as the rise in consumer prices. Table 2 shows the price increase between the first quarters of 1980 and 1982<sup>4</sup> for gasoline and light fuel oil in the seven OECD countries included

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<sup>4</sup>The first quarter of 1982 was the last period for which product prices were reported for France.

TABLE 2

REAL PRICES FOR GASOLINE, LIGHT HEATING  
OIL AND CRUDE OIL, FIRST QUARTER OF 1982  
(Index = 100 in 1980:1)

	<u>Gasoline</u>	<u>Light Heating Oil</u>	<u>Crude Oil</u>
United States	100.6	112.0	99.2
Canada	131.9	131.0	109.1
Japan	99.6	116.6	104.6
France	106.4	127.1	130.6
Germany	123.6	113.7	134.9
Italy	115.4	122.6	122.6
United Kingdom	105.7	113.8	120.6
7-Country Average (using crude oil imports as weights)	106.6	117.2	112.6

Sources: Product prices, Weisman [12], deflated by consumer prices and exchange rates, Council of Economic Advisors [2].

Crude oil prices, DOE [4], deflated by unit value of exports, International Monetary Fund [9].

in Table 1. These two patterns are generally representative of the other three products reported in the Weisman data set.

Both product prices followed the crude oil price experience in that they rose in real terms during the period.<sup>5</sup> Outside North America, the gasoline price index increased less than the crude oil price index. This was particularly the case in Europe, where large taxes on gasoline meant that the end-use price rose less than proportionately with crude oil prices. The light heating oil prices paid by residential and commercial sectors rose more rapidly than the crude oil price index outside Europe and generally with this price, or slightly below, within Europe. The very noticeable increase in Canadian product prices appears to reflect an internal policy to reduce the differential between world and domestic end-use prices that existed prior to 1980. Due to its small oil import volume, this Canadian experience does not significantly influence the seven-country averages reported in this table.<sup>6</sup>

Because real prices for both crude oil and petroleum products have moved for most countries in the opposite direction of that for the U.S. since 1980, conclusions about consumer behavior during this period based upon aggregate world price and consumption trends must be interpreted carefully. The rapid decline in world oil consumption has led some to ask whether consumers have become more sensitive to higher oil prices than previously was suspected. If the changing value of the dollar were not explicitly recognized, judgments about this response could be in error.

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<sup>5</sup>The crude oil and product real prices are not precisely comparable because they are deflated by different indices in order to measure different concepts. However, deflating crude oil prices by consumer prices does not appreciably alter the conclusions about the trend in real crude oil prices.

<sup>6</sup>These averages are shown to complement the crude oil price series. They are not meant to represent the average end-use price in this group of countries.

Since oil demand is dynamic, the effect of misspecifying the world oil price by a certain amount will grow over time. This can be illustrated most simply if one allows the complicated demand interactions to be represented by a Koyck distributed lag function, such as that used by Hogan[8] and Rowen and Weyant [11] for similar applications. The oil-GNP ratio is assumed to adjust partially, indicated by an adjustment parameter  $\lambda$ , to any change in oil price. If lower case letters denote logarithms, the following demand relationship can be expressed:

$$(d_t - y_t) = \alpha - \lambda\beta (p_t) + (1-\lambda) (d_{t-1} - y_{t-1})$$

where  $d$  is the oil demand,  $p$  is the real oil price,  $y$  is the world GDP in real terms, and  $\alpha$ ,  $\lambda$ , and  $\beta$  are constants, the latter being the long-run price elasticity for oil. Reflecting the recent world recession, we assume GDP to be held constant at its 1980 level,  $y_0$ , so that  $y_t = y_{t-1} = y_0$ . This allows GDP to be folded into the constant term. The incremental effect of using an oil price based upon the U.S. rather than OECD can then be written as

$$d_t - d_t^* = -\lambda\beta (p_t - p_t^*) + (1-\lambda) (d_{t-1} - d_{t-1}^*)$$

where the asterisk indicates an OECD-based oil price and its associated oil demand as distinct from ones based upon U.S. prices (which are unmarked).

Table 3 shows the implications for oil demand projections if one uses U.S.-based real oil prices rather than OECD product prices. In this analysis the latter is assumed to have risen 6 percent in real terms during 1980-82, based upon the gasoline price trends just analyzed.<sup>7</sup> The Rowen-Weyant

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<sup>7</sup>This assumption may understate the price increases for oil products, given that light fuel oil prices rose more rapidly than gasoline prices in percentage terms. In this case the demand bias would be even larger than indicated here.

TABLE 3

OIL DEMAND BIAS INTRODUCED BY USING  
U.S.-BASED RATHER THAN OECD-BASED PRICES  
(All price indices equal 100 in 1980)

	(1st Year) 1981	(2nd Year) 1982	Third Year <sup>e</sup>
Crude Oil Price	110.6	105.9	
U.S. GNP Deflator	109.4	116.0	
U.S.-Based Price ( $P_t$ ) <sup>a</sup>	101.1	91.3	
OECD-Based Price ( $P_t^*$ ) <sup>b</sup>	106.0	106.0	
Oil Demand Bias			
Percentage <sup>c</sup>	0.3	1.2	2.0
MMB/D <sup>d</sup>	0.13	0.54	.90

Notes:

<sup>a</sup>  $100 \times (\text{Crude Oil Price}/\text{U.S. deflator})$

<sup>b</sup> Assumed from discussion in text.

<sup>c</sup>  $100 \times (d_t - d_t^*)$ , where  $d_t - d_t^*$  is derived by substituting  $p_t = \log(P_t)$  and  $p_t^* = \log(P_t^*)$ .

<sup>d</sup> Assumes base oil demand level (WOCA) is 45 MMB/D.

<sup>e</sup> Only for illustrating the third year effect. Price disparity between U.S. and OECD (i.e.,  $p_t - p_t^*$ ) is assumed to remain constant between second and third year.

parameters for their high-demand-response case ( $\beta=0.8$  and  $\lambda=.075$ ) are used for this table because this reflects their best judgment of the oil demand parameters operating over the latter part of the 1970s.

After a negligible effect in 1981, this bias increases to more than 1 percent (or 0.5 MMBD) in the next year as the exchange rate effect becomes more pronounced. The third column indicates that this bias could grow to 2 percent (or about 0.9 MMBD) if the price bias ( $p-p^*$ ) remains at its 1982 level. Thus, the use of U.S.-based oil prices will be introducing an increasingly more serious bias in projecting aggregate world oil demands, unless U.S. oil prices begin to rise more rapidly than OECD oil prices (e.g., through a reversal of the exchange rate trends of the last several years).

#### The Recent Price Break

These trends not only relate to recent history but also provide a perspective for current market trends. Beginning in 1983, crude oil prices fell sharply to under \$29 per barrel. How does one relate this price to those prevailing in previous years, e.g., 1980? For U.S. consumers, this price is about \$25 per barrel in 1980 dollars, using the U.S. GNP deflator (1.16 in 1982, where 1980=1.00). Relative to the dollar price of OECD exports, however, this price more closely approximates its 1980 level. The \$29 price would be closer to \$31 (the price in 1980) when deflated by the dollar price of exports for the seven major OECD countries (.947 for 1982, where 1980=1.00).<sup>8</sup> Interestingly, much of the current price break could be explained as a readjustment in crude oil prices back towards the prices of other traded commodities.

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<sup>8</sup>The .947 can be derived implicitly from Table 1 by dividing the nominal oil price index by the real oil price index for the major seven OECD countries.

The point can be easily missed when evaluating world oil price projections reported in constant 1980 dollars. For example, consider the 1982 prices reported in the sixth Energy Modeling Forum study, World Oil [6]. Beginning in early 1980 and continuing throughout that year, a group of world oil modelers, model users and policy analysts met to study that market by comparing simulations from ten models. The group did not consider any one case as a forecast for that market but rather viewed the scenarios as a set of possible long-run price paths, given certain exogenous assumptions about economic trends, political actions, and technological developments.

The median price projection in real 1980 dollars, as reported by the ten participating modelers, was \$31 per barrel in the low-economic-growth scenario, which assumed 2.1% OECD growth per year. In the appendix, I suggest a rudimentary approach for incorporating the absence of economic growth during the 1980-82 period. If this is adopted, the median price projection becomes \$29.50 per barrel in 1980 dollars. If these prices are inflated by the U.S. inflation experience, this projection of \$34 per barrel (1982 dollars) appears too optimistic given today's market conditions. However, if supply and demand decisions are governed by the price of oil relative to the price of other traded commodities, then the OECD export price would be the more appropriate index (.947), resulting in a price projection of under \$28 per barrel.

The U.S.-based price of \$34 appears reasonable for 1982 but would have completely missed the price break in 1983. (The trend between 1982-85 is relatively flat in the EMF projections). On the other hand, the OECD-based price of \$28 undershot the actual 1982 price but would have anticipated the lower 1983 price. If the latter set of projections were to be used for evaluating oil market conditions, the OPEC pricing strategy before 1983 would



have been judged as too aggressive for the longer-run market balance conditions captured by the models. A price break would have been expected in order to realign oil prices with those for other traded commodities.

Quantitatively, the bias introduced by an appreciating dollar is not a trivial or second-order effect. Without an adjustment for either effect, the \$31 price in the EMF projections would be \$36 per barrel ( $\$31 \times 1.16$ ) in constant 1982 dollars using the U.S. index. The recession effect lowers this to \$34 per barrel ( $\$29.50 \times 1.16$ ), while the OECD deflator reduces it still further to \$28 per barrel ( $\$29.50 \times .947$ ). Thus, about three-fourths of the \$8 difference can be attributed to the decline in OECD export prices relative to the value of the dollar. Clearly, a different analytical framework might lead to a more pronounced recession effect, but this analysis does suggest the importance of the problem of measuring prices.

Having introduced projections into the discussion, it appears only appropriate to close with a caveat about oil forecasting. Projecting short-run oil market prices and balances over the next few years will be difficult enough without having to assume the treacherous task of forecasting foreign exchange rate movements as well. The world economy is most likely in the midst of new swings in currency valuations, the direction of which may be highly uncertain. Although world oil analysts should not be expected to predict such movements, they should be prepared to incorporate them exogenously in the same manner that world economic growth is included in these analyses, particularly for evaluating oil market trends in the 1980s.

In particular, suppose the 1980-82 period should be reversed over the next several years. With the prices of goods in other countries (in dollars) increasing more rapidly than those in the U.S., real oil prices for these countries would be rising less (or declining more) than for the U.S. World

oil demand would be stronger than that predicted on the basis of U.S. prices alone. The oil glut would be mitigated more quickly than otherwise, with upward pressures on the dollar-denominated price of oil appearing sooner. In this way, the persistence of current slack conditions will be contingent upon both world economic growth and exchange rate movements versus the dollar.

## APPENDIX

### Data For Constructing Oil Price Indices

The real crude oil prices in Table 1 of the text were calculated by dividing the nominal oil price in dollars by the unit value of exports in dollars. The latter are reported in Table A.1 for the different country groups and major OECD countries.

Real product prices in Table 2 of the text were based upon the change in oil product prices, consumer prices, and exchange rates between the first quarters of 1980 and 1982. Indices were first constructed for each concept, where 1980:1 (first quarter) = 1.00. These are reported in Table A.2 for the seven major OECD nations. The gasoline and heating oil prices were then multiplied by 100 and divided by the product of the indices for exchange rates and consumer prices to obtain real prices.

All real oil prices reported in the text were calculated using indices for nominal oil prices, exchange rates and consumer prices that were not rounded off.

### The Recession Adjustment

The EMF projections discussed in the text were adjusted to incorporate the effects of the 1980-82 recession. This was based upon an elasticity relating the levels of the oil price and economic activity from the reference and low economic growth scenarios. This assumes that the world oil supply and demand quantities can be represented in the aggregate as log-linear functions of price and (in the case of demand) economic activity. This

TABLE A.1

UNIT VALUE OF EXPORTS IN U.S. DOLLARS  
(1980=100)

<u>Area</u>	<u>1981</u>	<u>1982</u>
Non-OPEC Countries	96.7	93.0
Industrial Countries	96	92
Major Seven OECD Countries <sup>a</sup>	99.3	94.7
United States	109	110
Canada	104	102
Japan	106	100
France	88	83
Germany	87	85
Italy	92	79
United Kingdom	93	86

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<sup>a</sup> Each country's price was weighted by its crude oil imports.

Source: International Monetary Fund [9]

Table A.2

INDICES FOR GASOLINE, HEATING OIL, AND  
 CONSUMER PRICES AND FOR EXCHANGE RATES, FIRST QUARTER OF 1982  
 (1980:1 = 1.00)

<u>Country</u>	<u>Price (U.S. Dollars) of:</u>		<u>Consumer Prices</u>	<u>Exchange Rate \$ Per Unit of Foreign Currency</u>
	<u>Gasoline</u>	<u>Light Heating Oil</u>		
United States	1.204	1.341	1.197	1.000
Canada	1.685	1.673	1.251	1.021 <sup>a</sup>
Japan	1.141	1.336	1.099	1.043 <sup>a</sup>
France	0.945	1.129	1.284	0.692
Germany	1.043	0.960	1.117	0.756
Italy	1.057	1.124	1.402	0.654
United Kingdom	1.085	1.168	1.253	0.820

<sup>a</sup>This trend runs counter to the annual one for 1980-82 that shows the Canadian dollar depreciating by about 5 percent and the Japanese yen by about 9 percent relative to the U.S. dollar.

appears to be an appropriate representation, given the discussion in Braden [1]. For any year, the elasticity can be calculated as:

$$b = \ln (P_1/P_r) / \ln (Y_1/Y_r),$$

where  $P$  is the oil price,  $Y$  is the GNP level, and the subscripts,  $l$  and  $r$ , refer to the low growth and reference scenarios, respectively. For example, from the Energy Modeling Forum [6,7],  $P_l = \$31$ , and  $P_r = \$32$  for 1982.\* In addition,  $Y_l = (1.021)^2 Y_0 = 1.042 Y_0$ , and  $Y_r = (1.032)^2 Y_0 = 1.065 Y_0$  for the same year, where  $Y_0$  represents the 1980 GNP level. These values yield the result,  $b = 1.45$ .

The next step is to estimate the actual 1982 GNP level and substitute that value for  $Y_r$  in Equation 1 to calculate a new  $P_r$ , given  $b = 1.45$ . This represents a new revised oil price in 1982 that is consistent with the lower GNP path in the world economy today. Table A.3 reviews the actual OECD growth rates experienced between 1980 and 1982 for the major groups within the OECD. By 1982, OECD economic activity was only 0.8% greater than its 1980 level ( $Y_a = (1.012) (.996) Y_0 = 1.008 Y_0$ ). On the basis of this calculation, the recession-adjusted real price becomes \$29.50 in 1980 dollars.

\* In the EMF report and supporting paper, the prices appear in 1981 dollars, having been inflated from 1980 dollars by the U.S. GNP deflator. We have converted them back to 1980 dollars for reasons that are obvious from the discussion in the text.

Table A.3

## ACTUAL ECONOMIC GROWTH RATES, 1980-82

<u>Area</u>	<u>1980 GNP(\$B)</u>	<u>Actual</u>	
		<u>GNP Growth Rate (%)</u>	
		<u>1981</u>	<u>1982</u>
U.S.	2626	2.0	-1.8
Canada	246	3.0	-5.0
Japan	1098	2.9	2.5
Europe	2740	-0.4	0.3
OECD Total	7553	1.2	-0.4

Sources: Council of Economic Advisors [2, 1982: P. 355 and 1983: P. 285].

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