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How Likely is the Consensus Projection of Oil Production Doubling in the Persian Gulf?

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Abstract

We examine a consensus in most recent long-term projections of the world oil market that OPEC oil capacity and production will increase rapidly over the next two decades to unprecedented levels, more than doubling in the Persian Gulf by 2020. Such projections are not based on behavioral analysis of Gulf countries' decisions; they are merely the calculated residual demand for OPEC oil, the difference between projected world oil demand and non-OPEC supply. We focus especially on the detailed projections of the *International Energy Outlook 2001* (IEO-2001) by the Energy Information Administration within the U.S. Department of Energy (DOE). Their projections exhibit only minimal price-responsiveness, which leads to conclusion that the underlying model is internally inconsistent. If it accurately represents the price-responsiveness of world oil demand and non-OPEC supply, then both the Reference Case and the High Price Case project future oil prices that are far too low – because these cases rely on supply behavior by Gulf producers that is not in their own self-interest. The IEO-2001 projections of world oil prices *could* be reasonable, but only if world oil demand and/or non-OPEC supply are much more price-responsive than are represented in their numerical projections. Then, using an updated version of the model from Gately (1995), we demonstrate that the effect of greater price-responsiveness for world oil demand and non-OPEC supply is to make faster output growth – not higher prices – the reliable path to higher OPEC revenue. We conclude with comments about the plausibility of consensus projections. Oil price in the range \$20 to \$25 (1999 \$/barrel) is plausible, but it requires substantial growth in non-OPEC supply and much greater price-responsiveness than is assumed in IEO-2001. Projections that Persian Gulf capacity and output will double by 2020, however, seem very implausible. It requires not only that Gulf producers experience high price-responsiveness to any slowdown in their output growth, but also that aggressive output growth must make them significantly better off than more modest expansion efforts. However, it was shown in Gately (1995) that discounted export revenue for the Gulf countries is relatively insensitive over a fairly wide range of output-growth strategies: modest output growth will do just about as well as aggressive growth.

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A key component of most recent long-term projections of the world oil market is that OPEC oil capacity and production will increase rapidly over the next two decades to unprecedented levels, more than doubling in the Persian Gulf by 2020. Two prominent recent projections are:

- the *World Energy Outlook 2000* by the International Energy Agency (IEA);
- the *International Energy Outlook 2001* (IEO-2001) by the Energy Information Administration within the U.S. Department of Energy (DOE).

However, these projections include virtually no analysis of whether a doubling of capacity and output is in the Gulf countries' own interest. That is the issue we address here. Does it make sense to *assume* that the world's rapidly growing need for OPEC oil will be met by key producers in the Persian Gulf? Might these Gulf producers choose much slower increases in capacity and output, and be better off for doing so? Under what conditions might such rapid output increases be plausible?

The outline of the paper is as follows. In Section I we summarize the Reference Case projections of these two organizations, and discuss their similarity to other groups' projections. In Section II we focus on the alternative-price-case projections by DOE in IEO-2001 and their extraordinarily low price-responsiveness. We argue that the model underlying IEO-2001 is internally inconsistent:

- if it accurately represents the price-responsiveness of world oil demand and non-OPEC supply, then both the Reference Case and the High Price Case project future oil prices that are far too low – because these cases rely on supply behavior by Gulf producers that is not in their own self-interest;
- the IEO-2001 projections of world oil prices *could* be reasonable, but only if world oil demand and/or non-OPEC supply are much more price-responsive than are represented in their numerical projections.

In Section III we demonstrate, with an updated version of the model from Gately (1995), the effects of greater price-responsiveness for world oil demand and non-OPEC supply, using the DOE price-paths:

- the High Price path could make OPEC worse off than the Reference Case, and is thus less likely;
- the reliable path to higher OPEC revenue is via faster output growth rather than higher prices.

Section IV draws conclusions about the plausibility of consensus projections: oil price in the range \$20 to \$25 (1999 \$/barrel), and a doubling of oil capacity and output from the Persian Gulf. We judge the price projections to be plausible, but they require substantial growth in non-OPEC supply and much greater price-responsiveness than is assumed in IEO-2001. Projections that Persian Gulf capacity and output will double by 2020, however, seem very implausible.

I. Reference Case Projections for the World Oil Market to 2020

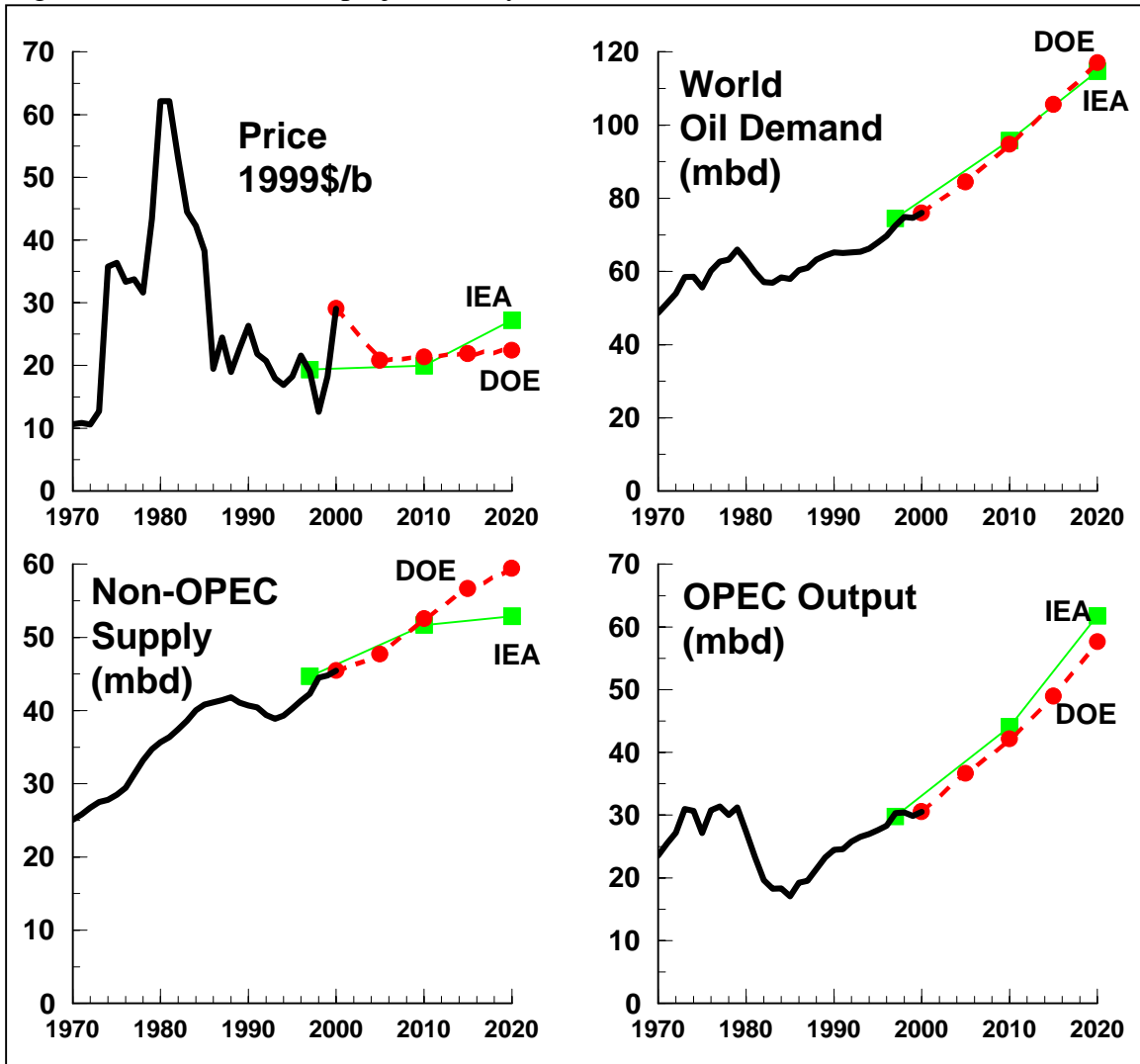
In Figure 1 below, we plot Reference Case projections by two important organizations noted above, the International Energy Agency (IEA) and the Energy Information Administration within the U.S. Department of Energy (DOE). Real price is projected to remain within the range of \$20 to \$28 (in 1999\$/barrel). World oil demand is projected to grow steadily. Similarly for non-OPEC supply, at least in the DOE projection; the IEA projects a leveling off after 2010.¹ OPEC oil output – determined as the residual (the difference between world oil demand and non-OPEC supply) – is projected to double over the next two decades, with almost all of that increase coming from the Persian Gulf. Such increases in production and the required capacity investments are unprecedented. Yet there is virtually no analysis of whether such increases are likely, or even whether such aggressive output expansion would benefit these countries.

Projections from other groups are generally similar, as summarized in Tables 14 and 15 of IEO-2001. Of the 8 projections of price (in 1999 \$/barrel) for year 2020, only the IEA (\$27.04) and DOE High Price Case (\$28.42) were above the DOE Reference Case (\$22.41). Four other groups projected prices for 2020 that ranged from \$17.68 to \$21.24. Output projections for non-OPEC supply were also generally similar to those of DOE (in million barrels/day: mb/d): 53 in 2010 and 60 in 2020. Only PIRA² projected substantially higher non-OPEC supply (58 in 2010), and only the IEA was substantially lower, in 2020 (53). Projections of total world output were all fairly similar. Hence, most projections of OPEC output are similar to those of IEO-2001, except for PIRA's lower projection and IEA's higher projection.

¹ For IEA we calculate non-OPEC supply as the difference between total world output and OPEC output as shown in Table 15 of IEO-2001; it thus includes all processing gains and unconventional oil.

² PIRA: Petroleum Industry Research Association. See Table 15 of IEO-2001.

Figure 1. Reference Case projections by DOE in IEO-2001 and IEA



Source: IEO-2001 Tables 11, 12, 14, 15

II. IEO-2001: Minimally Price-Responsive and Internally Inconsistent

In this section we focus on the projections of IEO-2001, which are the most detailed of any group and include results for multiple scenarios.³ In particular, we examine the alternative price projections, in order to analyze the following assertion (IEO-2001, page 35):

“The reference case projection implies aggressive efforts by OPEC member nations to apply or attract investment capital to implement a wide range of production capacity expansion projects. If those projects were not undertaken, world oil prices could escalate; however, the combination of potential profitability and the threat of competition from non-OPEC suppliers argues for the pursuit of an aggressive expansion strategy.”

We shall demonstrate that the numerical projections in IEO-2001 are minimally price-responsive, and actually would imply the opposite conclusions:

- Such rapid expansion of capacity is not profitable for Saudi Arabia and its neighbors
- Higher prices have relatively little effect on the demand for oil from Saudi Arabia and its neighbors.

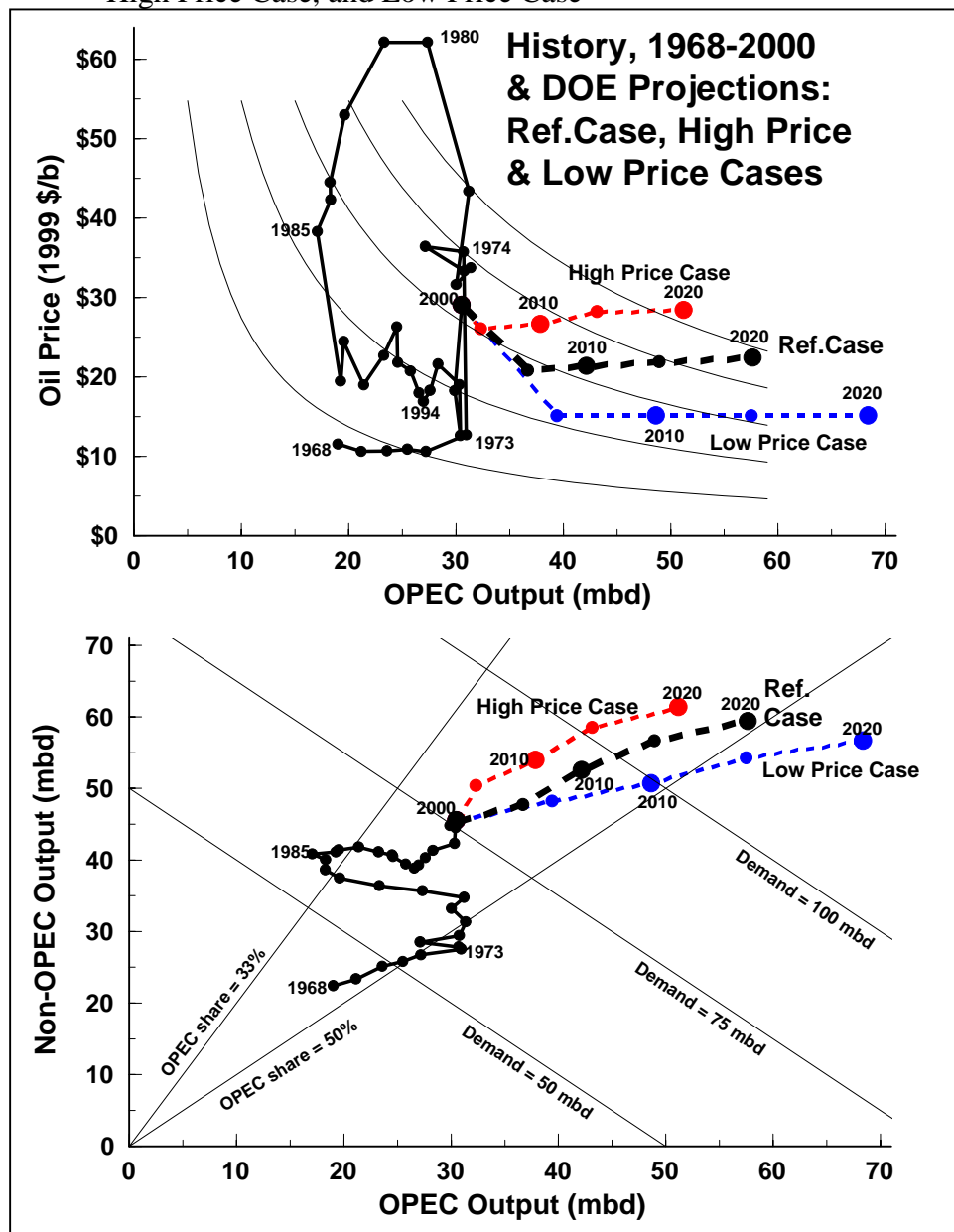
We argue that the model underlying IEO-2001 is internally inconsistent. If it accurately represents the price-responsiveness of world oil demand and non-OPEC supply, then both the Reference Case and the High Price Case project future oil prices that are far too low – because these cases rely on supply behavior by Gulf producers that is not in their own self-interest.

³ Unlike IEO-2001, the IEA's *World Energy Outlook 2000* provides details only for its Reference Case projection.

II.1 Alternative Price Cases in IEO-2001: Minimal Price Responsiveness

In Figure 2 we plot the projections to 2020 (as well as historical values) for three alternative-price cases of IEO-2001: the Reference Case, the High Price Case, and the Low Price Case. The upper graph in Figure 2 plots the real price of oil on the vertical, and OPEC oil output on the horizontal; the five rectangular hyperbola in the background are iso-revenue curves for OPEC, ranging from \$100 billion/year to \$500 billion/year. The lower graph uses the same horizontal axis (OPEC oil output) but with non-OPEC oil output as the vertical axis; in the background, the three diagonal lines represent levels of world oil demand (50, 75, 100 million barrels per day, mb/d) and the two rays from the origin represent OPEC's market share of world production (33% and 50%).

Figure 2. Alternative Price Projections by DOE in IEO-2001: Reference Case, High Price Case, and Low Price Case



In each of these three alternative projections, the real price stays below \$30/barrel, and the need for OPEC oil increases dramatically, as does OPEC's market share. Ordering the cases from lower to higher prices, we see from the iso-revenue curves in the upper graph that the higher the price the higher is OPEC revenue.

Summary results for year 2020 are presented in Table 1 for the three cases from IEO-2001, with calculations of the implied price-responsiveness relative to the Reference Case. The higher the price, the lower the demand for OPEC oil in 2020: 70 mb/d in the Low Price Case, 59 mb/d in the Reference Case, and 53 mb/d in the High Price Case. However, there is extremely little price-responsiveness displayed. Comparing the High Price Case to the Reference Case, we see that price is 26% higher but world oil demand is only 3.4% lower by 2020, and non-OPEC supply is only 3.3% higher by 2020. Hence the reduction in demand for OPEC oil (10.2%) is much less than the 26% increase in price, and OPEC revenue is higher, by 13.6%. Clearly OPEC would prefer the High Price Case to the Reference Case: higher revenue, less capacity expansion required, lower production, and more oil remaining for the future.

Table 1. Price-responsiveness in IEO-2001

	Low Price Case	Reference Case	High Price Case
Price (1999\$/barrel), average 2005-2020	\$ 15.10 (- 30%)	\$ 21.63	\$ 27.36 (+ 26%)
World Oil Demand, year 2020 in mb/d	127 (+ 6.7 %)	119 mb/d	115 (- 3.4%)
Non-OPEC Supply, year 2020 in mb/d	57 (- 5.0%)	60 mb/d	62 (+ 3.3%)
Demand for OPEC oil, year 2020 in mb/d	70 (+ 18.6%)	59 mb/d	53 (- 10.2%)
Revenue to OPEC, year 2020 in m\$/d	1057 (- 17.2%)	1276 m\$/d	1450 (+ 13.6%)

Notes: % differences shown are relative to Reference Case values.

mb/d: million barrels per day

m\$/d: million dollars per day

In Table 2 are presented similar comparisons for year 2010 as well as 2020, between the Reference Cases and the High Price Case, with more detail on the projected levels of output within OPEC⁴. We see that most of the projected output increase comes from the Persian Gulf, especially from Saudi Arabia, Kuwait and UAE. In the Reference Case, these 3 countries are projected to increase their oil production (and capacity) dramatically. By 2010 their production is projected to be 20.3 mb/d, or 6.4 mb/d higher than in 1998, which is nearly 60% of the projected increase of 11.1 mb/d for OPEC as a whole. By 2020 their production is projected to be 31.0 mb/d, or 17.1 mb/d higher than their 1998 production of 13.9 mb/d.

Table 2. Comparison of Reference Case and High Price Case from IEO-2001 for 2010 and 2020

	1998	2010		2020		
		Ref.Case	High Price	Ref.Case	High Price	
Oil Price (1999\$/b)	\$12.02	\$21.37	\$26.66	\$22.41	\$28.42	
Oil Production (mb/d)	OPEC	30.5	41.6	37.4	59.3	52.7
	Persian Gulf	20.6	28.5	25.3	41.5	36.3
	of which: Saudi Arabia, Kuwait & UAE	13.9	20.3	17.7	31.0	26.7
	Other OPEC	9.9	13.1	12.1	17.8	16.4
	Non-OPEC	44.5	53.1	54.4	60.0	62.0
	World	75.0	94.7	91.8	119.3	114.7
Oil Revenue (m\$/d)	OPEC	\$367	\$889	\$997	\$1,329	\$1,498

Notes: mb/d: million barrels per day
m\$/d: million dollars per day

II.2 The Implications in IEO-2001 of Output Growth Slowdown by Core Producers in the Persian Gulf

As noted above, OPEC would get lower revenue from the Reference Case than it would from the slower output growth of the High Price Case. Moreover, its production costs and capacity expansion costs would also be lower in the High Price Case. Clearly, OPEC collectively would prefer the High Price Case.

Of course, the fact that OPEC collectively would prefer the High Price Case to the Reference Case does not mean that OPEC could bring about such a result, given its notorious inability to coordinate its actions. However, the minimal price-responsiveness in the projections of IEO-2001 suggests that even a smaller, more coherent group that acted alone to restrain output growth might be better off as well.

Consider the group consisting of Saudi Arabia and its neighbors Kuwait and the United Arab Emirates (UAE). What would be the implications if they were, by themselves, to bring about a slowing of output growth sufficient to shift the price from the Reference Case to the alternative High Price path? We assume that only these three countries – Saudi Arabia, Kuwait, & UAE –

⁴ In IEO-2001, projections for the Persian Gulf are disaggregated by country for capacity but not production. In order to calculate the projected levels of production shown here for Saudi Arabia, Kuwait & UAE, we assumed that all Gulf countries would operate at the same level of capacity utilization.

would restrict output growth; the other, non-core members of OPEC are assumed to be satisfied in producing the levels projected for them under the Reference Case.⁵ The details are presented in Table 3; the boldfaced, italicized entries in the High Price column indicate the intra-OPEC differences from the similar column in Table 2. These three countries are assumed to increase their production only to 16.1 mb/d in 2010 (rather than to 20.3 mb/d) and “only” to 24.4 mb/d in 2020 (rather than to 31.0 mb/d) – bearing the entire “burden of output restriction” by themselves with no help from the non-core members of OPEC, who are assumed to be satisfied producing the amounts projected in the Reference Case (21.3 in 2010 and 28.3 in 2020).

Parenthetically, it is difficult to describe a doubling of capacity to unprecedented levels as “output restriction” – but this “restriction” is relative to even greater expansion of capacity and production in the Reference Case. Within cartel theory such a group would normally be called the “output-restricting core” of OPEC. In this instance, however, it would be more appropriate to label it the “output-growth-slowdown core”.

Table 3. Implications in IEO-2001 of Output Growth Slowdown by Saudi Arabia, Kuwait & UAE

	1998	2010				2020			
		Ref.Case	High Price			Ref.Case	High Price		
Oil Price (1999\$/b)	\$12.02	\$21.37	\$26.66			\$22.41	\$28.42		
if output-growth-slowdown core = Saudi Arabia, Kuwait & UAE									
difference									
Oil Production (mb/d)	OPEC	30.5	41.6	37.4	-4.2	59.3	52.7	-6.6	
	core: Saudi Arabia, Kuwait, UAE	13.9	20.3	16.1	-4.2	31.0	24.4	-6.6	
	non-core: rest-of-OPEC	16.6	21.3	21.3	0	28.3	28.3	0	
Oil Revenue (m\$/d)	OPEC	\$367	\$889	\$997	\$108	\$1,329	\$1,498	\$169	
	core: Saudi Arabia, Kuwait, UAE	\$167	\$435	\$430	-\$5	\$694	\$692	-\$2	
	non-core: rest-of-OPEC	\$200	\$454	\$567	\$112	\$635	\$805	\$170	

Notes: mb/d: million barrels per day
m\$/d: million dollars per day
Boldfaced, italicized entries indicate intra-OPEC differences from the IEO-2001 projections in Table 2.

What would be the implications for these three countries if they were not to produce an extra 4.2 mb/d in 2010 -- increasing output to 16.1 mb/d instead of 20.3 mb/d? They would have to forego \$5 million/day in revenue, which is less than \$1/barrel. Likewise for year 2020: if they were to slow their output growth by 6.6 mb/d, their revenue would be lower by only \$2 million/day – substantially less than \$1 per barrel. In other words, if they were to expand their output as aggressively as required in the Reference Case, the extra revenue they would get – less than than \$1/barrel – would not even cover their production costs, much less their capacity-expansion costs, or the opportunity costs of being unable to sell that oil in the future.⁶

⁵ If non-core members of OPEC increase their output even faster than projected for them under the Reference Case – in response to higher prices, as if they were non-OPEC producers – then it will make it more difficult and less attractive for the core countries to restrain output growth and increase prices.

⁶ The IEO-2001 states (p. 34): “Production costs in Persian Gulf OPEC nations are less than \$1.50 per barrel, and the capital investment required to increase production capacity by 1 barrel per day is less than \$5000.” The source cited is DRI/McGraw-Hill, *Oil Market Outlook* (Lexington, MA, July 1995), Table 1, p.10.

Clearly, these three countries would prefer the High-Price path even if by themselves they had to bear the entire “burden” of slowing output growth from Reference Case projections. They would get virtually the same revenue, with lower production costs, less need for capacity expansion, and more oil reserves left for the future. Despite the assertions in IEO-2001 of “potential profitability” from aggressive output expansion, it is not in these countries’ interest to expand capacity and output so rapidly.

II.3 Output Growth Slowdown by Various Core Groups in OPEC

The calculations of Table 3 illustrate why the output-growth-slowdown core consisting only of Saudi Arabia, Kuwait and UAE would prefer – and could impose – the High Price path rather than the Reference Case. Of course, there are several alternative core groups that are possible within OPEC. Table 4 summarizes the implications for a few of these alternative core groups:

- all OPEC acts together to restrict output growth
- Persian Gulf members of OPEC act together: Iran, Iraq, Kuwait, Qatar, Saudi Arabia, UAE
- Saudi Arabia, Kuwait & UAE (with results as shown above in Table 3)
- Saudi Arabia acting unilaterally

The same assumptions are made as before: any non-core members of OPEC are assumed to be satisfied producing Reference Case levels of output, while the core members restrict output growth by enough to impose the High Price path. That is, the core members must slow output growth by 4.2 mb/d in 2010 and by 6.6 mb/d in 2020.

	1998	2010			2020		
		Ref.Case	High Price		Ref.Case	High Price	
Production for output-growth-slowdown Core, in million barrels per day							
Core:				difference			difference
OPEC	30.5	41.6	37.4	-4.2	59.3	52.7	-6.6
Persian Gulf	20.6	28.5	24.3	-4.2	41.5	34.9	-6.6
Saudis, Kuwait & UAE	13.9	20.3	16.1	-4.2	31.0	24.4	-6.6
Saudi Arabia	9.2	13.8	9.6	-4.2	21.5	14.9	-6.6
Revenue for output-growth-slowdown Core, in million dollars per day							
Core:				difference			difference
OPEC		\$889	\$997	\$108	\$1,329	\$1,498	\$169
Persian Gulf		\$609	\$648	\$39	\$930	\$992	\$62
Saudis, Kuwait & UAE		\$435	\$430	-\$5 (-\$1.04/b)	\$694	\$692	-\$2 (-\$0.23/b)
Saudi Arabia		\$295	\$255	-\$40 (-\$9.30/b)	\$483	\$425	-\$58 m\$/d (-\$13.83/b)

Table 4. Implications in IEO-2001 of Output Growth Slowdown by various Core groups within OPEC

Notes: mb/d: million barrels per day

m\$/d: million dollars per day

Boldfaced, italicized entries indicate intra-OPEC differences from the IEO-2001 projections in Table 2.

Table 4 shows, not surprisingly, that the smaller the core's membership, the less is the benefit to them of collective action to slow output growth. If the core consists of all of OPEC or all of the Persian Gulf, then core revenue will be higher from the High Price path. If only 3 countries – Saudi Arabia, Kuwait, and UAE – act together to slow output growth, then their revenue will be almost the same as in the Reference Case (and their costs will be lower). If only Saudi Arabia were to act to restrict its output growth so as to impose the High Price path they would have to forego revenue. But even these amounts of additional revenue (\$9.30/barrel in 2010 and \$13.83/barrel in 2020) might not be enough to induce Saudi Arabia to increase their production as aggressively as is projected in IEO-2001, because they might well be unwilling to incur the production costs, capacity expansion costs, and the opportunity costs of being unable to sell that additional oil in the future.

We draw the following conclusions about the projections in IEO-2001, from Table 4 and the underlying analysis:

- Even the smallest core in OPEC would prefer the High Price path to the Reference Case: there is too little incentive to increase output so rapidly. The Reference Case could not occur, because OPEC's core prefers the High-Price-Case instead, and it has the power to impose it.
- Similarly, by extension, neither could the High-Price Case occur – because OPEC's core prefers an Even-Higher-Price Case, and it has the power to impose it.
- Unless world oil demand and non-OPEC supply are much more price-responsive than projected in IEO-2001, then key producers in OPEC will slow output growth, let price increase, and be better off for doing so. Such a decision might be accompanied by statements of concern about the effect on global warming of aggressive increases in oil output, and a willingness of these countries “to do their part and accept the consequences” (higher revenue).

III. The Effects of More Price-Responsive Oil Demand and Non-OPEC Supply

It must be emphasized that the above calculations were based upon the numerical projections of IEO-2001, which exhibit minimal price-responsiveness of oil demand and non-OPEC supply. If, in fact, the world oil market is more price-responsive than as described by IEO-2001, then the above result – OPEC's key producers would prefer and could impose much higher prices than even the High-Price Case, with much slower growth in oil output – need not be true. With more price-responsive oil demand and/or non-OPEC supply, the consensus projections of price in the range of \$20 to \$25 for the next two decades are plausible, and might require only modest increases in OPEC oil output. This conclusion will be the focus of this section.

We use an alternative model to make projections, namely an updated version of the model used in Gately (1995)⁷. This model has been recalibrated slightly – so that it tracks exactly the IEO-

⁷ The updated model made the following assumptions:

- Long-run price-elasticities of Oil Demand: - 0.4 for Transportation Oil, and - 0.8 for Non-Transportation Oil; similar to parameter values in Gately (1995), these are still price-inelastic, but they are much more elastic than what IEO-2001 assumes.

2001 projections for the Reference Case – in order to simplify the comparisons with IEO-2001. However, this model is significantly more price-responsive than IEO-2001. Thus, the High-Price path would increase non-OPEC supply more, reduce world oil demand more, and these combined effects would reduce the demand for OPEC oil by much more – compared to IEO-2001 projections. Its projections for year 2020 are summarized in Table 5. The High Price path reduces world oil demand more (by 13% rather than 3.4%), increases Non-OPEC supply more (by 15% not 3.3%), and reduces the demand for OPEC oil by much more (41% not 10%), causing OPEC revenue to be lower not higher than in the Reference Case.

Detailed projections for the Reference Case and High Price Case – between the IEO-2001 results and the more price-responsive Gately (1995) model – are presented in Figure 3 and Figure 4.

Table 5. Price-responsiveness in Gately(1995), with comparisons to IEO-2001

	Reference Case	High Price path
Price (1999\$/barrel), average 2005-2020	\$ 21.63	\$ 27.36 (+ 26%)
World Oil Demand, year 2020 in mb/d	119 same as IEO-2001	104 (-13%) IEO-2001: 115 (-3.4%)
Non-OPEC Supply, year 2020 in mb/d	60 same as IEO-2001	69 (+ 15%) IEO-2001: 62 (+3.3%)
Demand for OPEC oil, year 2020 in mb/d	59 same as IEO-2001	35 (- 41%) IEO-2001: 53 (-10.2%)
Revenue to OPEC, year 2020 in m\$/d	\$ 1276 same as IEO-2001	\$ 958 (-25%) IEO-2001: \$1450 (+13.6%)

Notes: % differences shown are relative to Reference Case values.
 mb/d: million barrels per day
 m\$/d: million dollars per day

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- Non-OPEC Oil Supply: same specification and parameter values as Gately (1995): short-run price elasticity of .05 – which implies much greater price-responsiveness than IEO-2001.

Figure 3. Results comparison of Gately (1995) model with IEO-2001: same for Reference Case but more price-responsive for High Price path

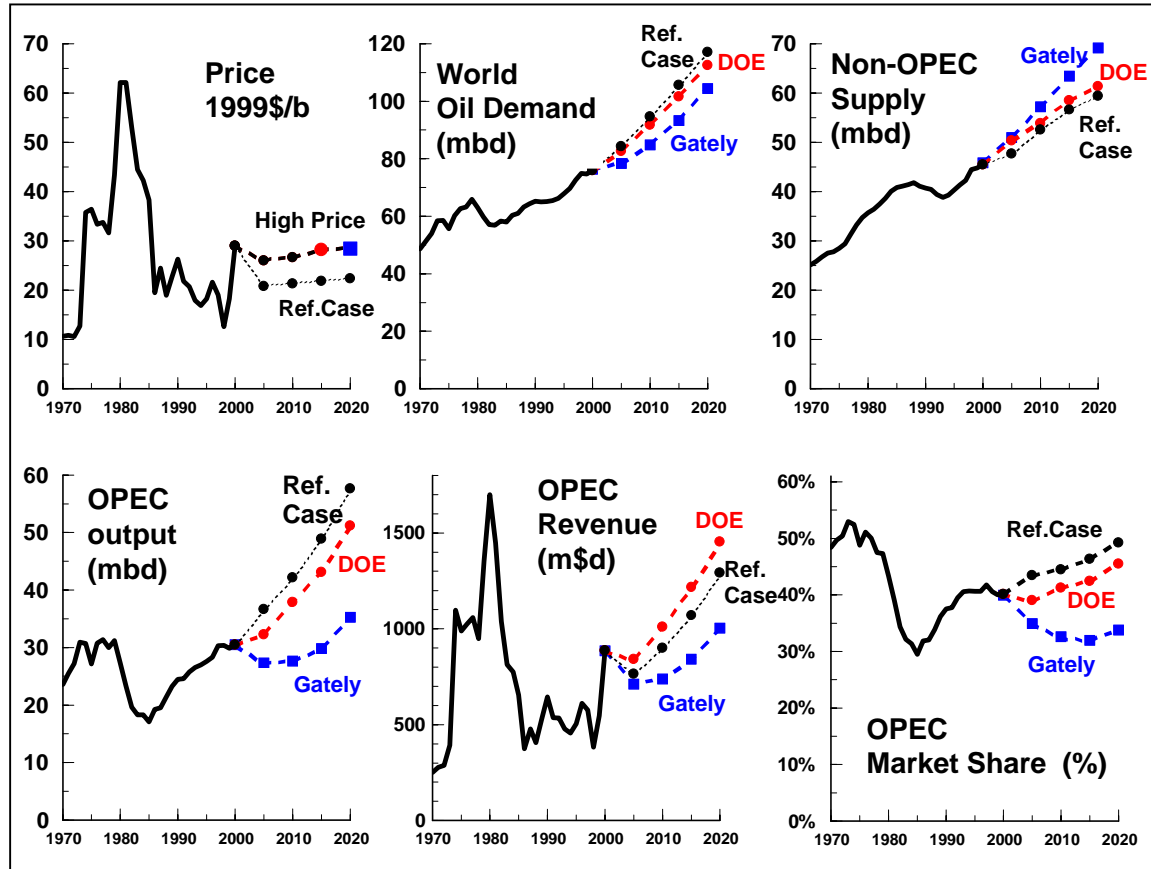


Figure 3 presents standard graphs of the main variables plotted over time. The IEO-2001 projections for the High-Price path exhibit minimal price-responsiveness: little reduction in world oil demand, and little increase in non-OPEC supply. The reductions in the demand for OPEC oil output are modest; the percentage decline is smaller than the percentage price increase. Hence the High Price path yields higher OPEC revenue. OPEC's market share is slightly lower, but it still continues increasing from 2005 to 2020. In contrast, the model results from Gately (1995) reflect its greater price-responsiveness: greater reduction in demand and increase in non-OPEC supply. The percentage decline in demand for OPEC oil exceeds the percentage increase in price; hence OPEC revenue is lower with the High Price path. OPEC market share is also significantly lower; its level is stagnant, at one-third of the market.

Figure 4. Comparing High Price Path with Reference Case, for IEO-2001 and model from Gately (1995)

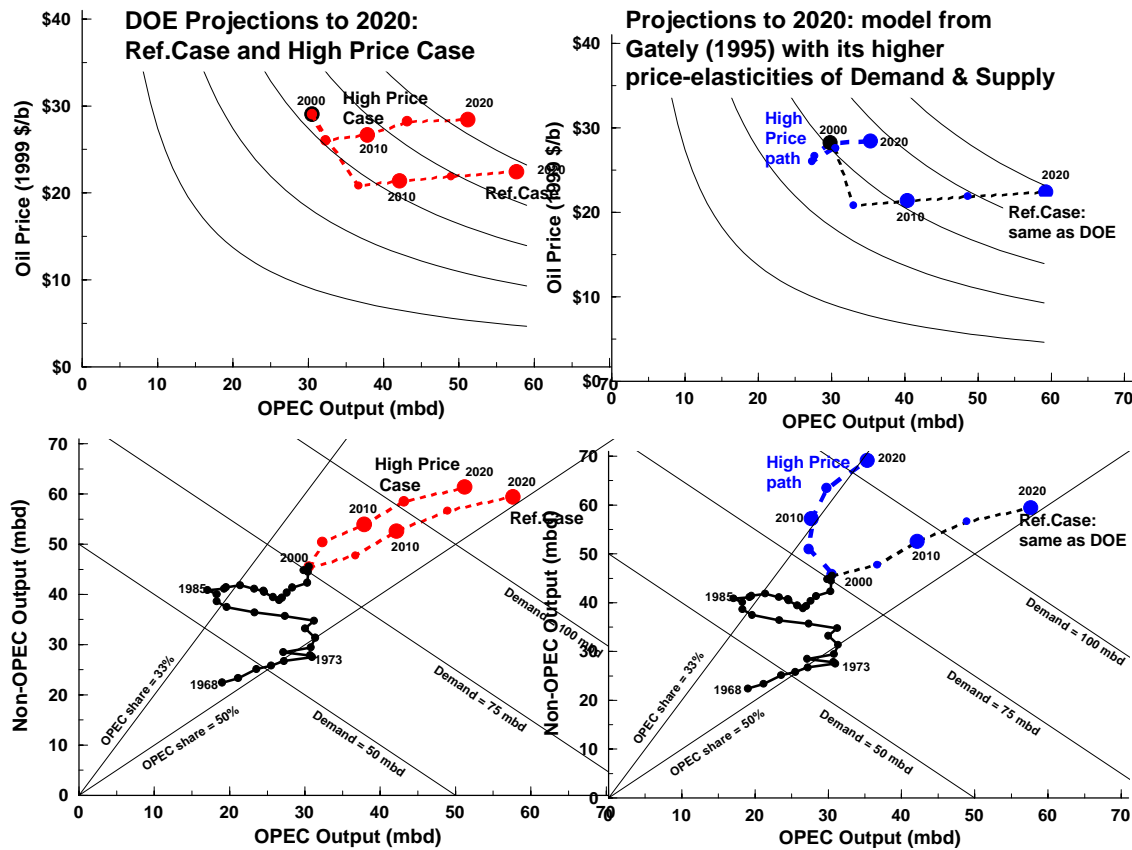


Figure 4 presents the same comparison of results, using the pair of graphs used previously in Figure 2. The DOE results appear on the left graphs and the results from Gately (1995) on the right. The greater price-responsiveness of the Gately (1995) model is evident in the effects of the High Price path. In the lower graphs, we see that in the right graph:

- non-OPEC supply increases more (vertical movement)
- world oil demand falls more (decreasing in Southeast direction, perpendicular to the three iso-demand lines)
- the demand for OPEC oil output declines much more (horizontal movement)
- OPEC's market share declines more (counterclockwise movement)

In the upper graphs we see the alternative paths to higher revenue: for IEO-2001 higher revenue can be achieved by slowing output growth and keeping price high. For Gately (1995) keeping price high will yield lower revenue; the path to higher OPEC revenue is via the lower prices and faster output growth of the Reference Case.

IV. Conclusions

Here we address the plausibility of consensus long-term projections of oil prices in the range of \$20 to \$25 (1999 \$/barrel), and of a doubling of capacity and oil output from the Persian Gulf by 2020.

The consensus long-term projection of oil prices in the range of \$20 to \$25 is plausible only under one or both of the following assumptions:

- Faster growth of non-OPEC supply, such as that projected by PIRA and in the High Non-OPEC Supply Case of IEO-2001, which would relieve pressure on OPEC to increase its capacity and output as aggressively as is projected by most groups. Slower growth in oil demand would also have the same effect, but this seems less likely.
- Price-responsiveness of oil demand and non-OPEC supply that is closer to the assumptions of Gately (1995) than to the model underlying IEO-2001. This would make the High Price path yield worse results for OPEC than the Reference Case – forcing it to pursue higher revenue via output growth rather than via price increases. The higher the price elasticities, the less likely are higher prices.

Less plausible than the consensus projection of price is the projection of a doubling of capacity and oil output from the Persian Gulf by 2020. Given that OPEC's oil production capacity has not changed significantly in a quarter century, it seems unreasonable to expect now that it would *double* within two decades. Projections of output doubling are not based upon analysis of OPEC behavior, but are merely the calculated residual – the difference between projections world oil demand and non-OPEC supply. For such a doubling to occur, OPEC's key producers would need to be convinced that:

- this is the only reliable path to higher revenue – which would require relatively high price-elasticities of world oil demand and non-OPEC supply, and
- aggressive output expansion will make them significantly better off than more modest expansion efforts.

The latter consideration is important in a model as price-responsive as Gately (1995), because discounted export revenue for the Gulf countries is relatively insensitive to a fairly wide range of output growth rates.⁸ An output-growth strategy based on the rate of world income growth (3.2% annually in IEO-2001) – from half as fast as world income growth to about as fast – does well relative to other strategies, over the range of parameter assumptions that were examined in Gately (1995).⁹ But there is relatively little difference to the Gulf countries' discounted export revenue within this range of output growth rates – whether they increase oil output by 1%

⁸ See Gately (1995, pp. 23-28).

⁹ Note that the alternative parameter values considered in Gately (1995) did not include such low price-elasticities as are used in IEO-2001; hence the IEO-2001 projection of OPEC output growth about as fast as world income cannot be viewed as near optimal for OPEC. In the Reference Case of IEO-2001, OPEC output is projected to grow at 3.24% annually over the period 1999-2010, and 3.61% annually from 2010 to 2020. These growth rates are only slightly faster than the 3.2% annual rate of world income growth that is assumed. They appear close to being consistent with the conclusion from Gately (1995) that a robustly optimal strategy for OPEC would be to increase its output no faster than world income growth. However, that conclusion was based upon parameter values that assumed much greater price-responsiveness than is evident in IEO-2001. Given the minimal price-responsiveness that is assumed in IEO-2001, such rapid rates of output growth would be disastrous for OPEC revenues, and could not possibly be optimal for them.

annually or 3% annually. Faster output growth rates will be partially offset by the depressing effect on price, so that there is little incentive for aggressive expansion of capacity and output. Modest output growth will do just about as well. Hence, even assuming greater price-responsiveness as in Gately (1995), it's difficult to construct a scenario by which the Persian Gulf's capacity and output would double by year 2020.

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