ECONOMIC RESEARCH REPORTS

THE IMPERFECT PRICE-REVERSIBILITY OF WORLD OIL DEMAND

BY

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RR # 92-21 **May, 1992**

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Abstract:

This paper analyzes the imperfect price-reversibility ("hysteresis") of oil demand in the OECD and LDC.

The oil demand reductions following the oil price increases of the 1970's will not be completely reversed by the price cuts of the 1980's. The response to price cuts in the 1980's is perhaps only one-fifth that for price increases in the 1970's. This has dramatic implications for projections of oil demand, especially under low-price assumptions.

We also consider the demand effects of a price recovery in the 1990's (due either to OPEC or to a carbon tax), specifically whether the effects would be as large as for the price increases of the 1970's or only as large as the smaller demand reversals of the 1980's. On this the results are inconclusive.

Finally, we demonstrate the implications of wrongly assuming that demand is perfectly price-reversible. Such an assumption will grossly overestimate the demand response to price declines of the 1980's, and it will underestimate the effect of income growth on future demand. Moreover, it will inevitably mischaracterize the demand response to a price recovery.

Keywords: oil demand; price reversibility; asymmetry; hysteresis
Journal of Economic Literature classification number: Q41

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The author is grateful for research support from the C. V. Starr Center for Applied Economics of New York University. He is grateful to Wei Zheng for excellent research assistance, to Ken Rogoza for technical assistance, and to Joyce Dargay, William Hogan, Alan Manne and Malcolm Shealy for comments on an earlier paper. Of course, none of the above are responsible for any remaining errors.

1. Introduction

Oil demand analysts are challenged by the path of world oil prices since the 1973-74 and 1979-80 price shocks. Prices in the 1980's have declined sharply, returning almost to pre-1973 levels; see Figure 1. The price declines raise at least two questions regarding the price-reversibility of oil demand. First, will the demand reductions caused by the price increases of the 1970's be reversed by the price declines of the 1980's? Second, if price recovers in the 1990's, will demand decline by as much as it did in the 1970's, or will it only reverse the slight demand increase of the 1980's?

Figure 1. International Price of Crude Oil, 1960-90 (1982 $ / barrel)

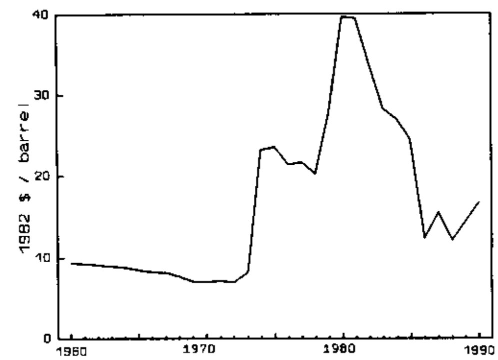

Figure 2. Oil Demand, 1960-89 (in MBD)

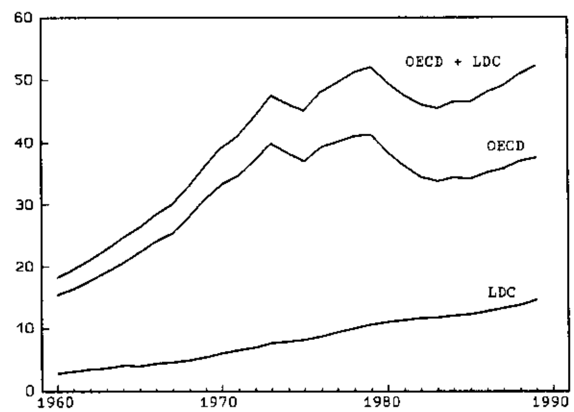

Figure 2 shows oil demand, in million barrels per day (MBD), for the industrialized (OECD) countries and for the Less Developed Countries (LDC: Market Economies only, which excludes former Centrally Planned Economies). As we shall see in the econometric analysis below, the answer to our first question is that only a small part of the demand reductions following the price increases of the 1970's will be reversed by the price declines of the 1980's. The answer to the second question is not yet conclusive.

The sources of price-irreversibility of energy demand are twofold: the durability of capital-stock improvements, and the irreversibility of improved technological knowledge. First is the durability of energy-efficiency improvements in the capital stock that were made in response to the price increases of the 1970's, including both new capital and the improved energy efficiency of existing capital. For neither of these will the increased energy efficiency be reversed by the drop in oil prices. Attic insulation, once installed, will not be undone.

The second source is the irreversibility of improvements in technological knowledge. Oil price increases of the 1970's spurred a huge increase in research and development in energy conservation technologies. Using automobiles as an example, there were major technological advances in aerodynamic design and the possibilities for materials substitution. Once this technological knowledge had been achieved, it was not lost when oil prices collapsed. Automobile fuel-efficiency will not return to its pre-1973 levels.

The outline of this paper is as follows. In Section 2 we describe a method of analyzing imperfectly price-reversible demand. This is based upon a decomposition of price changes into three types: increases in maximum historical price, price cuts, and price recoveries (sub-maximum increases). This method is applied in Section 3, in which we analyze econometrically oil demand data for the OECD and LDC for the 1960-89 period, using three different specifications of imperfect price-reversibility, as well as the conventional assumption of perfect price-reversibility .

In Section 4 we describe the effects upon demand projections of wrongly assuming that oil demand is perfectly price-reversible. Most important is the fact that reversibility implies that rapid demand growth would follow the oil price collapse of the mid-1980's. But what has happened to demand since the 1986 oil price collapse can only be described as very modest growth. The second error caused perfect price-reversibility is that it grossly mischaracterizes the sources of future demand growth. It attributes far too much growth to the lagged response to the price collapse of the 1980's, and it attributes far too little demand growth to the effects of future income growth.

2. The Analysis of Imperfectly Price-Reversible Demand

If oil demand were perfectly price-reversible, then demand would respond to all types of price change in similar ways. A demand reduction caused by a price increase would be exactly reversed if price were to decline to its original level: demand also would return to its original level. Moreover, if price were to recover subsequently to its previous maximum level, the demand reduction would be the same as when price increased initially.

However, if demand were not perfectly price-reversible, then the oil demand reduction following a price increase would not be completely reversed when price fell. For example, if oil price increases resulted in better insulated attics and reduced oil demand, we would not expect that an oil price decline would cause insulation to be removed and oil demand to increase. Nor would it necessarily be true that the demand response to a price recovery would be the same as to the original price increase. Attic insulation would not be re-done because it had not been un-done.

Previous work on irreversibility in economic relationships has proceeded along several lines. The first work was done on the price-reversibility of agricultural supply, by Wolffram(1971) and by Traill, Colman, and Young(1978). Analysis of the price-reversibility of energy and oil demand has utilized this approach[1], which is used below.

Subsequent work has been done in other areas of economics, adopting the physics term *hysteresis*: an effect that persists even after the factor that caused it has been removed. Much of this work is based upon the irreversible, sunk-cost nature of investment. Applications have appeared in international economics and in macroeconomics. But this literature made no reference to the previous work on the price-reversibility of agricultural supply. Nor did it utilize the econometric techniques which were proposed there; equations were only examined for structural breaks at the time of the price decline.

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[1] The initial studies estimated demand-elasticities with respect to price and income, and the dynamics of the long-run adjustment; see Pindyck(1979) and Hogan(1986), among others. But after the oil price collapse of 1986, economists began to address the question of whether the demand reductions might be reversed: see Gately & Rappoport(1988), Brown & Phillips(1991), Shealy(1990), and Dargay(1990a,1990b).

2.1 Decomposing Price into 3 Monotonic Series

In order to distinguish between the three possibly different responses to the three different types of price change, let us decompose the price P_t into its three component series, each of which is monotonic: maximum historical price $P_{max,t}$ (positive and non-decreasing), the cumulating series of price cuts $P_{cut,t}$ (non-positive and non-increasing), and the cumulating series of price recoveries $P_{rec,t}$ (non-negative and non-decreasing):

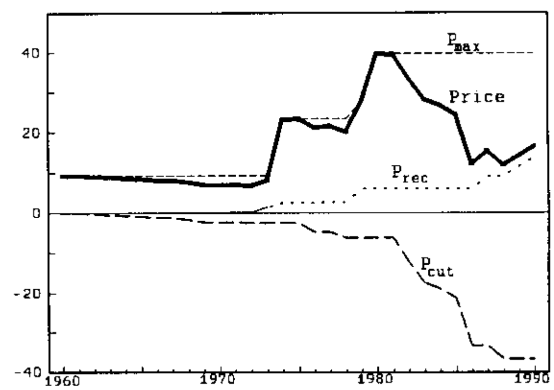
(1) $P_t = P_{max,t} + P_{cut,t} + P_{rec,t}$

(1a) $P_{max,t} \equiv \max(P_0,\ldots,P_t)$

(1b) $P_{cut,t} \equiv \Sigma^t_{i=0} \min\{0, (P_{max,i-1}-P_{i-1})-(P_{max,i}-P_i)\}$

(1c) $P_{rec,t} \equiv \Sigma^t_{i=0} \max\{0, (P_{max,i-1}-P_{i-1})-(P_{max,i}-P_i)\}$

Figure 3. Decomposing Price into 3 Series



The graph at right shows the real oil price (from Figure 1), together with its three-way decomposition. We see the jump in P_{max} in 1973-74 and 1979-80; it is always positive and non-decreasing. The cumulating series of price cuts, P_{cut}, is negative and non-increasing; it shows the dramatic price declines of the 1980's. Also shown is the cumulating series of price recoveries, P_{rec}, which is positive and non-decreasing; but such price increases are relatively few, and small.

2.2 Demand, with or without Perfect Reversibility

Given this decomposition of price, we can now deal explicitly with different types of price-irreversibility. Suppose we have a simple linear demand equation, with no lagged adjustment to changes in price, and no other explanatory variables. If demand were perfectly price-reversible, then we would have the equation:

(2) $D_t = k_0 - k_1 P_t$

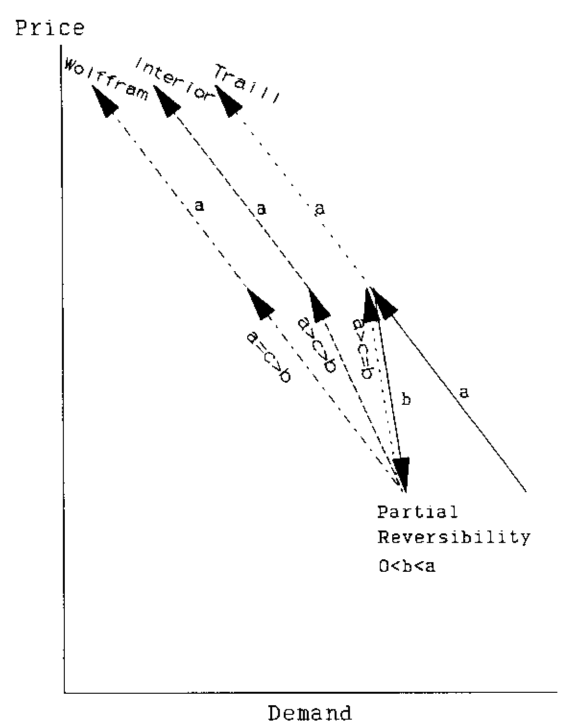
To allow for imperfect price-reversibility, we substitute the price decomposition (1) into (2):

(3) $D_t = k_0 - aP_{max,t} - bP_{cut,t} - cP_{rec,t}$

We expect that the response to a price cut would be smaller than to an increase in P_{max}: $a > b$. We also expect that the response to an increase in P_{max} ought to exceed the response to a price recovery: $a > c$. Finally, we expect that the response to a price recovery ought to be no smaller than to a price cut: $c > b$; that is, the net effect of letting price collapse and then recover cannot be to *raise* demand -- demand would either decrease or be unchanged. Thus, in the most general case, we expect the size of these coefficients to be as follows: $a \geq c \geq b \geq 0$.

This approach has its origins in the literature on irreversible agricultural supply, in which the irreversibility results from asset fixity and the divergence between the acquisition cost of an input and its salvage value. Wolffram(1971) first proposed a specification in which irreversibility was possible. Using our notation, he assumed $a = c > b$. That is, he assumed that the response to an increase in P_{max} would be greater than to a price cut ($a > b$). But he also assumed that the response to a price recovery would be as large as it would be to an increase in P_{max} ($c = a$).

Figure 4. Coefficients $a \geq c \geq b \geq 0$ & types of price-irreversibility



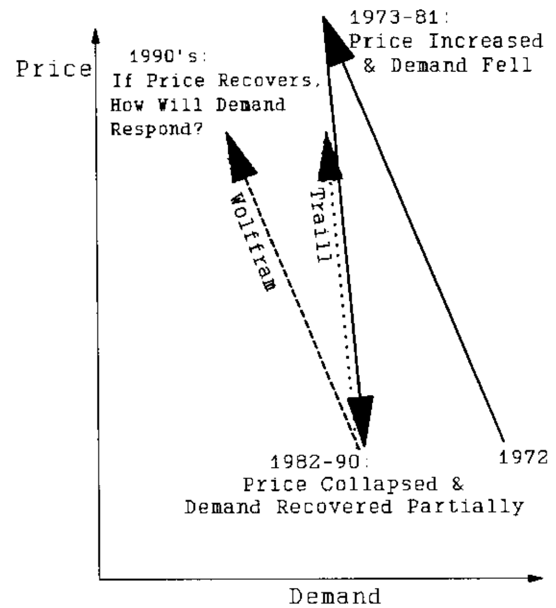
Traill *et al.*(1978) modified Wolffram's approach. They assumed that the response to an increase in P_{max} would exceed that of a price recovery ($a > c$). But they also assumed that the response to a price recovery would be equal to the response to a price cut ($c = b$), which precludes the possibility of ratchets.

Our approach in this paper allows for all of these as special cases, since we can provide estimates for all three coefficients of the price-decomposed series. In particular, we allow for the intermediate case in which $a > c > b$. In the graph, this case lies between those of Wolffram and of Traill. Unlike Wolffram, we do not necessarily assume the same response to all price increases. Unlike Traill, we do not necessarily assume that the response to a price cut will match the response to a price recovery.

A full taxonomy of all the possible types of imperfect price-reversibility is provided in Gately(1991), and this approach is used there to analyze US gasoline demand. Previous work in energy demand has used various of these specifications. A specification equivalent to Wolffram's was used in Gately & Rappoport(1988), and in Brown & Phillips(1991); used as regressors were both P_t and $(P_{max,t}+P_{rec,t})$. A Traill-equivalent specification has been used in Gately(1990) and in Shealy(1990); the regressors include both P_t and $P_{max,t}$. Dargay(1990a), which had an especially clear discussion of the issues involved, examined several of the specifications.

At the risk of getting ahead of our story, let us present graphically -- in a greatly simplified form -- what has happened since the price increases of the 1970's, and what we might expect in the 1990's if price were to be increased. With respect to our first question, of whether the price collapse of the 1980's would reverse the demand reductions that followed price increases of the 1970's, the answer is no. The demand response to the price cuts has been much smaller than for the price increases: only about one-fifth of the demand reductions will be reversed.

Figure 5. Oil Demand Responses to Price Increase, Decrease, & Recovery: 1972-2000



Our second question, which amounts to a choice between the Wolffram and the Traill specification of irreversibility, is whether a price recovery in the 1990's would reduce demand by as much as the price increases of the 1970's (Wolffram), or only by as much as the partial demand reversal when price collapsed (Traill). On this question, unfortunately, the evidence is inconclusive.

Wolffram-irreversibility yields the best outcome for consumers, and the worst outcome for OPEC. Demand falls when price rises to new historical levels. But when price falls, the demand reductions are not fully reversed; demand does not recover completely. Yet when price recovers, demand falls again, by as much as it did originally. Thus, demand is ratcheted down: reduced when price increases, but not increased when price falls, and reduced again when price recovers.

For Traill-irreversibility, the message is mixed. Demand fell when price jumped in the 1970's, and did not recover completely when price fell in the 1980's. However, a price recovery in the 1990's will not reduce demand by much at all: it will exactly reverse the small reversal of demand caused by the price cuts of the 1980's. Demand did not surge when price collapsed, so neither can it fall by much when price recovers.

3. Econometric Results for OECD & LDC Oil Demand, 1960-89

In the econometric results which follow, we estimate log-linear, partial-adjustment demand equations for the OECD & LDC regions separately, using four alternative specifications. The first is the perfectly price-reversible specification, in which all price changes have the same size of effect, in absolute value.

(4.1) Perfectly Price-Reversible

$$D_t = k_0 + k_1 GNP_t + k_2 P_t + k_3 D_{t-1} .$$

The next three are variants of imperfectly price-reversible specifications. The most general case, in which the three types of price change can have different effects:

(4.2) Imperfectly Price-Reversible

$$D_t = k_0 + k_1 GNP_t + a\, P_{max,t} + b\, P_{cut,t} + c\, P_{rec,t} + k_3 D_{t-1} .$$

Next is the Wolffram case in which the response differs between price cuts and price increases, but not between the two types of price increases (increases in P_{max} and price recoveries):

(4.3) Wolffram: Imperfectly Price-Reversible ("Wolffram Irreversible")

$$D_t = k_0 + k_1 GNP_t + a\, (P_{max,t} + P_{rec,t}) + b\, P_{cut,t} + k_3 D_{t-1} .$$

Finally, the Traill case in which increases in P_{max} have different effects from sub-maximum price changes (price cuts and price recoveries, whose effects are themselves equal in absolute value):

(4.4) Traill: Imperfectly Price-Reversible ("Traill Irreversible")

$$D_t = k_0 + k_1 GNP_t + a\, P_{max,t} + b\, (P_{cut,t} + P_{rec,t}) + k_3 D_{t-1}.$$

The results are presented in Tables 1 and 2, for the OECD and LDC respectively, using data from the 1960-89 period. In general, the results are better for the OECD. All the coefficients in Table 1 have the expected signs. However, income is not statistically significant in any of the four specifications, and in the three Irreversible cases the only statistically significant price coefficient is for P_{max}.

The LDC coefficients in Table 2 have the expected signs, except for the price coefficients in the Irreversible specifications other than P_{max} but these are not statistically significant. Unlike the OECD however, income is statistically significant for all specifications but the Perfectly Reversible case.

Within Tables 1 & 2 respectively, the most noticeable difference between the Reversible and the three Irreversible specifications are the Chow forecast test probabilities. Using break-point years of 1984 or 1985 or 1986, estimates based on pre-break-point data provide dramatically better forecasts of post-break-point data for the three Irreversible cases than for the Reversible case.

Table 1. OECD Oil Demand; data sample 1960-89; data in logarithms.

(4.1) Perfectly Price-Reversible:

$$D_t = k_0 + k_1 GNP_t + k_2 P_t + k_3 D_{t-1}$$

(4.2) Imperfectly Price-Reversible:

$$D_t = k_0 + k_1 GNP_t + a\ P_{max,t} + b\ P_{cut,t} + c\ P_{rec,t} + k_3 D_{t-1}$$

(4.3) Wolffram: Imperfectly Price-Reversible ("Wolffram Irreversible"):

$$D_t = k_0 + k_1 GNP_t + a\ (P_{max,t} + P_{rec,t}) + b\ P_{cut,t} + k_3 D_{t-1}$$

(4.4) Traill: Imperfectly Price-Reversible ("Traill Irreversible"):

$$D_t = k_0 + k_1 GNP_t + a\ P_{max,t} + b\ (P_{cut,t} + P_{rec,t}) + k_3 D_{t-1}$$

	Perfectly Price-Reversible	Imperfectly Price-Reversible			Wolffram: Imperfectly Price-Reversible		Traill: Imperfectly Price-Reversible	
constant	.28	-.18 (t=-.7)			-.17 (t=-.6)		-.10 (t=-.4)	
GNP	.002 (t=.07)	.21 (t=1.7)			.19 (t=1.7)		.18 (t=1.6)	
lagged demand	.97	.88			.89		.89	
	P	P_{max}	P_{cut}	P_{rec}	P_{max} & P_{rec}	P_{cut}	P_{max}	P_{cut} & P_{rec}
Price	-.066	-.092	-.017 (t=-.6)	-.053 (t=-.8)	-.082	-.025 (t=-1.)	-.099	-.017 (t=-.6)
Adjusted R^2	.9928	.9931			.9933		.9933	
F-statistic	1285	805			1041		1034	
Probabilities, Chow Forecast Test 1984	.76	.96			.98		.94	
1985	.70	.96			.99		.94	
1986	.69	.98			.99		.95	

Notes: The t-statistic is shown only when coefficient is not statistically significant.
All variable coefficients have the expected signs.
For each equation, the hypothesis of no autocorrelation could not be rejected by Lagrange multiplier (Breusch-Godfrey) tests.

Table 2. LDC Oil Demand; data sample 1960-89; data in logarithms.

(4.1) Perfectly Price-Reversible:

$D_t = k_0 + k_1 GNP_t + k_2 P_t + k_3 D_{t-1}$

(4.2) Imperfectly Price-Reversible:

$D_t = k_0 + k_1 GNP_t + a\ P_{max,t} + b\ P_{cut,t} + c\ P_{rec,t} + k_3 D_{t-1}$

(4.3) Wolffram: Imperfectly Price-Reversible ("Wolffram Irreversible"):

$D_t = k_0 + k_1 GNP_t + a\ (P_{max,t} + P_{rec,t}) + b\ P_{cut,t} + k_3 D_{t-1}$

(4.4) Traill: Imperfectly Price-Reversible ("Traill Irreversible"):

$D_t = k_0 + k_1 GNP_t + a\ P_{max,t} + b\ (P_{cut,t} + P_{rec,t}) + k_3 D_{t-1}$

	Perfectly Price-Reversible	Imperfectly Price-Reversible			Wolffram: Imperfectly Price-Reversible		Traill: Imperfectly Price-Reversible	
constant	-.8 (t=-1.6)	-1.4			-1.5		-1.49	
GNP	.38 (t=1.9)	.64			.65		.66	
lagged demand	.65	.49			.48		.47	
	P	P_{max}	P_{cut}	P_{rec}	P_{max} & P_{rec}	P_{cut}	P_{max}	P_{cut} & P_{rec}
Price	-.01 (t=-.8)	-.049	*.033* (t=1.7)	*.059* (t=.9)	-.025 (t=-1.9)	*.02* (t=1.2)	-.042	*.03* (t=1.7)
Adjusted R^2	.9974	.9979			.9978		.9979	
F-statistic	3581	2635			3199		3407	
Probabilities, Chow Forecast Test 1984	.31	.86			.86		.93	
1985	.27	.81			.79		.87	
1986	.55	.93			.87		.93	

Notes: The t-statistic is shown only when coefficient is not statistically significant.
variable coefficients with wrong sign are italicized.
For each equation, the hypothesis of no autocorrelation could not be rejected by Lagrange multiplier (Breusch-Godfrey) tests.

3.1 Coefficient sensitivity to different ending years of the data sample, 1984-89

In order to understand the differences across specifications in Chow-forecast-test performance, it is useful to examine the effect on each equation's coefficients of successively including additional years of the data sample, from 1984 through 1989. Including these years of low prices but only modest demand growth (with moderate income growth) has a dramatic effect on the coefficients of the Perfectly Price-Reversible specification, but relatively little effect for any of the Imperfectly Reversible specifications. Graphs for each of the four specifications are shown first for the OECD (Figures 6-9) and then for the LDC (Figures 10-13).

Consider first the effect on the OECD demand coefficients. In the Perfectly Reversible case, the inclusion of the additional years of the 1984-89 period reduces the income coefficient dramatically, and the price coefficient slightly. During these years, neither income growth nor low prices was able to stimulate demand very much; hence the estimated coefficients become smaller.

3.1.a OECD Oil Demand:

Coefficient sensitivity to different ending years of the data sample, 1984-89

Figure 6. Perfectly Price-Reversible

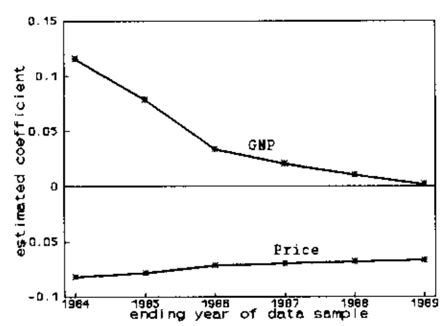


Figure 7. Imperfectly Price-Reversible

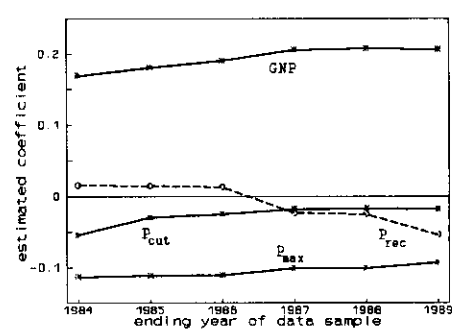


Figure 8. Wolffram Irreversible

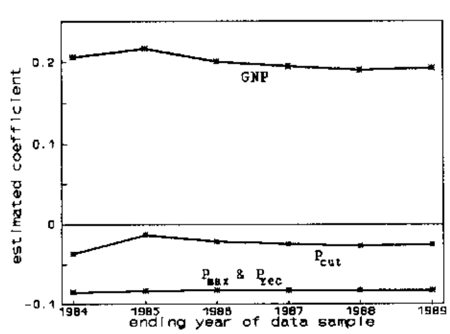
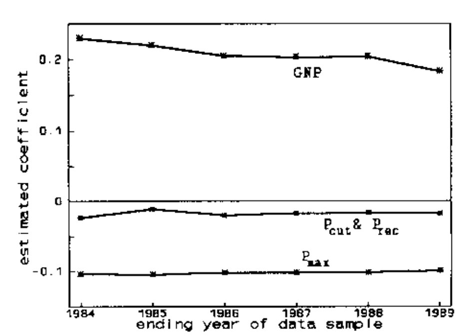


Figure 9. Traill Irreversible



In contrast, the OECD's three Imperfectly Reversible cases are little affected when the additional years are added. Only the coefficient for P_{rec} changes very much. But this is not surprising, given that P_{rec} had varied so little prior to 1984, so that early estimates were never statistically significant and sometimes had the wrong (positive) sign.

3.1.b LDC Oil Demand:

Coefficient sensitivity to different ending years of the data sample, 1984-89

Figure 10. Perfectly Price-Reversible

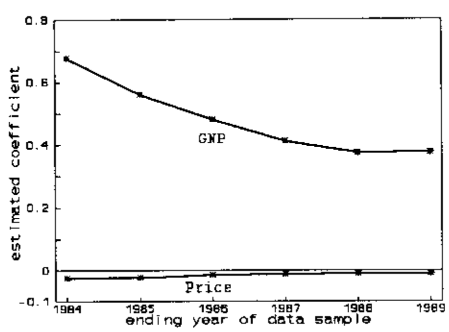


Figure 11. Imperfectly Price-Reversible

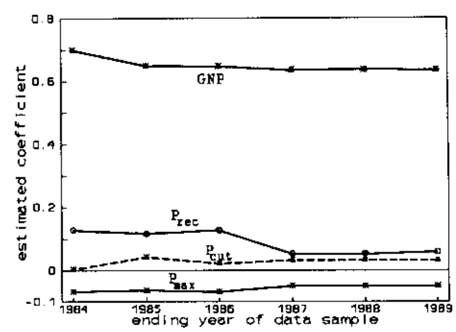


Figure 12. Wolffram Irreversible

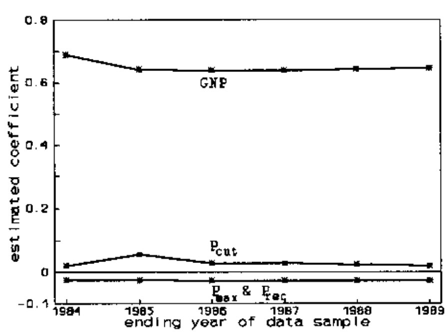
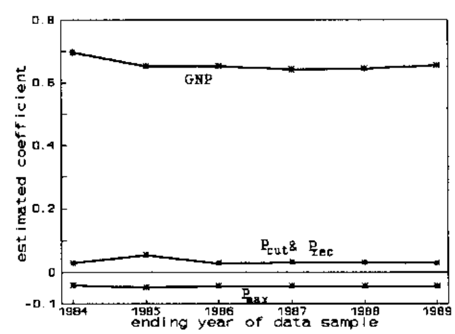


Figure 13. Traill Irreversible



The coefficient sensitivity results for the LDC are similar to those of the OECD. However, in each of the three Imperfectly Reversible specifications, only the P_{max} coefficient has the expected sign; the other price coefficients have the wrong sign (but are statistically insignificant). For this reason, in the next section's examination of alternate specifications' respective demand projections, we shall examine only projections for the OECD.

4. Errors resulting from incorrectly assuming perfect price-reversibility

4.1 If projections had been done in 1985:

perfectly price-reversible demand overprojects the modest 1986-89 demand growth.

The obvious implication of assuming perfect price-reversibility is that it overstates the demand response to a price collapse. If econometric analysis had been done in 1985 (prior to the 1986 oil price collapse), then demand projections for 1986-89 would have greatly overestimated the modest demand growth which actually occurred. Given the price collapse of 1986, perfect price-reversibility would have implied a relatively large demand increase in the late 1980's (reversing the demand reductions following the price increases). But such projections would have greatly overstated the modest demand growth which actually occurred in 1986-89.

For each of the four demand specifications, OECD demand projections for 1986-2000 are shown in Figure 14, together with the actual demand levels for 1985-89. This graph also decomposes the total demand growth into two effects, the Initial Momentum Effect and the Income Effect[2].

1) The Initial Momentum Effect shows the projected demand growth that would occur if we assume that there was *zero* income growth during 1986-2000, and that oil price remained constant at the level of the 1986 collapse, from 1986-2000. This effect measures the demand-increasing influence of the 1981-86 price declines, which continue through the 1990's (and beyond).

2) The Income Effect shows the additional demand growth that would occur if we assumed actual income growth rates for 1986-89 and 2.5% for 1990-2000, with the same price assumptions as above.

We see that the Reversible specification projects much more rapid demand growth than the three Irreversible specifications. OECD demand is projected to more than double between 1985 and 2000. Moreover, most of the projected demand growth consists of the Initial Momentum Effect, the delayed demand growth in response to the price declines of 1981-86: 30 MBD by 2000, and still climbing. In contrast to the modest demand growth of 3.3 MBD which actually occurred in 1985-89, the Reversible specification projects three times as much growth, 10 MBD.

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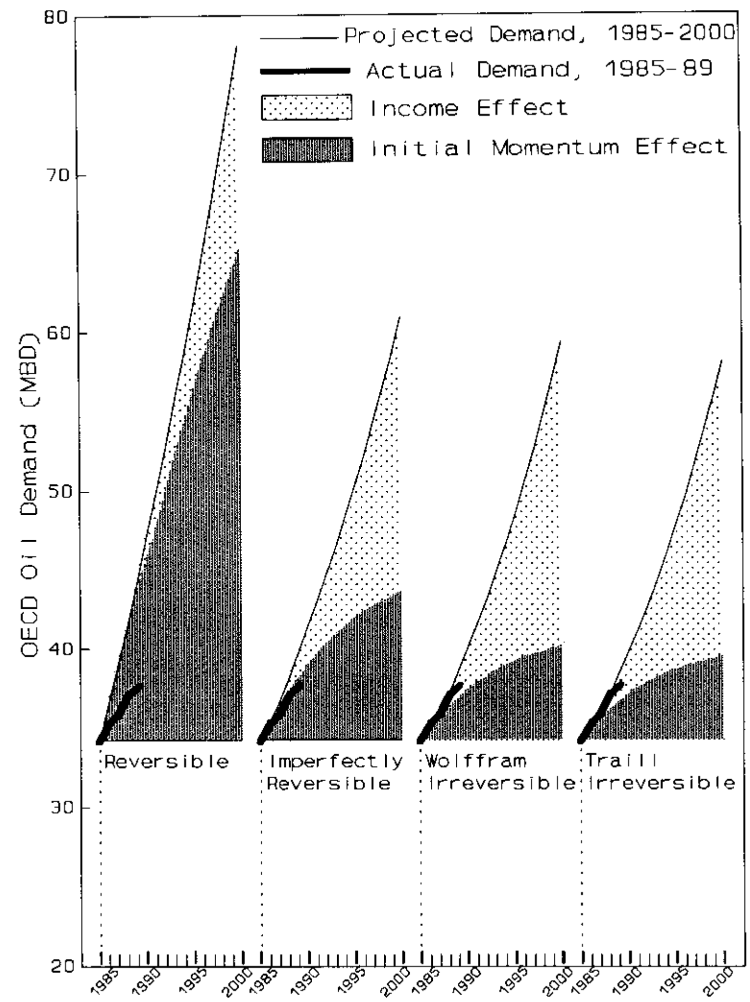
[2] This decomposition of the demand growth follows that adopted by the Energy Modeling Forum (1991).

Figure 14. OECD Oil Demand Projections 1986-2000, with Price Constant



For the three Irreversible specifications, OECD demand is projected to grow much less rapidly than for the Reversible case. And the cause of the demand growth is due more to income growth than to the lagged adjustment to past price declines. The actual demand growth of 1986-89 is better tracked by these three Irreversible specifications, and especially by the Wolffram and Traill specifications.

4.2 If projections were done in 1989:

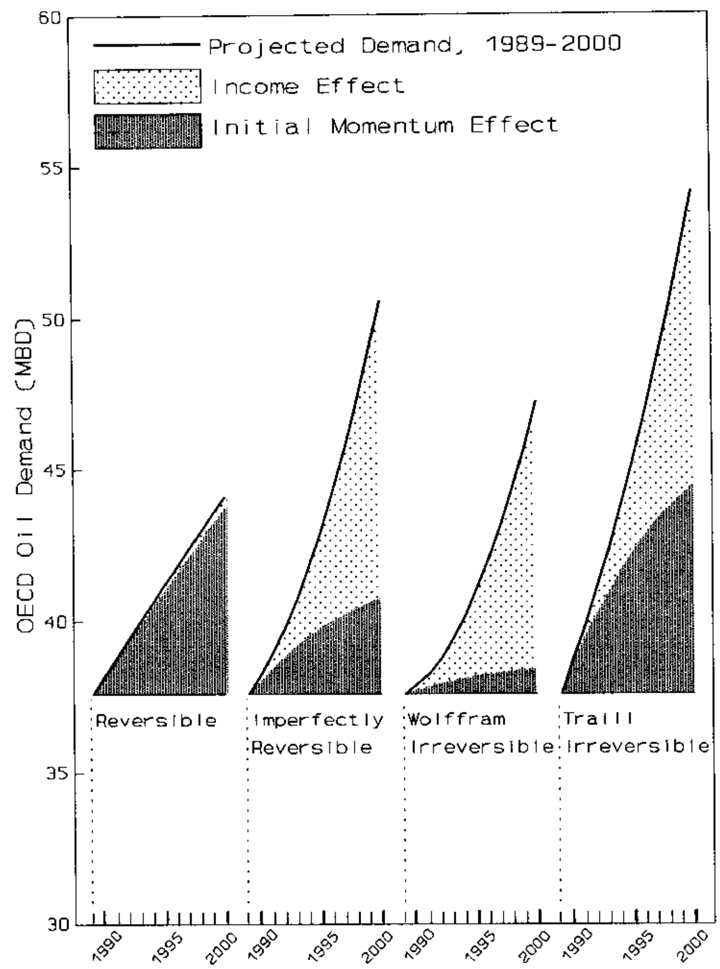
perfectly price-reversible demand underestimates demand growth in the 1990's

Next we consider the less obvious, and somewhat paradoxical implication of assuming perfect price-reversibility. If the data period used for econometric estimation were extended through 1989, then demand projections for the 1990's could be too low, rather than too high, as they would have been if done in 1985. This follows from the effect upon the estimated income and price elasticities of including the years 1985-89. As we saw in Figure 6, because 1986-89 were years of low prices, moderate income growth, and low demand growth, their inclusion in the data sample will reduce not only the estimated *price* elasticity but also the estimated *income* elasticity. The latter effect will greatly reduce projected demand growth in the 1990's.

Figure 15 shows demand projections for 1989-2000, for each of the four specifications. Note the Reversible specification's dramatic revision of projected demand growth in the 1990's, from the highest projection in Figure 14 to the lowest in Figure 15.

As in Figure 14, there are important differences in the decomposition of demand growth for the different specifications. For the Reversible case, virtually all the demand growth comes from the Initial Momentum Effect, whereas the Income Effect is more important for the three Irreversible cases. Less obvious, but important for an understanding of the projections, is the fact that the Reversible case now has much slower demand adjustment than for the three Irreversible cases. This can be observed in the near-completion by year 2000 of the Initial Momentum Effect for the three Irreversible cases: the Initial Momentum curves are close to flattening out by the year 2000. In contrast, the Reversible case's Initial Momentum Effect is continuing to rise almost linearly at the year 2000; it has a long way to go before the curve flattens out.

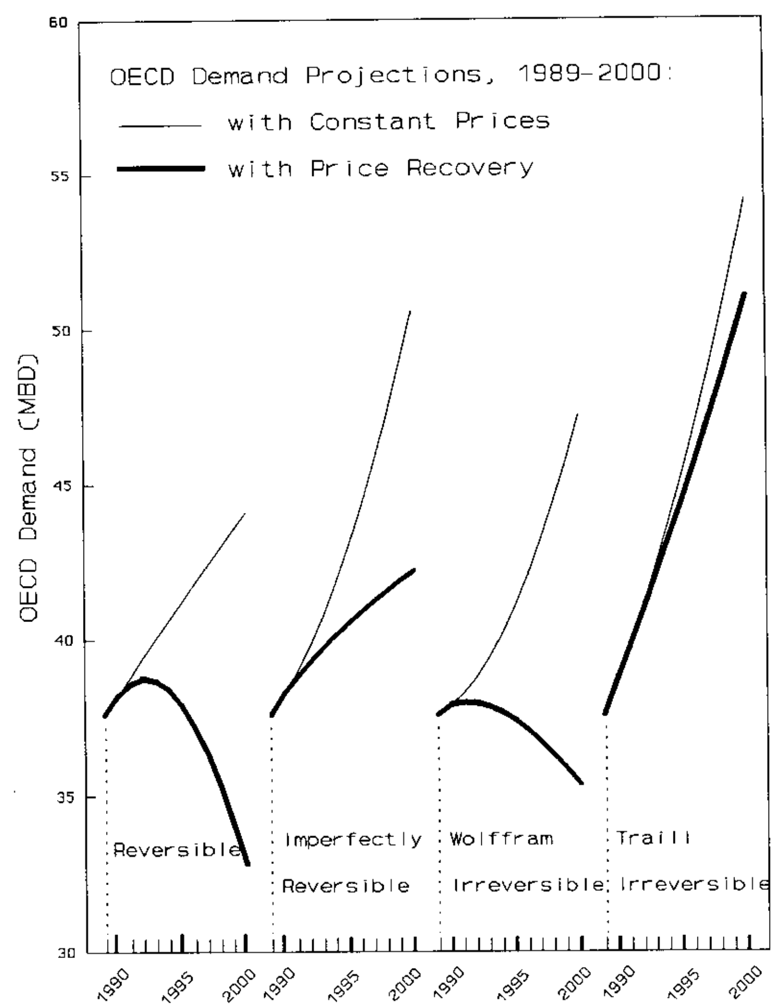
Figure 15. OECD Demand Projections 1989-2000, with Price Constant; Decomposition of Demand Growth into Initial Momentum Effect & Income Effect



The total demand growth is relatively similar across specifications, as shown in Figure 15. The projected totals would be even closer together if the income growth rate were lowered from the 2.5% annual growth that is assumed here, because this would lessen the Irreversible specifications' growth due to a lessened income effect, but do little to the projections of the Reversible case.

Another illustration of the differences across the four specifications is presented in Figure 16. This shows the effects upon OECD demand growth of a prolonged price recovery in the 1990's, one in which price is assumed to rise linearly, returning by the year 2000 to its previous 1980 maximum. The effects of a price recovery are substantial, for all specifications except for the Traill case. The latter assumes, of course, that the response to a price recovery is equal to the response to a price cut, which was found to be relatively small in the 1980's.

Figure 16. OECD Demand Projections 1989-2000: The Effect of a Price Recovery



5. Conclusions

In the Introduction, we posed two questions. First, whether the demand reductions following the price increases of the 1970's would be reversed by the price declines of the 1980's. And second, whether a price recovery in the 1990's would reduce demand by as much as did the price increases of the 1970's.

On the first question, the answer is clear: only a small fraction of the demand reductions will be reversed. In the OECD, the response to price increases of the 1970's was three to five times greater than the response to the price cuts of the 1980's. In the LDC, there has been little or no demand response to the price cuts of the 1980's.

For the second question -- the effect of a price recovery upon demand -- unfortunately the data does not provide an answer. We remain uncertain whether the response to a price recovery in the 1990's could be as great as it had been to the price increases of the 1970's (Wolffram-irreversibility), or whether the response would be no greater than the small response to the price cuts of the 1980's (Traill-irreversibility). We have not had sufficient experience since 1973 with price recoveries to know whether the demand response would be as large as it was for the price increases of the 1970's. Certainly, some demand reductions will not be repeated: attic insulation installed in the 1970's will not be re-done, because it had not been un-done when oil prices fell in the 1980's. But other energy-saving technologies (such as compact florescent bulbs), whose development was spurred by the energy price increases of the 1970's but whose distribution has been depressed by price declines in the 1980's, could be quickly revived by a price recovery.

To appreciate the importance of the first question, consider the following. If oil demand were incorrectly assumed to be perfectly price-reversible, then using conventional-wisdom estimates of price elasticity would have greatly overestimated the effect of the price declines of the 1980's upon demand growth in the 1990's. For example, in the recently completed study of world oil models by the Energy Modeling Forum (1991), the three econometrically-based models that assumed perfect price-reversibility had dramatically higher demand projections under low-price assumptions than did other models. In effect, they assumed that the price collapse of the mid-1980's had reduced price well below a level to which demand had already adjusted. Thus, when demanders re-adjusted to these lower prices, if demand were perfectly price-reversible, then demand would surge. By the year 2000, they projected OECD demand to be anywhere from 15 to 30 million barrels per day higher than the average of the other models. This amounts to needing another OPEC by the year 2000 in order to satisfy world oil demand, if price were to remain low.

Incorrectly assuming that demand is perfectly price-reversible will distort any demand projections, because it grossly mischaracterizes the sources of demand growth. It causes overestimates of the lagged effects of adjustment to the price declines of the 1980's, and underestimates of the effect of future income growth. Nor can any confidence be placed in its estimate of the effects of a price recovery in the 1990's.

Data Sources:

Real GDP: *Energy Balances for OECD Countries* (Paris: International Energy Agency); taken originally from *OECD Main Economic Indicators*.

Oil Consumption: *Energy Statistics of OECD Countries* (Paris: International Energy Agency).

Prices: *Energy Prices and Taxes* (Paris: International Energy Agency); *Annual Energy Review* (Washington: US Department of Energy).

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