Stanford University • June 2006

SIEPR policy brief

Stanford Institute for Economic Policy Research

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Lower Oil Price Volatility for a Smooth Transition to a Green Energy Future

By Frank A. Wolak

For the past two years, there has been enormous public outcry over the level of oil and gasoline prices. The price of oil has recently risen above $70 per barrel and the retail price of gasoline has persistently exceeded $3 per gallon. For both oil and gasoline, these prices are more than double their values from less than three years ago. However, this percentage increase in nominal oil and gasoline prices is not unprecedented.

Figure 1 plots the nominal price of West Texas Intermediate (WTI) crude oil from January 1946 to May 2006. It also plots these same prices adjusted to May 2006 dollars using the consumer price index (CPI). There have been two periods of comparable percentage nominal price increases. The first occurred in the early 1970s when the price of oil rose from slightly less than $4 per barrel (bbl) to over $10/bbl. The second occurred in the late 1970s when the price rose from approximately $12/bbl to over $30/bbl. Since that time until the late 1980s, the price of oil steadily fell, and it has fluctuated in the range of $10/bbl to $20/bbl until early 2000.

Excluding these two periods of rapid price increases and slower price decreases during the post-1973 period, the average real price of oil in May 2006 dollars before 1973 is roughly equal to the average real price during the post-1973 period. The major difference between the pattern of prices during the pre- and post-1973 time periods (even if the period from October 1973 to December 1985 is excluded from the post-1973 period) is the increased volatility of real oil prices after 1973. Including the period October 1973 to December 1985 only increases the post-1973 period real price volatility relative to the pre-1973 real price volatility.

Determinants of Oil Price Volatility

The major factor explaining the increase in price volatility after 1973 is the domination of the world oil market by a sometimes successful cartel of the major oil producing countries—the Organization of Petroleum Exporting Countries (OPEC). The eleven members of OPEC are Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates and Venezuela.

Although OPEC first started in 1960 as an association of producing countries attempting to capture a greater share of world oil market revenues, it wasn't until the early 1970s that OPEC was able to gain some control over world oil prices. Following the nationalization of many of the oil-

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producing assets in their member countries during the early 1970s, OPEC was able to have a greater effect on world oil production and used it to raise world oil prices.

The record high real price of oil in 1979 led to a substantial reduction in the world demand for oil and an increase in exploration activity. In addition, OPEC faced the standard problem that plagues all cartels of maintaining the reduced output level necessary to sustain high prices. A cartel raises prices and earns higher profits for its members by producing less than each member country would find unilaterally profit maximizing given the cartel output levels of the remaining firms.

A simple example illustrates this point. Suppose that the cartel is composed of 10 identical firms and at the cartel's profit-maximizing level of output each firm produces 1 million barrels per day (bbl/day) for a total demand of 10 million bbl/day and market price of $30/bbl. However, if each of the remaining nine firms produces 1 million bbl/day, country 1 would find it unilaterally profit maximizing to produce 2 million bbl/day. Then, suppose that this higher level of supply, 11 million bbl/day as opposed to 10 million bbl/day, causes the price to drop to $25/bbl.

Under the cartel solution, country 1 makes $30 million per day, but by producing 2 million bbl/day it earns $50 million per day, assuming in both cases that all other firms continue to produce the cartel output level of 1 million bbl/day. As long as the variable cost of producing oil is less than $20/bbl, country 1 would prefer to produce 2 million bbl/day instead of the 1 million bbl/day output level that maximizes the joint profits of the cartel. Country 1 is not unique in this example. All countries would prefer to produce more than the cartel output amount if they were confident that the remaining cartel members would produce their cartel output amount.

This divergence between each country's unilateral incentive and what is in the joint interest of all cartel members causes countries to cheat on their agreed-upon cartel output levels. Reduced world demand and greater supply from non-OPEC members at these higher prices also increases this incentive to defect because the cartel member that expands its output only slightly reduces market prices.

All of these factors make it extremely difficult for countries to maintain cartel output levels for a long period of time. Consequently, the pattern of prices after 1973 is consistent with temporary periods of coordination on the cartel output levels and higher prices that trigger greater output from non-cartel members and reduced demand. This results in cheating on the cartel output levels by some or all cartel members. This leads to price reductions and renewed attempts of OPEC to coordinate on cartel output levels. These movements between varying degrees of successful and unsuccessful coordination on cartel output levels have been the major cause of the price volatility that has occurred in the world oil market after 1973.

The second factor that explains the current run-up in real oil prices is the unexpectedly rapid increase in the demand for oil from developing countries, such as China and India. According to the U. S. Department of Energy, China has accounted for approximately 40 percent of world oil demand growth over the past five years. To put this in perspective, China's growth in oil demand over the past year is equal to slightly more than half of California's annual demand for oil. Although India's demand for oil is substantially less than China's, the growth in India's demand for oil has recently increased.

The final factor allowing OPEC to raise world oil prices is that its share of world oil production is now above 40 percent for the first time since 1980, when the real price of oil was almost $100/bbl in March 2006 dollars. Controlling a large share of world oil output implies that OPEC now has a greater ability to influence world oil prices.

These high real oil prices will trigger reductions in demand and increases in supply from non-OPEC producers and competing energy sources, which are likely to make it more difficult for OPEC to maintain real oil prices at their current levels. The increased incentives for OPEC members to cheat on their cartel production levels could trigger a percentage decline in real oil prices similar to the one that occurred from 1980 to 1985.

Why Limit Oil Price Volatility

The unpredictability of future oil prices has a number of negative consequences. First, there are many environmentally friendly and financially viable competitors to oil if the real price of oil was known to be greater than $70/bbl into the distant future. These competing technologies require substantial up-front investments and longtime lags between the investment decision and actual production of energy. These facilities are unlikely to be built unless investors expect to earn a reasonable return on their investment. Examples of environmentally-friendly energy sources that are economic if current real oil prices persist into the distant future include solar power, wind power and cellulosic ethanol.

Virtually all ethanol currently produced in the United States comes from corn. There is considerable debate whether more energy is required to produce corn ethanol than it contains and whether greenhouse gas emissions are, in fact, reduced by producing ethanol from corn. In contrast, cellulosic ethanol is produced from agricultural and forestry residues, municipal solid wastes, and even fast-growing plants cultivated specifically for this purpose.

Producing ethanol from cellulosic biomass uses a significantly more complex and expensive process than the one used to produce ethanol from corn. However, this process results in dramatically less greenhouse gas emissions than ethanol made from corn. Moreover, the many possible biomass inputs to produce cellulosic ethanol imply that a substantial investment in this technology could allow it to replace a significant fraction of U.S. gasoline consumption. Unfortunately, the capital costs of a facility that would produce about 25 million gallons of ethanol per year are easily more than $100 million.

Consequently, unless potential investors are very confident that oil prices will remain at or above current levels, it is unlikely that they will sink this amount of money into a cellulosic ethanol facility. Similar logic applies to solar- and wind-powered electricity generation facilities. Without government subsidies to invest in existing versions of these technologies, it is unlikely that investors will construct these renewable energy facilities unless they are confident that oil prices will remain at or above current levels into the distant future.

A worst-case scenario for these technologies is if the real price of oil fell back to $20/bbl, as it did during the middle of the 1980s. Investors would be forced to shut down their facilities unless they were given production subsidies. At $20/bbl oil, the price of gasoline would be far too low for ethanol to compete with. The price of fuel oil and diesel fuel would be too low for solar power and wind power to compete with oil-fired electricity generation on a subsidy-free basis.

Therefore, a necessary condition for the development of alternative energy sources is greater certainty about future oil prices. In fact, it seems likely that these energy sources would be developed if investors were certain that real oil prices would stay above $50/bbl in May 2006 dollars. Thus, a key factor in a smooth transmission from an oil-based economy to a renewable energy economy is oil price stability. By limiting oil price volatility into the distant future, the best possible economic case for these alternative energy sources can be made.

How to Limit Oil Price Volatility

The usual way to limit short-term price volatility is to develop an active forward market for the product. Instead of purchasing gasoline in the short-term market when it is needed, consumers should instead purchase in advance their expected demand for gasoline for the next year or two. This would significantly limit their exposure to short-term gasoline price fluctuations.

An example of how forward-market purchases limit a consumer's exposure to short-term price volatility comes from the airline industry. A consumer always has the option to show up at the airport on the day he would like to fly and purchase the ticket at that time. If there are plenty of available seats on the flight, the consumer may be able to purchase the ticket at a very low price. But if the flight is over-booked, the consumer may be unable to get on the flight at any price, unless he can convince another passenger to give up his ticket. Because consumers would prefer not to bear this short-term price risk, they purchase their tickets in advance of the day they would like to fly. This

hedges them against any short-term fluctuations in the price of the flight. However, this does not guarantee the consumer the lowest possible price for the flight, as anyone who has priced the same itinerary a few days after purchasing it can attest. Nevertheless, the customer has locked in the fare for the itinerary and guaranteed a seat on the flight.

The fact that customers hedge this price risk also benefits the airline. Because the airline knows how many customers are flying from one city to another on given flight, it is better able to plan which airplanes to fly on which routes. This reduces the operating cost of the airline and, if there is sufficient competition between airlines on the route, a portion of these cost savings should be passed on to consumers in the form of lower fares.

These forward sales to final consumers provide a strong incentive for the airlines to hedge their input price risk. All airlines are active participants in the forward market for jet fuel. The profitability of U.S. airlines in recent years is highly correlated with how well they hedged their short-term jet fuel price risk.

Applying this logic to the case of gasoline implies that consumers should purchase their gasoline demand in advance of the date that they plan to consume it. For example, each year a consumer could purchase a large portion of his expected annual consumption at a fixed price. This limits his exposure to short-term price volatility. If the customers for other refinery products, such as jet fuel and fuel oil, also make substantial purchases in the forward market, oil refineries will have far more certain demands for oil into the distant future.

Large forward purchases of refinery output by consumers of these products will also cause refineries to purchase the necessary oil in the forward market to meet these fixed-price future output obligations. This process will stimulate the development of an active forward market for oil.

If a substantial fraction of oil consumption is purchased in the forward market far in advance of delivery, there will greater opportunities for alternative energy sources to compete against oil. For example, if a cellulosic ethanol supplier can sell a forward contract for ethanol to final consumers for several years into the future, this can provide the needed revenue certainty to finance the investment needed to construct a new production facility.

It is unlikely that consumers will sign long-term supply agreements for a long enough time into the future to provide the revenue to fund the full construction cost of the cellulosic ethanol facility or solar- or wind-powered electricity generation facility. However, forward contracts of even one to two years will increase revenue certainty, which will increase the likelihood that these facilities are constructed.

Fuel Banks for Gasoline

Forward contracts for gasoline may sound far-fetched, but they already exist in parts of the United States. A small chain of gas stations in St. Cloud, Minn., offers customers the option to buy such contracts. This company, First Fuel Banks, allows customers to purchase a pre-specified number of gallons of gasoline at a fixed price and then pump this gasoline as needed. Other retailers around the United States are planning to offer similar products. One retailer plans to offer a product similar to the one offered by First Fuel Banks, which allows the customer to lock in the price for a fixed quantity of gasoline. Retailers are also offering price-spike insurance where a customer might pay 20 cents per gallon to cap the price they will pay for a fixed period of time into the future at today's price of gasoline.

If consumers of refinery products purchase a substantial amount of their expected consumption far in advance of when they need it, this will limit their exposure to short-term price variability. If little oil is purchased on the short-term market, OPEC will have less incentive to raise short-term prices, because less of its output will be sold at short-term prices. To understand this incentive, suppose a large supplier expects to sell 100 million barrels of oil next year. If this supplier has already sold 90 million barrels in a fixed-price forward contract, then it has little incentive to take actions to raise short-term prices because it is a net buyer of oil until it meets its forward market obligations of 90 million barrels. If this supplier eventually sells 100 million barrels, it will earn the short-term price on only 10 million barrels. Any change in the short-term price that this supplier is able to implement will only apply to 10 million barrels, rather than 100 million barrels. Forward

sales of 90 million barrels implies that this supplier receives one-tenth (=10/100) the pay-off from increasing short-term prices relative to the case that it sold all 100 million barrels at the short-term price.

Evidence that forward-market obligations limit the incentive of suppliers to take actions to raise short-term prices comes from wholesale electricity markets, where suppliers typically sign fixed-price long-term contracts with electricity retailers for a virtually all of their final demand. These forward contracts limit the exposure of electricity retailers to short-term wholesale price fluctuations. They also provide strong incentives for the suppliers to meet their fixed-price forward-market obligations in a least-cost manner, because they are net buyers of electricity from the short-term market until they produce and/or purchase their forward-market obligations from the short-term market.

If a substantial amount of refinery product purchases are made under long-term contractual arrangements, this will provide two sources of benefits to final consumers. The first benefit will come from greater opportunities for suppliers of alternative fuel sources to compete with fossil fuel suppliers to serve final consumers. A more certain future revenue stream will increase the likelihood that the alternative energy suppliers construct new facilities to compete against existing fossil fuel sources to provide electricity and transportation fuels. A second benefit will come from the reduced incentive of OPEC to take actions to raise short-term oil prices.

It is important to emphasize that there is no guarantee that purchases in the forward market will be at lower prices than the short-term price on the delivery dates of the contracts. However, the longer the duration of these fixed-price forward contracts, the greater the reduction in the volatility of the revenues to oil producers and suppliers of alternative energy sources. Longer duration contracts yield a revenue stream that is more conducive to financing investments in more environmentally friendly energy sources. In addition, larger market shares for these alternative energy sources reduce the ability of OPEC to move market prices through its output decisions.

Although the development of an active forward market for gasoline and other refinery products will take some time, the barriers to developing this market are not technological. The Internet represents the ideal mode for selling and administering this market. One can very easily imagine going online to purchase and sell forward contracts for gasoline and other refinery products with very low transactions costs.

U.S. consumers and politicians can limit the ability of OPEC to control world oil prices. Purchase energy far in advance of delivery. Federal, state and local governments and large private organizations can also help by purchasing their expected energy needs at least one year into the future in the forward market. These actions will give clean energy sources their best chance to compete and will limit the ability and incentive of OPEC to raise short-term oil prices.

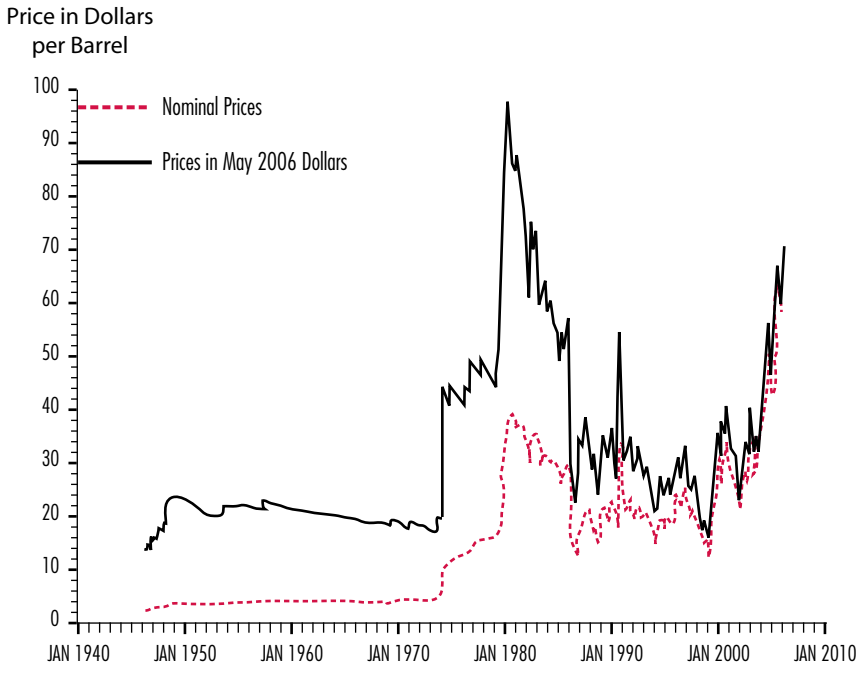

Figure 1: Nominal and Constant Dollar (May 2006) Price of Oil

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