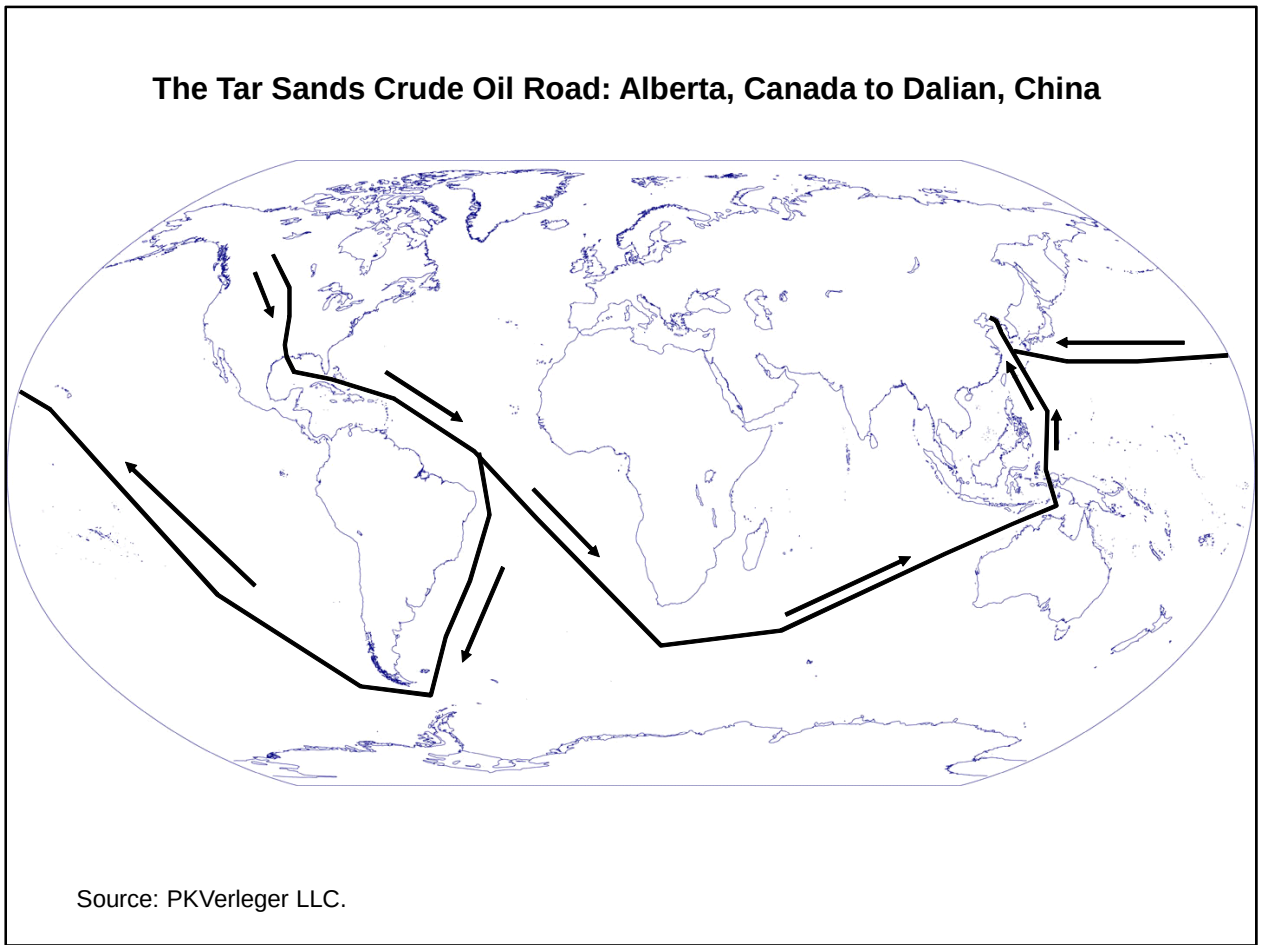
The Petroleum Economics Monthly

Philip K. Verleger, Jr. Volume XXVIII, No. 2 February 2011

THE TAR SANDS ROAD TO CHINA: THE LONG, TORTURED ROUTE FROM ALBERTA TO DALIAN



(Publication Date: 3/22/2011)

The Tar Sands Road to China: The Long, Tortured Route from Alberta to Dalian

Philip K. Verleger, Jr.
PKVerleger LLC

Table of Contents

List of Figures

List of Tables

Summary

This issue of *The Petroleum Economics Monthly* covers two topics: 1) the market impact of the Libyan disruption and the earthquake in Japan, and 2) the implications of efforts by Canadians to expand the Keystone pipeline, a facility for starting tar sands crude on the first leg of a long journey from Alberta to China. If built, the Keystone XL pipeline would run from Hardisty to Houston. The report begins with the pipeline.

The TransCanada Corporation is behind the Keystone XL pipeline. The U.S. State Department is now reviewing the company's environmental impact statement. According to Platts, the State Department decision should come by the end of the year.[1]

The pipeline's proponents claim it will improve U.S. energy security by allowing us to replace oil imported from politically volatile foreign sources such as the Middle East and Venezuela. In filing with Canadian regulators, the proponents also assert the pipeline will allow Canadians to manipulate U.S. oil prices and thus extract an extra $4 billion per year from American consumers.[2]

The pipeline's opponents object to the environmental impacts of producing crude from Canadian oil sands. They believe production will boost greenhouse gas emissions and destroy Canadian resources unnecessarily. Consumer groups also oppose the project based on its stated intent to push gasoline and diesel prices in the U.S. Midwest higher.

This debate is almost irrelevant, however. The proposed pipeline is really the Canadian equivalent of the "Silk Road," that is, a long, torturous way to move crude oil from Canada to China. As the cover-page map shows, crude will flow south from Alberta to Houston and then east on large tankers through the Gulf of Mexico. From there, it will go southeast to the Cape of Good Hope and then east to China or south to Cape Horn and then northwest to China. The crude path that begins with the Keystone pipeline is no different from Marco Polo's famous trade route through Asia. We call our version the "Tar Sands Road."

If it is built, the Tar Sands Road Pipeline (TSRP), in addition to allowing Canadian crude to reach China, will turn the U.S. Gulf Coast into the world's most profitable refining center. Margins on the Gulf will likely be $4 to $6 per barrel higher than margins in Asia, the Middle East, or Europe for equivalent facilities. The high margins result from shipping economics that will force all crude prices on the U.S. Gulf to be $3 to $6 per barrel lower than in Asia.

By implication, the TSRP will also lead to lower prices for crude oil produced from U.S. facilities in the Gulf of Mexico and midcontinent. In short, Canada's push to market its crude will hurt U.S. producers but benefit U.S. refiners.

TSRP proponents disagree with this view. The pipeline, they argue, will displace crude from the Middle East and Venezuela. They present an analysis by energy industry consultants Purvin & Gertz to support their view. The study is an excellent example of "static economic analysis," that is, analysis that does not account for market behavior. Purvin & Gertz ignore the economic incentive of Gulf Coast refiners to limit Canadian crude purchases to force sales to China. Exercise of such market power profits refiners because it depresses all prices. Purvin & Gertz also

[1] *Platts Oilgram News*, March 18, 2011.
[2] See Purvin & Gertz, "Western Canada Supply and Markets," February 12, 2009.

ignore the fact that Saudi Arabia, a key U.S. Gulf supplier, sells crude on a market-related basis and thus cannot be pushed out. Saudi Arabia may also want to sell crude to the U.S. Gulf to depress North American prices and discourage production there.

As we explain in Section I, if built, the TSRP will contribute to much larger refining margins in the Gulf and lower U.S. crude prices, including for WTI. It will also link Canadian with Chinese markets.

Section II reviews the market situation after the Libyan crisis and the Japanese earthquake. These events will once again squeeze the global ultra-low-sulfur diesel (ULSD) market. Our analysis suggests prices could easily surpass the 2008 peaks absent actions by consuming governments. These could include the release of strategic sweet crude reserves or the relaxation of sulfur standards for some petroleum products. We view either action as unlikely and anticipate much higher crude prices as a result. Section II concludes with a price scenario.

I. The Tar Sands Pipeline

TransCanada Corporation, a Canadian firm, is obtaining approvals to build a 36-inch pipeline to move crude oil from Hardisty, Alberta, to storage facilities near Houston. To do this, TransCanada needs U.S. State Department approval because the pipeline would cross the U.S.-Canadian border. The State Department, in turn, must file an environmental impact statement before issuing its decision.

Debate over the pipeline has been intense. Its proponents claim the facility would move 1.1 million barrels of Canadian crude south. This would, according to TransCanada's economic consultants, increase U.S. energy security and boost U.S. economic activity by $20 billion.[3] The pipeline has also garnered support from the usual suspects, including the American Petroleum Institute. Opposition to the project has come from groups that object to the emissions associated with synthetic crude (tars sands oil) production, as well as the potential environmental damage brought on by the pipeline's construction.

With the exception of one report that proponents apparently have tried to hide, the debate has ignored the project's economic impacts. The suppressed document, prepared by the energy industry consulting firm Purvin & Gertz, describes how the pipeline would allow Canadian producers to manipulate U.S. crude oil prices to extract another $2 to $4 billion from U.S. consumers. The report also tried convince its readers that Canadian crude oil would be processed by U.S. Gulf Coast refiners.[4]

In this issue of *The Petroleum Economics Monthly*, we focus on the pipeline's economic impacts. Our basic conclusion is this: the pipeline, if built, will facilitate Canadian crude exports to China rather than the United States. These exports will result in U.S. crude prices significantly below world crude prices, with U.S. Gulf Coast production selling for $4 to $6 per barrel less than equivalent crudes in China or on the U.S. West Coast. (The West Coast typically sees the highest prices for U.S. oil.) The midcontinent prices will be depressed even more. WTI could settle, in equilibrium, at an $8-per-barrel discount to international crudes.

We base this conclusion on our assessment of the economic interests of principal crude oil buyers on the U.S. Gulf, as well as existing relationships between Gulf Coast refiners and buyers. Specifically, we note that the Gulf refiners identified by Purvin & Gertz as possible buyers of Canadian crude have existing long-term agreements that will limit how much they can purchase. We also note that potential Canadian crude buyers collectively have market power to depress crude prices by limiting purchases of Canadian crude. At the same time, oil-exporting countries sending crude to the U.S. can match the discount on Canadian crude. The exercise of such market power is frequent in the oil industry. We suggest here that the pipeline's completion will allow buyers for refineries to squeeze crude prices down and boost refining yields. This will make the Keystone pipeline (dubbed earlier the Tar Sands Road Pipeline, or TSRP) a vehicle for earning Gulf Coast refiners as much as $6 per barrel more in profits.

[3] The Perryman Group, "The Impact of Developing the Keystone XL Pipeline on Business Activity in the United States," June 2010 [see http://www.transcanada.com/economic_benefits.html].
[4] Purvin & Gertz, 2009.

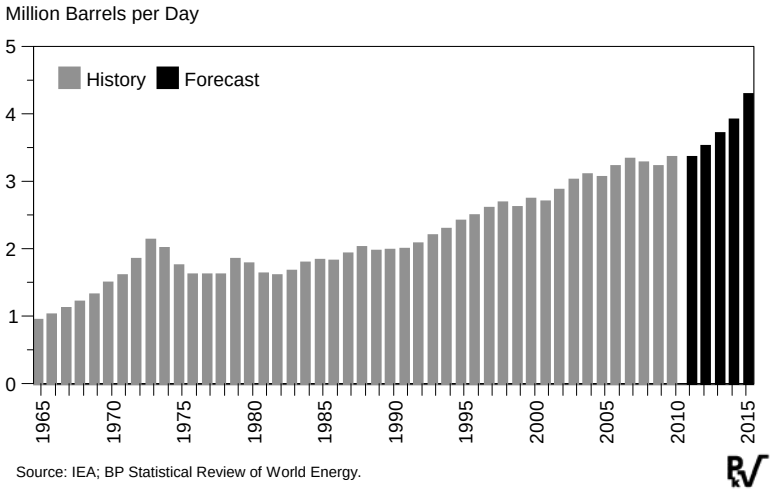
We expect refiners will exercise their new power. As noted below, a good part of the Canadian oil shipped to Houston will move on to China as crude prices in the U.S. Gulf drop below those received by producers of equivalent grades in Europe, Africa, the Middle East, or Asia. We estimate the potential annual cost to U.S. producers to be $8 billion.

We offer no conclusion here as to whether the pipeline should be built. Our focus is on the potential economic impact. We leave it to others to decide whether the facility merits construction.

Background

The expansion of crude oil production from the Canadian tar sands will alter world oil market dynamics. As noted in our January report, Canadian production has increased from 2.7 million barrels per day in 2000 to 3.3 million barrels per day in 2010. The International Energy Agency (IEA) projects this output to rise to 4.2 million barrels per day by 2015.[5] (Figure 1 shows the historical and projected production.) The boost in output can only be achieved, though, through construction of additional means to move the oil to market.

Figure 1
Crude Oil Production in Canada — History and Projection



Source: IEA; BP Statistical Review of World Energy.

Traditionally, Canadian oil was shipped east by pipelines across Minnesota, Wisconsin, Illinois, Michigan, Ontario, and Quebec. Its primary buyers were in those states and provinces. However, demand from refiners in these areas was not sufficient to absorb the higher production. As output rose, the pipelines were reversed to take the crude south on facilities initially built to bring oil north from Oklahoma and Texas to refineries in Illinois. Further transport capacity was added by Keystone, which converted a natural gas line to crude service.

These facilities will not be adequate, though, to accommodate the projected production from the tar sands. Thus, proponents in Canada have focused on building additional capacity. One company, Enbridge, would like to run a line to Kitimat, British Columbia, where oil could be

[5] IEA, *Medium-Term Oil Market Report*, June 30, 2010, p. 132.

loaded on ships bound for Asia. As initially proposed, this Northern Gateway pipeline would carry 525,000 barrels per day.[6]

Northern Gateway, however, faces significant objections from British Columbia residents, as well as First Nation tribes, over whose reservations the pipeline would pass. Under Canadian law, these objections can prove formidable and they might stop the project in its tracks.

Figure 2
Current Keystone Pipeline and Proposed Keystone XL Pipeline

Source: PKVerleger LLC.

TransCanada has proposed an alternative line. The Keystone XL expansion line would run south from Hardisty, Alberta, to Houston (see Figure 2). The proposed line would carry 1.1 million barrels per day. The TransCanada proposal faces fewer legal obstacles due to U.S. pipeline law. However, the facility must be approved by the U.S. State Department. (Canada's National Energy Board gave its blessing to the project on March 11, 2011.) As noted, the State Department authorization is proving to be the real obstacle as U.S. and Canadian environmentalists have mounted strong objections to the proposal, arguing that excessive pollution would be associated with the crude shipped on the pipeline. These groups know that this pollution will be prevented if the approvals are denied.

Economic Arguments for the TransCanada Keystone XL Pipeline

The Keystone proponents argue that the pipeline will offer significant benefits to the United States. These include greater energy security and the significant employment opportunities associated with its construction. TransCanada's economic consultants, The Perryman Group based in Waco, Texas, estimate the project would yield $20 billion in benefits to the U.S. over its life. By our calculation, this works out to be 0.001 percent of GDP per year.

The Perryman Group also asserts that the pipeline will enhance U.S. energy security. Perryman makes the traditional case regarding the economic risks associated with importing oil, repeating *ad nauseum* the usual arguments regarding supply reliability.

The group's report ignored the move toward a globalized economy and the abandonment of autarky in favor of free trade in the late twentieth and early twenty-first centuries. As noted recently by this author in "Forty Years of Folly," the quest for energy independence has led to eco-

[6] See "We're Building More Than Pipelines," Enbridge brochure [http://www.northerngateway.ca/files/ENB_NGP_BrochureOct26.pdf].

nomic disaster.[7] Neither the United States nor any other country pursues autarky for other commodities, including strategic materials such as rare earth minerals.

The Perryman Group also missed the fact that the United States has invested billions in oil security by developing the Strategic Petroleum Reserve (SPR). The existence of the SPR moots any economic protection argument for the pipeline.

Thus the economic case for the Keystone XL rests on it generating a significant number of construction and support jobs.

Market Impact of the XL Pipeline

In presentations to Canada's National Energy Board (NEB), proponents of the Keystone XL pipeline suggested that constructing the line would enable Canadians to exercise market power in the United States. Specifically, TransCanada made this assertion in its NEB filing:

> Existing markets for Canadian heavy crude, principally PADD II, are currently over supplied resulting in price discounting for Canadian Heavy Crude Oil.
>
> Access to the USGC [U.S. Gulf Coast] via the Keystone XL Pipeline is expected to strengthen Canadian Crude oil pricing in PADD II by removing the oversupply. This is expected to increase the price of heavy crude to the equivalent cost of imported crude. Similarly, if a surplus of light synthetic crude develops in PADD II, the Keystone XL pipeline would provide an alternative market and therefore help to mitigate a price discount.
>
> The resultant increase in the price of heavy crude is estimated to provide an increase in annual revenue to the Canadian producing industry in 2013 of U.S. $2 billion to U.S. $3.9 billion.[8]

In simple terms, the TransCanada application states that the firm will be able to use its market power to raise the heavy crude price to Midwest refiners above the level that would prevail in a competitive market. The explanation for the market power can be found in Figure 2 above. This graph shows the existing Keystone pipeline flow from Hardisty, Alberta, to Midwestern refiners, Cushing, and Houston. Also shown as a dotted line is the proposed Keystone XL line, which goes directly south. Historically, the competitive price to refiners in the Midwest exceeded the Gulf Coast price because the Gulf crude had to flow north. Midwestern prices reflected the cost of imported crude *plus* transportation.

Today, however, crude flows south. Thus crude reaching the Gulf of Mexico from Canada will compete there with imported crude. *On the Gulf Coast, refiners will pay the price of imported crude for Canadian oil.*

The Midwest refiners should benefit from this regime because the oil they purchase does not include the cost of transportation to the Gulf, which some estimate to be $5 per barrel. Thus in a competitive market, Midwestern refiners should get a discount—as they do today.

TransCanada, acting as a good monopolist, though, proposes to divert crude from Midwestern refiners so Canadian producers can get a price higher than the competitive price, that is, oil would be diverted until those refiners have to pay the same price as Gulf Coast refiners. Trans-

[7] Philip K. Verleger, Jr., "Forty Years of Folly," *The International Economy*, Winter 2011, pp. 49-51.
[8] Keystone XL Pipeline Section 52 Application, Section 3: Supply and Markets, Section 3.4.3, "Crude Pricing Impact," p. 7.

Canada' consultants, Purvin & Gertz, even suggest TransCanada might be able to raise prices to the point where Midwestern refiners become indifferent between bringing oil from the Gulf at an added transport cost and processing Canadian crude.[9] If successful, TransCanada's exercise of monopoly power will extract $3.9 billion from U.S. consumers according to TransCanada, or $6 billion according to its consultants.

Such behavior is not unusual in the oil industry. Indeed, it is commonplace. As we explain below, potential buyers of Canadian crude in Houston have every incentive to limit their purchases of it to force the oil to be exported to Europe or more likely Asia. This would drive the Canadian crude price down—doing to Canadians just as TransCanada proposes to do to Midwest refiners.

ConocoPhillips provides the most recent example of the exercise of market power. As we noted in our January issue, the WTI price has been depressed relative to Brent crude oil because capacity to move crude to the Gulf Coast is insufficient. As a result, oil is backing up in Cushing and thus lowering the price of midcontinent and Canadian crude.

As it turns out, the Cushing bottleneck could be relieved simply by reversing the Seaway pipeline. Seaway can move 350,000 barrels per day of crude from the U.S. Gulf to Cushing. However, little oil is flowing now because midcontinent prices are well below the price of imported crude.[10] The Seaway operator, Enterprise Product Partners, Inc., would gladly change the pipeline's direction if it could. However, its partner in the line, ConocoPhillips, has no interest in this. As ConocoPhillips' CEO told an investor group in February, "We don't really think that's in our interest because we need more crude in the area."[11]

In fact, ConocoPhillips is moving almost no oil through the line. Platts estimated throughput at 20 percent of capacity, or 68,000 barrels per day. ConocoPhillips is doing this because it earns tremendous benefits by bottling up crude in Cushing. Through February, the company could probably acquire crude for its two Midwestern refiners at a $10 to $15-per-barrel discount from world prices. If these facilities ran at their full capacity of 340,000 barrels per day during that month, the firm may have earned as much as $125 to $186 million per month. Such profits give it every incentive to resist attempts to reverse the line in the short term.

TransCanada, as noted above, seeks to achieve similar monetary benefits by diverting crude from the Midwest until refiners there must pay a price equivalent to that of imported oil. However, TransCanada's efforts may be frustrated by buyers for refineries on the Gulf Coast. These buyers can also exercise market power. By limiting their purchases of Canadian crude, these firms could force Canadian producers to seek buyers in markets such as Europe, Asia, or the Middle East. The most likely buyer would be in China, which would add $4 to $6 per barrel to the cost of transporting the tar sands crude.

The economic explanation for this development is relatively straightforward. The market clearing price of a commodity is usually set at a single point: the market where supply and demand clear. The completion of the Keystone XL pipeline would create a surplus in the U.S. Gulf.

[9] Purvin & Gertz, 2009.
[10] "Lower Q4 Seaway Line Throughput Cuts Enbridge Onshore Pipeline Margins," *Platts on the Net*, February 17, 2011.
[11] Aaron Clark, "ConocoPhillips Not Interested in Reversing Seaway Pipeline," Bloomberg.com, February 15, 2011.

This surplus would require some oil to move from the Gulf to other markets unless existing importers vacate the market. As noted below, existing importers are not expected to concede market share to Canada. Instead, some Canadian oil will need to be exported from the Gulf. At this point, Asia would be the clearing market. Prices would be set there and prices in other parts of the world, such as Africa, the Middle East, the North Sea, or the U.S. Gulf, would be lower, reflecting the cost of transportation to China.

TransCanada's refining consultant Purvin & Gertz provides the basis for our assertion that Canadian oil will be exported. It appears in TransCanada's filing with NEB. According to the consultants, refiners in the key market area have a combined capacity of almost four million barrels a day. They suggest these refiners would all be open to purchasing Canadian crude.

For a variety of reasons, though, the potential market is smaller, probably no more than 1.7 million barrels per day. Table 1 (page 9) shows our calculation and the consultant's calculation of market size. The Keystone XL would push between 500,000 and one million barrels per day of crude on these buyers. Price reductions must be expected.

The market for Canadian crude is relatively small because other oil producers have long-term supply agreements with Gulf refiners. These contracts effectively tie up more than half the refining capacity on the Gulf. The refiners that have made these arrangements will be unable to buy significant quantities of Canadian crude. Furthermore, it would be in the interest of these refiners to see Canadian oil shipped to China.

Start with Saudi Arabia. Today, the Kingdom has several key term buyers of its crude on the Gulf. These are the Motiva refinery in Port Arthur, jointly owned by Saudi Aramco and Shell, ExxonMobil, and, to a lesser extent, Marathon. The Motiva joint venture is not likely to become a significant customer for Canada. ExxonMobil also has a longstanding relationship with Saudi Arabia. ExxonMobil will no doubt stay on as a customer if Saudi Arabia continues to price its crude competitively. In Table 1, we show that the ExxonMobil, Motiva, and Marathon refineries are not likely customers for Canadian crude.

Venezuela has also locked in a number of buyers. Thirty years ago, that country and other producers of heavy crude confronted the market power exercised by Gulf Coast refiners. The buyers could process significant volumes of heavy sour crude but generally chose to limit purchases to increase refining margins. Venezuela had to beg customers to take its crude and paid dearly.

The country responded by purchasing Citgo refining and signing long-term contracts with firms such as Conoco. As part of these deals, various refiners constructed cokers and other facilities to process heavy Venezuelan crude. (This strategy was defined in a paper by Bressler and Verleger published more than 20 years ago.[12]) Venezuela now has contracts with Conoco and HOVENSA (a joint facility owned in part by Hess) and it still owns Citgo. Each facility is contractually obligated to take Venezuelan crude. Each is also guaranteed a healthy profit on its operations though netback contracts with PDVSA.

[12] James L. Bressler and Philip K. Verleger, Jr., "Strategies for Maximizing the Value of Heavy Crude," *Journal of Energy and Development* 7, No. 2 (Spring 1982), pp. 271-287.

Table 1. U.S. Gulf Coast Refiners Expected to Purchase Crude from Canada
(Thousand Barrels per Day)

	Location	Refining Capacity	Potential Purchases from Canada
BP	Texas City, TX	478	478
Calcasieu Refining	Lake Charles, LA	53	53
Citgo	Lake Charles, LA	430	0
ConocoPhillips	Lake Charles, LA	239	0
Deer Park Refining	Houston, TX	330	0
ExxonMobil	Beaumont, TX	349	0
ExxonMobil	Baytown, TX	567	0
Lyondell Refining	Houston, TX	271	271
Marathon Refining	Texas City, TX	78	0
Motiva Refining	Port Arthur, TX	285	0
Pasadena Refining	Pasadena, TX	100	100
Total Refining	Beaumont, TX	232	232
Valero Refining	Houston, TX	83	83
Valero Refining	Port Arthur, TX	289	289
Valero Refining	Texas City, TX	200	200
Total		3,984	1,706

Source: Purvin & Gertz; PKVerleger LLC.

Venezuela will almost certainly work hard to maintain its arrangements with its buyers due to the unique characteristics of its crude. Most Venezuelan oil can only be fully processed at refiners configured to handle it, refineries such as those owned by Citgo and Conoco in Louisiana. Thus Venezuela can be expected to fight aggressively for its market.

Mexico followed the Venezuelan lead by signing a joint venture with Shell to operate a refinery at Deer Park. Under the agreement, several cokers were built at the facility and the refinery operated primarily with Mexican Heavy Mayan crude. Going forward, we expect Deer Park to continue to process Mexican crude. Bluntly speaking, Canadian producers have not paid the price of admission.

In Table 1, we suggest that the refineries owned by Conoco, Citgo, ExxonMobil, Marathon, Motiva, and Mexico/Shell—identified as potential customers by TransCanada's consultants—are unlikely buyers of Canadian crude. They have been tied up under the long-term relationships proposed by Bressler and Verleger many years ago.

The efforts of Gulf refiners to force prices down could be further supported by oil-exporting countries, particularly Saudi Arabia. For the last 25 years, Saudi Arabia has priced crude on a "to arrive market-related basis." Under this practice, the price paid by buyers of Saudi crude is determined by conditions at the destination market. Those firms buying crude for delivery in the United States pay a price tied to an index of crudes produced on the U.S. Gulf Coast, ones that are similar to Saudi crude. The price is set when the crude arrives.

Saudi Arabia adopted this procedure in 1987 to frustrate Venezuela's efforts to capture market share in the United States. Venezuela attempted to boost sales by using its locational advantage. PDVSA told buyers that Venezuelan crude was three days from the market compared to two months away for Saudi crudes. The firm also reminded buyers of the lesser market risk.

Saudi Arabia responded by setting its crude prices on the date the crude arrived, removing the Venezuelan advantage.

At the same time, Saudi Arabia also began to set its crude prices by reference to local markets. Each month, Saudi Aramco advises buyers of the discount or premium they will pay relative to the local index of crude prices. Buyers nominate volumes based on these discounts. If Saudi Arabia chooses to boost sales, it just increases its discounts. The system assures that buyers will take its crude.

Canadian producers will not be able to displace the Saudi oil unless Saudi Arabia allows them to do this. Saudi Arabia's commercial entity, Aramco, has the power to offset any discounts offered by Canadian producers.

Saudi Arabia also has compelling political reasons to maintain a strong relationship with the United States. As recent events in the Middle East have demonstrated, Middle Eastern producers have an obvious motivation for staying on the good side of the U.S. They will do this by remaining major suppliers to the country. In all likelihood, then, Canadian crude will not displace Saudi crude.

Squeezing Canada: why independent refiners will want to limit purchases of Keystone crude. As noted above, the firms shipping oil on Keystone will vie for a market of possibly 1.7 million barrels per day. The largest buyer will be Valero, which has committed to receive 100,000 barrels per day via the pipeline. TransCanada has trumpeted Valero's commitment. Canadian producers, though, should see Valero as an enemy, not a friend, because its agreement is akin to a Trojan horse.

Valero has every reason to want the pipeline built. It also has every reason to want a significant volume of Canadian crude to be exported to China. The Valero position should be obvious. Today, as noted, the cost of shipping crude to China from the U.S. Gulf will range from $4 to $6 per barrel. Large crude carriers that offload crude from Saudi Arabia to ExxonMobil and Motiva facilities can then be loaded with Canadian crude. The ships would then transit and exit the Gulf of Mexico, turn south in the Atlantic, and then either down and east around Africa and up past the Persian Gulf and on to China, or down and then west around Cape Horn, following the path pioneered by the clipper ships that brought goods from China to the United States.

Valero also would seem to have the market power to force Canadian oil into the export market. According to the calculations presented in Table 1, Valero owns almost 500,000 barrels per day of the 1.7 million barrels per day in available refining capacity in the Gulf market. By limiting its purchases of Canadian oil, Valero would force Canada sellers to look to owners of 1.2 million barrels per day in refining capacity to place 400,000 to 500,000 barrels per day of crude. It will be a buyer's market.

By forcing Canadian crude to China, Valero and other refiners will drive U.S. Gulf crude prices down significantly. The large volume of crude Keystone proposes to deliver there hands U.S. refiners market power of enormous proportions. Their power comes from the following factors:

The global ultra-low-sulfur distillate market is extraordinarily tight. U.S. refiners located on the Gulf Coast, especially Valero, are uniquely situated to satisfy it. They will obtain the world price for this production.

European customers will become increasingly dependent on distillate exports from the U.S. The European distillate price will effectively set the price of light sweet crude in world markets.

The U.S. Gulf Coast, like Cushing, will become a location where crude prices are significantly below equivalent world prices. A surplus of heavy crude from Venezuela, Mexico, and Canada, as well as increased U.S. production, will depress prices in the market, forcing exports.

Refiners such as Valero will benefit from this development. Crude producers in Canada, Mexico, and the United States will pay the price, receiving $4 to $6 per barrel less for their production than producers of like crude receive for oil delivered to Asian buyers.

Canadian efforts to sell crude in the United States will also be hampered by the Jones Act. U.S. shipping laws require that goods moving between U.S. ports move on U.S.-flagged ships with U.S. crews. Shipping costs on the few such ships available are prohibitive. To move oil by sea, Canadian companies would have to order new tankers from U.S. shipyards to move the crude and pay U.S. companies to own them, since Jones Act ships cannot be owned by foreign companies. Such a step would require significant time and money.[13]

As noted earlier, the Tar Sands Road shown on the cover would be the route for Canadian oil to China. We based this name on the Silk Road used by European and Asian traders to move goods between China and Europe more than 3,000 years ago. The Tar Sands Road will be noted by historians if the Keystone pipeline is built. They may also note that the pipeline's backers believed they would have market power when in fact they had none.

Historians may also note that the TSRP's construction provided a lifeline to some U.S. refiners. By virtue of the pipeline's existence, these firms could earn significant profits that would not have been possible had Canadian producers chosen to pursue the route to British Columbia.

In addition, historians may observe that one or more Canadian producers became integrated companies by purchasing refining capacity on the U.S. Gulf. Recently, BP put its Texas City refinery on the market. Canadian producers could be well advised to purchase it, following the lead of Saudi Arabia, Venezuela, and Mexico in tying up refining capacity to process their crude. Failing that, they will need to brush up on their Chinese.

[13] Canadian firms might attempt to ship the crude in bond to Houston and then assert they had the right to move the oil to U.S. buyers on foreign-flagged ships. The likely success of such efforts is hard to gauge. In any case, the U.S. shipping industry's opposition will likely be strong.

II. Oil Price Implications of Forced Suspension of Libyan Exports and Disruption of Japanese Distillate Exports

World oil markets have experienced three serious supply crises in the last 20 years: the first in 1990 when Iraq invaded Kuwait; the second in 2005 when Hurricanes Katrina and Rita battered crude oil production and petroleum refining facilities in the Gulf of Mexico, and the third in 2008 when civil unrest in Nigeria coincided with Europe's adoption of limits on diesel fuel sulfur content. It is now facing a fourth caused by the curtailment of Libyan exports of crude oil and the disruption of Japanese refining tied to the March earthquake.

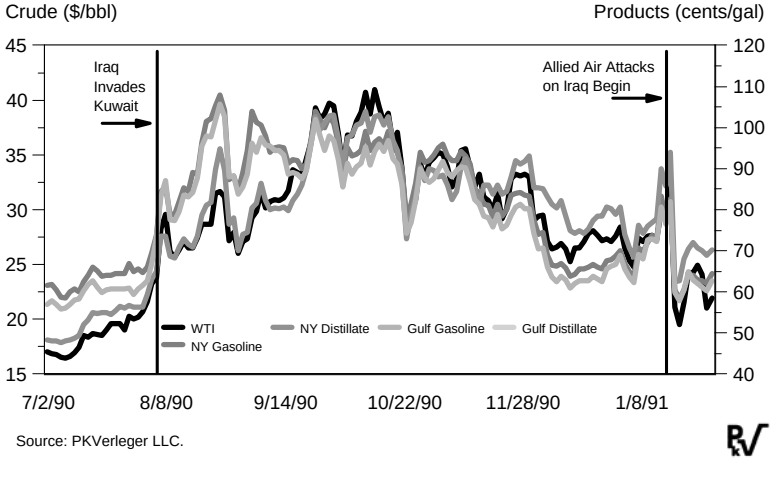
The first disruption initiated five months of chaos in global oil markets. The second caused a petroleum product price increase that was rapidly ameliorated by cooperative actions by energy policy officials here and abroad. The third crisis sent crude prices from $70 per barrel to $150. The first crisis contributed to the 1990/91 recession, which started, according to the National Bureau of Economic Research, in July 1990. No recession occurred following the 2005 storms because governments responded so rapidly. The third crisis contributed to the Great Recession, the direst economic calamity since the Great Depression of 1929-1938. The fourth disruption could create another recession.

Here we assess the potential impact of the current crisis on markets and the global economy, noting that the response of energy policymakers is an important determinant of how the market situation will develop. Our analysis suggests crude prices could rise in the current situation to $160 per barrel if action is not taken.

Background

The disparate impacts of the 1990/91, 2005, and 2008 disruptions can be illustrated with three graphs. Figure 3 traces crude oil and product price movements during the 1990 crisis. This graph shows daily WTI prices from July 2, 1990, to January 30, 1991. It also shows the movement of unleaded gasoline and distillate spot prices in New York Harbor and at the Gulf Coast pipeline terminal for the same period. Crude, priced in dollars per barrel, is graphed against the left vertical axis and product prices, shown in cents per gallon, against the right. Vertical lines mark Iraq's invasion of Kuwait on August 2, 1990, and the start of the war to liberate Kuwait on January 16, 1991.

Figure 3
Daily Spot Prices for Crude Oil and Principal Products
July 1990 to January 1991



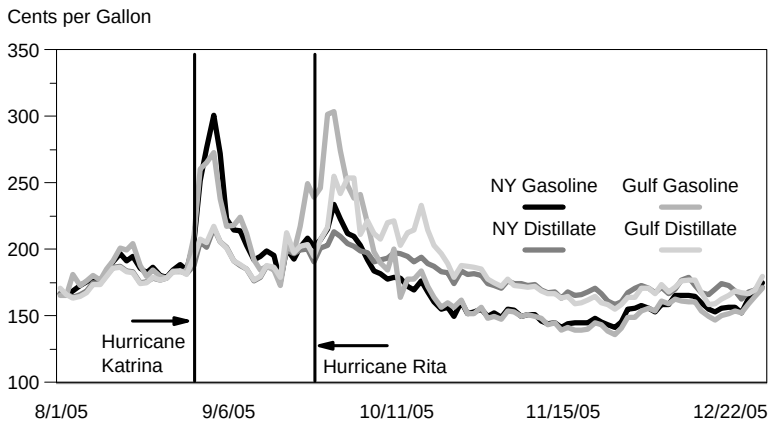
Source: PKVerleger LLC.

Note that crude prices doubled from the pre-invasion level of around $17

per barrel in July 1990, rising to a peak of $40 in September 1990. Product prices followed. These prices stayed artificially high for nearly six months and then returned to pre-crisis levels almost immediately after the Gulf War began.

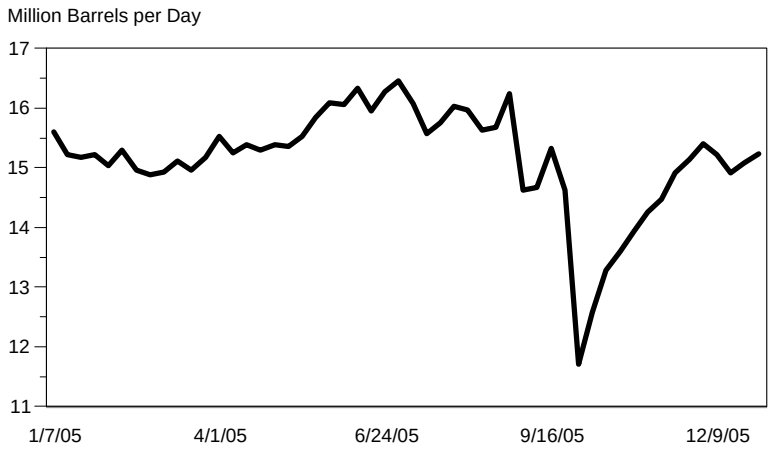
Figure 4 tracks spot product price movement from August 1, 2005, to December 31, 2005, in the New York and Gulf Coast markets. During this five-month period, Hurricanes Katrina and Rita roared across the Gulf of Mexico and slammed into Mississippi, Louisiana, and Texas. The storms severely damaged U.S. refining facilities, as well as offshore crude production operations. The loss of refining capability caused very brief hikes in product prices but no increases in crude prices. (Crude oil prices did not rise because the forced shutdown of refineries reduced U.S. demand for crude oil.) As can be seen from Figure 4, product prices doubled briefly after each hurricane but then quickly returned to normal.

Figure 4
Daily Spot Prices for Gasoline and Distillate Fuel Oil in New York and on the Gulf Coast, August 1, 2005 to December 31, 2005



Source: Platts.

Figure 5
Weekly Crude Inputs to U.S. Refineries in 2005



Source: U.S. DOE.

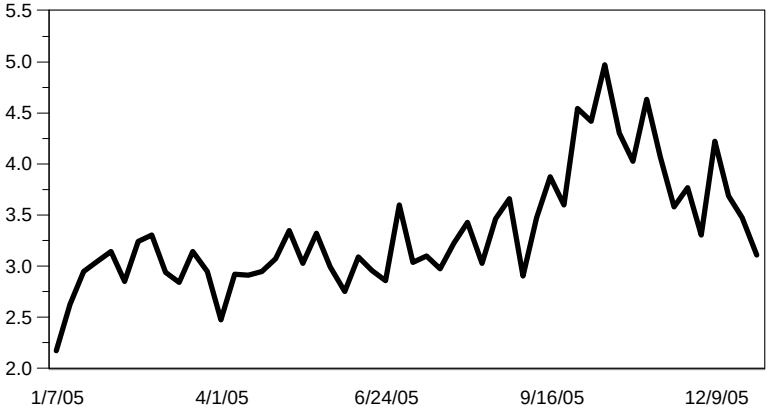
Those prices did not return to normal because refinery problems were solved quickly. Indeed, the crude oil volume processed at U.S. refineries fell 25 percent in early September 2005 and did not return to pre-hurricane levels until December (see Figure 5).

What offset the lost refining capacity was an increase in product imports, primarily from Europe. Following the hurricanes, product-sharing agreements negotiated previously through the International Energy Agency were implemented. These pacts allowed European countries to

draw down strategic inventories of gasoline, diesel fuel, and jet fuel and ship the products to the United States.

The effect of the emergency action taken by European countries can be seen in the amount of imported products recorded at the time. Figure 6 traces import volumes by week during the disruption. As the graph shows, these shipments jumped sharply in September and October, rising from three million barrels per day to around five million barrels per day.

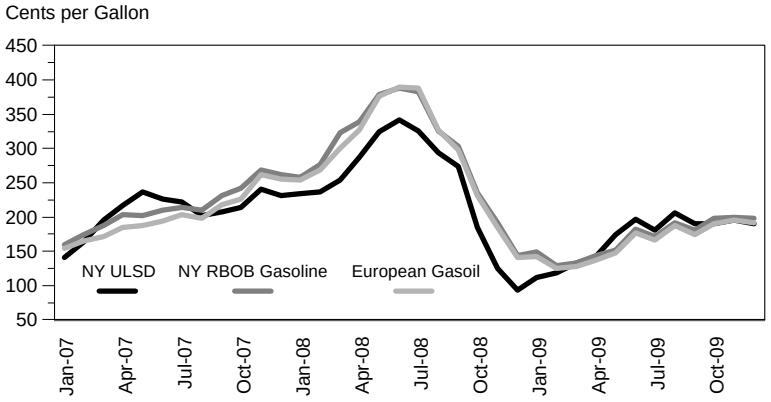
Figure 6
Weekly U.S. Imports of Petroleum Products in 2005



Source: U.S. DOE.

Figure 7 traces the movement of spot product prices from January 2007 to December 31 2009. During this period, petroleum markets were buffeted by several forces, including a weakening dollar, Europe's shift to ULSD, a Bush administration decision to remove sweet crude (the ideal feedstock for producing ULSD) from the market, and production disruptions in Nigeria caused by civil war. The European shift to ULSD, which contains fewer than 10 parts per million (ppm) of sulfur, led to a change in refiner demand for crude. Refiners required more light sweet crude to produce diesel fuel meeting the new specifications. Such crude was not available, however, because of curtailed Nigerian production and the DOE taking limited volumes from the market. As a result, diesel prices rose at retail in Europe. As diesel prices rose, refiners were willing to pay more for crude.

Figure 7
Evolution of Spot Prices for Three Petroleum Products, January 2007 to December 2009

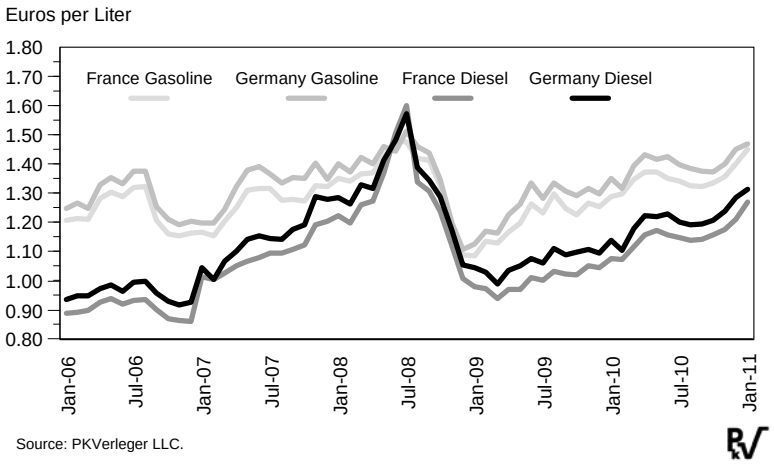


Note: spot gasoil prices converted to cents per gallon.
Source: PKVerleger LLC.

The diesel price rise can be observed from Figures 8 and 9. Figure 8 compares retail diesel and gasoline prices in Germany in euros per liter. Figure 9 shows the retail diesel price as a percentage of the retail gasoline price.

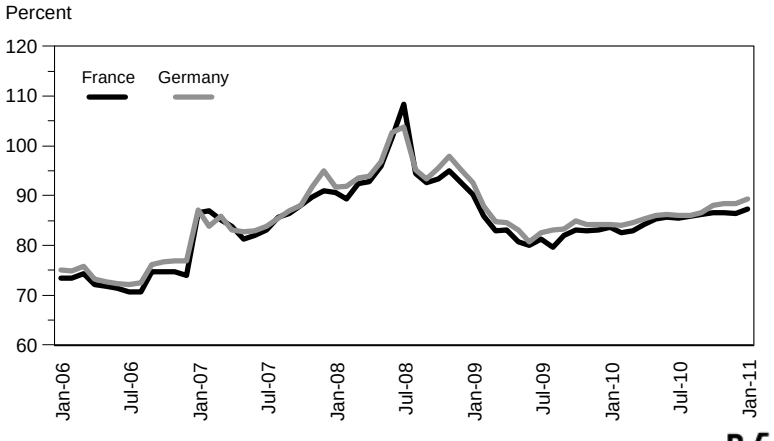
From Figure 8, one can see that diesel fuel in Germany had sold historically for less than gasoline. The situation was not unique to Germany. Diesel went for less in every EU country due to lower taxes. One can also see that the retail diesel price rose to parity in June 2008 as refiners scrambled to meet consumer demand. Figure 9 confirms this trend.

Figure 8
Retail Gasoline and Diesel Fuel Prices in Germany and France, January 2006 to January 2011



Source: PKVerleger LLC.

Figure 9
Retail Diesel Prices as Percentage of Retail Gasoline Prices (including Taxes) in Germany and France, January 2006 to January 2011



Source: PKVerleger LLC.

The price impact was magnified by a strengthening euro. European consumption was determined by the price in euros, not dollars. Thus, the price increase required to balance supply and demand in dollars was magnified as the euro-dollar exchange rate rose from 1.4 dollars per euro to 1.6 dollars per euro.

Refiners bid up low-sulfur crude prices as diesel's dollar price rose because the value of light low-sulfur oil to them went up. Studies by competition authorities such as the U.S. Federal Trade Commission have concluded that refining is a highly competitive business. Refiners offer more for crude as product prices rise and less when product prices fall. Between the end of 2007 and mid-2008, refiners bid light sweet crude prices higher and higher. The increase was only re-

versed when U.S. refiners boosted diesel production by ten percent in June 2008 (following specific adjustments made by one refining company) and Congress ordered DOE to suspend its removal of sweet crude from the market for storage in the Strategic Petroleum Reserve.[14]

The additional supply broke the upward price spiral. The spiral could have been stopped far earlier had governments released strategic stocks of sweet crude. In December 2007, Verleger warned a Senate committee that prices would rise above $120 per barrel if strategic stocks were not released.[15] As prices climbed, the Democrat leaders of the House of Representatives called repeatedly for a stock release, all to no avail.

The difference in market behavior between the 1990/91 and 2008 crises compared to the 2005 troubles can be explained by the quick response of energy policymakers to the latter event. In 1990, their actions actually made matters worse. As noted, the effect of their reaction in both cases can be seen in the price movements.

Discussing the 1990 crisis, Verleger made these observations:

> The embargo [on Iraq's oil exports] provided consuming nations with their first opportunity to test the emergency programs designed and implemented in the last two decades to deal with just such a sudden loss of oil supplies. Today, more than 60 days after the embargo began, it is clear that these programs have failed. Prices of crude oil almost doubled in the wake of the invasion. Prices of jet fuel tripled. Yet the officials of consuming nations did not act. Indeed, in many countries one could observe an all too familiar pattern of behavior. As in 1973 and 1979, government representatives blamed "speculators" for the rise in prices. Some even went so far as to call for the closure of futures markets. At the same time, political leaders of several countries demanded "responsibility" on the part of companies, discouraging increases in prices and interfering with free trade. As in the past, this shortsighted market interference drove prices even higher.
>
> Government officials also proved unwilling to use the single best tool at their command: strategic stocks. The governments of Germany and Japan dragged their feet, stubbornly maintaining that there was no physical "shortage." The government of the United States was immobilized by the need to declare a "severe energy emergency" before it could act.
>
> This ill-advised behavior on the part of high government officials of several supposedly market-oriented nations leads to three very uncomfortable conclusions. First, policies that rely solely on free market mechanisms cannot be used during a crisis. Politicians in most countries find the resulting sharp increases in prices simply too painful to accept. Second, strategic stocks must be greatly enlarged so that there is absolutely no fear of using them in a crisis. The demonstrated inability to rely on the market may ultimately lead the consuming nations into a price stabilization agreement with the producing nations, as abhorrent as the concept is too many economists. Third, to complement the strategic stocks, consuming nations must promote the development of some strategic refining capacity that could be used in a future

[14] Valero Refining changed the catalysts it used in the spring. See "Distillates Key to Valero Earnings," *Platts on the Web*, July 29, 2009. The change boosted diesel production. At the same time, Congress passed a law to halt DOE from filling the SPR after repeated attempts to negotiate such an action with the Bush administration.

[15] See Philip K. Verleger, Jr., Testimony before the Subcommittee on Energy of the Committee on Energy and Natural Resources and the Permanent Subcommittee on Investigations of the Committee on Homeland Security, December 11, 2007.

> crisis. This capacity should include facilities capable of processing heavy crude oils and producing a high percentage of light products.[16]

The Verleger view proved correct, although at the time many took exception to it. For example, three weeks after the invasion, Fereidun Fesharaki described the U.S. response as follows:

> First, DOE directed its efforts to ensuring that International Energy Agency members do not engage in panic buying.
>
> Second, DOE assessed the available excess production capacity of OPEC and non-OPEC nations and has encouraged high oil production to combat rising prices.

Fesharaki observed that Japan had been most affected by the invasion and added:

> It should be noted that Japan's commercial stocks stand at 88 days—compared to 82 days legally mandated. If a physical shortage appears, the six extra days of commercial stocks would be used first.

He then offered this conclusion:

> The Gulf crisis is entering a more dangerous phase. The psychological "shortages" will give way to physical shortages by late September. A military conflict can send prices skyrocketing to $40 a barrel or more [referring to a possible retaliation to Iraq's attack]. Surely, that should be the time to release the Strategic Petroleum Reserve.[17]

One interpretation of the thinking of Fesharaki and others seems to be that oil prices will only rise if supply is disrupted by war. In 1990, these individuals apparently had no conception of the role played by expectations in market disruptions. This may be the case today as well. The writings of many energy economists even now suggest there is only one time dimension to the oil market: *the present*. According to this view, current prices are set by current supply and current demand. Expectations of future supply and demand are unimportant.

Central bankers may seek to keep inflation expectations firmly anchored. Oil economists do not seem to believe they exist. Nobel Prize winning economists such as Robert Lucas suggest that fiscal policies will not stimulate growth because consumer expectations will be changed. Energy economists, especially those focusing on oil markets, deny the existence of expectations or do not believe they apply to the oil market. This conviction is incorrect and leaves markets vulnerable to upsets.

Regarding the situation in 1990, Fesharaki was obviously wrong about the timing of a price increase. Prices rose to $40 per barrel not when the Gulf War began in January 1991 but on October 10, 1990, well before winter and well before a "physical tightness" could be measured.

The government response to the 2005 disruption was quite different from the first Gulf War. Hurricane Katrina struck the Gulf Coast on Sunday, August 28. By September 1, it became evident that many critical refineries had been affected. Platts reported that 11 facilities, which in aggregate could process 1.8 million barrels per day (11 percent of the nation's capacity), were

---

[16] Philip K. Verleger, Jr. "Understanding the 1990 Oil Crisis," *The Energy Journal* 11, No. 4 (October 1990), pp. 15-33.

[17] Fereidun Fesharaki, "Fesharaki: U.S. Oil Crisis Management Praised," *Petroleum Intelligence Weekly*, August 27, 1990, p. 7.

shut. In addition, another 12 refineries had to reduce throughput because their crude oil supplies from the Gulf had been cut.[18]

After Katrina, the U.S. government declared that crude supplies would be made available to operational refineries that had lost access to Gulf Coast oil. Simultaneously, the Environmental Protection Agency temporarily relaxed its regulations, particularly those regarding gasoline RVP and diesel fuel sulfur content. These changes opened the U.S. market to quantities of foreign products that would not normally qualify for domestic sales.

This U.S. emergency action was supplemented on September 2 by the International Energy Agency's announcing that emergency product stocks would be made available to the United States. At that time, the IEA ordered its members to supply the U.S. with 60 million barrels of product over the next 30 days from strategic reserves, primarily those in Europe.[19] Justin Blum explained the release as follows in *The Washington Post*:

> A group of 26 countries, including the United States, yesterday agreed to release oil, gasoline or other petroleum products from their emergency reserves in an attempt to bring down soaring prices and avert domestic shortages.
>
> The decision by the members of the Paris-based International Energy Agency goes far beyond previously announced plans by the United States to allow some oil companies to borrow from its own Strategic Petroleum Reserve. Unlike the United States, some of the member countries have emergency stockpiles of gasoline, which analysts said could eventually stabilize retail prices and help alleviate scattered shortages in some parts of the country.
>
> Although the exports could take two weeks to arrive, Energy Secretary Samuel W. Bodman said he hoped the added supplies would eliminate shortages. "That's really the major concern we have is to avoid disruptions in the flow of fuel throughout our country," Bodman said.[20]

Blum also reported that a number of companies were boosting product shipments from foreign sources to the United States. However, he and other writers noted that the products would take time to arrive, and one commentator warned of transitory shortages in the meantime.

The announcement of a release from strategic reserves had the desired effect on price expectations. Prices peaked on September 2 and began to fall after the news. The effect can be observed in Figure 4 above. New York unleaded gasoline prices topped out at $3 per gallon on September 1. Within a week, they fell to $2.14 even though the supplemental supplies had not arrived yet.

The price-dampening effect can also be observed in the gasoline forward price curve. Figure 10 (page 19) shows the curve in early August 2005, at the close of business on September 1, 2005, and at the close of business on September 16, 2005. At the time, the New York Mercantile Exchange traded 12 consecutive contracts for gasoline. One can observe that buyers had bid prices for all contracts up sharply on September 1, but particularly the contract for gasoline to be delivered in October. No doubt buyers would have insisted on taking delivery had the crisis con-

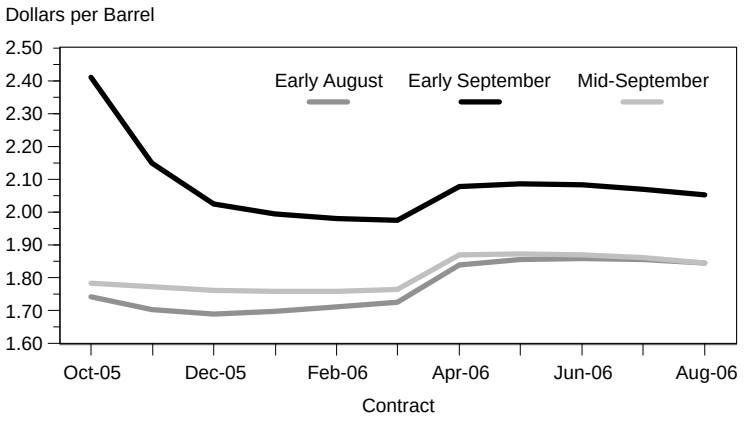
[18] "Hurricane Katrina Fact Box," *Platts on the Net*, September 1, 2005.
[19] "IEA Calls for Release of 60 Million Barrels: AEP," *Platts on the Net*, September 2, 2005.
[20] Justin Blum, "26 Nations to Release Petroleum Reserves," *The Washington Post*, September 3, 2005, p. D1.

tinued. However, by September 16 the panic had ended and prices fell back to early August levels. The IEA's emergency action worked.

Heating oil prices experienced a similar effect (see Figure 11). Again, prices for all contracts were bid higher between early August and September 1, 2005, and then collapsed to earlier levels when it became clear that disrupted supplies would be replaced.

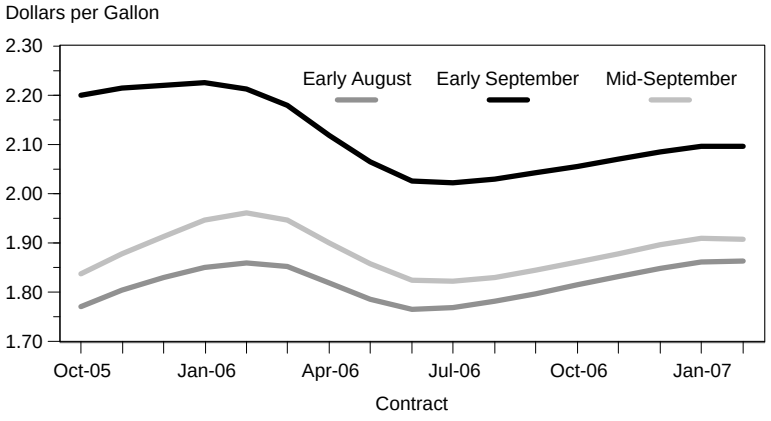
The market reaction in 2005 sharply contrasts with the 1990 response after the Kuwait invasion. Three graphs tell that story. Figure 12 (page 20) shows the forward price curve for crude by week from the last week in July 1990 through the end of August. The curve began in contango. The news of Iraq's invasion of Kuwait pushed the market into slight backwardation. Then over the next 90 days, the backwardation became more and more extreme as energy policy officials in consuming countries repeatedly refused to use strategic stocks while blaming speculators for driving up prices.

Figure 10
Forward Price Curve for WTI: Early August, Early September, and Mid-September in 2005



Source: PKVerleger LLC.

Figure 11
Forward Price Curve for Heating Oil: Early August, Early September, and Mid-September in 2005



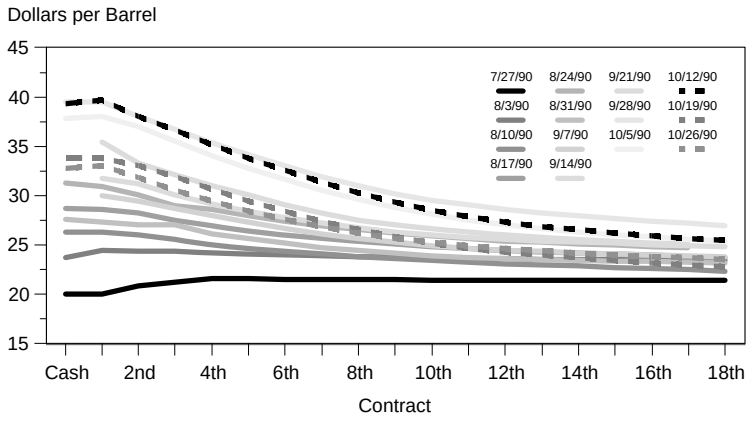
Source: PKVerleger LLC.

By the end of October, the combined forces of higher prices, spreading recession in the United States, and increased production from other countries brought the market into balance. The effect on the oil market was evident as prices dropped from the high 30s back to the mid-20s and the backwardation narrowed (see Figure 13, page 20).

The quick Allied victory over Iraq in January then restored order to the market. As can be seen from Figure 14 (page 21), the forward curve fell back to the $20 or less from whence it started its rise in July.

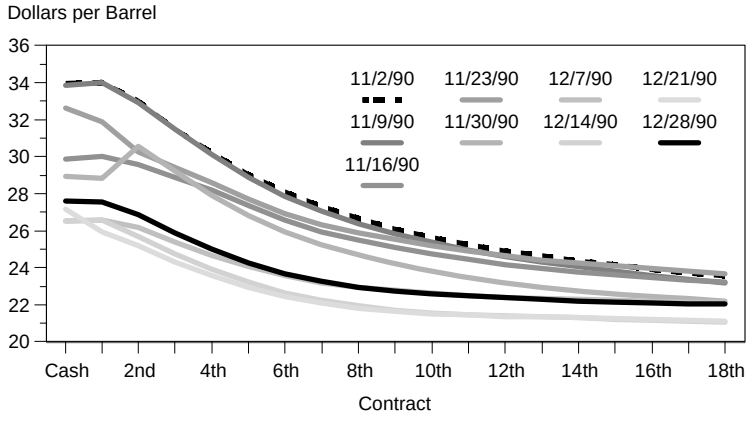
This did not keep the government failure to act from spilling over into the world economy, however. According to the International Monetary Fund, global growth in 1991 averaged only 1.5 percent, roughly half the 1990 rate and well below the nearly four percent of 1989. In the United States, growth dropped from 3.6 percent in 1989 to 1.9 percent in 1990 and then declined by 0.2 percent in 1991, according to the Bureau of Economic Analysis. Hamilton finds that the oil shock cut GDP growth almost four percent between mid-1990 and mid-1991.[21] In contrast, there were no indications of economic losses associated with the 2005 oil shock. The prompt action of energy policymakers to the second crisis clearly merits much credit for preventing a recession or slowdown.

Figure 12
Rise in Crude Oil Forward Price Curve,
July 27, 1990 to October 26, 1990



Source: PKVerleger LLC.

Figure 13
Reversion of Crude Forward Price Curve,
November 2, 1990 to December 28, 1990

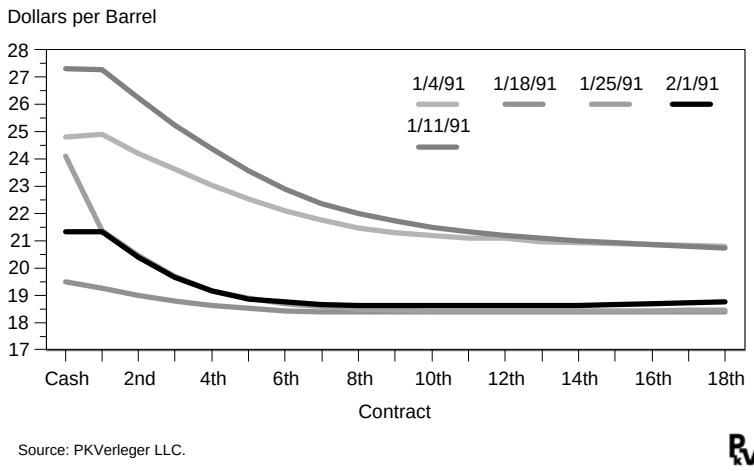


Source: PKVerleger LLC.

[21] James D. Hamilton, "Causes and Consequences of the Oil Shock of 2007-08," Brookings Paper on Economic Activity: Spring 2009.

The Current Situation

Figure 14
Reversion to Stability: Weekly Forward Price Curve for Crude, Beginning of January to Beginning of February 1991



Source: PKVerleger LLC.

The recent market and policy reaction to the revolutions in Egypt, Libya as well as the Japanese Earthquake has mimicked the response to Iraq's invasion of Kuwait. There were concerns, for example, that the revolution in Egypt would result in the Suez Canal's closure. Such an action should, in theory, concern energy policymakers. However, the IEA issued a report asserting that a closure would have no impact "because commercial inventories were ample."[22] Once again, energy policy officials ignored the role of expectations, a subject of vast research in the economics literature for over 20 years.

Weeks later, the IEA again noted that no action was required to deal with the cut in Libyan exports, denying once more the function of expectations. At the end of February 2011, the head of the IEA's oil market division asserted that oil companies could cover themselves.[23]

This response ignores economic theory which holds that economic agents will *increase* their demands for inventories when prospects for future supplies become more uncertain. Williams breaks down the demand for inventories by commercial firms into three categories in his 1986 treatise on commodity markets. These can be described as operational, speculative, and precautionary. Commercial firms require a certain level of inventories to maintain operations. Refineries and pipelines must, for example, always have supplies, which the industry describes as minimum working levels.

Precautionary stocks are inventories above minimum operating stocks held at times when firms worry that supplies may be disrupted. Finally, firms will hold speculative stocks when they see the opportunity to profit by doing so.[24]

Expectations clearly play an important role in determining precautionary demand for inventories. Firms holding stocks will be less willing to sell from inventories when they become concerned that expected shipments may be delayed. Other firms will be more aggressive in seeking additional stocks out of concern that supplies to the market could be slowed.

[22] "IEA Says Suez Canal Closure Would Not Take Oil Off the Market," *Platts on the Web*, February 4, 2011.
[23] "Saudi Arabia Begins Offering Additional Crude," *Platts Oilgram News*, February 28, 2011, p. 9.
[24] Jeffrey C. Williams, *The Economic Function of Futures Markets* (Cambridge, England: Cambridge University Press, 1986).

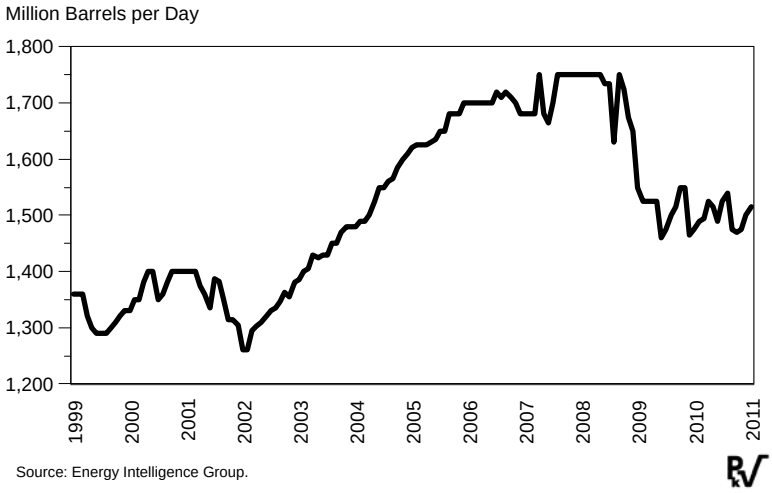
This expectations phenomenon raises demand for a commodity relative to consumption. Global oil use in 2011 may total 88.5 million barrels per day. Absent uncertainty, demand for oil may also total 88.5 million barrels per day. However, the injection of uncertainty could boost the call for oil to 90 or even 91 million barrels per day as precautionary demand for inventories rises.

In 2011, it appears that an increase of one million barrels per day in precautionary demand for inventories would raise world crude prices 25 percent. This calculation is based on a short-run price elasticity of demand for crude of 0.05. The price hike would rise to 45 percent if the price elasticity were lower.[25] The crude price increases since the beginning of the Egyptian revolution are fully in accord with these estimates.

Potential for Disruption of Libyan Supplies and Loss of Japanese Refining Capacity

Today, the world faces two new oil market disruptions. The first has been caused by the revolution in Libya. Oil exports have been reduced as rebels fight with President Gaddafi's army. Furthermore, UN economic sanctions may make it impossible for commercial buyers to purchase Libyan crude for months. According to the IEA, Libyan production had already dropped to 750,000 barrels per day, one-third of the country's output, at the end of February 2011. By the end of March, Libya may not be producing crude at all.[26]

Figure 15
Monthly Libyan Crude Oil Production, 1999 to 2011



Source: Energy Intelligence Group.

Figure 15 tracks Libya's production. Most of this oil works its way into the world market because Libya's consumption is modest. Based on the most recent numbers available, it appears that Libya produces around 1.5 million barrels per day, implying that its net exports are roughly 1.4 million barrels per day. (The U.S. Energy Information Administration and the IEA

[25] Empirical estimates of price elasticities of demand reveal that demand is not sensitive to price changes in the short run. Elasticities of demand for products over a one or two-month period generally are found to be less than 0.1 and usually around 0.05. Elasticities for crude derived from such estimates should be around 0.025 given the markup in retail prices.

[26] "IEA Says that Reports Suggest that 500,000 to 750,000 bd Crude Off the Market," *Platts on the Net*, February 24, 2011.

estimate that Libya exported 1.5 million barrels per day in 2010.[27]) On this basis, Libya plays almost the same role in the market as Iran, which exports around two million barrels per day when it can find buyers. A disruption of Libyan exports could create problems for the world oil market because Libya's crude is of exceptionally high quality, containing almost no sulfur. Buyers would thus be forced to scramble for alternative supplies. Table 2 shows our estimates of the distribution of Libya's exports today. We have identified buyers for 1.5 million barrels per day of Libyan shipments during 2010. OECD countries purchase more than two-thirds of Libyan exports, with most going to Western Europe. China is the only large non-OECD importer.

The Libyan crisis has been followed by the Japanese earthquake. The IEA reports that 31 percent of the nation's refining capacity was shut following the disaster.[28] *Argus Global Markets* estimated that half of the lost capacity will be out indefinitely. *AGM* also noted that Japan usually exports 500,000 barrels per day of products, two thirds of which are jet and diesel fuel. These exports are expected to stop.[29] Indeed, one should not be surprised to see Japan begin importing some distillates soon.

Table 2. Estimated Distribution of Libyan Exports, Early 2011

Importing Country	Imports from Libya (Thousand Barrels per Day)
OECD Europe	1,020
of which	
Italy	420
France	225
Germany	150
Greece	75
The Netherlands	
Spain	150
United Kingdom	60
United States	45
China	165
Others	210
Total	1,500

Source: Compiled by PKVerleger LLC from various DOE sources.

Measures to Mitigate the Crisis

There have been two responses to mitigate the effects of the current crisis. One was intentional. The second may have been an accident.

Saudi Arabia acted in response to the Libyan troubles. In its March report, the IEA explained that Saudi Arabia can produce a crude blend similar to Libyan crude that may meet the needs of European refiners. However, the agency did not offer estimates of volumes available. Separately, the March 21 *Argus Global Markets* reported that Saudi Arabia had boosted shipments to Europe by 200,000 barrels per day, apparently replacing one-sixth of the lost Libyan crude. This helps but does not eliminate the problem.[30]

China has also done something that will help ease the problems. However, its effort may have been accidental and last only a short while. *AGM* reported that shipments of distillate rich sweet crudes form Africa to China fell to a two-year low of 630,000 barrels per day April loading, down 300,000 barrels per day from March levels.[31] The reduced pull from China will allow

[27] U.S. Energy Information Administration fact sheet on Libya, February 2011.
[28] IEA, *OMR*, March 2011, p. 55.
[29] "West African Crude: Chinese Loadings Fall to a Two Year Low," *Argus Global Markets*, March 21, 2011.
[30] "Crises Support High Prices," *Argus Global Markets*, March 21, 2011, p. 16.
[31] "West African Crude: Chinese Loadings Fall to a Two Year Low," *Argus Global Markets*, March 21, 2011 p. 3.

these crudes to flow north to European buyers, further ameliorating the pinch caused by the troubles in Libya. *AGM* noted, however, that much of the crude is going to the US, not Europe, due to the latter's low margins.

Totaling the Impact

The combined effect of Libya's problems, Japan's catastrophe, increased distillate demand, and the shift in Chinese buying patterns apparently leaves the world short 600,000 barrels per day of distillate going forward in 2011. Unless addressed, the supply reduction should carry sweet crude to at least $140 per barrel and even as high as $160. This calculation is based on the following thinking:

First, the reduction in Libyan supply of 1.2 million barrels per day leaves the world short 600,000 barrels per day of distillate.

Second, the increased sweet crude production from Saudi Arabia boosts distillate supply by perhaps 150,000 barrels per day.

Third, China's reduction in West African crude purchases—if continued—will allow North Atlantic distillate production to rise 150,000 barrels per day.

Fourth, high crop prices will add possibly 100,000 barrels per day to market demand for the summer months.

Fifth, the removal of Japan's exports takes, say, 200,000 barrels per day of distillate from the market.

The combined effect of these events is reduced distillate availability to the market of between 500,000 and 600,000 barrels per day this summer from levels that would otherwise have prevailed. Most of the gap will occur in ULSD. While data on global distillate use are opaque, one can estimate, on a conservative basis, that the gap will represent a four-percent reduction. The cut could actually amount to seven or eight percent of global demand.

Market Dynamics from the Disruption

There are two ways to estimate the impact of the disruptions on prices. The first involves the use of a price elasticity of demand for crude. The second backs into the crude price increase from the calculation of demand for distillate.

Calculating the Price Impact from Crude Markets

A loss of Libyan crude exports and Japanese distillate imports offset partially by Saudi Arabia, but not by a strategic stock release of light sweet crude or products meeting the specifications of the lost crude, could drive crude prices up from $100 per barrel on January 25, the date

the Libyan crisis began, to as high as $185 for a short time. In equilibrium, though, prices would settle around 140.[32]

Table 3 provides the basis for this calculation. We begin by assuming that base demand for oil today is around 88 million barrels per day. Removing Libyan exports would cut supply by 1.7 percent. Increased Saudi supply of light crude would cut this percentage to 1.3 percent but the loss of Japanese distillate supply would offset the gain.

Table 3. Price Increase Predicted for Libyan Disruption vs. Disruption of Persian Gulf Exports

	Libyan Exports Disrupted in 2011	Persian Gulf Exports Disrupted in 2010	Benchmark: Third Quarter 1990 after Iraq's Invasion of Kuwait
Base Oil Demand (Million Barrels per Day)	88	87	66
Supply Loss (Million Barrels per Day)	1.5	2.5	2.3
Supply Loss (%)	1.7	14.9	3.5
Elasticity of Crude Price re % Loss in Supply	0.04	0.04	0.04
Predicted Price Increase (%)	42	374	87
Starting Price ($/bbl)	100	80	20
New Equilibrium Price ($/bbl)	143	378	37
Peak Price ($/bbl)	185	678	

*No release of strategic stocks; 1990 benchmark uses same parameters as 2010.

Source: PKVerleger LLC.

The required crude price increase to compensate for the reduction is 42 percent if one uses a short-run price elasticity of demand for crude of 0.04.[33] If one assumes a starting base price for oil of $100 per barrel (the price at the time this was written), then prices must rise to around $140 to balance the market, assuming no change in economic activity. (The actual calculated price is $137 per barrel.)

To test the calculation, we applied the same parameters to the 1990 disruption. The right-hand column of Table 3 provides these calculations, which show that as the 1990 crisis peaked in the third quarter of that year, supply was cut 3.5 percent. Applying the same demand elasticity (0.04), we calculate that it would take an 87-percent price increase to balance the market. Assuming prices started at $21 per barrel, the price would have had to increase to $40 per barrel, almost precisely the level reached in late September 1990.

We note, however, that a 2011 price increase could easily be much greater at first. A very large derivative market has developed since 1990. This type of market, made up primarily of put and call options, has demonstrated a historical tendency to overreact. In particular, firms that have written call options to consumers such as airlines must buy futures as prices rise. This "delta hedging" can accelerate price movements and, at times, cause the equilibrium price to over-

[32] Note that we use the price of $100 per barrel, the Brent price at the start of the crisis. The WTI price was substantially lower at the time. However, the low WTI price was caused by unique circumstances in the U.S. market. See Verleger, "Explaining the Divergence in Crude Prices," *The Petroleum Economics Monthly*, January 2011.

[33] This is the elasticity used by Nordhaus in several studies. See William D. Nordhaus, "Whose Afraid of a Big Bad Oil Shock," *Brookings Papers on Economic Activity 2:2007*.

shoot. One should be concerned that markets will do so dramatically during the first months of any future crisis.

A Second Price Impact Calculation

The market's response to the reduced Libyan exports will also be magnified by the loss of very high quality crude. Libya's oil contains almost no sulfur. As a result, it is a valued input for ultra-low-sulfur diesel (ULSD) production in European and North American markets today. Few other countries produce such crude and no oil-exporting country appears to have any surplus capacity, although, as noted above, Saudi Arabia is boosting production of a special light crude to partially compensate for the loss. The Saudi action is negated, though, by the loss of Japanese supply. For this reason, the unavailability of Libyan crude will likely lead to a cut in diesel production, reducing the amount available to the Atlantic market in the U.S. and Europe by four to six percent.

The three to six percent supply cut will require *retail price increases between 30 and 100 percent*, depending on the price elasticity of demand used and the size of the supply reduction. The marginal market that will set the crude price rise is primarily the United States because U.S. consumers pay less per gallon than others. In January, European consumers paid approximately $6.60 per gallon, while U.S. consumers paid $3.30 per gallon for diesel. Assuming price elasticities of demand for diesel in Europe and the U.S. are identical, any price increase of a fixed amount will have twice the impact in the United States as in Europe.

We estimate that U.S. retail diesel prices will need to rise to approximately $7 per gallon while European prices rise to $10.30 per gallon (€2 per liter) if the magnitude of the shortage remains unchanged. Under current circumstances, sweet crude prices could go as high as $200 per barrel should ULSD prices reach these levels. Such a price increase would no doubt lead to another recession or worse, and an economic slowdown would cause diesel demand to drop and bring crude prices back perhaps to current levels.

The Ultimate Policy Response

Ideally, news of the disrupted Libyan and Japanese supplies would be accompanied by IEA members offering to sell sufficient crude volumes and products to meet global demand. The amount put up for sale should be well in excess of the lost supply. For example, if the 1.5 million barrels per day of Libyan exports are not available, IEA countries should offer two million barrels per day. An IEA indication that any lost Libyan oil would be fully offset would likely have neutralized panic buying and the resulting upward price movement, especially given the well-stocked global inventories today.

Alternatively, governments might consider relaxing sulfur standards for diesel and gasoline until the crisis has passed. This action would make it possible for companies to produce more diesel fuel, meet current demand, and avoid an economic recession.

Unfortunately, energy and economic policymakers stubbornly refuse to understand market developments. As a consequence, expect much higher prices. Our price forecast, shown in Table 4 (page 27), reflects our belief that policymakers will get it wrong once again.

In the forecast, we assume consuming governments do not jointly agree to release strategic reserves. Japan is using its reserves to meet demand and offset its lost refining capacity. However, the United States or the IEA's European members will not likely follow this lead. Instead

prices will be allowed to rise. In the United States, Secretary of Energy Chu actually seems to welcome such increases because they support the administration's energy conservation program.[34] In our forecast, we show prices rising to an average of $125 per barrel for Brent in the second quarter and then retreating slowly back to $115 by year's end. WTI prices will lag behind Brent by an average of $10 per barrel for the forecast period as the crude bottleneck in Cushing continues. Distillate prices will continue to lead the rise in markets, tugging Brent and WTI higher. Gasoline prices will lag.

In the forecast table below, **note we have substituted Brent for WTI in computing refining margins**. These margins will likely be weak on an average basis. Refiners without access to supplies of price-constrained WTI or WTI-related crudes will struggle going forward unless they can produce very high percentages of distillate. Refiners that can do so will fare well.

Table 4. Price Forecast

	Q1:11	Q2:11	Q3:11	Q4:11	Q1:12	Q2:12
WTI ($/bbl)	94	115	110	100	100	100
Brent ($/bbl)	105	125	120	115	115	115
NY Harbor						
RBOB (¢/gal)	258.2	322.6	304.3	271.4	274.5	282.9
Conv. (¢/gal)	258.4	325.9	310.7	270.5	272.7	282.2
Distillate (¢/gal)	277.5	340.3	328.4	308.6	305.8	304.6
Gulf Coast						
RBOB (¢/gal)	260.0	322.1	302.6	269.1	275.3	282.4
Conv. (¢/gal)	255.8	328.4	309.3	267.2	272.1	284.7
Distillate (¢/gal)	274.9	338.8	327.5	306.3	302.2	303.1
3-2-1- Crack (Conv. Gasoline)						
New York ($/bbl)	6.20	13.89	12.96	3.94	4.16	6.65
Gulf ($/bbl)	5.11	14.38	12.46	2.69	3.49	7.14
3-2-1 Crack (RBOB)						
New York ($/bbl)	6.14	12.97	11.17	4.20	4.66	6.85
Gulf ($/bbl)	6.30	12.61	10.59	3.23	4.40	6.49

Note: Refining cracks measured against spot Brent crude.

Source: PKVerleger LLC.

[34] "U.S. Secretary of Energy Says He Understands the Pain of High Prices," *Platts on the Net*, March 10, 2011.

Glossary

Availability — Availability is the amount of supply that can be brought to the market in a market cycle. *Available* supply includes inventories, product that has not been produced at the time of measurement but will be produced and delivered within the market cycle, and product that is not in the delivery market at the time of measurement but will be *imported* into the market area within the market cycle.

Backwardation — The condition said to exist when spot prices exceed forward prices.

Call — An option that gives the buyer (holder) the right, but not the obligation, to buy a futures contract (enter into a long futures position) for a specified price within a specified period of time in exchange for a one-time premium payment. It obligates the seller (writer) of an option to sell the underlying futures contract (enter into a short futures position) at the designated price, should the option be exercised at that price.

Call on OPEC — This term refers to the number (in million barrels per day) representing the annual demand for OPEC exports given the level of non-OPEC production and reported consumption.

Cash-and-Carry Transactions — Cash-and-carry transactions involve the simultaneous purchase of a physical commodity and sale of a future at a higher price to establish a trading profit. Cash-and-carry transactions can only be entered into in contango markets.

CFTC Commitments of Traders Data — CFTC data on Commitments of Traders defines three types of traders: commercials, noncommercials, and nonreporters. *Commercials* are traders who customarily use a futures position to hedge their position in a commodity market. *Noncommercials* are traders who do not use the futures market for hedging. *Nonreporting* traders are those who hold positions that fall below the reporting requirements established by the CFTC. By custom, speculators are defined as noncommercial and nonreporting traders.

Contango — The condition said to exist when forward prices exceed spot prices.

Cost of Carry — The costs associated with holding (or carrying) a commodity or an asset. These include financing costs, storage costs, and insurance costs.

Endogenized Forecast — An endogenized forecast or simulation uses the predicted values of all explanatory variables for the current and prior periods to forecast the next period.

NDTFI—Non-Deposit-Taking Financial Institution.

OPEC Basket — The OPEC basket comprises Algeria's Saharan Blend, Indonesia's Minas, Nigeria's Bonny Light, Saudi Arabia's Arab Light, Dubai of the United Arab Emirates, Venezuela's Tia Juana Light, and Mexico's Isthmus crude (definition from *Platts Global Alert*).

Open Interest — Open interest represents the number of open contracts at the end of trading. By convention, it is the number of long or short positions, not the sum of the positions. An open contract is an obligation to take or make delivery at the expiration of the contract.

Put — An option that gives the buyer, or holder, the right, but not the obligation, to sell a futures contract at a specific price within a specific period of time in exchange for a one-time premium payment. It obligates the seller, or writer, of the option to buy the underlying futures contract at the designated price, should an option be exercised at that price.

Refinery Crack — The spread between the price of products (customarily gasoline or heating oil) and crude (customarily WTI).

Spread Position — As defined by the CFTC, a spread position involves the purchase and sale of futures contracts for delivery of the same commodity, with the contracts having different

maturities. For example, a spread trade in gasoline might involve the purchase of a September contract and the sale of an October contract.

Sterilization — Sterilization of a commodity occurs when the commodity is transferred to a storage facility to be held for purposes other than meeting current or near-term demand. For example, the oil held in the strategic petroleum reserves of IEA countries is sterilized.

Sovereign Wealth Funds (SWFs) — "Vehicles that are long of capital at a time when developed Western marketers seem suddenly short of it." (Source" Michael Gordon, *Financial Times*, November 6, 2007); *Technical Definition*: SWFs are pools of capital controlled by government entities from developing or non-industrialized countries such as Singapore, China, United Arab Emirates, or Kuwait.

Technicals — Indicators of future price trends computed by mathematical formulas from historical price data.

Statistical Appendix

Table S-1. Gasoline Cracks, Returns to Storage, and Open Interest as of 3/18/2011 Compared to Prior Years

	Current	Last Week	Last Month	2010	2009	2008	2007	2006	25-Year Average
Cracks (Product less Crude, Dollars per Barrel)									
Spot	2.04	n/a	n/a	8.18	14.18	3.22	21.90	15.11	6.71
April	9.94	n/a	n/a	14.06	10.13	7.88	19.59	15.35	7.98
May	10.31	n/a	n/a	13.71	9.81	8.74	17.77	12.07	8.02
June	10.18	n/a	n/a	12.88	8.47	9.19	16.47	11.17	7.87
July	9.85	n/a	n/a	11.98	7.24	9.15	15.47	10.63	7.48
August	9.41	n/a	n/a	11.12	6.22	8.56	13.99	10.54	6.93
September	8.64	n/a	n/a	10.30	5.12	3.70	9.14	10.12	5.92
Average	8.63	n/a	n/a	11.75	8.74	7.21	16.33	12.14	7.27
Returns to Storage (Percentage at Annual Rates)									2005
April	126.0	85.6	46.5	308.2	-75.2	101.4	6.5	-2.8	288.6
May	50.7	40.4	30.9	65.3	-35.5	30.8	-19.6	-19.1	152.2
June	29.4	24.3	22.5	28.5	-21.7	17.0	-17.4	-14.5	83.9
July	19.2	16.1	17.2	18.3	-15.7	10.2	-15.8	-12.5	55.8
August	13.1	11.0	13.2	12.6	-12.4	5.4	-14.6	-9.8	38.0
September	8.8	7.3	10.0	9.0	-10.8	1.6	-15.3	-9.2	25.0
October	-0.3	-1.4	2.1	-1.7	-19.1	-8.0	-23.1	-14.5	13.6
November	-1.7	-2.6	0.8	-2.6	-16.6	-8.8	-23.7	-14.9	8.0
December	-2.1	-3.1	0.3	-2.7	-13.6	-8.5	-23.1	-14.4	5.0
Open Interest (Number of Contracts)									
Total	269,781	273,503	284,402	322,935	207,084	246,424	172,257	140,554	176,646
April	47,246	65,706	76,506	55,941	31,508	37,625	28,258	34,411	37,074
May	76,542	65,224	49,204	103,846	68,612	76,504	58,753	61,541	70,466
June	40,327	39,490	33,391	52,766	30,874	42,633	30,126	15,399	25,111
July	21,160	21,372	18,872	29,773	16,984	21,190	13,925	7,701	14,206
August	11,816	10,904	11,603	12,909	12,641	10,538	9,819	6,343	10,848
September	13,014	13,584	7,079	20,544	13,563	10,467	16,161	6,278	8,864
October	9,844	7,579	5,098	9,977	11,023	9,515	4,454	4,306	4,508
November	5,069	5,560	2,881	12,615	2,483	4,043	2,175	1,200	601
December	23,561	23,661	23,250	11,978	8,710	12,585	4,396	2,473	2,603

Note: All returns to storage have been adjusted for the cost of funds using the three-month LIBOR.

Sources: Petroleum Argus, NYMEX, and PKVerleger LLC.

Table S-2. Heating Oil Cracks, Returns to Storage, and Open Interest as of 3/18/2011 Compared to Prior Years

	Current	Last Week	Last Month	2010	2009	2008	2007	2006	25-Year Average
Cracks (Product less Crude, Dollars per Barrel)									
Spot	12.64	n/a	n/a	6.26	5.84	19.55	9.93	11.98	5.12
April	13.09	n/a	n/a	6.54	7.04	20.23	9.84	12.04	4.63
May	13.76	n/a	n/a	6.77	6.72	19.22	9.14	11.01	4.22
June	14.51	n/a	n/a	6.99	5.98	19.84	9.27	10.46	4.11
July	15.32	n/a	n/a	7.32	5.73	20.67	9.68	10.42	4.27
August	16.19	n/a	n/a	7.71	5.83	21.48	10.47	11.05	4.64
September	17.04	n/a	n/a	8.25	6.15	22.25	11.50	11.72	5.12
Average	14.65	n/a	n/a	7.12	6.19	20.46	9.98	11.24	4.59
Returns to Storage (Percentage at Annual Rates)									2005
April	3.0	6.1	5.7	10.6	50.4	68.2	8.0	-6.3	-13.6
May	3.8	4.8	5.6	8.4	25.7	-1.9	1.5	-2.1	-18.1
June	4.1	4.4	5.7	8.5	23.2	-8.9	2.6	-1.3	-16.7
July	4.2	4.4	5.9	9.0	23.7	-7.5	5.4	0.3	-13.0
August	4.3	4.5	6.0	8.5	23.8	-6.1	7.1	2.8	-9.9
September	4.4	4.6	6.2	8.9	24.3	-5.0	8.9	4.2	-7.2
October	4.5	4.6	6.6	9.3	24.5	-4.0	10.5	5.6	-5.3
November	4.6	4.6	7.0	9.6	24.6	-3.2	11.7	6.8	-3.5
December	4.5	4.5	7.2	10.0	24.5	-2.6	12.0	7.3	-2.4
Open Interest (Number of Contracts)									
Total	311,699	304,130	321,793	329,435	267,795	228,625	206,367	172,816	183,921
April	54,293	73,023	78,104	53,650	31,696	31,487	30,084	31,118	38,934
May	80,502	63,184	42,556	80,253	56,057	76,869	64,364	63,765	63,888
June	55,171	51,712	42,860	51,807	38,360	36,160	31,874	18,475	22,560
July	25,412	23,786	18,918	23,827	21,799	15,540	14,832	15,965	11,156
August	17,293	15,777	13,416	13,282	11,387	7,621	6,902	7,268	7,375
September	14,710	12,547	13,164	14,253	12,806	10,061	8,539	4,658	9,524
October	6,566	7,208	6,256	10,874	9,243	3,646	4,056	2,258	2,022
November	6,411	6,694	6,895	9,890	9,687	3,316	2,839	2,122	2,942
December	27,831	28,267	27,413	30,876	21,697	21,817	19,400	11,096	11,586

Note: All returns to storage have been adjusted for the cost of funds using the three-month LIBOR.

Sources: Petroleum Argus, NYMEX, and PKVerleger LLC.

Table S-3. WTI Returns to Storage and Open Interest as of 3/18/2011 Compared to Prior Years

	Current	Last Week	Last Month	2010	2009	2008	2007	2006	2005
Returns to Storage (Percentage at Annual Rates)									
April	-5.0	6.1	32.1	2.5	-5.3	-7.6	3.1	-9.6	-8.9
May	2.8	10.4	35.4	3.4	10.2	-5.7	4.1	12.1	2.2
June	4.2	9.2	31.2	4.3	21.8	-7.6	11.1	12.1	5.2
July	4.7	8.3	27.7	4.7	25.1	-8.4	11.5	10.1	4.9
August	4.4	7.4	24.1	4.8	25.0	-9.1	10.5	8.4	3.7
September	4.0	6.7	21.5	4.6	24.4	-9.0	9.3	7.0	2.1
October	3.6	5.9	19.4	4.3	23.6	-8.8	8.2	5.9	0.6
November	3.2	5.1	17.7	4.1	22.7	-8.5	6.6	5.0	-0.6
December	2.9	4.6	16.3	4.0	22.0	-8.2	5.7	4.1	-1.5
January	2.4	3.9	15.1	3.7	21.1	-8.1	5.0	3.4	-2.4
February	1.9	3.3	13.9	3.5	20.5	-7.9	4.3	2.8	-3.1
March	1.5	2.8	0.2	3.3	20.0	-7.8	3.7	2.3	-3.7
Open Interest (Number of Contracts)									
Total	1,540,236	1,596,178	1,531,205	1,403,466	1,151,749	1,363,112	1,324,569	973,921	850,396
April	91,395	215,405	276,260	52,698	18,018	8,396	11,719	61,566	44,448
May	343,874	286,005	179,133	361,171	316,701	373,668	387,729	264,573	252,224
June	152,032	152,627	130,329	189,402	174,025	156,648	157,753	128,290	112,668
July	89,694	85,690	67,433	94,673	83,128	61,076	66,098	40,219	40,041
August	40,661	39,528	47,108	36,019	30,963	33,928	29,404	24,863	29,944
September	60,404	56,819	44,688	41,269	32,346	48,002	39,508	31,583	26,057
October	33,371	32,725	31,727	21,587	27,873	38,760	26,960	27,271	23,905
November	31,513	30,234	32,575	25,469	19,722	22,009	24,745	15,680	18,091
December	176,016	182,445	166,202	210,828	90,009	205,521	149,921	85,344	67,048
January	35,126	34,637	30,500	29,912	22,385	24,546	35,188	19,952	15,501
February	16,070	15,776	13,028	17,881	10,935	13,188	12,443	7,410	7,854
March	23,954	23,719	90,287	14,112	12,328	12,193	15,545	8,286	11,183

Note: All returns to storage have been adjusted for the cost of funds using the three-month LIBOR.

Sources: Petroleum Argus, NYMEX, and PKVerleger LLC.

Table S-4. Natural Gas Returns to Storage and Open Interest as of 3/18/2011 Compared to Prior Years

	Current	Last Week	Last Month	2010	2009	2008	2007	2006	2005
Returns to Storage (Percentage at Annual Rates)									
May	14.8	9.6	12.7	11.8	16.2	4.4	13.2	14.4	10.8
June	17.2	13.2	14.6	15.2	25.4	6.3	17.1	17.3	11.0
July	18.3	16.0	15.3	18.7	29.8	7.8	18.8	18.4	10.4
August	16.2	15.8	14.1	19.4	27.3	7.1	17.5	18.2	8.5
September	13.9	14.0	12.2	17.8	24.3	5.3	14.7	17.0	6.6
October	14.2	14.2	12.4	20.6	25.5	5.4	14.7	17.5	5.7
November	19.2	20.0	18.3	34.0	41.8	8.6	27.5	46.2	12.2
December	25.1	26.5	23.9	46.2	54.3	12.5	36.9	62.7	16.9
January	26.3	27.8	25.3	47.8	56.1	13.8	37.6	67.3	18.3
February	23.2	24.7	22.5	41.6	49.4	12.0	32.5	58.4	15.7
March	19.6	21.1	0.0	34.6	41.4	7.9	25.4	48.9	11.8
Open Interest (Number of Contracts)									
Total	912,890	942,049	950,215	842,516	650,761	887,911	771,092	637,867	474,828
April	91,465	149,459	198,359	81,842	55,397	57,961	35,480	50,822	38,423
May	258,655	236,903	206,501	222,508	102,282	147,252	129,888	88,896	74,762
June	65,294	70,629	64,626	52,889	47,104	42,088	33,528	28,526	27,707
July	80,295	79,776	54,760	64,706	40,818	37,658	28,147	21,939	32,747
August	31,040	28,598	24,125	30,514	30,668	27,829	27,478	22,878	21,955
September	45,159	38,481	23,493	35,338	25,417	19,914	18,942	20,585	24,395
October	72,562	72,888	74,577	83,997	44,046	60,249	42,277	41,208	41,597
November	30,883	30,792	25,802	14,683	19,674	29,157	21,156	29,614	14,546
December	26,691	25,706	23,980	24,968	32,427	35,479	37,757	20,067	27,355
January	59,964	59,207	54,196	39,237	27,218	56,032	33,932	45,803	21,232
February	12,982	12,519	13,121	16,102	11,034	13,189	20,238	18,455	13,505
March	27,266	28,202	56,176	35,548	23,441	44,551	48,055	24,331	20,274

Note: All returns to storage have been adjusted for the cost of funds using the three-month LIBOR.

Sources: NYMEX and PKVerleger LLC.

Table S-5. Brent Returns to Storage and Open Interest as of 3/18/2011 Compared to Prior Years

	Current	Last Week	Last Month	2010	2009	2008	2007	2006	2005
Returns to Storage (Percentage at Annual Rates)									
May	-0.9	-0.8	-0.4	21.5	29.4	4.6	-7.6	-4.6	-4.4
June	-1.2	-0.8	0.3	14.8	31.2	0.2	-2.1	-1.0	-2.2
July	-1.6	-1.1	0.5	12.2	27.6	-1.8	0.1	0.4	-2.7
August	-2.0	-1.3	0.5	10.6	26.2	-2.8	1.1	0.8	-3.2
September	-2.3	-1.6	0.5	9.4	25.0	-3.4	1.4	0.8	-3.7
October	-2.4	-1.7	0.6	7.8	24.2	-3.8	1.3	0.6	-4.3
November	-2.6	-1.8	0.5	7.2	23.4	-4.0	1.1	0.3	-4.8
December	-2.7	-1.9	0.5	6.7	22.9	-4.3	0.9	0.1	-5.1
January	-2.7	-2.0	0.5	6.3	22.2	-4.4	0.8	-0.2	-5.5
February	-2.8	-2.1	0.5	6.0	21.3	-4.3	0.5	-0.4	-5.8
March	2-.8	-2.2	0.8	5.7	20.8	-4.5	0.2	-0.7	-6.1
April	-3.0	-1.1	-2.3	5.5	20.0	-4.5	-0.1	-0.9	-6.3
Open Interest (Number of Contracts)									
Total	834,701	863,528	890,678	872,200	638,926	608,865	720,373	408,314	376,239
May	185,744	160,603	139,773	255,648	150,512	144,822	153,335	109,189	105,560
June	185,888	176,108	129,258	207,404	121,808	142,291	182,942	120,990	95,621
July	54,522	48,136	41,334	71,608	51,779	53,859	55,157	23,660	21,168
August	29,671	28,135	25,029	39,072	24,768	27,401	27,764	13,291	9,461
September	34,139	31,922	30,072	23,179	23,329	19,205	28,456	16,568	9,433
October	23,435	19,378	17,945	20,390	14,611	12,027	24,464	12,568	10,563
November	18,569	15,559	14,887	14,327	13,793	9,519	19,150	6,648	4,360
December	101,311	94,332	109,776	93,814	78,132	57,189	71,376	34,476	42,318
January	22,881	22,349	15,028	12,961	13,117	12,923	11,078	9,603	5,679
February	13,592	12,450	9,131	6,554	6,798	7,412	4,009	6,669	1,606
March	16,882	16,683	16,589	7,364	5,978	4,942	3,381	4,944	4,880
April	5,218	84,830	211,173	4,406	3,214	5,759	1,295	1,375	1,825

Note: All returns to storage have been adjusted for the cost of funds using the three-month LIBOR.

Sources: IPE and PKVerleger LLC.

Table S-6. Gasoil Returns to Storage and Open Interest as of 3/18/2011 Compared to Prior Years

	Current	Last Week	Last Month	2010	2009	2008	2007	2006	2005
Returns to Storage (Percentage at Annual Rates)									
April	5.6	2.5	7.5	3.9	78.5	50.4	21.2	-3.5	-33.2
May	2.1	1.9	6.8	0.2	38.8	-1.6	7.6	-0.8	-24.8
June	0.9	1.7	6.4	0.7	34.7	-7.1	6.5	0.9	-20.3
July	0.9	1.9	6.7	2.2	32.9	-7.6	7.4	2.4	-16.6
August	1.1	2.0	6.6	3.5	30.8	-6.9	7.9	3.8	-13.6
September	1.2	2.1	6.4	4.3	30.0	-6.2	8.3	4.4	-11.3
October	1.0	1.9	6.1	4.8	28.8	-5.9	8.5	4.7	-10.0
November	0.8	1.6	5.6	4.9	27.5	-5.8	8.1	4.4	-9.5
December	0.6	1.4	5.3	5.0	26.5	-5.8	7.8	3.9	-9.3
Open Interest (Number of Contracts)									
Total	606,864	630,513	702,424	556,535	453,931	255,389	318,915	223,264	181,140
April	125,864	180,609	148,724	107,039	57,311	66,606	56,142	64,639	51,092
May	114,431	95,374	72,975	99,308	74,720	56,839	67,457	46,412	36,631
June	66,835	71,808	66,523	66,628	57,048	28,509	48,602	25,834	21,300
July	32,378	36,449	24,706	30,814	24,309	12,931	20,822	11,545	6,768
August	27,186	24,040	25,640	25,718	26,251	9,046	13,831	6,505	3,117
September	39,035	28,676	20,879	30,699	25,237	9,720	15,686	6,708	9,251
October	24,069	22,052	19,027	18,391	19,730	5,857	6,401	8,552	5,148
November	19,776	16,126	15,366	15,225	12,484	6,711	6,950	3,445	3,001
December	53,609	56,599	52,528	73,455	56,556	25,926	37,315	28,549	17,011

Note: All returns to storage have been adjusted for the cost of funds using the three-month LIBOR.

Sources: IPE and PKVerleger LLC.