Estimating the Economic Benefits of Forward-Engaged Naval Forces

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In preparing for the 1997 quadrennial defense review, US Navy leaders asked us if we could quantify the economic benefits of forward-engaged naval forces and communicate them to policy makers. Until this point, the only evidence of such benefits was anecdotal. Forward-engaged naval forces are US-based ships deployed to such areas as the Mediterranean Sea, the Persian Gulf, or the western Pacific Ocean. Forward engagement affords the opportunity to work with regional states in shaping the international security environment and also enables rapid response to unexpected crises. Using a methodology based on oil-futures prices, we estimated the economic benefits of crisis response by forward-engaged naval forces for the 1990 Iraqi invasion of Kuwait. We showed that the economic benefits to the United States and its trading partners are conservatively in the tens of billions of dollars.

In the spring of 1996, US Navy leaders were preparing for the upcoming quadrennial defense review (QDR). The QDR would be the 1997 version of the Bush administration's base force study of 1991 and Secretary of Defense Aspin's bottom-up review (BUR) of 1993. These reviews were enormously important because they set the force levels of the military services. After the Cold War, the US trimmed its military forces and the 1997 QDR could result in further reductions. The de facto unit of

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measurement of force structure in the US Air Force is aircraft wings; in the US Army, it is divisions; and in the US Navy, it is aircraft carriers.

The 1993 bottom-up review resulted in the reduction of the number of Navy carriers from 15 to 12. Even 12 exceeded the number required to fight the two simultaneous major regional contingencies that were the requirement baseline for the BUR. The justification for a force of 12 carriers was the requirement to provide naval forward presence. Naval forward presence can be manifested in a number of ways, but the most common is the presence of a carrier battle group in an area of interest, such as the Mediterranean Sea or the Persian Gulf. The ability to provide naval forward presence depends primarily upon force structure. Because of training, maintenance, and limitations on the crews' time at sea, the Navy needs several ships for each ship deployed.

The regional commanders in chief, as articulated in Joint Chiefs of Staff policy, establish the requirement for forward-engaged naval forces. Still, in the US democracy, ultimately voters must support this requirement as well. Thus in preparing for the 1997 QDR, the deputy chief of naval operations for resources, warfare requirements, and assessments, then Vice Admiral Thomas J. Lopez, asked the Naval Postgraduate School to study the economic aspects of forward engagement. Admiral Lopez uses the term *engagement* rather than *presence* in recognition of the fact that forward-deployed naval forces are not just present but are actively engaged in working with regional states and shaping the international security environment. They are also likely to be well positioned to respond to crises. The admiral noted that the average voter does not understand the economic benefits of forward-engaged naval forces. Prior studies of the economic benefits of forward-engaged naval forces were based on anecdotes and lacked analytical rigor. We needed a new approach to quantify the economic benefits in understandable terms. The target audience was policy makers and the general public.

The Naval Postgraduate School assembled an interdisciplinary team of faculty from the operations research and national security affairs departments and it prepared a study plan consisting of three interrelated tasks. The first task was to analyze the flexibility and effectiveness of naval forces in providing crisis response options to the president and to the national command authority. The second task was to quantify economic benefits. The third task was to quantify how the navy's ability to provide forward engagement and crisis response depends upon force structure. We approached this task as a scheduling-optimization problem, taking into account ship-maintenance requirements, restrictions on crew deployment periods, battle group and air wing training requirements, and other deployment parameters. In this paper, we focus on the second task, quantifying the economic benefits of forward-engaged naval forces.

Ultimately voters must support the requirement for forward-engaged naval forces.

Methodology

Crises tend to have a negative impact on markets and economic activity. Forward-engaged naval forces are often the first to respond to a crisis, and their arrival usually has a stabilizing political influence. The stabilizing influence extends to economic activity. We decided that oil would be the most tractable vehicle for analyzing the economic benefit of forward-engaged naval forces. Because oil is essential to nearly all economic activity in the industrialized world, changes in oil prices in reaction to world events form a useful index of the overall economic impact of international crises and of the response of naval forces to them.

We thought it was essential to select an index capable of reflecting the market's interpretation of the severity of a crisis and the degree to which trader confidence was restored following naval response to the crisis. Because oil-futures prices provide more information than spot prices, we used futures prices to explore the effect of naval forward engagement and crisis response. Oil-futures markets serve as an efficient substitute for the bulk storage of oil. Instead of stockpiling oil reserves, futures markets, such as the New York Mercantile Exchange (NYMEX), allow companies to purchase contracts to buy or sell oil at some future time. These contracts are transacted for individual months in the future. Traders base their offers on the best economic, political, and military information available to them at the time the contract is traded. As a result, futures prices are considered to be the best, unbiased estimate of the likely spot or daily price of oil when the contracted delivery date actually arrives [Bopp and Lady 1991].

Crises tend to have a negative impact on economic activity.

Transactions in the futures markets produce forecasts of oil prices that reflect traders' confidence that oil will be readily available at some future time. Futures prices can thus be used to assess the effects of naval forward engagement and crisis response on market confidence in oil availability. Perhaps more important for our purposes in this study, by using futures markets we could isolate the effects of naval crisis response on oil markets from those caused by other events.

The methodology we followed was to track oil-futures prices and to observe the increase in prices caused by a crisis and the reduction and stabilization of the prices when naval forces arrived on scene. We could then estimate the value of the response of naval forces in terms of the price paid for oil. Furthermore, as an input to econometric models, futures prices can be used to compute the long-term effects on economic activity in the United States and other world economies.

The notional pattern is as follows. Prior to a crisis, oil-futures prices generally slope upward (Figure 1, Curve 1). The upward slope reflects both the cost of storage and the general expectation among traders that oil prices will increase over time. With the advent of a crisis, however, future availability of oil is in doubt and traders attach an uncertainty premium to their asking price [Gabilon 1995]. The effect on futures prices is twofold. First, such a development increases futures prices for all

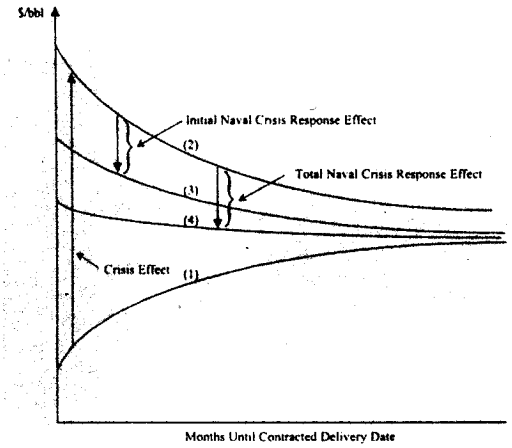


Figure 1: In the absence of a crisis, oil futures prices trend upward, reflecting, if nothing else, the cost of storing oil (Curve 1). A crisis in the region will cause a shock in prices, illustrated by the upward shift and change in slope from Curve 1 to Curve 2, reflecting traders' willingness to pay a premium for the immediate possession of oil due to concern about its future availability. Crisis response by naval forces moderates concerns about future availability of oil and lowers the futures price curve over all contract periods (Curve 3). This trend continues until market confidence is restored and the markets equilibrate (Curve 4).

months (indicated by an upward shift in the futures price schedule). Second, the slope of the futures market curve becomes negative (Figure 1, Curve 2), reflecting traders' willingness to pay a premium for immediate possession of oil. When naval forces respond to the crisis, some of the uncertainty concerning oil supplies is alleviated, which shifts the futures price curve downward and decreases the short-run premium paid for immediate possession of oil. These effects are evidenced by a downward shift and flattening of the futures price schedule (Figure 1, Curve 3).

We used futures prices to compute two measures of the benefits derived from naval response to crises. First, we estimated potential savings in oil-import bills by multiplying the differential between the higher prices caused by the crisis and the prices moderated by naval crisis response by the amount of oil imported during the period from the onset of the crisis to the stabilization of the markets. For a second, far larger measure we calculated the effect of lower oil prices over time as they spread through the economy, affecting production, employment, inflation, and more.

We estimated these much larger effects on economic activity in the United States and other world powers using econometric models developed by Christopher Sims [1980] of Northwestern University. Ir Figure 2, the box labeled "Vector autoregression econometric model" refers to the Sims model.

Compared to an examination of oil spot prices, our methodology based on futures prices better captures the true effects of naval forward engagement and crisis response. Relying solely on spot prices may lead to a conclusion that naval forces produce a temporary price effect that is of little economic significance. In reality, naval forward engagement and crisis response alters key price structures months into the future. Because oil-futures prices provide more information about the response of oil markets to naval activity than do spot prices, our methodology captures larger, longer-term economic benefits of naval forward presence.

The Iraqi Invasion of Kuwait

In the summer of 1990, Iraq was in need of oil revenues to pay for its long war with Iran. Iraq was frustrated by the depressed oil prices caused in part by overproduction in Kuwait and the United Arab Emir-

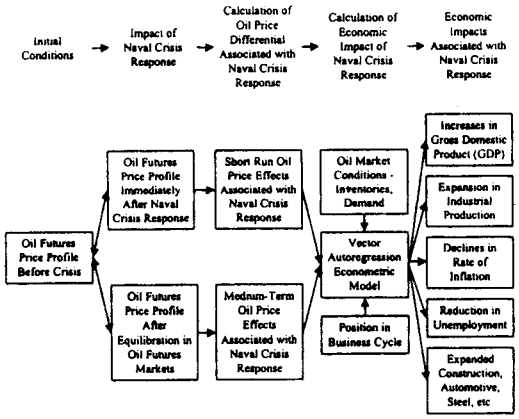


Figure 2: In our analysis, we tracked futures prices from prior to the crisis through the crisis and crisis response by naval forces. We used differences between the elevated futures prices created by the crisis and the futures prices moderated by crisis response to estimate the savings in oil purchased. We estimated the larger economic benefits of crisis response from an econometric model with these same oil price profiles. The econometric model indicates that naval crisis response prevents losses in economic activity.

ates (UAE). After moving armed forces to the border with Kuwait several weeks earlier, Iraq invaded the state of Kuwait on August 2, touching off an international crisis and creating an upward surge in oil prices.

In the summer of 1989, Saudi Arabia had isolated Kuwait by signing a nonaggression pact with Iraq. This, combined with Saudi Arabia's emerging support for increased prices, pushed oil prices higher in the latter part of the year [Dodson 1989]. Price increases were not sustainable, however, with 1990 becoming a normal post-1986 cartel year of weak oil markets. Prices declined during the first six months of the year because of two developments. First, Kuwait had been investing much of its oil income in the economies of the industrialized countries. By 1990, over half of its income came from overseas investments, and it was vulnerable to any recession in the industrialized countries induced by sharp oil-price increases. Second, Kuwait and the UAE had systematically driven down the price of oil by exceeding their OPEC quota by nearly 1.5 million barrels a day. In early May 1990, the main concern of many analysts was "weathering another price slump" [*Los Angeles Times*, May 4, 1990].

By June, OPEC had failed several times to reduce output, and the key members were quarrelling over which country would have to reduce production the most. By the end of June, OPEC realized its target price of $18 was too high. Spot rates weakened as offerings exceeded demand and inventories neared maximum storage capacities. This ruined prospects for the normal autumn price pickup. Also in late June, Iraqi threats against overproducers became increasingly strident.

When Saudi Arabia announced an output reduction and persuaded others to do likewise, prices began to increase [Reuters, July 10, 1990]. Still, the markets were skeptical as OPEC continued to deal with bloated inventories and apparently faced a long wait for higher prices [Lee, July 10, 1990]. OPEC ministers met in Geneva, Switzerland on July 26 and 27 and set new quotas aimed at raising the price of oil to $21 a barrel by the end of the year. Given that world oil stocks were the highest since the early 1980s, analysts were divided over how quickly oil prices might increase. Some expected prices to fall in the near term before turning up by year-end. Many, however, believed that OPEC could

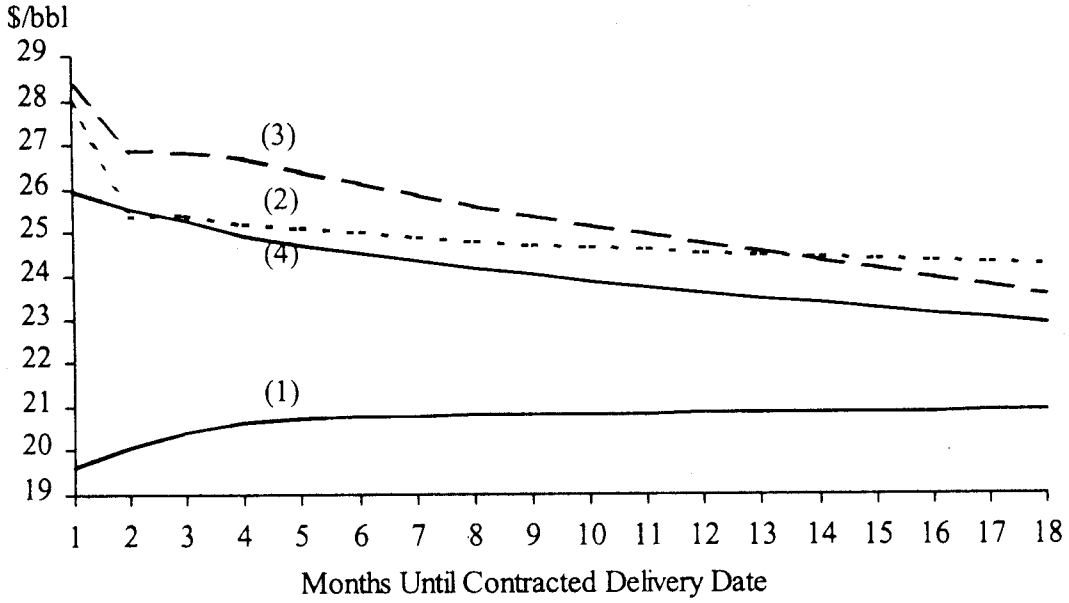


Figure 3: This figure is the Kuwait crisis realization of the notional behavior of NYMEX oil-futures prices shown in Figure 1. Curve 1 is the preinvasion price profile. Curve 2 is the post-invasion price profile of August 6, 1990, and Curve 3 is the postinvasion price profile of August 7, 1990. Curve 4 is the postinvasion price profile of August 8, 1990 as the market began to equilibrate. The invasion's impact on futures prices is clearly indicated by Curves 2 and 3: prices for all contract lengths increased and the slope of the curves is negative, indicating a willingness to pay a premium for immediate possession of oil. As evidenced by Curve 4, the impact of naval crisis response is a significant lowering of the entire futures price curve and a decrease in slope, reflecting the restoration of market confidence and reduced willingness to pay a premium for immediate possession of oil.

achieve the price of $21 per barrel if it could effect a fair degree of production discipline.

For its part, up to the end of July, the NYMEX anticipated a slight rise in price throughout the remainder of 1990 and into 1991. This anticipation was reflected in the futures markets, which trended toward higher prices as contract lengths increased. It was impossible to predict Iraq's invasion of Kuwait on August 2.

Oil Price Movements

The last NYMEX price for an August futures contract was $19.65. Following the invasion on August 2 (a Thursday), oil spot prices increased to $28.05 by August 6 (the following Monday). (The spot price and the first futures contract normally differ by only a few cents.) Traders at first didn't know what to make of the invasion. But, as events unfolded over the weekend, uncertainty heightened and futures markets shifted from upward sloping (Figure 3, Curve 1) to downward sloping (Figure 3, Curves 2, 3, and 4). The steep slope of the August 6 futures price profile (Figure 3, Curve 2) reflects the high premium placed on immediate possession of oil. Futures prices increased again on August 7 before beginning to stabilize on August 8 as US intentions became clear. Spot prices declined to $26.00 by August 8 as well.

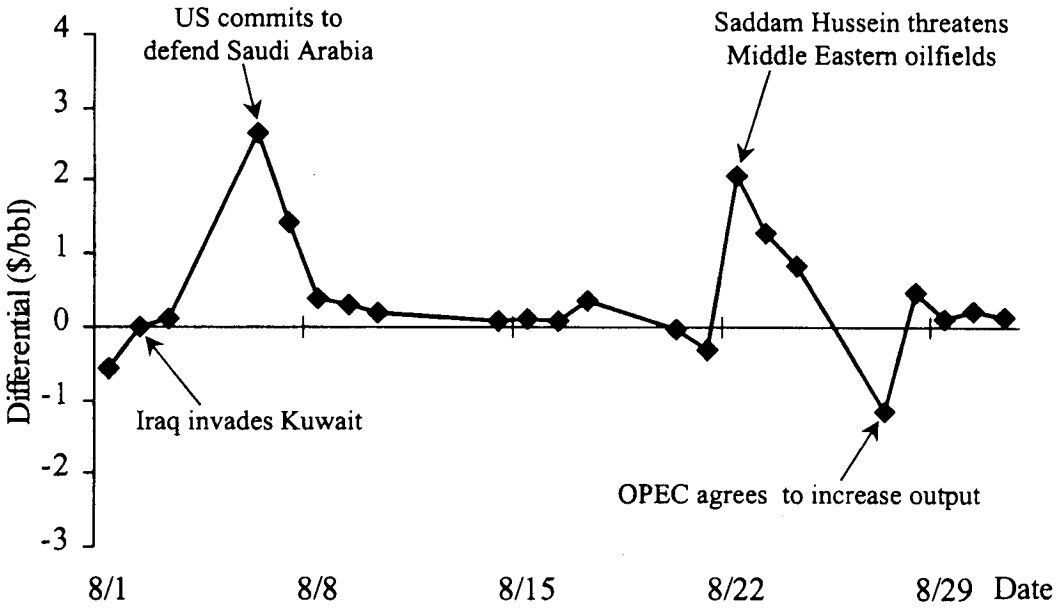


Figure 4: The NYMEX oil-futures prices show that when the differential between the first futures contract (September delivery) and the second futures contract (October delivery) is positive, traders prefer immediate possession of oil because they are concerned about its future availability. A return to equilibrium is indicated by the disappearance of a positive differential. An initial equilibrium is evidenced by the near-zero differential that exists between August 8, 1990 and August 22, 1990.

Movements in the sensitive NYMEX futures market (Figure 4) show that futures prices stabilized around August 9. In general, as markets stabilize, the differential between the price a trader offers for delivery of oil next month and the price offered for delivery of oil in two months decreases. The differential between these two futures contracts is a very sensitive indicator of oil traders' uncertainty over oil availability. In this case, stabilization of the price differential (that is, the first futures contract minus the second futures contract) indicates that the impact of naval crisis response had taken place, and a new equilibrium in oil markets had been established by August 9. In Figure 4, a positive differential in the futures market reflects greater risk; that is, steeper downward slope in the futures price curve. Conversely, a negative differential reflects the elimination of a risk premium. Specifically, the narrowing differential observed in this case reflects the reduced risk premium that sellers were able to charge for oil as concern over destruction of Saudi oil fields decreased. Put differently, because of the greater likelihood of continued Saudi oil availability, buyers were no longer willing to pay a high premium for delivery in the immediate future.

Despite the high oil inventories and therefore soft oil prices, the Kuwait crisis drove oil prices up sharply. The subsequent decline in futures prices can be attributed to the market's confidence that US response in the region would prevent further encroachment by Iraq. While

prices later began to drift up from this initial equilibrium, a close reading of the events of August 1990 suggests that this subsequent increase was caused largely by factors other than US naval presence in the region. General market uncertainty over US intentions regarding Kuwait was heightened by Iraq's threat to attack Middle Eastern oil fields and the deliberate inaction of other OPEC producers to increase output. These factors, not US forward presence, were primarily to blame for prices increasing beyond the initial equilibrium level reached by August 9.

Although subsequent movements in spot and futures prices occurred throughout the fall of 1990, other factors explain these fluctuations. The question to be answered is, "What factors acted to blunt the oil-price shock created by the invasion on August 2 and begin to reverse it by August 8?"

In the first days after Iraq's seizure of Kuwait, no one knew whether Iraq had further objectives. The major oil-producing region of Saudi Arabia lies near the northeastern coastline, south of the border with Kuwait. Two major concerns were the potential for damage to Saudi oil fields and the possibility of Iraq's domination of so much of the world's oil production and reserves. Indeed, in a meeting on the day after the invasion, President Bush with the National Security Council devoted as much time to discussing the impact of the invasion on the price of oil as they did to how the United States should respond to Iraq's aggression [Powell and Persico 1995]. These concerns were quickly moderated, however. On August 6, King Fahd formally requested US assistance, and President Bush announced that US forces would be committed to the defense of Saudi Arabia. The president's announcement undoubtedly did much to moderate world concerns. The president acted alone at this time and was implementing a variation of the Carter doctrine that "any assault by any outside force in the Persian Gulf region will be regarded as an assault against the United States" [Palmer 1992, p. 98].

The president's declaration of support for the defense of Saudi Arabia was somewhat risky. The statement of US commitment could have prompted the Iraqi leadership to reevaluate its objectives and alternatives. If Iraq had believed that the US would take a long time to establish a credible defensive force in Saudi Arabia, it might have decided to push into northeastern Saudi Arabia and thereby control an even greater portion of all Middle East oil production. If President Bush considered this possibility too and decided to announce US support for the defense of Saudi Arabia anyway, he must have concluded that he would not have to wait long for credible forces to arrive. The first forces on scene that were capable of sustained operations that could cripple an Iraqi invasion of northeastern Saudi Arabia were forward-deployed naval forces.

We estimated the total worldwide impact to have been $83.6 billion.

On August 8, the *Eisenhower* carrier battle group arrived in the Red Sea, and the *Independence* carrier battle group arrived in the Gulf of Oman. Each carrier battle group was capable of initiating and sus-

taining combat operations that would have seriously challenged the movement of Iraqi ground forces. Also on August 8, the maritime prepositioning squadron (MPS) ships sailed from Diego Garcia and Guam. MPS 2 ships arrived in the port of Al Jubayl, Saudi Arabia, from Diego Garcia on August 15 and married-up with US Marines who had been flown into the theater. When matched with their equipment and sustainment stocks from the MPS ships, these marines represented the first credible, sustainable defensive forces on the ground.

Aircraft of the US Air Force First Tactical Fighter Wing began arriving in Saudi Arabia on August 8 as well. They had flown, armed, directly from the United States. The arms they carried were all the ordnance they had and they lacked the ordnance stocks, fuel, and maintenance capability for sustained operations in the early weeks of the crisis.

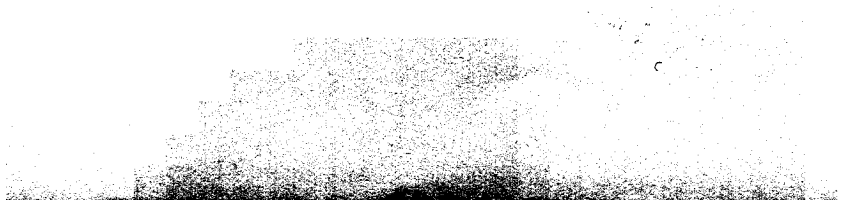
Also on August 8, the first troops of the US Army 82nd Airborne Division began arriving at the airport in Dhahran, Saudi Arabia, but they arrived with only the weapons and supplies they carried on their backs. These light forces were not capable of confronting Iraqi armor. The US Army 24th Mechanized Infantry Division arrived in Saudi Arabia between August 27 and September 25, with the second Armored Cavalry Regiment beginning to arrive on October 19.

Thus, if the president evaluated the alternatives and the risks and decided on August 6 that he had the capability to defend Saudi Arabia, this capability could only have come from forward-engaged naval forces. While the players in the oil futures markets did not have access to the same intelligence estimates as President Bush, they surely moderated their concerns because naval forces capable of sustained combat operations arrived quickly.

Economic Impact of Naval Crisis Response

The economic impact of crisis response by US naval forces can be gauged by the difference between the elevated oil prices caused by the crisis and the moderated prices after crisis response. In terms of what actually happened, the Iraqi invasion of Kuwait drove oil prices sharply upward from below $20 on the last day to purchase an August future to above $28 on August 7 (Figure 5, Curves 1 and 2). The arrival of naval forces on August 8 reduced prices by well over $2 by August 9 (Figure 5, Curve 3). We calculated two economic impacts. The first is the savings in oil purchases computed as the difference between August 7th and August 9th futures prices times the US net crude-oil imports from August 1990 through February 1991. These savings amount to $3.21 billion in FY 1997 dollars.

The second and far larger impact is the effect of the difference in oil prices as they ripple through the economy. Using an optimized vector autoregression model of the US economy we found that crisis response averted a potential loss of $55.2 billion in gross domestic product (GDP) [Looney 1996]. Most of the members of the Organization for Economic Cooperation and Development (OECD) experienced similar benefits. In addition to the United States, the OECD comprises Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany,



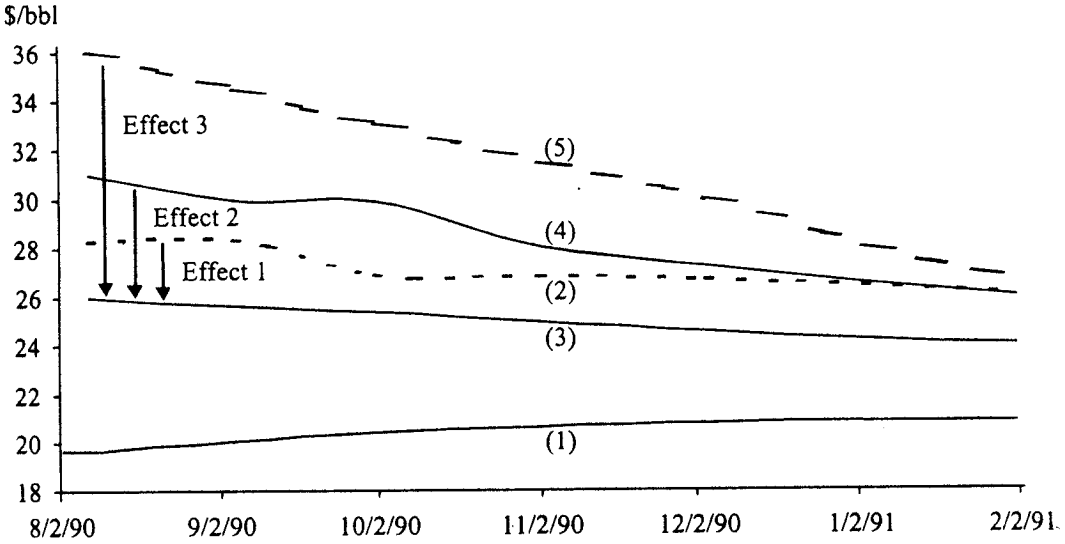


Figure 5: We used actual and hypothetical NYMEX oil-futures price curves to compute the economic benefits of naval crisis response. Curve 1 is the preinvasion futures prices for the next seven months (through the liberation of Kuwait). Curve 2 indicates the higher futures prices existing on August 7, 1990, five days after the invasion. Curve 3 indicates the reduction in futures prices found on August 9, 1990, after crisis response. Effect 1 measures the potential loss in gross domestic product that was avoided when futures prices shifted from Curve 2 to Curve 3 as a result of naval crisis response. For the US, Effect 1 was estimated to be worth $55.2 billion. Curve 4 is hypothetical in that it represents a possible futures prices curve had there been no crisis response. Effect 2 measures the potential loss in gross domestic product that would have resulted if there had been no crisis response, as indicated by the difference between Curve 4 and Curve 3. For the US, Effect 2 was estimated to be worth $94.0 billion. Curve 5 is a conservative estimate of what Curve 2 would have been if the invasion had occurred at a time of tight oil supplies. Effect 3 measures the potential loss in gross domestic product that would have resulted in such a scenario, as indicated by the difference between Curve 5 and Curve 3. For the US, Effect 3 was estimated to be worth $182.7 billion.

Great Britain, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, and Switzerland. Because of insufficient data, we did not examine the effects on the Czech Republic, Iceland, and Luxembourg. Norway alone was adversely affected by the moderation of oil prices, reflecting the importance of North Sea oil production in its economy. We calculated the net economic benefit to the OECD countries to be $69.5 billion. Because the OECD countries account for about 80 percent of world income, we estimated the total worldwide impact of naval crisis response to have been $83.6 billion.

While the economic impact of naval crisis response in what actually happened is significant, it is interesting to also look at two hypothetical situations. In the first of these situations, we assume an absence of naval crisis response within the first three weeks of the crisis. Our analysis of this hypothetical situation suggests that the benefits we calculated for the actual crisis scenario provide a lower bound on the value of naval crisis response.

Assuming that the United States did not

respond to the crisis, it is not unreasonable to project increasing trader concern over future oil availability at reasonable terms. Even with naval crisis response, Iraqi threats to Saudi oil fields forced the oil-price profile (spot and associated forward contracts) upward with the spot price reaching $32 per barrel by August 24th. Given the economic forces at play, it is most likely that futures prices would have risen to at least this level in the absence of naval crisis response. With the understanding that this represents a very conservative estimate of the economic benefit associated with naval crisis response, we derived a second measure, Effect 2 in Figure 5, by subtracting the August 9 futures-price profile from the profile actually occurring on August 24 (Figure 5, Curve 4 minus Curve 3).

With the hypothetical Effect 2, we computed the value of naval crisis response to the United States to be $5.4 billion in the cost of oil purchases and the avoidance of the loss in GDP that would have resulted from higher oil prices as $94 billion. We computed the GDP impact for the OECD countries and the world as $119.6 billion and $143.9 billion, respectively.

We hypothesized a third effect to compensate for the weak oil markets existing at the time of the invasion of Kuwait. We adjusted futures prices to reflect a situation in which inventories are low and excess production capacity is limited. This market environment exists today and is likely to be the most common one in the foreseeable future. Under these circumstances, oil prices would likely have risen more rapidly and to higher levels than they actually did during the invasion. (The referee noted that, in this case, while the spot price would be higher after the invasion, it would have been higher before the invasion as well.) Under such tight market circumstances, it is not unreasonable to assume that prices would have been at least $5 per barrel higher than the August 24 prices we used to calculate Effect 2. Incorporating this price differential into the August 24 futures profile, crisis response Effect 3 is therefore the August 24 futures price profile, adjusted to a hypothetical starting point of $36, minus the August 9 futures price profile (Figure 5: Curve 5 minus Curve 3).

With the hypothetical Effect 3, we calculated the value of naval crisis response to the United States to be $10.0 billion in the cost of oil purchases and the avoidance of the loss in GDP that would have resulted from higher oil prices as $182.7 billion. We computed the GDP impact for the OECD countries and the world as $231.4 billion and $278.4 billion, respectively. Table 1 summarizes the GDP losses avoided.

Another way of viewing these findings is to imagine what would have happened

	United States	OECD	Worl
Effect 1	$55.2	$69.5	$83.(
Effect 2	$94.0	$119.6	$143.9
Effect 3	$182.7	$231.4	$278.4

Table 1: We show the GDP losses avoided in FY 1997 dollars (in billions). Prompt naval crisis response ameliorated the shock in oil prices created by the invasion of Kuwait and this is reflected in Effect 1. If there had been no crisis response and oil prices had gone higher, the losses in GDP might have been as shown in Effect 2. Finally, if the crisis had occurred at a time of tight oil supplies, a conservative estimate of the impact on GDP is shown in Effect 3.

if oil prices had remained constant after naval crisis response in early August 1990. As a result of the oil-price reductions brought about by naval crisis response, the United States economy, over time and facing lower oil prices and associated energy costs, was able to generate $55.2 billion more in GDP than it would have if preresponse prices had held.

Conclusion

The analysis shows a linkage between oil prices and naval crisis response. Brown et al. [1997] examined two additional crises in a similar manner. Although the three crises vary in terms of the threat posed to US and Allied interests, prevailing oil-market conditions, business cycles, and the general world economic climate, these analyses show a clear trend in the futures-markets profiles resulting from each crisis. Oil-futures prices, which shoot up at the onset of the crisis, begin to decline a day or so after the markets become aware of crisis response by US naval forces.

Oil prices have significant and lasting impacts on the US economy and indeed on the economies of all industrialized nations. Naval crisis response eases oil traders' concerns resulting from such crises, thereby reducing the premium that traders are willing to pay for immediate possession of oil. Their reactions are based partly on their assessment of US capabilities and the track record of the US that, once committed, carries its commitments through to successful conclusion. Whenever possible and necessary, it augments the crisis response provided by naval forces with other military forces to successfully resolve crises. However, this pattern holds even when naval forces cou not be augmented with other military forces that would have required land b ing in the region (as was the case in th 1987–1988 "Tanker War" in the Persia Gulf, one of the two other crises examined).

Forward-engaged naval forces are li to be the first to respond to a crisis, dc require permission to be on scene, and remain as long as required. If forward gagement alone is insufficient to deter crisis, naval forces are capable of enga with a full range of combat capabilitie and sustaining such operations for as l as required. This capability, combined with its inherent signal of US commitr to resolve a crisis, consistently stabiliz oil prices and ameliorates the impact c the crisis on the world economy.

Our analysis showed that the down ward movements in the price of oil as ated with naval crisis response produc significant cost savings to the United States economy. However sizable, thes estimates of savings may not reflect th vast year-to-year benefits provided by forward-engaged naval forces. As the *Washington Post* noted in an editorial v ten during the so-called Tanker War o 1987–88, naval presence in the Persian Gulf may provide benefits to the Unit States economy through the suppressi of increases in the level of oil prices [V *ington Post* 1988]. The editorial said in part:

> "Because of the number of Navy ships no the Gulf, and their demonstrated readines hit back at Iranian provocation, American standing among the Gulf Arabs is currentl high. One result is that the price of oil wil the present stay low. . . The Gulf is a turb

place, and this happy state of affairs won't last forever. But while it continues, it will mean higher economic growth around the world, and lower inflation. Credit for that goes to the Navy."

Client interest was high throughout the eight months during which we conducted the study, and we made the results available in March 1997 in time for inclusion in the final Navy input to the QDR. The study was briefed fairly widely to Navy leadership. The chief of naval operations referred to the study in his remarks during the Center for Strategic and International Studies conference on Naval Forward Presence in May 1997, and the deputy chief of naval operations for plans, policy, and operations referred to it in the Current Strategy Forum in June 1997. The outcome of the QDR was that Navy force structure remained at 12 carriers.

References

Bopp, A. E. and Lady, G. M. 1991, "A comparison of petroleum futures versus spot prices as predictors of prices in the future," *Energy Economics*, Vol. 13, No. 4 (October), pp. 274–282.

Brown, R. L.; Lawphongpanich, S.; Looney, R. E.; Moran, D.; Schrady, D. A.; Wirtz, J. J.; and Yost, D. S. 1997, "Forward engagement requirements for US naval forces: New analytical approaches," Final report, Naval Postgraduate School Technical Report NPS-OR-97-011PR, 23 July, pp. 18–21.

Dodson, Steve 1989, "Commodity prices spurred by cold," *New York Times*, December 31, Section 3, p. 12.

Gabilon, J. 1995, "Analyzing the forward price curve," in *Managing Energy Price Risk*, Risk Publications, ENRON Capital and Trade Resources, London, England.

Lee, Patrick 1990, "Whatever became of big, bad OPEC?," *Los Angeles Times*, July 10, World Report, Part H, p. 1.

Looney, R. E. 1996, "Estimating the economic benefits derived from forward-engaged naval forces," Interim report, Naval Postgraduate School Technical Report NPS-OR-96-014PR 23 October, pp. 45–47.

Los Angeles Times 1990, "Oil prices slump despite OPEC pact," May 4, Business Section Part D, p. 5.

Palmer, Michael A. 1992, *On Course to Desert Storm: The United States Navy and the Persian Gulf*, Naval Historical Center, Washington, DC.

Powell, Colin L. with Persico, J. E. 1995, *My American Journey*, Random House, New Yo

Reuters 1990, "OPEC moves closer to plan to end energy glut," *Los Angeles Times*, July 1 Business Section, Part D, p. 5.

Sims, C. 1980, "Large scale econometric models," *Econometrica*, Vol. 48, No. 1 (January), pp. 1–48.

Washington Post 1988, "Oil prices and the navy," editorial, May 4, Section A, p. A22.