The Future of World Oil Prices: Some Keys to the Puzzle

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INTRODUCTION

More Since the success or failure of biofuels is critically dependent on the future price of gasoline and diesel fuel, it is altogether fitting that we should begin by examining the world oil market and its future pricing prospects. The prices of ethanol and biodiesel will essentially be set by the prices of gasoline and diesel fuel, whose prices depend critically on the price of their key input – crude oil. The purpose of this chapter is to focus our attention on the world oil market and the future price of crude oil. The second section provides useful background information, describing four distinctive characteristics of the world oil market. This chapter argues that the future oil price puzzle will depend critically on three factors. The first piece of the puzzle is the ability and willingness of OPEC oil producers to expand future production capacity; accordingly, the third section examines five potential constraints that could, in principle, prevent capacity expansions. The other two pieces to the puzzle are the magnitude of long-term price-induced conservation and the supply responsiveness of nonconventional fuels. In the fourth section, a simulation model of the world oil market is used to quantify the magnitude of these effects. The chapter ends with concluding thoughts.

FOUR DISTINCTIVE CHARACTERISTICS OF THE WORLD OIL MARKET

In thinking about the price of crude oil, it is important to keep in mind several background facts. First, the price of oil is determined in one worldwide market. Indeed, Adelman used the analogy of a huge

[1] The author thanks Rebecca Willis and Leslie McDonald for able research assistance.

“bathtub” to describe the world oil market. The faucets running into the bathtub correspond to the various oil producing countries, while the drains from the bathtub carry oil to the various consuming nations. When the flow rate into the bathtub is less than the withdrawal rate from the bathtub, world oil prices rise sufficiently to equilibrate supply and demand. Even though crude oils are molecularly quite different and transportation costs tie certain oil producing and consuming countries together, crude oils are “fungible” and the market is “worldwide,” being governed by worldwide supply and demand conditions. For example, even though Mexican crude oils tend to be heavy (low gravity) with high sulphur content, complex refineries can convert these crude oils into the same slate of refined products as produced by light (high gravity), sweet crude oils like West Texas Intermediate. Likewise, the flexibility and low cost of transporting crude oil in supertankers mean that if the price of one particular crude oil becomes cheaper than other crude oils destined for a particular location, it will be bid away and redirected to the higher priced market.

Much has been said in the press about the shortage of US refining capacity to process heavy, sour crude oils, resulting in a widening price differential between light, sweet crude oils and heavy, sour crude oils. In addition, the Environmental Protection Agency’s (EPA) practice of approving boutique blends of gasoline to meet an individual city’s air pollution limits has further exacerbated the refinery flexibility problem here in the US. Consequently, in areas with very stringent gasoline blends, gasoline prices sell for a premium compared to the cost of the crude oil. Nevertheless, problems of refining shortages for heavy, sour crude oils and boutique gasoline blends can and will be overcome with investment in refining capacity. Consequently, the bathtub analogy still holds as a reasonable approximation of reality. Because of the bathtub, we must expand our view of the “market” from NAFTA to the world.

A second distinguishing feature about the supply and demand for crude oil is its short-run price inelasticity – or lack of responsiveness of both consumption and production to price changes. For crude oil, the short run responsiveness of demand to price increases is very “inelastic” – about -0.1 or less.[2] Immediately following a price shock, consumers have little ability to substitute petroleum products for either other fuels or other consumption items. They must still get to work and buy groceries, and the fleet of autos on the road cannot be replaced instantaneously. Thus, the short-run demand for gasoline as well as most petroleum products is very price inelastic. On the

[2] Economists measure the price elasticity of demand (or supply) by computing the ratio of the percentage change in consumption (or production) to the percentage change in price. Thus, a price elasticity of -0.1 indicates that a 100 percent price increase would induce only a ten percent reduction in consumption.

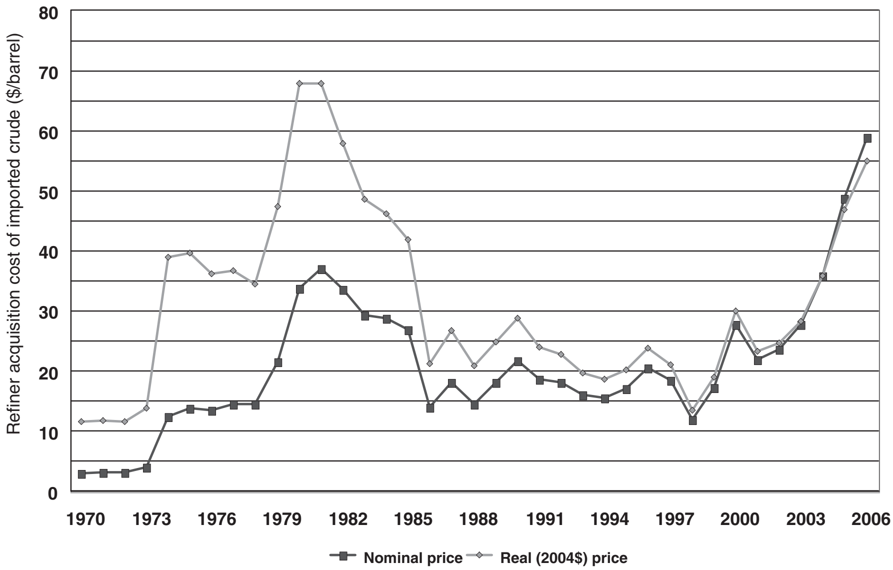
supply side of the market, most of the wells (at least those in the non-OPEC countries) are producing at their engineering capacity limits, so higher prices do not elicit substantially higher oil production in the short-run.

Why should we care that both the short-run price elasticities of supply and demand are very inelastic? Small supply disruptions can create large price spikes just like an oil glut can provoke a precipitous price drop. High price volatility is the norm for this market. I mention this because extreme price volatility has important risk implications for an emerging biofuels industry.

A third distinctive characteristic of the world oil market is that it is not a competitive market, governed by the forces of supply and demand. Instead, since the early 1970s, the OPEC cartel has succeeded in artificially holding oil prices above their competitive levels. The cartel assigns production quotas to its members and monitors their production for compliance. Figure 2.1 shows the path of world oil prices since 1970, both in current and 2006 constant dollars. The cartel gained widespread attention in 1973-74 when it engineered a four-fold price increase during the Arab Oil Embargo of 1973-74. Oil prices doubled again in 1979-80, as Iranian oil production plummeted during the Iranian Revolution and the Saudis unilaterally cut production. But even a monopolist can charge too high a price, and market forces took their revenge on the cartel during the period 1981-1986 as oil prices plummeted. The cartel found itself caught in a vise between falling world demand and increasing oil production from non-OPEC countries. OPEC was forced to reduce prices.

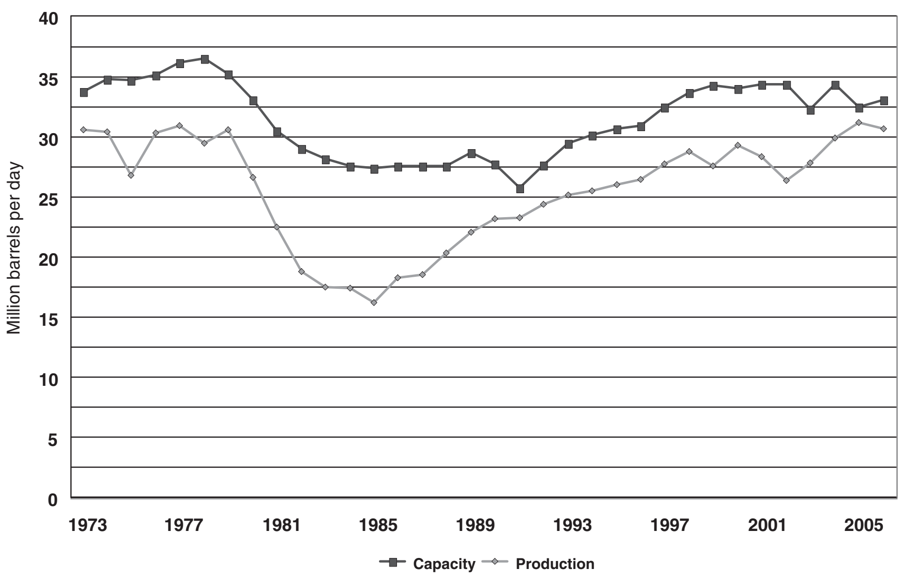
Over the period 1986 to 2003, energy policy and concerns about OPEC largely disappeared as oil prices fluctuated in a range between $15 and $30 per barrel – well below the peak reached in 1981. A widespread assumption was that OPEC was ineffectual, serving only to ratify what the market would have done in its absence (Alhajji and Heuttner). As shown in figure 2.2, sharply higher oil prices from 1973-81 resulted in a large drop in the demand for OPEC crude as world oil demand stagnated while non-OPEC oil production continued to march steadily upward. The line showing OPEC's production capacity shows that for much of the period there was considerable spare capacity in the cartel, which contributed to cheating on the production quotas (Griffin and Neilson). Even though oil prices continued to fluctuate in the same range, OPEC's bargaining strength steadily improved in the 1990s. The demand for OPEC crude oil began to increase steadily because worldwide oil demand was growing faster than supply from non-OPEC sources, leading to steadily increasing OPEC sales. Relative political stability allowed OPEC countries to expand production capacity to

Figure 2.1: World oil prices, 1970-2006.



Source: US Energy Information Administration.

Figure 2.2: OPEC production vs. production capacity, 1973-2006.



Source: Alhajji and Huettner; Griffin and Neilson.

keep pace with the rising demand, leaving a cushion of two to three million barrels per day (MMB/D).

Beginning in 2003, things began to unravel. With the political instability caused by Hugo Chavez's rise to power in Venezuela, production capacity fell while increasing world demand left little spare capacity. Not surprisingly, oil prices began ratcheting upward. Figure 2.3 demonstrates that even though oil prices were rising, so too was world oil consumption. Indeed, between 2003 and 2006, world oil consumption grew from 79.7 MMB/D to 84.3 MMB/D – while the price of crude oil effectively doubled.[3] What could explain this apparent contradiction of the law of demand?

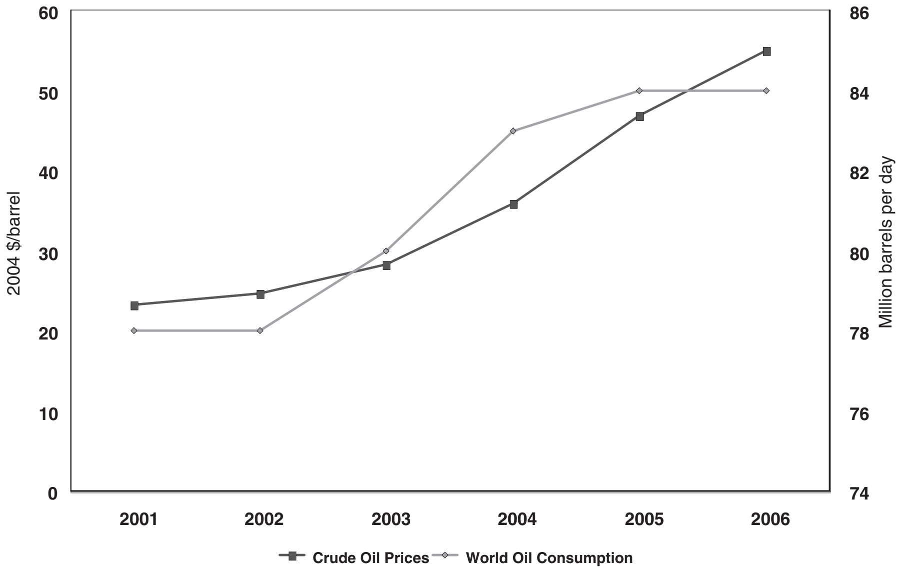
This brings us to the fourth distinctive characteristic of the world oil market – the emergence of China and other Asian countries as major oil consumers. Figure 2.4 decomposes the annual increments in world oil consumption to see what regions best explain this abnormally high rate of demand growth. For each year, we compute the total increase in consumption and then ask what the source of this demand growth was. Demand growth is broken into five groupings – China, India, Other Asia, USA, and Rest of World. China, by itself, is the single largest contributor. With the Chinese economy growing at a ten percent rate, it should not be surprising to see that China's absolute increases in consumption are growing sharply over time. Indeed, by 2006, China's oil consumption put it in second place in the world. India and other Asian countries have played smaller, but nevertheless prominent roles. By 2006, India's oil consumption put it in fifth place. Since its economy is growing at a rate of seven to eight percent, it will surely move up in coming years. In sum, rapid GDP growth by China, India, and other Asian countries has added a new component to world oil demand to go along with the US and other consuming nations. Particularly, if these rapid GDP growth rates for Asian countries persist, world oil consumption may well grow significantly despite the dampening effects of higher oil prices on future consumption. This brings us to the first piece of the puzzle – the prospects for capacity expansions.

THE FIRST ELEMENT OF THE PUZZLE: THE ABILITY AND WILLINGNESS OF OPEC TO EXPAND CAPACITY

The current run-up in world oil prices is understandable in retrospect, even if it was not predictable. World oil consumption has grown at an unexpectedly rapid rate while political instability in many oil producing regions has hampered capacity expansions. At the same time, while oil consumption was growing by 4.6 MMB/D over the period 2003-2006,

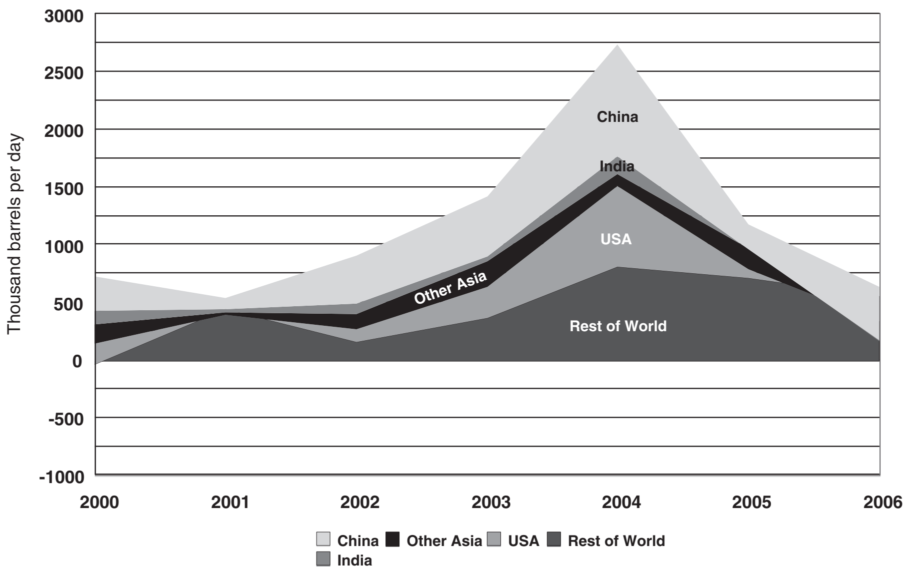
[3] Unless otherwise stated, oil statistics used in this chapter are from the US Department of Energy's Energy Information Administration website.

Figure 2.3: Oil prices and world oil consumption, 2001-2006.



Source: US Energy Information Administration.

Figure 2.4: Annual increase in oil consumption, 2000-2006.



Source: US Energy Information Administration.

non-OPEC oil production grew only by 1.1 MMB/D. This meant that the call on OPEC crude increased rather sharply by 3.5 MMB/D. As shown in figure 2.2, this surge in OPEC's demand pushed production up near its production capacity, creating a "tight" market in which oil price increases are to be expected.

Clearly, the limitations on OPEC capacity were a major factor in explaining the current price run-up, but what about the future? OPEC's capacity to produce is a key decision variable. It is not cast in stone. But what factors could impact the capacity expansion decision? Listed below are five factors that are often discussed as constraints:

1. physical limitations on the size of the underlying oil reserve base;
2. the technical expertise to expand capacity;
3. investment funds necessary to finance such expansions;
4. geo-political constraints; and
5. the implications of wealth maximization.

Let us consider each of these potential constraints on the ability of key oil producing countries to expand production.

Physical Resource Constraints?

Concerns about the adequacy of the underlying resource bases of the OPEC countries is a relatively new concern best illustrated by Simmons' recent book, "Twilight in the Desert." Simmons argues that productive capacity in Saudi Arabia's giant Ghawar field will soon decline and that Saudi reserves may well be considerably overstated. He notes that while Saudi Aramco has been successful in finding additional fields, the sizes of these fields tend to be much smaller than Ghawar and other giant and super-giant Saudi fields.

Simmons' assertions stand in sharp contrast to official reports that Saudi Aramco has identified 80 known oil fields in the kingdom and is only producing from 12 fields. There are apparently only about 1000 plus producing wells in the kingdom as compared to more than 300,000 in the US (US Department of Energy). Furthermore, oil reserves are like groceries on a shelf – not an immutably fixed supply. They can be replenished by additional exploration. Indeed, the US Geological Survey (USGS) estimates that in addition to Saudi Arabia's 263 billion barrels of known reserves, there are another 87 billion barrels of undiscovered reserves. Assuming an ultimate resource base of 350 billion barrels, we have computed the feasibility of increasing production from 11 MMB/D in 2006 to 25 MMB/D by 2016. Figure 2.5 shows that production could theoretically be ramped

Table 2.1: Actual reserves, undiscovered reserves, and years remaining.

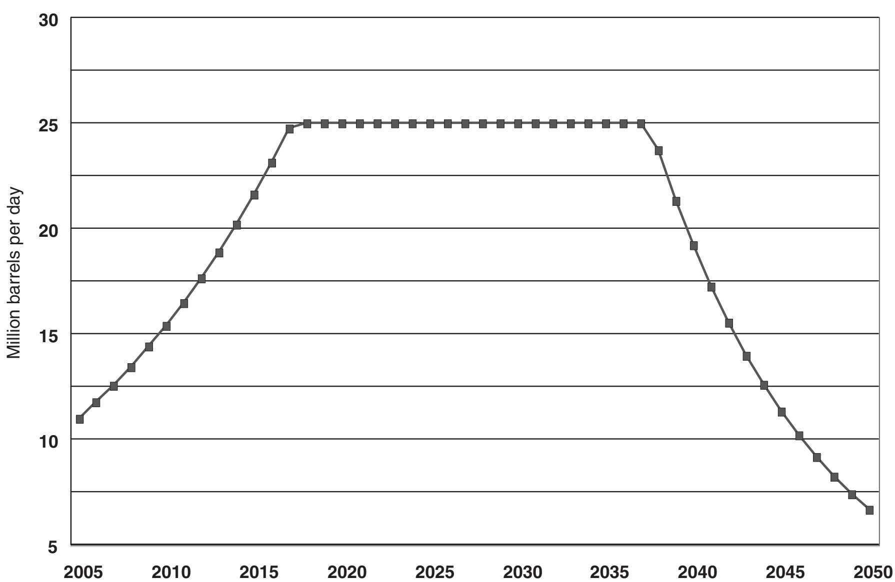
Country	Reserves[a]	Estimated Undiscovered	Total	Years Remaining[b]
Saudi Arabia	263	87	350	86.9
Iraq	115	45	160	240.9
Iran	133	53	186	125.9
Venezuela	77	20	97	88.4
Kuwait	99	4	103	106.8
The United Arab Emirates	98	8	106	105.6

[a] In billion barrels as of 2005.
[b] Assuming current production rate.
Sources: British Petroleum Statistical Review, United States Geological Survey.

up to 25 MMB/D and sustained at that rate for another 20 years before resource constraints would push production down. Obviously, unless Saudi oil reserves are a complete fabrication, it is clear that in the absence of other constraints, production could be increased sharply to accommodate rapidly expanding oil consumption.

But as shown in table 2.1, Saudi Arabia is not the only OPEC country with a large reserve base compared to its production. Venezuela's

Figure 2.5: Physically possible Saudi production through 2050.



Source: US Department of Energy.

heavy oil reserves are not even included in these figures. If included, Venezuela's reserves are estimated to be 315 billion barrels, eclipsing Saudi Arabia's reserves (Fox and Wilpert). Nevertheless, dividing the total resource base (reported reserves plus USGS estimated undiscovered reserves) by annual production gives the number of years that current production could theoretically be maintained at a constant rate. We see in table 2.1 that at current production rates the estimated total reserve base exceeds 87 years remaining for all six OPEC countries. Years remaining greater than ten years indicate that productive capacity could be significantly increased.[4] In principle, most of these countries, like Saudi Arabia, could double their productive capacity without the reserves to production ratio falling below ten. Furthermore, as illustrated in figure 2.5, these higher production rates could be sustained for a number of years. These calculations suggest that the magnitude of the underlying resource base is not a constraint for the foreseeable future.

It should be remembered that doomsday predictions have been around for a long time in the oil patch. During the energy crisis of the 1970s, probably the most influential book published was "Energy: Global Prospects 1985-2000" by the prestigious MIT Workshop on Alternative Energy Strategies. Based on world oil reserves of 658 billion barrels in 1975, the report concluded that world oil production would peak sometime between 1983 and 1993 and decline precipitously thereafter. Curiously, the world consumed 800 billion barrels of oil between 1976 and 2006, and yet oil reserves in 2007 totaled 1317 billion barrels! Oil reserves are like groceries on a shelf in the grocery store. They can be replaced and the only question is at what price. Obviously, at some point, their replacement cost will rise to a level that other substitutes will be preferred and conventional oil production will decline. There is no reason to think that this transition date will lead to massive economic upheavals. In sum, even if Simmons is correct about Saudi reserves being grossly overstated, the reserve estimates for other OPEC countries suggest that there is no "physical" constraint on the ability to sharply increase future production capacity. For the foreseeable future, OPEC will remain in business.

Technical Constraints on Capacity Expansion?

A common feature of oil production in most OPEC and many non-OPEC countries is the monopoly position of its own state-owned oil company. Today, 77 percent of the world's reserves are in the hands of state-owned oil companies. State-owned companies represent 14

[4] Reservoir engineering constraints limit the rate of current production relative to the remaining reserves because faster production can severely reduce ultimately recoverable reserves. As a rough rule of thumb, we use a reserves-to-production ratio of ten as an approximate guide.

of the largest 20 oil companies in the world in terms of production (Baker Institute for Public Policy). There is little question that these state-owned oil companies tend to be high-cost, inefficient operations compared to the international oil companies (Baker Institute for Public Policy). Not only are they higher-cost operators, but they tend to not have the level of technical expertise as the international oil companies, which are quite active in many high-tech applications.

The more salient issue, however, is whether these state-owned companies can obtain the requisite technological know-how necessary to exploit oil fields in their country and elsewhere around the world. There are a large number of privately-owned oil field service providers who stand ready to provide key technical support to these state-owned oil companies. Furthermore, for the development of these fields, which are predominantly onshore, a high level of technical expertise is not necessary. In sum, state-owned companies may be high-cost and inefficient, which can slow development, but in the end, technical expertise is not a binding constraint on the ability to expand capacity.

Financial Constraints – Limited Investment Funds?

Rational self interest would suggest that a government would grant favorable treatment to its major cash source and thus place top priority on funding capacity expansions. Under President Hugo Chavez, Venezuela seems to be defying the paradigm. The conflict between Petroleos de Venezuela (PDVSA) and Socialist President Chavez had dire repercussions for the company and its top management. Following a widespread oil strike in December 2002, production plummeted from almost three MMB/D to only 630,000 B/D. The top managers – along with 17,000 workers – were fired and replaced by individuals loyal to Chavez. Since then, Venezuelan production has recovered only to 2.5 MMB/D, yet the work force loyal to Chavez has risen by 29 percent. Even more ominous are the implications for Venezuela's ability to develop its enormous deposits of heavy oil contained in the Orinoco Belt. In the 1990s, the international oil companies were encouraged to bring their expertise to develop these reserves, which many believe could match that of Saudi Arabia. Now President Chavez is threatening to expropriate the assets of Exxon-Mobil, Conoco-Phillips, and Chevron and place these properties under the management of PDVSA (New York Times).

While the profit maximization or wealth maximization paradigm applies to the Exxon-Mobils of the world, state-owned oil companies like PDVSA operate in an entirely different setting with different objectives and operating constraints. Unlike private firms that can simply go to financial markets for additional exploration or development funds, national oil companies (NOCs) generally face far greater impediments in obtaining funds to provide capacity expansions. For many of the NOCs, the lack of financial transparency and history of government intervention makes access to foreign capital markets prohibitively expensive. For these, the question is whether internally generated funds can finance such expansions or if these funds be diverted elsewhere.

In most OPEC countries, oil revenues are a major government revenue source. Therefore, the national oil companies serve as a cash cow to support government expenditures of a diverse nature, meaning that NOCs must vie with other government agencies for development funds. For example, PDVSA is a major funding source for Chavez's social programs. Two-thirds of PDVSA's budget is dedicated to social welfare. In addition, many NOCs receive diminished revenues because of the subsidy on fuels for domestic consumption. Iran has some of the highest product subsidies in the world, with the price of gasoline selling for $0.10 per liter ($0.38/gallon). Low prices stimulate consumption, thus reducing the crude oil available for export. Indeed, it has been estimated that by 2011 Iran will no longer be a net exporter of oil (Baker Institute for Public Policy).

Still another factor restricting the availability of investment funds is the typically large labor forces employed in the NOC. In Mexico, PEMEX is a typical example of a state-owned oil company with a bloated bureaucracy. In effect, NOCs are asked to perform a number of noncommercial obligations that sacrifice wealth maximization, such as supporting government welfare initiatives, subsidizing domestic fuel consumption, and employing a large labor force. The Baker Institute study concludes that these inefficiencies vary considerably among NOCs, but they generally have a pronounced negative effect on the ability of NOCs to expand capacity.

It would be a mistake to paint all NOCs as grossly inefficient and incapable of expanding production. Saudi Aramco stands as an example of a well-run firm whose success the government values. Even for those mired in government-mandated noncommercial constraints, there is recognition – both by the company and the government – of the critical importance of the NOC to the government. At some point, noncommercial objectives must be relegated to the long-run viability of the NOC. Paradoxically, during periods of high oil prices, these companies are flush with cash and government is free to divert funds for a variety of non-investment uses. Instead of there being strong incentives to expand production at high prices as with profit maximizing firms, NOCs find themselves under little pressure to expand production. Curiously, when oil prices fall to low levels, government leaders of oil rich countries know that rising future oil revenues are critical to economic development and their ability to remain in power. To get higher oil revenues, a country must invest in additional capacity. Curiously, the pressures to increase capacity may be stronger in an environment of low oil prices than high prices, adding to the underlying instability of the oil market.

Geopolitical Constraints?

In looking at the six OPEC countries listed in table 2.1, it appears that three of the six have been significantly constrained by geopolitical events. We are, of course, referring to Iran, Iraq, and Venezuela. For example, prior to the Iranian Revolution in 1978, oil production in Iran stood at almost six MMB/D. Following the revolution and the war with Iraq, production was constrained by hostilities. However, with the return of peace in 1989, oil production recovered only to 2.8 MMB/D, and in 2006 production averaged four MMB/D. Over the same period, internal consumption almost trebled, leaving only 2.5 MMB/D for export. Thus, despite the impressive reserves shown in table 2.1, Iran's role in the world oil market has diminished dramatically because of political instabilities.

Another example is Iraq. Prior to its invasion of Kuwait in August 1990, Iraqi production stood at 3.3 MMB/D. Even with the "Oil for Food Program," Iraqi production reached only 2.5 MMB/D prior to the US led invasion of Iraq in April 2003. Following the departure of Saddam Hussein and the ensuing revolution, 2006 production stood at only two MMB/D. Years of neglect have no doubt taken their toll on Iraqi infrastructure. Likewise, one should not overlook PDVSA, Venezuela's state-owned oil company. Following the abortive attempt to depose Chavez in December 2003, the top management of the company was replaced with those loyal to Chavez and production capacity has continued to shrink. Compared to earlier periods, geopolitical instabilities have emerged as particularly strong factors impeding the ability to expand production from those key countries with exceptional oil reserves.

Constraints Imposed by Wealth Maximization?

There is yet another reason why key OPEC countries might consciously decide not to expand production capacity. Namely, it might not be in their economic self-interest to do so! Wealth maximization might dictate that they should simply freeze production capacity at current prices, allowing prices to rise sufficiently to limit demand to available supply. But would such a strategy maximize the wealth of the OPEC countries – particularly those shown in table 2.1 – which have large reserves capable of producing at the same rate for 50 or 100 years?

The power of discounting is particularly instructive in answering this question. Consider the following hypothetical situation. Should an oil producer like Saudi Arabia produce an additional barrel today at a price of $65 per barrel or defer production of that barrel for say 50 years from now and sell it at some future price? To be conservative, let us assume that the Saudis adopt a very conservative real discount rate of five percent to convert future oil revenues into their present value or value today.[5] For example, the present value of selling a barrel of oil next year using a five percent discount rate is $61.90 since, theoretically, if one had $61.90 today, he could invest it at a five percent interest rate and have $65 next year. The next question is what price (expressed in 2007 dollars) would they anticipate selling that barrel of oil for 70 years from now? Would it be $65, $100 or even $200 per barrel? We know that alternative energy forms will place an effective ceiling on the price of oil. Indeed, after considering the variety of long-run oil substitutes, it is difficult to imagine long run prices far in excess of $100 per barrel when measured in 2007 dollars. Adopting the conservative discount factor of five percent and substituting in future prices of $65, $100, or even $200 per barrel, we get some astounding results. The present value of that barrel of oil varies from $2.24 to $3.45 to $6.90 per barrel, respectively. Conversely, by selling the barrel today, the present value of the barrel is $65. Indeed, even if oil prices fell to half their current levels, wealth maximization would still dictate to expand production capacity and sell the oil today. Griffin and Xiong reach similar conclusions using a sophisticated model of the world oil market that incorporates cartel incentives.

TWO OTHER KEY PIECES TO THE PUZZLE

The preceding section might leave one with the impression that the future of oil prices will depend solely on the ability and willingness of OPEC countries to expand production. To be sure, this is a key consideration, but two other factors deserve particular attention as well. They relate to the long-run price elasticity of oil demand and the long-run supply elasticity of oil substitutes like oil sands, gas-to-liquids, and biofuels. As noted earlier, the short-run price responsiveness of demand to price increases is very price inelastic. But there is considerable evidence that in the long-run – after consumers adjust their auto fleet and diesel vehicles to higher prices – there is considerable elasticity. Using annual data spanning the period 1961-99 for 16 OECD countries, we found, as expected, a very inelastic short-run demand elasticity of

[5] Note that this is a real rate of discount which factors out inflation. Nevertheless, it is very conservative compared to discount rates typically applied in the private sector.

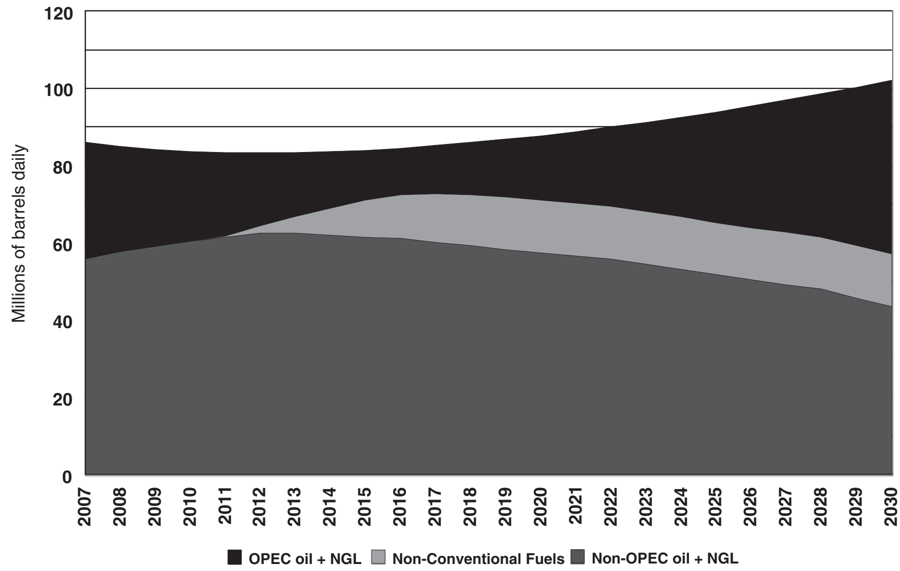
-0.09. But the long-run elasticity was -0.94 (Griffin and Schulman). It should be noted that this elasticity is measured with respect to the "retail prices" of petroleum products – not the wholesale price of a barrel of oil. Because of taxes and the costs of refining and distribution, the markup over crude prices in many countries exceeds twice the price of crude oil, meaning that the implied elasticity with respect to the price of crude oil would be cut in half. Yet, even with a long-run elasticity of -0.47, conservation effects are quite significant.

To illustrate the potential impact of higher oil prices on the long-run growth in oil consumption, we have simulated a mathematical model of the world oil industry called OPEC Genie. Figure 2.6 assumes that the price of oil remains constant at $70 per barrel for the period 2007 to 2030. To illustrate the sensitivity of oil consumption to long-term price changes, we show in figure 2.7 an example of the effects of oil prices ratcheting down to $30 per barrel by 2010 and remaining constant in 2007 dollars thereafter. In the low price scenario, price has no dampening effect on oil consumption, whereas rising world GDP causes oil consumption to grow at an approximate annual rate of 3.1 percent. Even though world GDP is assumed to grow at the same rate in both cases, the conservation effects of higher prices largely counterbalance the effects of rising GDP in the high price scenario out to 2015. Beyond 2015, the primary driver of oil consumption is world GDP because the long-run effects of the price increases in 2004-2007 have been realized. But because oil consumption is growing from a smaller base, oil consumption reaches 102 MMB/D by 2030. In contrast, under the low price scenario, world consumption reaches 145 MMB/D by 2030. Clearly, Genie posits that the magnitude of the long-run price elasticity will play a critical role in determining the world's demand for crude oil. In principle, world oil demand, not OPEC's ability to expand capacity, could over the next ten years be the constraining factor on prices.

Also shown in figures 2.6 and 2.7 is the potential for nonconventional fuels to significantly augment supply outside of OPEC. Assuming a return to $30 per barrel oil, the supply of nonconventional fuels is assumed to make an insignificant impact. At a $70 per barrel oil price, however, the model suggests there could be as much as 12.5 MMB/D coming on-stream within ten years. Production of Canadian oil sands is already ramping up to a projected 4.4 MMB/D by 2015. Estimated reserves of Canadian oil sands are 174 billion barrels (National Energy Board of Canada). Even though gas-to-liquids (GTL) plants are in their infancy, there are huge supplies of "stranded" natural gas that can be converted to sulphur-free diesel fuel.[6] Construction is currently

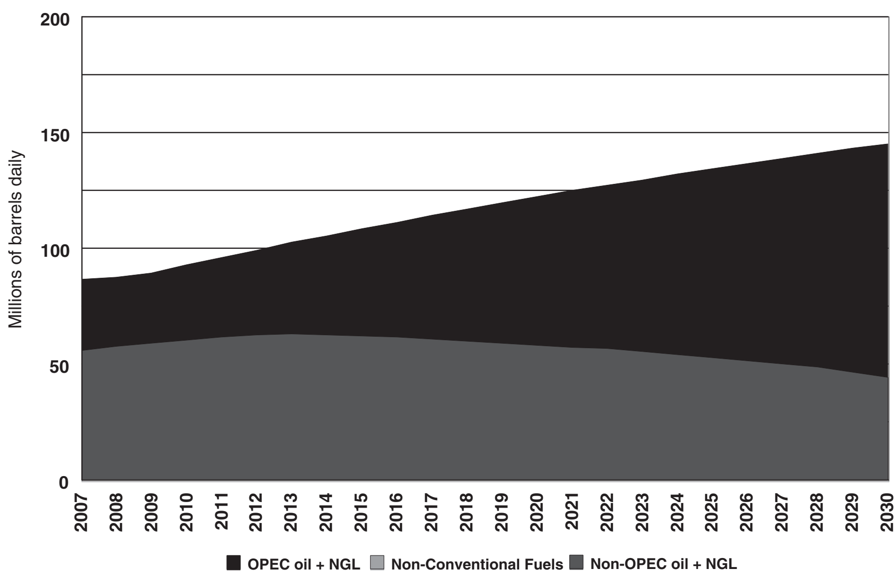
[6] Stranded gas supplies are located in areas sufficiently far from major consuming areas as to prevent their transport by pipeline. Consequently, their value is quite low and in the past, natural gas was flared as an unwanted byproduct of oil production in many remote areas.

Figure 2.6: The supply/demand balance under continued high prices.



Source: Author's calculations.

Figure 2.7: The supply/demand balance under reversion to low prices.



Source: Author's calculations.

underway for a 140,000 B/D Shell plant in Qatar. Also, Exxon-Mobil has a 154,000 B/D plant under construction in Qatar, which boasts almost 15 percent of world gas reserves and the world's largest gas field (Lyne). Shell and Exxon-Mobil are not alone, as virtually all of the large international oil companies have plans to build GTL plants. Finally, there is enormous potential for biofuels such as ethanol. Current forecasts predict that by 2010 ethanol production will reach 570,000 B/D. President Bush's recent State of the Union speech proposed US production of 2.3 MMB/D of biofuels by 2017. In sum, if high oil prices persist, the future for nonconventional fuels appears quite promising.

Interestingly, to the extent that long-run conservation effects slow the future growth in world oil demand and the supply of nonconventional fuels expands rapidly, this could have monumental effects on OPEC and in turn on the price of oil they choose. Because OPEC is a cartel, it is the residual supplier. At whatever price level OPEC chooses, OPEC supplies the quantity of oil remaining after subtracting nonconventional and non-OPEC conventional oil supply from world demand. As a consequence, should OPEC choose to leave prices at current levels, it could, according to Genie, lead to potentially intolerably low levels of OPEC production, as shown in figure 2.6. If such a scenario were to evolve, OPEC's resolve to defend prices at high prices becomes extremely problematic.

SUMMING THINGS UP

Ultimately, the pricing of ethanol and other biofuels will be determined not within the confines of NAFTA, but by the world oil market, which is best thought of as a huge bathtub. The world oil market has the following additional distinctive characteristics: 1) extremely price inelastic short-run supply and demand elasticities giving rise to great price volatility; 2) a reasonably effective OPEC cartel; and 3) rapidly growing oil consumption buoyed by Asian economic growth. Oil prices will fluctuate widely. The critical question is whether they will oscillate in the current high price range or return to the price pattern experienced in the 1985-2002 period. The answer to this puzzle appears to depend critically on: 1) the willingness and ability of OPEC countries to expand oil production; 2) the long-run price elasticity of oil demand; and 3) the price responsiveness of nonconventional fuels.

In today's world oil market, national oil companies increasingly dominate world oil reserves and, unlike private companies, their objectives diverge widely from the usual paradigm of shareholder wealth maximization. My analysis suggests that these companies' ability and willingness to expand capacity are not constrained by either the magnitude of the physical resource base or the technical expertise to exploit such reserves, or even the implications of wealth maximization. On the other hand, financial constraints coupled with geopolitical instabilities have hamstrung many of the national oil companies operating in countries with the largest potential for capacity expansion.

Before concluding that the future belongs to nonconventional fuels, like ethanol and biodiesel, one should be aware of two dark clouds on the horizon. Even if efforts to expand capacity are thwarted by all the noncommercial constraints facing the national oil companies, there are two other pieces to the puzzle that could make the issue of capacity expansion a moot issue. These are the long-run price responsiveness of oil demand and increased supplies of nonconventional fuels. Comparison of OPEC production under high versus low oil prices in figures 2.6 and 2.7 points us to the possibility that factors beyond OPEC's control may make current high prices unsustainable.

Genie tells us that the viability of the high price scenario could well be undermined by a combination of long-run price-induced conservation effects coupled with a rapid expansion of nonconventional fuels. Because OPEC is a cartel and thus the residual supplier, it could be the major loser in the high price scenario. In the years ahead, price induced lagged conservation effects could potentially offset rising worldwide GDP resulting in anemic demand growth. With increased non-OPEC production due to both increased conventional oil supplies and nonconventional fuels production, OPEC could find itself in a shrinking market share situation.

If indeed OPEC's market share shrinks as indicated in figure 2.6, all of the same factors contributing to the meteoric rise in oil prices over the last few years could work in the opposite direction. Paradoxically, state-owned oil companies which seem so inept at increasing production in a high oil price world may aggressively expand production in a low price world as a means for generating additional national revenues and staying in power. Cartel cohesion would be undermined, and the history of the 1981-86 period could be replayed.

Even if Genie overestimates the strengths of the long-run conservation and nonconventional fuel responses, investors in nonconventional fuels would do well to remember that price volatility is a permanent feature of the world oil market subjecting their investments to considerable risks.

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