The Oil Security Problem

By

Hillard G. Huntington

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Energy Modeling Forum
Stanford University
Stanford, CA 94305-4026

Abstract

This paper brings together several important recent strands in the energy security literature and evaluates their contributions. It does not survey the literature, because others have already provided excellent reviews and raised important reservations about how governments implement the security principle. Improving oil security in this paper refers to reducing an oil-importing country's reliance on insecure sources of foreign oil. The paper begins by discussing when private markets may fail to provide appropriate signals for economic efficiency and public policy might be considered. Next, it reviews a recent effort to estimate the benefits of limiting U.S. oil imports, based upon the externalities discussed in the previous section. The following section presents the key results from an effort to estimate the risks of another oil disruption over the next ten years. This study uses risk analysis techniques to elicit probabilities from leading geopolitical and oil security experts. Finally, the paper discusses why recent oil price trends are unlikely to create the same economic dislocations experienced by Western economies in the past.

Oil price disruptions, however, are likely to produce price shocks that could be much more damaging, depending upon the underlying inflationary expectations at the time of a disruption.

The oil security problem

Hillard G. Huntington*

Oil trading was suddenly curtailed after the nationalization of the Suez Canal in July 1956 and the subsequent invasion of Egypt by Israel, France and Britain. During the first three months of 1957, U.S. oil prices rose at a quarterly rate of 7.6 percent (more than 30 percent on an annual basis) at a time when the Texas Railroad Commission effectively fixed oil prices. An economic recession ensued. Since that event, Middle Eastern oil has played a critical role in the military strategies, foreign affairs and the economies of many Western nations for more than five decades. The fundamental economic problem has been how to balance the large gains from free and open trade with oil security policies that may limit dependence upon Persian Gulf energy supplies.

This chapter brings together several important recent strands in the energy security literature and evaluates their contributions. Although these studies emphasize the US oil security problem, the methodologies and basic principles apply to many European and Asian countries, too. The chapter does not survey the literature, because Toman (1993) and Bohi and Toman (1993, 1996) have already provided excellent reviews and raised important reservations about how governments implement the security principle. Improving oil security in this chapter will refer to reducing an oil-importing country's reliance on insecure sources of foreign oil.

Section 1 discusses when private markets may fail to provide appropriate signals for economic efficiency and public policy might be considered. Section 2 reviews a recent effort to estimate the benefits of limiting U.S. oil imports, based upon the externalities discussed in the previous section. Section 3 presents the key results from an effort to estimate the risks of another oil disruption over the next ten years. This study uses risk analysis techniques to elicit probabilities from leading geopolitical and oil security experts. Finally, section 4 discusses why recent oil price trends are unlikely to create the same economic dislocations experienced by Western economies in the past. Concluding comments are summarized in a fifth and final section.

Oil security as an externality

When buyers and sellers negotiate an oil price in the private market, they may not incorporate all of the oil security costs associated with increased oil use or imports. The oil import premium should represent the difference between the societal and private costs of purchasing one more barrel of imported oil. Some policymakers think of the premium as "hidden costs" because buyers and sellers do not directly see them.

Although this issue is fundamental to energy security analysis, it does not represent all of the issues that energy policymakers must address. Below are three fundamental decisions:

1. How much should the government spend to abate energy security costs?
2. Should policymakers use a particular policy for offsetting the impacts of price shocks, such as tariffs, fuel-efficiency standards, renewable portfolio standards, oil stockpiling reserves, monetary policy, or fiscal policy?
3. Is the oil security premium substitutable for the oil environmental premium or are the two premia complementary?

The premium addresses the first issue. Its estimation is important, because a small or non-existent value will make the other two questions moot. Estimating the premium (the first question), however, reveals nothing about the second question (the appropriate tradeoff between energy policies, monetary policies, or military expenditures to make oil less risky) or the third question (how to combine the oil security and environmental premia).

Market failures

This discussion will focus on the security but not the environmental premium. There are potentially three important market failures that might create hidden security costs.

First, oil producers might charge a price that exceeds their marginal costs. Governments owning oil resources and wanting to stay in power often exploit their resources more slowly than private companies. The resulting higher oil prices allow these governments to provide a range of public services that reinforce their control of the country's political process. Absent effective competition from private companies in developing these resources, governments have some leeway to depart from pricing strategies that achieve economic efficiency. Moreover, explicit or informal cooperation among oil-producing countries enhance the opportunities to overprice oil resources relative to competitive conditions. Although monopolistic conditions may expand or contract over time as market conditions change, many experts view the Organization for Petroleum Exporting Countries (OPEC) as a clumsy cartel that still exerts some upward pressure on oil prices (Adelman 1980). Empirical estimates of the oil import premium incorporate this market failure as the market (or monopsony) power component, estimated as the ability of the oil-importing society (organized as one buying unit rather than as individual consumers) to reduce the monopoly price charged by OPEC.[1]

Second, oil suppliers and consumers may not understand the actual risks of another oil disruption caused by political unrest in overseas areas. Typically, OECD governments spend enormous resources to develop information about political trends overseas and they do not share what they learn with the private sector. Although the government might overestimate the risks of oil disruptions under some conditions, it seems just as likely that the private sector may underestimate these risks. For example, the best analysis of private oil stockpiling within the OECD nations implies that it takes a reduction of 8 or 9 barrels of public stockpiles to encourage one more barrel of private crude oil stockpiles (Aldy 2007). This 8:1 ratio represents a very low "crowding out" between private and public stockpiles, much lower than for many other public expenditures.

Empirical estimates of the oil import premium include this market failure as the import cost disruption component. It equals the real income lost during a disruption by importing more expensive petroleum. This component will depend upon assumptions about how much oil producers and consumers correctly anticipate the risks of another disruption. Bhagwati and Srinivasin (1976) and Mayer (1977) argue that when an unanticipated disruption occurs, adjustment costs prevent producing firms from providing the lost good except at a very high price. Appropriate policy would be a subsidy to encourage more domestic production prior to a disruption because producers are undervaluing the commodity during normal times. Tolley and Willman (1977) expand this concept to include energy consumers with rigid capital stocks and long-standing habits. Since both consumers and producers of the embargoed commodity are undervaluing it, an oil tariff rather than a production subsidy is preferred. If firms and consumers correctly internalize the effects of future disruptions, however, their current private decisions will value the embargoed commodity properly (Srinivasan, 1987).

Third, firms and workers may make pricing and output decisions that harm other sectors of the economy in the form of increased unemployment and idle capacity. These effects might be considered macroeconomic externalities. Unlike the security costs in the second point above that are incurred by the decisionmaker who lacks sufficient information, these costs are external to the ones making the decisions. Since these interdependencies operate through the market system, these macroeconomic externalities should be viewed as pecuniary rather than technical externalities. If the oil-using economy is comprised totally of many competitive sectors, these pecuniary externalities can be ignored, because they do not influence welfare (Folkerts-Landau 1984). Many macroeconomic and industrial organization economists, however, think that monopolistic competition may be a better representation than perfect competition for modern economies (Bresnahan 1989). Under such a market environment, pecuniary externalities cannot be ignored because they do influence welfare (Romer 1996, p. 114). Using such a framework, Huntington (2003) shows that the risk-adjusted macroeconomic externalities might produce welfare losses that are comparable to the market or monopolistic power component.

OPEC taxes and terrorism

Other suggested components for the oil import premium are either subsets of the above market failures or do not belong in the estimate. For example, some public commentary calls today's higher oil price an oil tax imposed by governments owning oil resources. Although oil taxes on a single commodity are economically inefficient, the market or monopsony power component already incorporates this effect.

Alternatively, the revenue received by oil-exporting countries may finance terrorism, belligerent dictators controlling oil resources and other activities that are particularly distasteful to the OECD nations.[2] Essentially, this issue means that a dollar sent overseas to an oil-producing country represents a cost that exceeds that dollar. Cost-benefit analysis can place different values on the market power component to reflect our distaste for revenues collected by these governments and recirculated to harmful groups, but this approach would be an adjustment to the market power component rather than a new component. Generally, estimates of the oil import premium exclude this issue, because it is very difficult to determine a monetary value.

Military expenditures

Empirical premium estimates correctly exclude military expenditures to maintain peace and property rights in oil-producing countries. The premium measures what governments *should* spend to reduce a set of damages. Actual military expenditures indicate what the government *does* spend. What the government does spend may have nothing to do with the damages incurred by countries that depend too much on oil imports (Bohi and Toman, 1993). These expenditures describe the costs of a policy choice rather than the societal damages caused by the oil import level. The latter have already been captured by the market failures identified above. If you add military costs to the premium, you are essentially double counting damages or costs.

To elaborate further, suppose that you know that greenhouse gas emissions cost society $25 per ton-equivalent of carbon in terms of the damages on health, seacoast preservation and other socioeconomic impacts. The government responds by implementing a greenhouse gas emission fee of $25 per ton-equivalent of carbon. Adding the cost of the program (the greenhouse gas emission fee) to the damages that you are trying to avoid is similar to combining military expenditures with the premium. This procedure inflates the premium estimate to the point that it now has no meaning as a policy benchmark. In short, premiums should refer to damages caused by climate change or oil insecurity rather than the costs of implementing policies in response to those damages. In all likelihood, the government may spend too little on emissions reductions or too much on military protection to be good indicators of the true costs to society.

On the other hand, the premium computed previously may be useful for judging actual military expenditures that can be clearly identified with the U.S. oil interests. According to the director of the U.S. Congressional Budget Office, annual U.S. military expenditures in Iraq are now about $113 billion. Spreading those costs over the 5 billion barrels currently imported by the United States results in approximately $23 per barrel. This simple calculation suggests that the United States is spending too much if its military commitment was due solely to reaping societal oil benefits (estimated to be about $13 per barrel, as reported in the upcoming Table 1). In addition to excluding other reasons for its military commitment in Iraq, this simple calculation also ignores the wider social costs associated with additional deaths and permanent injuries.

Strategic petroleum reserve expenditures

The costs of maintaining the Strategic Petroleum Reserve should not be included in the premium estimates for the same reasons that military expenditures should be excluded. They are not damages caused by too much dependence upon oil imports but rather are policy options for reducing those damages. On the other hand, policymakers should use the oil premium estimates to decide whether or not to build additional public oil stockpiles.

A recent estimate of the oil import premium

The most widely cited empirical estimate of the oil import premium is Leiby *et al* (1997), which has been updated recently by Leiby (2007). These ambitious efforts have done much to clarify the oil import premium estimate and to provide policymakers with some useful benchmarks for evaluating policies. They use a probabilistic simulation framework to estimate the premium for the United States that incorporate many different perspectives on market behavior, including the assumption that United States actions may have very little impact on oil prices under some circumstances. Given the intensity of beliefs between those who believe in energy security market failures and those who do not, this eclectic approach serves a very useful purpose.

Oil market conditions and premium estimates

The newer Leiby estimates show that the oil import premium increases when baseline oil prices are higher than they were 10 years ago. The critical assumption is that the oil price elasticities for demand inside and outside of the United States and for supply inside and outside of the oil-exporting cartels are unchanged between the two time periods. This assumption appears justified by available empirical estimates for oil demand, e.g., see Goodwin, Dargay and Hanly (2004), Graham and Glaister (2004), Dahl (2007), and Dargay *et al* (2007). Combined with the assumption that the share of the USA imports in the total market is not dramatically different between the two periods, these conditions imply that the percentage change in the premium should be approximately the same. But if the baseline oil price *levels* are higher, the premium *level* will also increase proportionately. (Leiby provides a useful mathematical exposition of this point.)

These premium estimates are based upon a single oil market projection for the U.S. Energy Information Administration's reference case. This procedure is consistent with how the study's disruption probabilities were developed, which will be discussed in the next major section. It should be recognized, however, that this sole projection for world oil market conditions might bias the results towards higher oil premia. Gately (2007) criticizes these EIA projections as being much too bullish about OPEC's willingness to supply oil in future markets. Disruptions in any region will have a larger impact on the world oil price if that region is providing a larger share of the total market.

The estimates

The new and previous estimates are compared in Table 1. The median monopsony power premium increases from $2.57 per barrel in the 1997 study to $8.90 per barrel in the 2006 study (all prices are in 2004 U.S. dollars). When the macroeconomic premium is added to the first component, the median full premium increases from $3.59 per barrel to $13.58 per barrel between the 1997 and 2006 estimates.

<Insert Table 1 here>

Aggregating the two components implies that the total import premium should include the market power component when there is a disruption. The market power premium, however, usually applies to stable market conditions rather than to disruptions.[3] If importing countries do not earn market power benefits during disruptions, these estimates may be overstated.

Leiby recognizes that the macroeconomic externalities may derive more from the total consumption of an unstable energy source than from oil imports alone. But he also argues that oil imports increase the exposure to disruptions in the Middle East and cause disrupted prices to be higher than otherwise; hence, his justification for including the macroeconomic component for U.S. oil imports. If one believes, on the other hand, that there is little direct link between oil imports and the macroeconomic externalities of an oil price shock, one may prefer to focus exclusively on the market power component of the premium shown in Table 1. Although greater domestic ethanol or ANWR production may reduce imports, this development does not protect the economy from future oil price shocks. GDP effects may still apply for U.S. oil *consumption* when world oil market supplies are unstable, but that result suggests that there may be an oil *consumption* rather than an oil *import* premium component for macroeconomic externalities.

This estimate of the premium computes the damages attributable to macroeconomic externalities in terms of reduced real output as measured by GDP, the principal activity variable analyzed by macroeconomists. GDP is not the preferred measure for cost-benefit analysis because output changes do not necessarily reflect lost opportunities or welfare. It is unclear whether the use of real GDP overstates or understates the welfare lost from an economic recession. Those who argue that GDP losses and rising unemployment overstate the welfare losses usually argue that workers and firms anticipate and cope with many market frictions in an efficient manner (Bohi and Toman, 1996). Those who argue that recession-induced welfare losses often exceed the decline in GDP usually focus on the deadweight triangular losses from producing less than optimal output (Gertler *et al*, 2007). As output departs further from the full-employment level, welfare declines more than proportionately.

Oil disruption risks

The probability of the size and duration of another oil disruption is critical to the estimated oil import premium. Leiby and Bowman (2003) show that various estimates of the risk of comparable disruptions during the 1990s varied by as much as a factor of five depending upon the approach and assumptions. In response to the need for credible estimates of these disruption probabilities, the Energy Modeling Forum at Stanford University organized in 2006 a working group of leading geopolitical and oil market experts. This group developed a risk assessment framework and evaluated the likelihood of at least one foreign oil disruption over the next ten years (Beccue and Huntington, 2006). The study had three objectives:

- Develop a risk assessment framework and utilize expert judgment to develop the overall probability of a major oil disruption
- Characterize the likelihood, effective magnitude, and duration of potential supply disruptions
- Clearly document the logic and assumptions driving the risk analyses.

Formal probabilistic risk assessments have been widely used to analyze a range of topics where:

- uncertainty is paramount
- many interrelated factors cause significant complexity
- information is available from many sources
- policymakers want a quantitative, logical, and defensible analysis of the associated risks.

The most detailed, thorough and structured approach for evaluating these risks lies in elicitation of the views of an expert panel, such as that previously conducted by the Stanford Energy Modeling Forum in 1996 (Huntington *et al*, 1997). This approach, drawing on the tools and principles of decision analysis (Clemen, 1996), is based upon structured modeling where specific events are identified and their probabilities are evaluated. Critically, the approach allows interdependencies to exist between events, thereby providing a richer evaluation of the underlying risks of disruptions. The assessment incorporates expert judgment to provide an explicit quantification of the magnitude, duration and likelihood of oil supply events that could cause significant upward deviations in world oil prices.

The EMF conducted a series of three workshops between December 2004 and July 2005. These meetings focused on incorporating expert judgment in the explicit quantification of the magnitude and likelihood of oil disruptions. The panel consisted of leading geopolitical, military and oil-market experts, who provided their perspective on the probability of different events occurring and their corresponding link to major disruptions in key oil market regions. Special attention was made to differentiate disruptions by their magnitude, duration and likelihood of occurrence. Panel members represented a wide range of institutional/organizational backgrounds and were asked to reflect their individual judgments and to avoid technical or policy positions taken by their organizations. The participants are recorded in the more recent report (Beccue and Huntington, 2005).

Shortfalls and supply regions

For the oil risk assessment, a disruption or shortfall is defined as:

> A sudden shortfall in oil production from a world supplier that results in at least 2 MMBD unavailable within 1 month of the beginning of the disruption. After the period, world production recovers to the same level prior to the shortfall. The disruption occurs at least one time during the 10-yr period 2005-2014. (Beccue and Huntington, 2006, p.6).

This definition provides an explicit event for experts to evaluate the probability of an oil disruption. More than one disruption can occur during the 10-year timeframe 2005-2014. In these evaluations, a shortfall is not defined in terms of a specific movement in prices.

The evaluations focused on possible disruptions in four major oil supply regions: (1) Saudi Arabia, (2) Other Persian Gulf countries, (3) West of Suez, and (4) Russia and Caspian states. The Other Persian Gulf group included Iran, Iraq, Kuwait, Qatar, United Arab Emirates, and Oman. The West of Suez countries included Algeria, Angola, Libya, Mexico, Nigeria, and Venezuela. The analysis treated each set of countries within a region as a group. The production capacities from the IEO Reference Case for 2010 were nearly identical across regions, ranging from 13.2 million barrels per day (MMBD) for Saudi Arabia and Russia and the Caspian States to 15.7 MMBD for the heterogeneous West of Suez grouping.

The group estimated net disruptions after allowing offsets from undisrupted regions. Major offsets to the gross disruptions consist of excess capacity primarily located in Saudi Arabia, and to a lesser extent, the Other Persian Gulf sources. The U.S. strategic petroleum reserve (SPR) is not included as an offset, because the analysis estimates net disruptions arising from a lack of policy intervention by the U.S. government.

This information was entered into DPL software, a state-of-the-art decision and risk analysis package (Syncopation Software, 2003). To obtain summary information, the model calculated the disruption size for all combinations of event states (over 20 million scenarios) and weighted each scenario by its likelihood of occurrence.

The scenario-probability pairs are succinctly summarized and displayed in Figure 1 for all disruptions. The curve plots along the vertical axis the probability that a disruption will occur in the next 10 years of at least *x*, for each value of *x* (in MMBD, net of offsets) on the horizontal axis. The graph focuses on magnitudes of 2 MMBD and greater, because smaller disruptions are unlikely to have significant price impacts. These smaller disruptions are also difficult to identify and attribute to specific events. This chart shows that the data point at 5 MMBD and 45 percent can be described as a 45 percent chance that a 5 MMBD disruption or larger will occur at least one time in the 10-year timeframe 2005-2014. It is very likely that a net (of offsets) disruption of 2 MMBD (million barrels per day) or more and lasting at least 1 month will occur (over 80 percent).[4] The chance of a 3 MMBD net disruption or more lasting at least 1 month is 65 percent; the chance of 5 MMBD or more is about 50 percent. However, it is unlikely that disruptions greater than 15 MMBD will occur (less than 1 percent).

<Insert Figure 1 here>

This curve allows one to easily identify the likelihood of disruption sizes within a range. For example, the probability of a disruption between 5-10 MMBD is 37 percent (probability of >5 is 45 percent, probability of >10 is 8 percent, difference is 45 percent-8 percent = 37 percent). The graph shows a larger weighting for 3 MMBD and 8 MMBD by the steep drop in the curve in these regions. The reader should be extremely cautious in making conclusions for these specific magnitudes, because they reflect approximations underlying the assessment method.

The distribution in Figure 1 is a combination of events in each of four regions. The approach can show the contribution of each region to the summary distribution by eliminating disruptions in other regions (assuming no disruption occurs) and showing the results for a region independently. Figure 2 shows each region independently on the same probability graph. Other Persian Gulf and West of Suez regions have the larger probabilities of disruption (for any given disruptions size) than Saudi or Russian and Caspian States.[5] The probability of any disruption lasting more than a month is higher in the other Persian Gulf countries (83 percent) or in the West of Suez region (72 percent) than in Saudi Arabia (49 percent). The comparable probability for Russia and the Caspian States (17 percent) is lower than the Saudi Arabian estimate.

<Insert Figure 2 here>

Offsets from the use of excess capacity outside the disrupted region reduce the size of the disruption. Without the availability of this excess capacity, a flat region appears in Figure 3 between 0-3 MMBD, representing a near certainty that a disruption of this magnitude will occur in the next 10 years. The effect of eliminating any excess capacity tends to shift the distribution to the right by roughly 1 MMBD, indicating that net disruptions are larger without this excess capacity. The figure reveals that offsets reduce the probability that the net disruption reaches any given size by approximately 5 percent-15 percent.

<Insert Figure 3 here>

A key influence on these disruption risks are the possible events in the West of Suez region, which was excluded from the analysis conducted ten years ago. If this region were assumed to be stable in the most recent analysis, the probability of a disruption is 5 percent lower for sizes less than 3 MMBD, and 15 percent in the range of 3-7 MMBD, as shown in Figure 4.

<Insert Figure 4 here>

Middle East conflict was a critical, underlying event jointly affecting disruption risks in multiple regions. Figure 5 contrasts the base case assumptions with two extreme conditions in the Middle East: stable conditions with no conflicts, and extended or active war in the region. At 5 MMBD or greater, the probability varied from 34 percent to 60 percent, confirming the notion that middle east events and their linkages to the regional shortfall risks are an important element of the oil risk assessment.

<Insert Figure 5 here>

Relative to a similar EMF risk assessment in 1996, these updated estimates indicate an increased likelihood of disruptions equal to or below 10 MMBD, but a similar likelihood of disruptions that exceed 10 MMBD (7-8 percent or lower). The current assessment covers four regions of the world instead of two regions, has updated probabilities to reflect current world conditions, and has modified excess capacity and oil supply forecasts.

Oil disruption impacts

High world oil prices have transferred enormous wealth from oil-importing to oil-exporting countries in recent years, but they have not derailed world economic growth. Since most countries report their economic activity in terms of Gross Domestic Product (an indicator of real output), this loss in real income is often disguised by official statistics

(Huntington 2007). Nevertheless, the absence of declining real output when oil prices are high has been somewhat of a puzzle for many observers. The oil price movements over the last few years have received recent attention from several macroeconomists (e.g., see Blanchard and Gali, 2007, and Nordhaus, 2007).

Two frequent explanations emphasize the declining oil intensity in the economy and the demand-side origins of recent price increases. Declining oil intensity in the economy will reduce the direct impacts, but the substitution towards the relatively price-insensitive, transportation applications for petroleum may offset this effect. Demand-oriented oil price increases may be more gradual than oil price shocks from supply disruptions. They may also have different international trade effects than supply disruptions, because all economies are growing rather than stagnating.

Oil prices and prior economic conditions

Huntington (2005) emphasizes two important differences between recent oil price increases and the 1970's experience. Prices have searched for higher ground gradually over many months rather than being surprise shocks. In addition, these price increases have occurred in economies that have been relatively free from inflationary pressures. Both developments have made the economy relatively invulnerable to oil prices.

Figure 6 shows the oil price path over several critical periods in the last three decades. In each case, the line shows the oil price relative to its level in the beginning period for each of the following 17 months. Thus, the October 1973 oil price shock was 15 percent higher after one month but more than 120 percent higher by the third month. The

1990 line also displays a shock, while the 1979 path, while rising quickly, tends to increase more gradually than the 1973 and 1991 shocks. In contrast, the experience that began at the end of 2004 represented a more gradual elevation in the price level. It was high enough to outrage drivers at the gasoline stations, but it seems very different than the 1973 and 1990 price shocks.

<Insert Figure 6 here>

Table 2 considers four scenarios that highlight the different influences attributable to the type of oil price increase and the underlying macroeconomic conditions prior to the oil price change. "Higher oil price" conditions in the upper row on the far left reflect a situation much like today when market conditions are pushing prices along a steady upward or elevated path to restore demand and supply imbalances. Since oil prices are inherently volatile, this elevated path will not be smooth but it will avoid any major surprise events. These conditions are fundamentally different from those represented in the second row for the "oil price shock" conditions, where sudden supply or demand changes induce rapid price increases that scare people and firms and create such widespread uncertainty that firms and households delay major investments. Such price events appear more representative of the 1970s than recent price volatility. Although many energy economists treat these two conditions the same, they should be considered as very distinct events.

<Insert Table 2 here>

Both of these price events can happen at a time when economic conditions either prevent or allow an effective monetary policy response as an offset to the disruption.

During the 1970s, policymakers were faced with high interest rates and high inflationary expectations. Many professional economists at that time were pessimistic that the central bank could intervene successfully to offset output reductions without accelerating inflation. Today, inflation rates are tamed and interest rates have been relatively low. Armed with a policy rule that adjusts monetary policy to expected output growth and inflation rates (the Taylor rule), many economists are more confident about what they can achieve.

This confidence can be misleading for several reasons. First, monetary authorities throughout the world are very concerned about keeping inflation rates and expectations under control. Small mistakes in managing a nation's money supply can quickly worsen the situation. And second, the world is tiptoeing around the problem of terrorism, belligerent dictators and war in the major oil-producing regions. Small perturbations in very tight oil markets can become the catalyst for very rapid oil price shocks. If inflationary expectations should worsen just prior to an oil price shock, the world would be faced with a very different set of problems.

The box in the southeast corner of the table summarizes the "perfect storm" conditions, where oil shocks are rapid, unexpected and very scary to firms in the economy and where macroeconomic conditions prevent the central bank from mounting an effective offset. As with the California electricity restructuring fiasco, another "perfect storm", economists knew that the state was managing its electricity restructuring poorly, but they could not convince the policymakers to make the necessary changes before disaster struck.

Completely opposed to these conditions are those in the northwest box carrying the label "policy fix". At the end of 2007, oil prices are moving steadily higher but firms and households understand the trends. They know that some arbitrage to protect themselves from higher prices in the future can help them adjust to the new conditions. As a result, the central bank does not need to make major adjustments in their monetary policy to keep the economy's path from veering. And when they do adjust their rules, economic conditions are favorable to their success.

The other two boxes are more difficult to characterize. An economy with low inflationary expectations could survive a surprise shock, just as an economy with high inflationary expectations may be able to absorb oil prices that gradually move higher. Without more experiences to draw from, it is not possible to generalize about these alternatives.

Sudden and gradual price increments

Sudden price increases scare people and create widespread uncertainty about deciding the appropriate production techniques, purchasing new equipment or consumer durable goods like automobiles, and negotiating wages and prices. As firms and households adjust to the new conditions, some plant and equipment will remain idle and some workers will be temporarily unemployed. In contrast to a gradual oil price increase, the economy may no longer be operating along its long-run production-possibility frontier.

An important characteristic of a price shock is that the price change should be large relative to recent price changes. The price shocks during the Suez Canal crisis and the 1970s were immediately preceded by very stable oil prices that neither increased nor decreased much between months. After oil prices crumbled in 1986, oil price volatility became much more pronounced. With increased price volatility, market participants began to expect price oscillations and started to diversify their price risks through oil futures markets. Despite being pressured by steadily rising oil prices in the last several years, the economy has been relatively free of surprise oil price shocks in the last two decades, except for the events leading up to the first Persian Gulf War in 1990.

Economic impact estimates

Macroeconomists have estimated that a ten percent increase in crude oil prices will cause the Gross Domestic Product *level* to be between 0.2 and 0.5 percent lower than otherwise after six quarters.[6] This range, however, reflects the use of two very different methodologies. At the lower end are estimates from large macroeconomic models that do not distinguish today's high oil prices from events where oil supplies are explicitly disrupted. At the high end are estimates from smaller research econometric studies focusing explicitly on oil shocks.

The advantage of the large macroeconomic model is that new conditions and policies may be represented more comprehensively than in the smaller research studies. This greater detail, however, requires a number of important assumptions to control for these factors, about which there may be some critical differences of opinion. Moreover, their lower economic impact estimates may reflect their assumption that the economic response to oil price shocks are no different from the response to gradual oil price increases as well as price decreases.

A number of empirical studies have used reduced-form, time-series analyses relating economic growth and oil price changes, although they sometimes include several other variables. These empirical studies have shown that oil price shocks must be considered separately from other oil price changes. Gradual oil price increases as well as price declines fail to contribute to real aggregate output (GDP) changes. The principal concern about these statistical studies is that they may fail to control for key macroeconomic variables and relationships that influence how the economy responds to oil price changes.

After reviewing a number of different economic impact estimates, Huntington (2005) concludes that recent estimates from large macroeconomic models might be appropriate when inflationary fears are low and monetary authorities are more confident that they can accommodate oil price shocks. These frameworks usually simulate conditions similar to today's economic trends and often assume that monetary authorities will offset much of the output lost to disruptions. After six quarters in these simulations, the *level* of real GDP is approximately 2 percent lower for a rapidly doubling of crude oil prices.

If inflationary expectations are considerably higher than today, Huntington (2005) concludes that the estimates from the reduced-form, statistical approach may be more applicable, because the estimates will be incorporating the responses during periods of higher inflationary expectations. Under these conditions, the level of real GDP is approximately 5 percent lower for a doubling of crude oil prices. If there were a 40 percent chance that the economy could return to an environment of high inflationary expectations, the expected GDP loss after six quarters across both high and low inflationary expectation states would be 3.2 percent (=0.4 x 5 percent + 0.6 x 2 percent) from a disruption that doubled the price of crude oil.

Summary

Many countries are facing a twin-headed energy challenge over the next several decades. The "coal" problem relates to the perceived threat from global climate change if we continue to rely upon coal and other fossil fuels to propel our future power needs and economies. The "oil" problem results from our reliance upon petroleum supplies as the principal source for mobility at a time when oil supplies are probably more vulnerable than in our recent past. Policy must balance both concerns if robust strategies are to be developed.

After identifying possible externalities, this chapter has selectively reviewed three economic issues that are central to the discussion of the oil security problem. The oil import premium measures the value of intervening in oil market conditions to make the economy less vulnerable to an oil-exporting cartel and to sudden oil price disruptions. The premium says nothing about which oil-reduction policy should be adopted. Recent estimates for the United States suggest that the monopsony premium, the most widely adopted measure, ranges from approximately \$3 to \$18 per barrel, with a median estimate of almost \$9 per barrel. If oil prices should continue to rise over the next few years, these estimates should increase, more or less proportionately.

A second issue in this chapter concerns the risks of another oil supply interruption. A principal difference over the last ten years has been the spread of risks beyond the Persian Gulf region. An Energy Modeling Forum study on oil disruptions done in 1996 focused on Saudi Arabia and the neighboring Persian Gulf states. More recent estimates have expanded the coverage to Russia and the Caspian states as well as to a set of countries bordering up and down the Atlantic Ocean (principally, Nigeria, Angola, Venezuela and Mexico). Each of these countries could potentially experience political problems that would make its oil supplies vulnerable. An evaluation of top geopolitical and Middle Eastern experts in 2006 concluded that there was an 80 percent chance that a significant oil disruption could happen at some point over the next 10 years.

A third and final issue focuses upon the vulnerability of the economy to an oil disruption. If we could lock today's inflation-free economy into the future, there would be less urgency to resolve the turmoil in the Middle East or to accommodate other leaders of oil-rich states, although an oil disruption may still be quite harmful. If countries want to cushion the impact of future disruptions, their energy policies will need to focus upon oil consumption reductions more than oil import limitations.

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Notes

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[1] A large oil importer can reduce the price set by an oil-exporting cartel that consistently maximizes net profits. Retaliation by the exporting cartel would require that it deviate from its wealth-maximization position.

[2] It may be that these activities detract from and make more costly other public goods provided by oil-importing countries, such as international negotiations in politically sensitive regions where oil production dominates the economy. In these situations, the oil weapon may be used to thwart foreign affairs conducted by oil-importing countries. None of the premium estimates include such a cost.

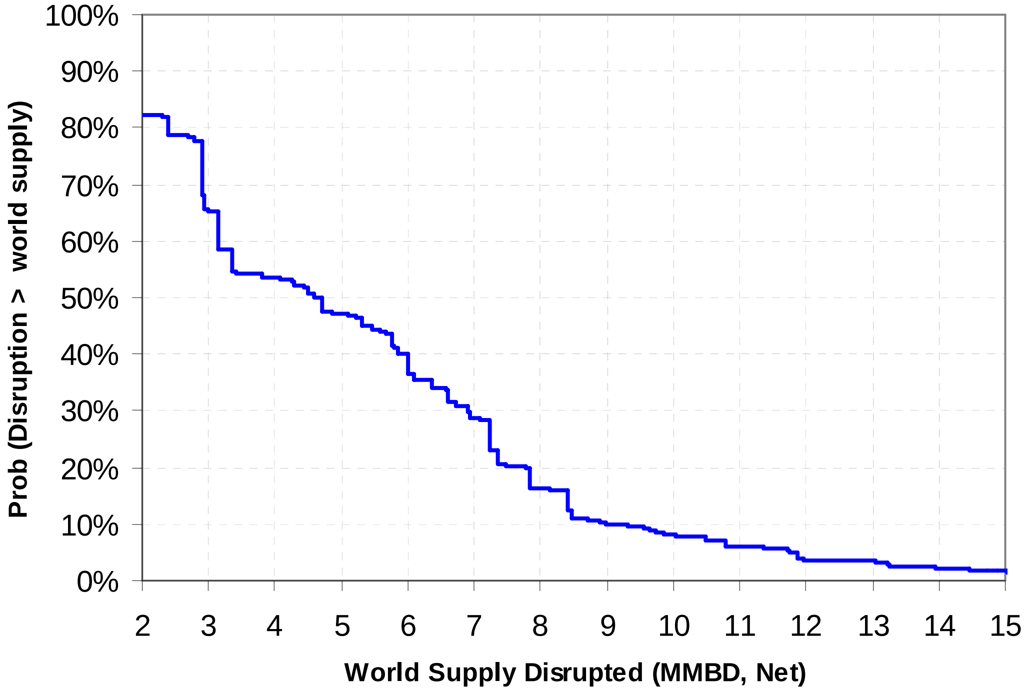
[3] See, for example, the premium estimates developed in Energy Modeling Forum (1982).

[4] Under stylized assumptions, this ten-year probability (80 percent) converts to approximately a 15 percent annual probability. The latter equals $1-(1-.80)^{(1/10)}$.

[5] Minor exception at 8 MMBD

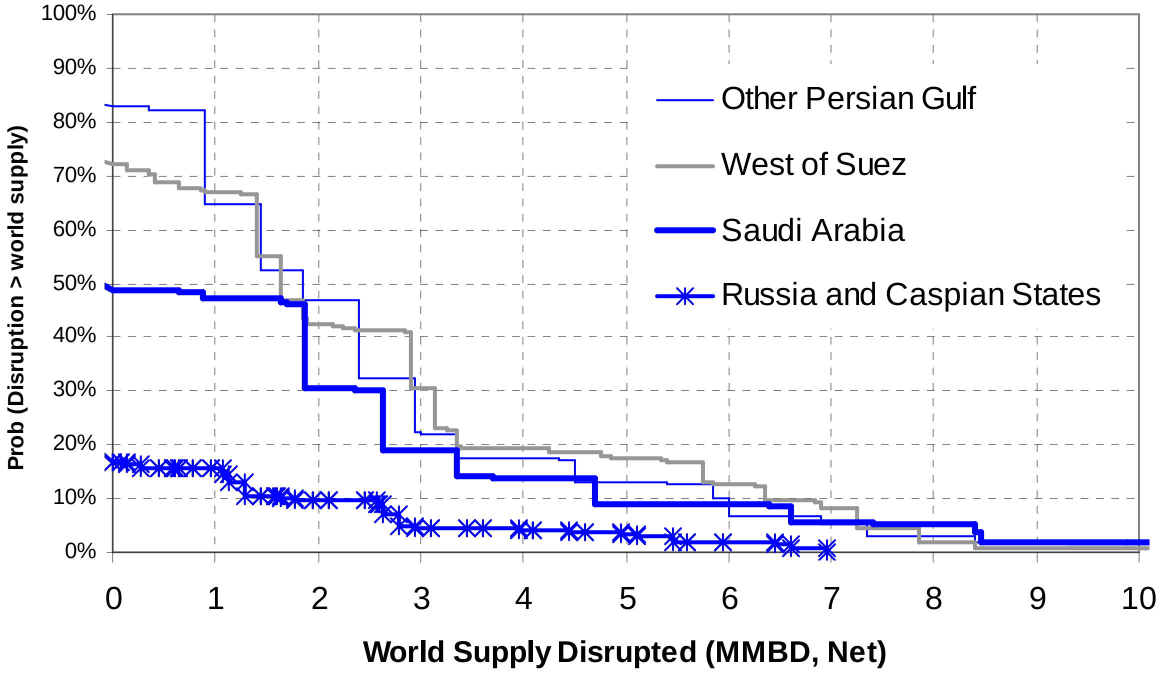
[6] This range applies for the United States as summarized by Jones, Leiby and Paik (2004), Brown and Yücel (2002) and Brown *et al* (2004), but it also seems consistent with international studies (Jimenez-Rodriguez and Sanchez, 2005).

Figure 1. Probability of an Oil Disruption Lasting 1-6 Months



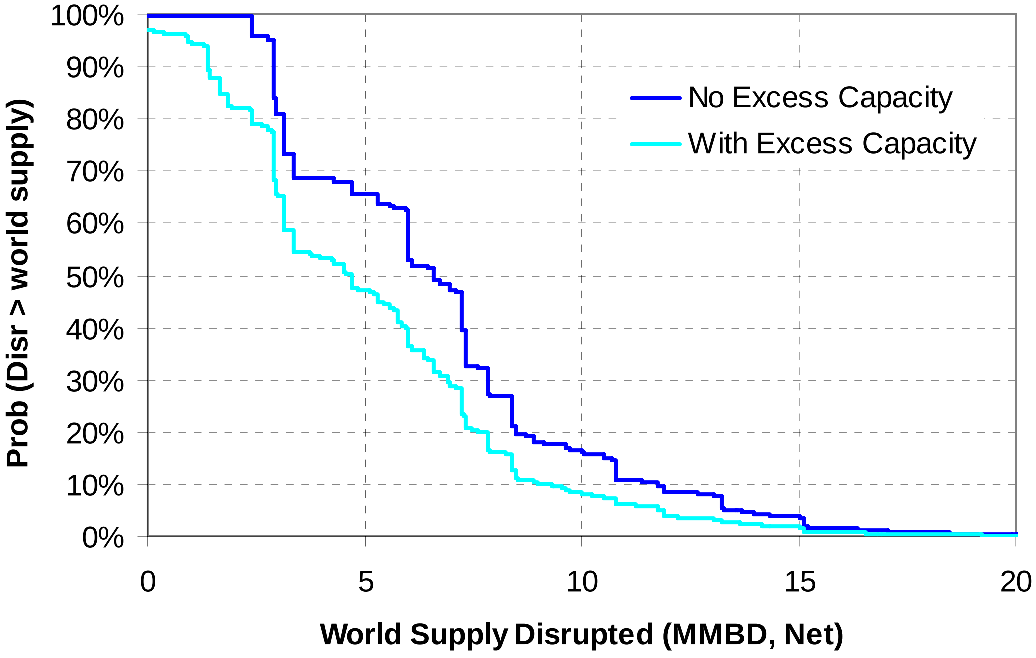
Source: Beccue and Huntington (2005).

Figure 2. Comparison of Short-Duration Disruptions by Region



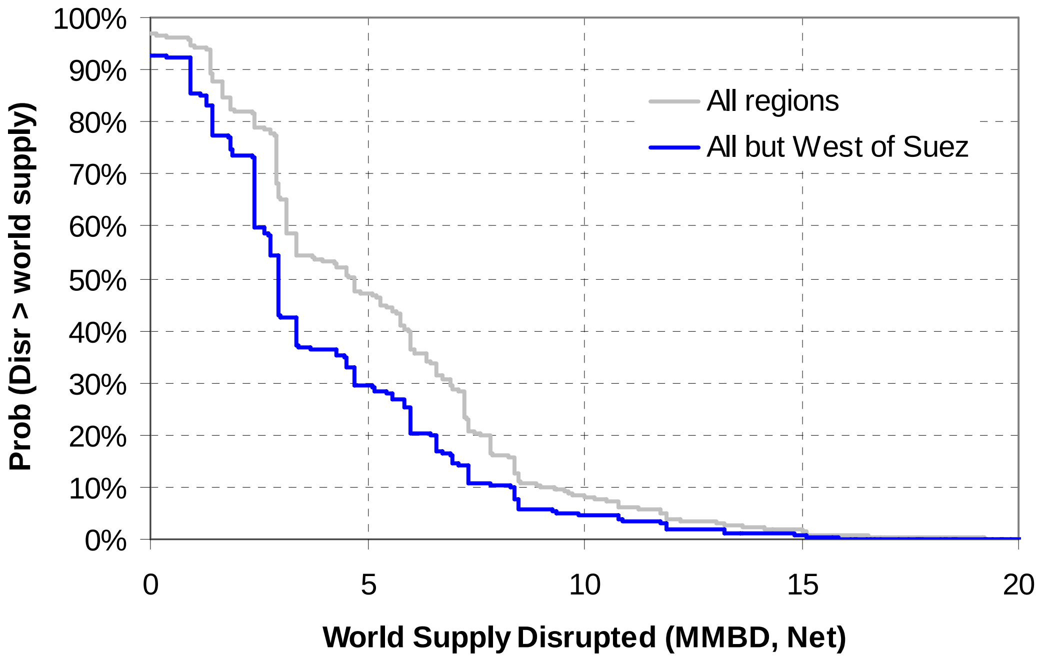
Source: Beccue and Huntington (2005).

Figure 3. Sensitivity to Removing Excess Capacity



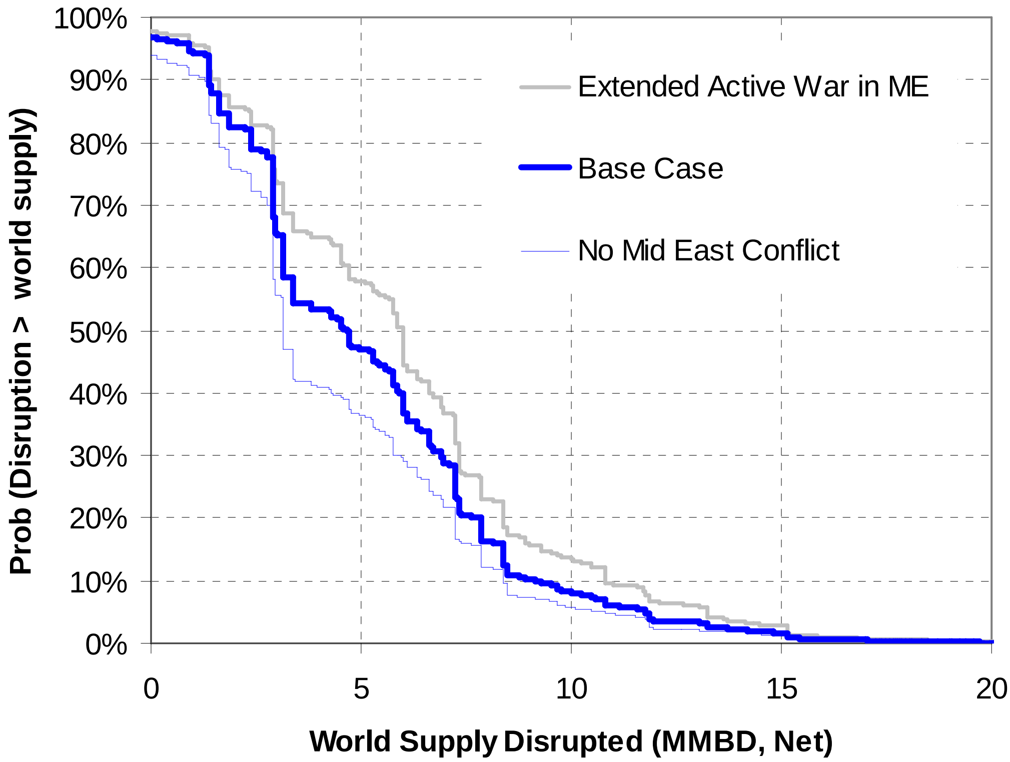
Source: Beccue and Huntington (2005).

Figure 4. Sensitivity to Removing West of Suez Region



Source: Beccue and Huntington (2005).

Figure 5. Sensitivity to War in the Middle East



Source: Beccue and Huntington (2005).

Figure 6. Oil Price Path for Four Different Price Increases

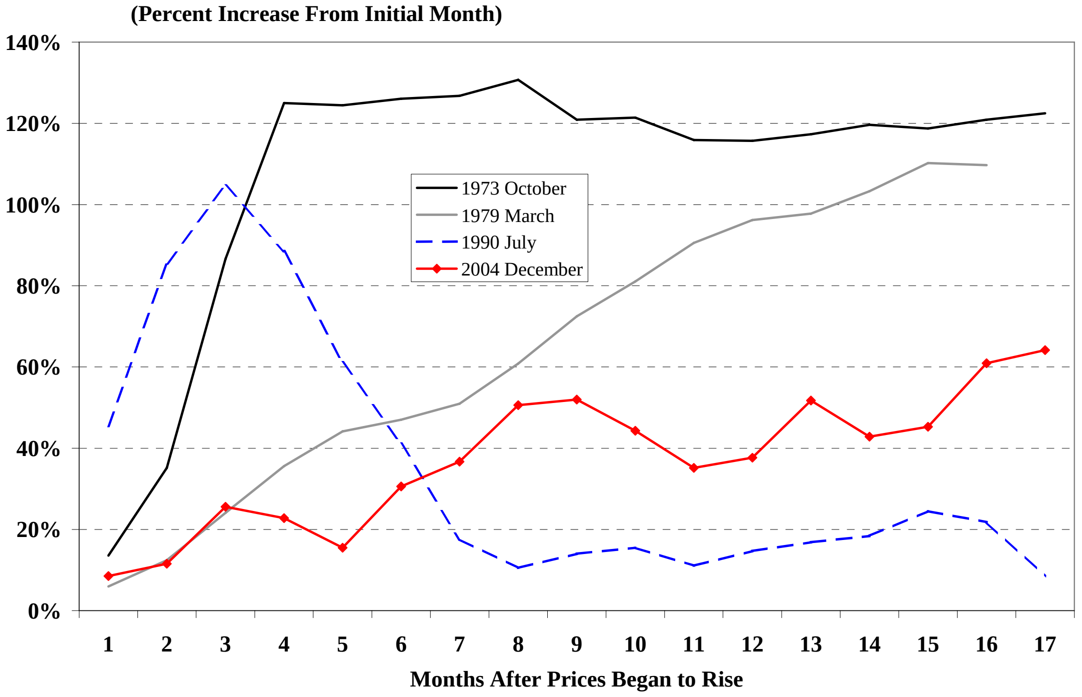


Table 1. Mean Estimate of Oil Import Premium

Effect / Study	1997 Study (2004$/BBL)	2006 Study (2004$/BBL)
Monopsony Component	$2.57 ($1.54 - $3.59)	$8.90 ($2.91 - $18.40)
Macroeconomic Disruption/ Adjustment Costs	$1.03 ($1.03 - $2.05)	$4.68 ($2.18 - $7.81)
Total Mid-point	$3.59 ($2.57-$5.64)	$13.58 ($6.71 - $23.25)

Sources: Leiby et al (1997) and Leiby (2007).
Ranges are reported in parentheses below the mean estimate.

Source: Leiby (2007).

Table 2. Oil Price and Prior Economic Conditions

		Low Inflationary Expectations and Interest Rates Prior to Oil Price Change	**High Inflationary Expectations and Interest Rates Prior to Oil Price Change**
		Monetary policy can be accommodating	Monetary policy can **not** be accommodating
Higher Oil Price	Oil prices move steadily higher but not rapidly over consecutive months.	*Policy Fix*	*?*
Oil Price Shock	Oil prices move rapidly upward over consecutive months.	*?*	*Possible Recession*

Source: Huntington (2005).