

# A REPORT OF THE HERITAGE CENTER FOR DATA ANALYSIS

IF IRAN PROVOKES AN ENERGY CRISIS:  
MODELING THE PROBLEM IN A WAR GAME

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From December 2006 to March 2007, Heritage Foundation scholars conducted a computer simulation and gaming exercise that examined the likely economic and policy consequences of a major oil disruption in the Persian Gulf. The exercise utilized a realistic scenario, state-of-the-art macroeconomic modeling, and a knowledgeable team of subject-matter experts from government, business, academia, and research institutes from around Washington, D.C.

This project was a proof-of-principle investigation that combined computer modeling and gaming to capture how U.S. decisions during a crisis might affect how global energy markets and the U.S. economy adjust to sudden and significant disruptions of oil supplies. In this scenario, the United States responded to a crisis precipitated by an attempted Iranian blockade of the Strait of Hormuz.

The game began with a series of economic results based on a scenario in which Iran began blockading the Strait of Hormuz in January 2007. The assumption was that Iran may succeed in fully blockading the strait for up to one week, but after that, some oil shipping would slowly resume.

The Heritage Foundation economics team, supported by analysts at Global Insight, then modeled the blockade's likely economic effects on world oil

prices and the U.S. economy. They found that under worst-case circumstances:

- The price of West Texas Intermediate (WTI) crude<sup>1</sup> would peak in the third quarter of 2007 at \$150 per barrel, an increase of \$85 per barrel;
- Real (inflation-adjusted) gross domestic product (GDP) would fall by over \$161 billion in the fourth quarter of 2007;
- Private non-farm employment would decline by over 1 million jobs by the middle of 2008; and
- Real disposable personal income would be more than \$260 billion lower by the fourth quarter of 2007.

With this set of economic forecasts, the game participants devised policy responses to mitigate the oil price shock and subsequent economic harm. They recommended a number of policy moves, which are described later in this report. The economics team ran new economic simulations based on these policy responses and found that:

- The price of WTI crude would peak in the first quarter of 2007 at \$75 per barrel, an increase of less than \$12 per barrel;
- Real GDP would remain at roughly non-crisis levels during 2007;

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1. The price of WTI crude is one of many benchmark spot market prices for petroleum.

- Employment would expand by 109,000 in 2007; and
- Real disposable personal income would grow at non-crisis rates during 2007.

The project demonstrated the feasibility of modeling the economic consequences of crisis decision making and responses during an oil price shock induced by a hostile foreign government. At the same time, the game emphasizes how much more work is needed to explore how various combinations of political, military, diplomatic, and economic initiatives might affect the course of a global energy crisis. The Heritage Foundation plans to expand and refine its simulation and modeling tools to evaluate international responses, environmental consequences, and private-sector and public responses to other foreign policy challenges.

The results of the game also suggest that an official response to an actual crisis based on an Iran blockade of the strait might be effective. The experts who played the roles of the U.S. government officials opted for a focused but restrained use of military power oriented toward objectives that directly addressed vital national interests and that were clear, relevant, and obtainable. This use of force demonstrated the U.S. determination to uphold freedom of navigation in the Strait of Hormuz. The American response did much to calm global markets and reassure American consumers.

In addition, the experts chose to take a minimalist approach to interfering in U.S. domestic markets. They focused primarily on liberalizing domestic energy policies and rolling back regulatory restrictions. They also strove to propose policy changes that would minimize fears over shortages beyond the immediate crisis. In this exercise, the combination of a determined but limited military response and minimal government intervention ameliorated the economic consequences of the crisis.

## **WHY WORRY?**

As global energy demand grows—especially among China, India, and other developing countries—competition for access to oil is escalating. The Persian Gulf is becoming the most important bottleneck, making freedom of navigation through the strait a vital American and global interest.

However, the U.S. has a poor track record in responding to real energy crises. The most notable incidents in recent history were the two great oil

shocks sparked by the Arab oil embargo in 1973–1974 and the Iranian revolution in 1978–1979. They led to fuel shortages, long gas lines, gasoline rationing, high inflation, and energy-related damage to the overall economy. The energy crises of the 1970s are among the most unpleasant memories from that era.

Yet despite the serious global turmoil during the 1970s, America's energy ills were not entirely the result of these external forces. At almost every turn, Washington policymakers exacerbated the already challenging energy situation with their own policy blunders. The federal government's newly created maze of economic and environmental regulations and implementing agencies greatly hampered domestic energy supplies and limited the private sector's ability to respond to events.

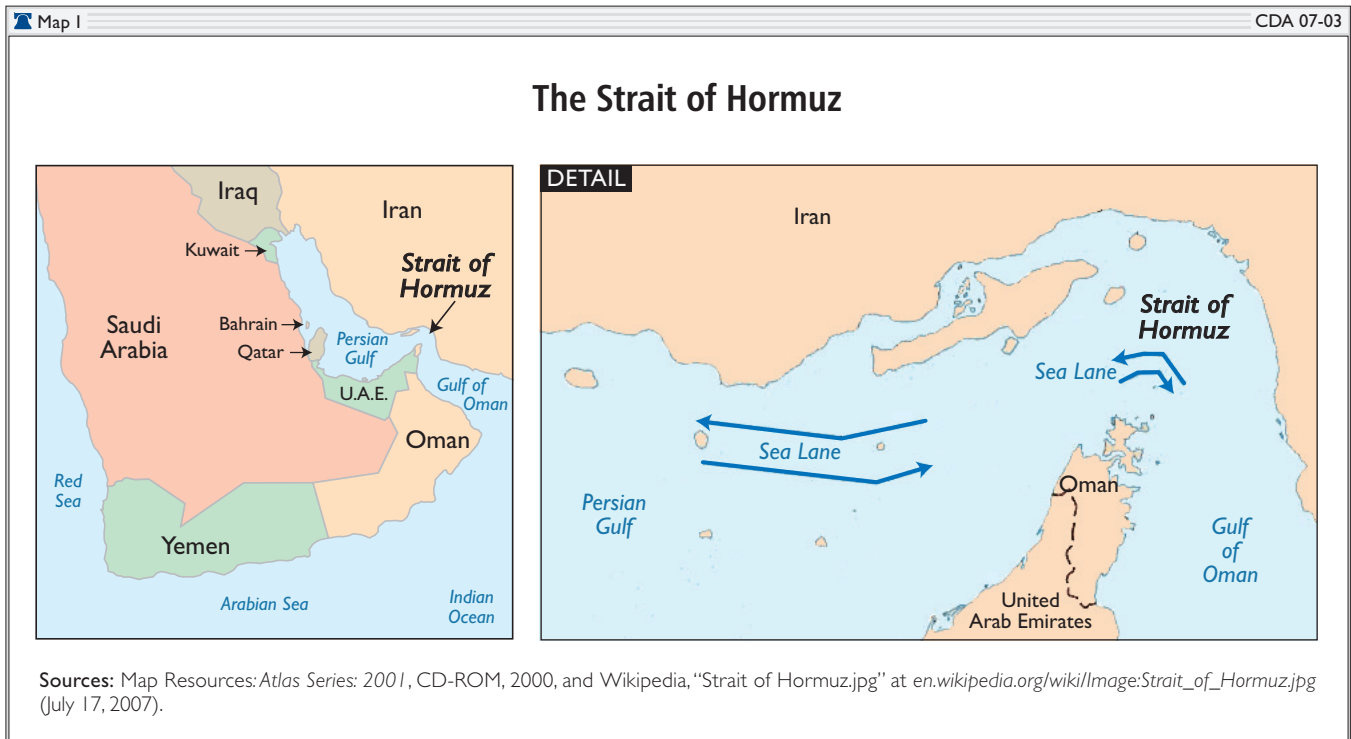
In retrospect, the U.S. government probably caused at least as much harm as any foreign entity did. Much of the energy crisis was self-inflicted by bad decisions made in Washington. The errors of the 1970s should serve as a cautionary tale as America again faces similar energy challenges.

America's leaders tend to act decisively in time of crisis—to “do something.” However, the lessons from the 1970s are clear: Bad decisions can make things much worse. Thus, developing tools to evaluate the character of decisions and explore the options and consequences of potential choices before a crisis occurs is critical for policymaking in this uncertain century.

Indeed, serious thinking about policy decision making during an energy crisis is needed more than ever before. Global energy markets have never been more integrated or more competitive. U.S. decisions during a crisis will affect not just every American consumer, but the worldwide economy. In turn, the global energy supplies will affect global markets and, consequently, America's ability to trade with the rest of the world. Thus, few skills are arguably more important than making the right decisions during an energy crisis, and the tools to evaluate these potential decisions are more crucial than ever.

## **ORGANIZING FOR CRISIS**

The purpose of this exercise was to gain data on how the United States would respond to an oil crisis resulting from an attempted blockade of oil flowing from the Persian Gulf. From these data emerge insights into policy decisions that should or should



not be made during an energy crisis. Additionally, the exercise proved the validity of the economic model used to simulate market responses to policy decisions made during an energy crisis.

Led by Ariel Cohen and James Phillips, Heritage Foundation experts developed the scenario used in

the simulation. The crisis was designed to be plausible, to make the results as realistic as possible, and to prevent players from "fighting the scenario."<sup>2</sup> Game participants were presented with the following "facts" as game parameters:

- Day 1** After one month of debate (which gives markets time to factor action into oil prices), the United Nations Security Council imposes significant sanctions on Iran over its suspicious nuclear program.
- Day 2** Iran withdraws from the Non-Proliferation Treaty and tests a nuclear weapon.
- Day 3** The U.S. bombs Iranian nuclear sites, air bases, and air defense targets but spares Iran's oil infrastructure to minimize disruption of the world oil market.
- Day 4** Iran announces that it will deny its oil exports to any country that does not condemn the U.S. action, but it continues to produce oil at the same levels. Most countries that refuse to condemn the U.S. action either are oil exporters (e.g., the United Kingdom and Canada) or do not import Iranian oil anyway.
- Day 5** Pro-Iranian Shiite militias in Iraq stage an uprising, attack coalition forces, and shut down Iraqi oil production in the southern oil fields. This takes roughly 60 percent of Iraq's oil exports off the world market for an indefinite period. Venezuelan President Hugo Chávez announces an oil embargo against the U.S. in support of Iran.<sup>3</sup> Most other members of the

2. Players "fight the scenario" when they become sidetracked on discussing or fixing supposed flaws in a scenario rather than conducting the wargaming and planning that the scenario was intended to facilitate.
3. If Venezuela actually followed through, this could lead to short-term disruptions and higher world oil prices. The U.S. would be forced to find substitutes for Venezuelan oil, which would be difficult in the short run because U.S. refineries are configured for the heavier and sourer Venezuelan oil.

Organization of Petroleum Exporting Countries condemn the U.S. “aggression” but ignore Iran’s call for an embargo. Sudan and Libya embargo oil exports to the U.S., but this has little effect because the U.S. imports very little oil from them. China, Japan, and the European Union condemn the U.S. and escape Iranian oil threats. Russia condemns the U.S. and continues oil production at maximum capacity to exploit higher oil prices.

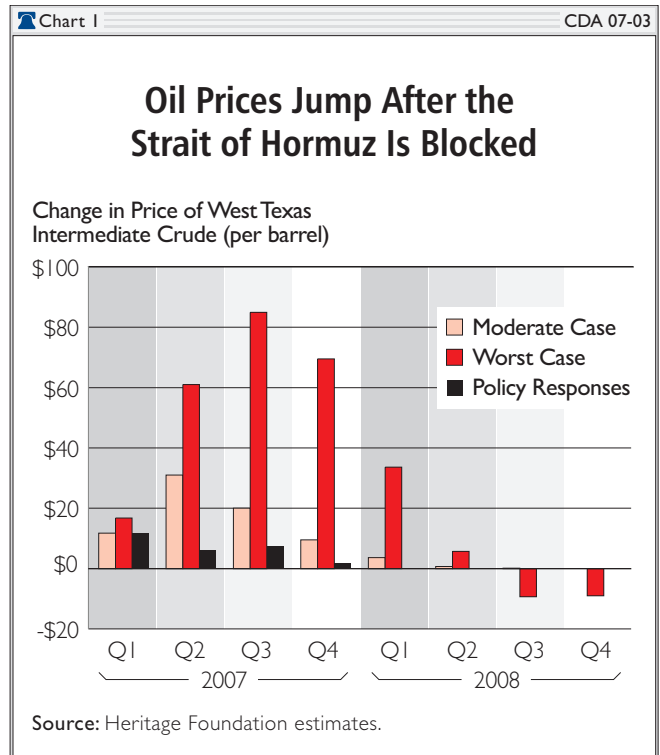
**Day 6** An oil tanker is sunk by a mine in the shipping channel in the Strait of Hormuz. Iran is believed to be responsible but does not claim responsibility. U.S. intelligence believes that the mine was laid by Iranian Revolutionary Guards in civilian clothes operating from a fishing vessel or an Iranian *Kilo*-class submarine. Saudi Arabia announces that it will divert as much oil as possible to Red Sea ports through secure pipelines.

**OIL LOSSES**

Based on this scenario, Heritage Foundation analysts estimated the losses in oil shipping out of the Persian Gulf and their effects on world oil spot prices. These estimates also became a central parameter of the game. Participants were presented with two levels of oil price spikes associated with a short interruption of oil supplies and a more protracted disruption.

**Scenario 1.** The moderate-case scenario is the loss of 2.5 million barrels per day (mbd). This amount is insufficient to trigger International Energy Agency (IEA) emergency mechanisms. Demand is reduced, but not enough to drive prices much higher than they were in the summer of 2006. Provided the U.S. government makes the appropriate decisions, the Strategic Petroleum Reserve (SPR) is utilized at a rate of 15 percent of the total decrease in supply.

**Scenario 2.** In the worst-case scenario, oil shipping drops by 6 mbd or more and supplies are disrupted significantly for the first two calendar quarters of 2007. This is sufficient to trigger IEA mechanisms, which start at a loss of 7 percent to IEA members in total or to an individual member. IEA Integrated Energy Policy calls for a 7 percent cut in demand when the policy is triggered, but analysts at Global Insight<sup>4</sup> who assisted Heritage Foundation scholars in estimating the economic effects of the oil disruption assumed that the cuts



were less than this. If demand is cut too much and the SPR is released, there are no real problems with supply, stocks rise too much, and there is no justification for a high price. SPR is utilized as in the moderate-case scenario.

Heritage Foundation experts also facilitated the actual game. The game began with a briefing on the scenario, including the trigger that disrupts oil

4. Global Insight provides the most comprehensive economic, financial, and political coverage of countries, regions, and industries available from any source, covering over 200 countries and spanning more than 170 industries and using a unique combination of expertise, models, data, and software within a common analytical framework to support planning and decision making. Recognized as the most consistently accurate forecasting company in the world, Global Insight has over 3,800 clients in industry, finance, and government, with revenues in excess of \$95 million, 600 employees, and 23 offices in 13 countries covering North and South America, Europe, Africa, the Middle East, and Asia. The Heritage Foundation worked with Global Insight to determine some of the results outlined in this report. For more complete information on the methodology and macroeconomic model used, see the appendices.

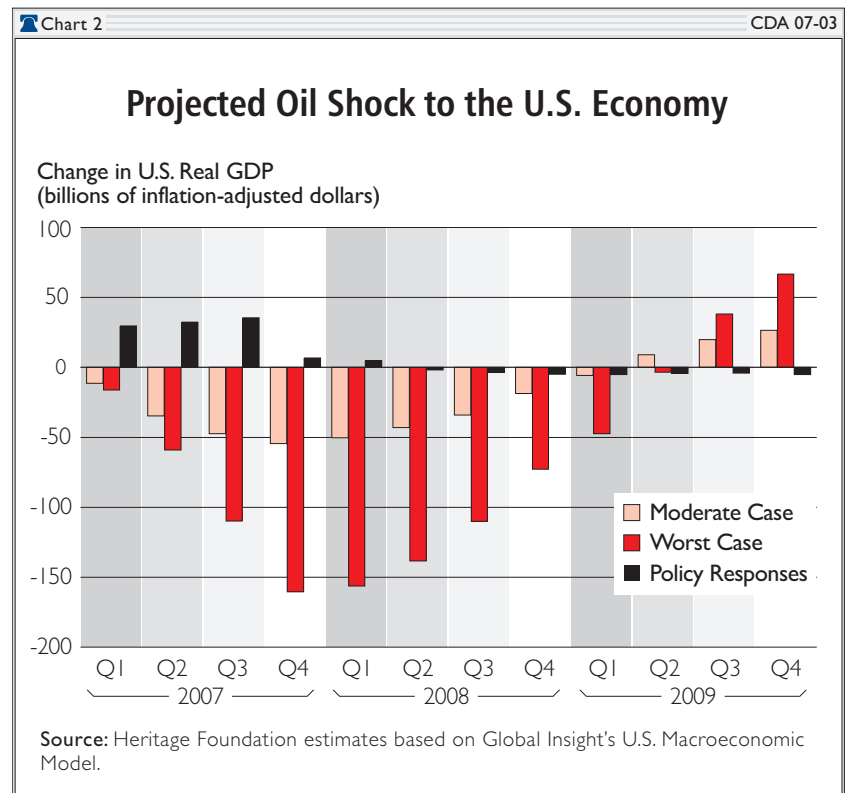
production and the reactions of key world players. Then the group broke up into three teams: policy-makers (National Security Council); government agencies that implement the policy (federal agencies); and industry that meets the technical needs of implementing policy (industry). Teams consisted of experts in foreign policy, including regional experts; experts from the Departments of State, Homeland Security, Energy, and Defense; and congressional staff members. The policymakers directed policy; the federal agencies and industry members determined the best way to implement and meet the technical needs of the policy.

The teams reconvened after the exercise to conduct an after-action report that outlined lessons learned from the game. Lessons included considering ways to improve methodologies and conduct of the game, as well as emerging insights for national energy policy.

The simulation of the energy market responses to the crisis and policy decisions was based on the Global Insight Short-Term U.S. Macroeconomic Model. (See Appendix A.) The energy simulations to produce data results were conducted in three steps that are detailed in Appendix B. The two scenarios were run to see the different effects on the market. These scenarios were then compared to a third scenario that accounted for the policy recommendations from the players.

Chart 1 shows the changes in crude oil prices in the scenarios. In the moderate-case and worst-case scenarios, prices increased significantly, but the worst-case scenario clearly delineates the policy challenge. As a prudent measure, the participants quickly decided to address the worst-case outcome, in which the price of WTI crude rose to \$150 per barrel by the third quarter of 2007, compared to \$65 per barrel if no crisis had occurred.

This significant jump in crude prices caused a substantial economic response. For example, real GDP fell by more than \$150 billion in both the fourth quarter of 2007 and the first quarter of 2008. (See Chart 2.) In fact, the simulation forecasted that



the two-quarter crisis could depress GDP for 10 quarters, or two and a half years.

This fall in real GDP is mirrored by reductions in private non-farm employment and real disposable income. (See Chart 3 and Chart 4.) The simulation forecasted that the worst-case scenario would result in roughly 1 million fewer jobs one year after the strait was blocked. Changes in employment commonly lag behind shocks to the economy, and that lag is apparent in the forecasts. If Iran's blockade of the strait produced an \$85-per-barrel increase in crude oil prices, employment would not recover for almost three years.

In addition, households would have slower income growth. The oil-induced economic slowdown would reduce real disposable personal income by nearly \$260 billion by the fourth quarter of 2007, and real disposable income would average roughly \$100 billion lower during 2008. It would not recover until the first quarter of 2010.

## CRISIS RESPONSE

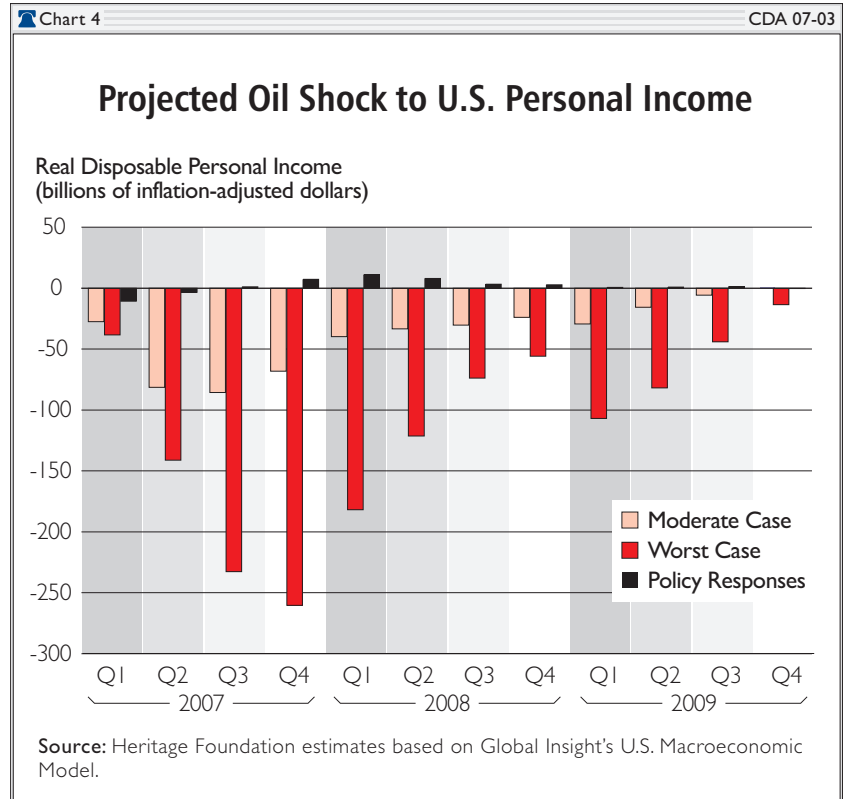
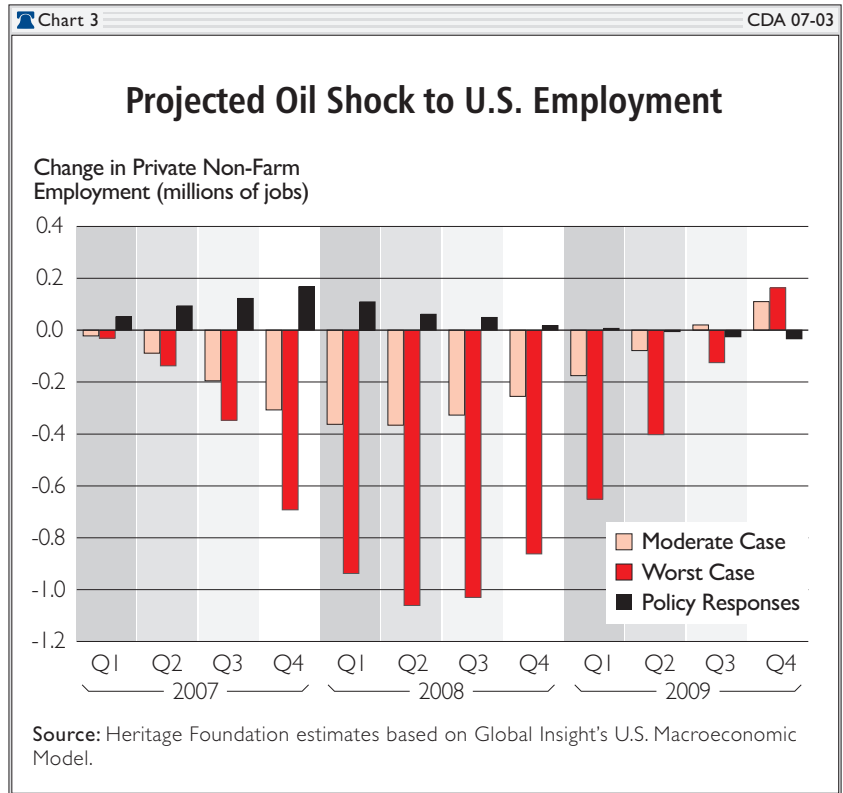
In the exercise, the game managers assumed that the crisis started on January 1, 2007, and tasked players with finding practical policy responses to the crisis that would have the likely effect of reducing the spike in oil prices and mitigating the eco-

conomic harm that inaction would likely produce.

At the end of the game, the participants recommended that:

- **The U.S. and its allies deploy sufficient military forces to protect freedom of navigation in the Strait of Hormuz.** The participants assumed that the military response would be extensive, swift, and effective. They further assumed that the U.S. and allied military response to the blockade of the Strait of Hormuz would reduce Iran's obstruction of tanker traffic by 50 percent by January 31, 75 percent by March 31, and 100 percent by October 1, 2007.
- **The U.S. government employ the Strategic Petroleum Reserve according to the rules laid out in international treaties.** The participants assumed that every country with SPR inventories would respond according to these rules beginning on January 1, 2007. (Full compliance in sharing, much less in reducing demand, is highly unlikely. Global Insight optimistically assumed 50 percent compliance.)
- **Congress pass a one-time emergency supplemental defense appropriation of \$30 billion.** Not only would the appropriation fund military operations in the Persian Gulf, but the game participants believed that it would stimulate the U.S. economy, mitigating some of the immediate economic distress.
- **Congress and the Administration agree to increase funding for the Low-Income Home Energy Assistance Program.** The participants assumed that funding increases, passed by Congress in February 2007, would be proportional to the national average increase in home energy prices (oil, natural gas, electricity, and other distillates).

- **Congress and the Administration temporarily reduce regulatory burdens that would otherwise cause energy prices to increase.** The participants assumed that, in March 2007, Congress



would delay implementation of fuel economy standards and relax compliance with the Jones Act and clean air regulations regarding power plant improvements.<sup>5</sup>

- **The U.S. government end tariffs on ethanol as of January 1, 2007.**<sup>6</sup> This would encourage ethanol imports and reduce retail biofuel prices.
- **The Administration make no change in retail gasoline and diesel taxes.** This recommendation supports federal revenue growth at a time of extra spending.
- **The Administration request permission to permit petroleum recovery in the Arctic National Wildlife Refuge (ANWR) and the off-shore reserves immediately west of Florida.** The participants assumed that Congress would pass this legislation in late January 2007.<sup>7</sup> The game participants further assumed that this policy change would apply downward pressure on petroleum and gasoline prices in the futures markets.

## WEATHERING THE CRISIS

To determine whether these policy recommendations would offset some of the economic harm produced by the oil blockade, Heritage Foundation analysts implemented these recommendations in the same economic model that was used to estimate the original economic effects in order to allow accurate comparisons.

The results were impressive. The policy recommendations eliminated virtually all of the negative outcomes from the blockade. Charts 1 through 4 show the simulation results for the price of crude oil, real GDP, employment, and personal income under the three scenarios: moderate case, worst case, and the participants' policy responses. In virtually every economic indicator, incorporating policy responses neutralized the negative effects of the crisis.

Overall, the military response had the greatest effect, because it shortened the length and severity of the crisis. However, supplemental budgetary appropriations increased defense spending, which helped to keep GDP from falling significantly even with increased oil prices.

Additionally, the lack of government response (or limited influence on the market through regulations) helped by allowing market forces to adjust to the crisis without artificial constraints, keeping the overall price shock from being too severe.

Most important, the exercise demonstrated that the model can account reliably for the effects of policy decisions on market forces, making it a viable model for future simulations.

## THE WAY FORWARD

As is often the case with first-time modeling, several changes have been identified that would improve the overall effectiveness of the exercise:

- Broadening the number of countries covered by the model so that their reactions are taken into consideration.
- Making more energy and defense policy experts available during the exercise to provide guidance on policy decisions. For example, such experts could help to determine an appropriate amount for an emergency defense supplemental bill.
- Directing participating groups to clearly indicate the desired outcomes of their policy recommendations. Measuring desired outcomes against actual outcomes would offer a better assessment of the effectiveness and unintended consequences of individual policy decisions.

The analysis also suggests that the right blueprint for an American response to any attempt by a hostile state to use armed force to disrupt global energy supplies is that the United States must lead. An American-led military response focused on objec-

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5. Global Insight noted that power plant improvements (adding pollution-abatement equipment) are far too advanced to have any impact in the short or medium term. Utility companies have ordered equipment that is scheduled to be installed through 2012. They have already paid money that they cannot recover through rates unless the equipment is installed. There may be some ability to waive NOx emission standards for a few months, but this would have minimal impact. Oil consumption by power generators is extremely small and is limited to a few East Coast states that have little capacity to turn to coal. To the extent that oil consumption could be reduced further, it would require increased reliance on natural gas—a fuel already in short supply.
  6. The U.S. is already at capacity for the most part, so this would not have any real short-term effects.
  7. Opening ANWR would have no short-term impact because production could not begin for several years. Therefore, it is not relevant in a short-term simulation.



tives that are clear, relevant, and obtainable would demonstrate U.S. determination to uphold freedom of navigation, which would be essential to calming global energy markets and reassuring producers and consumers. At the same time, minimizing disruptions and focusing on measures that liberalize energy policies and roll back regulatory restrictions would allow the marketplace to find the best market-based solutions to meet global energy needs.

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Ariel Cohen, Ph.D., is Senior Research Fellow in Russian and Eurasian Studies and International Energy Security in the Allison Center, Lisa Curtis is Senior Research Fellow for South Asia in the Asian Studies Center, Tracy L. Foertsch, Ph.D., is a Senior

Policy Analyst in the Center for Data Analysis, Alison Acosta Fraser is Director of the Thomas A. Roe Institute for Economic Policy Studies, Ben Lieberman is Senior Policy Analyst in Energy and the Environment in the Roe Institute, and James Phillips is Research Fellow for Middle Eastern Affairs in the Allison Center at The Heritage Foundation.

Preparation of the war game, its execution, and the writing of this report were collaborative efforts. Carafano and Beach shared the overall direction of the project and the writing of this report. Cohen, Philips, and Curtis constructed the war game scenario. Foertsch used the Global Insight U.S. Short-Term Macroeconomic Model to simulate the economic effects of a major oil disruption in the Persian Gulf. She also simulated the extent to which the participants' policy responses neutralized the negative effects of the crisis. Fraser and Lieberman interpreted the participants' policy recommendations and advised the economics team on how to implement them in the economic model. Marietta Sanders, a Heritage Foundation intern, assisted in writing this report.

**APPENDIX A****DESCRIPTION OF THE GLOBAL INSIGHT SHORT-TERM U.S. MACROECONOMIC MODEL**

The Global Insight Short-Term U.S. Macroeconomic Model is a large-scale 10-year (40-quarter) macroeconomic model of the U.S. economy. It is used primarily for commercial forecasting.

Over the years, analysts in The Heritage Foundation's Center for Data Analysis (CDA) have worked with GI economists to adapt the GI model for policy analysis. In simulations, CDA analysts use the GI model to evaluate the effects of policy changes not just on disposable income and consumption in the short run, but also on the economy's long-run potential. They can do so because the Global Insight model imposes the long-run structure of a neoclassical growth model and makes short-run fluctuations in aggregate demand a focus of analysis.

The Global Insight model can be used to forecast over 1,400 macroeconomic aggregates that describe final demand, aggregate supply, incomes, industry production, interest rates, and financial flows in the U.S. economy. The model includes such a wealth of

information about the effects of important changes in the economic and policy environment because it encompasses detailed modeling of consumer spending; residential and non-residential investment; government spending; personal and corporate incomes; federal, state, and local tax revenues; trade flows; financial markets; inflation; and potential GDP.

Consistent with the rational expectations hypothesis, economic decision making in the Global Insight model is generally forward-looking. However, in some cases, Global Insight assumes that expectations are largely a function of past experience and recent changes in the economy. Such a retroactive approach is taken in the model because GI believes that expectations change little in advance of actual changes in the economic and policy variables about which economic decision makers form expectations.<sup>8</sup>

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8. Additional information on the Global Insight model is available from the authors upon request.

## APPENDIX B

### SIMULATION METHODOLOGY

The energy simulations were done in three separate steps.<sup>9</sup>

**Step 1.** To simulate the effects of the oil price shock, the Heritage Foundation economics team introduced the change in oil prices and the contribution to domestic oil supply from the Strategic Petroleum Reserve into the Global Insight model. They then directly changed three separate oil prices in the model: the weighted average price of imported crude, the weighted average price of domestic crude, and the average price of West Texas Intermediate crude. All three were assumed to deviate from baseline levels by the same amount; namely, the change in WTI crude oil prices forecast by Global Insight.

The contributions to the domestic oil supply from the SPR were also calculated by Global Insight. They were converted to quadrillion BTU before they were input into the GI model.

In Step 1, the team assumed that the Federal Reserve would adjust the effective federal funds rate in response to changes in the civilian unemployment rate and the rate of Consumer Price Index (CPI) inflation. They next imposed the model's monetary reaction function that mimics the actions of the Federal Reserve.<sup>10</sup> Heritage economists excluded the GI model's exchange rate variables, solved the model, and saved the new forecast before continuing to Step 2. This new forecast was used as the starting point for Step 2.

**Step 2.** The team adjusted the response of real non-residential investment in mines and wells on

the advice of economists at Global Insight. Global Insight recommended this move because this variable in the current version of the GI model is very responsive to oil price shocks. As a result of these discussions, the team halved the change in the mines and wells variable from the baseline forecast. They then ran the model again with these adjustments before continuing to the next step. This new forecast was used as starting point for Step 3.

**Step 3.** The team next neutralized the relative price effects of oil-related energy products and adjusted the world GDP. U.S. trading partners would likely face the same price changes as the U.S. and take similar hits to their GDP from an oil price shock. Neutralizing the relative price effects and adjusting world GDP helped to ensure that the final simulation results reflect these shared effects.

The team neutralized the relative price effects by adjusting the baseline. They made adjustments, first, by calculating the deviation from baseline in the GI model's variable for the U.S. producer price index excluding energy and, second, by applying that deviation to the model's two variables for foreign producer price indices.

They adjusted foreign GDP inside the model by modifying key indices of the real trade-weighted GDP of U.S. trading partners. The team then solved the model and saved the forecast. This new forecast was used to generate the summary results spreadsheets.

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9. The methodologies, assumptions, conclusions, and opinions presented here have not been endorsed by and do not necessarily reflect the views of the owners of the Global Insight model or their employees. *Fortune* 500 companies and numerous government agencies use Global Insight's Short-Term Macroeconomic Model to forecast how changes in the economy and public policy will likely affect major economic indicators. Additional information on the simulation methodology is available upon request.
  10. The Federal Reserve Board is assumed to follow historic patterns of behavior when reacting to the oil price shock. Heritage Foundation economists implemented this assumption in the Global Insight model using an econometrically estimated function that adjusts the effective interest rate on federal funds in response to changes in the unemployment rate and the rate of CPI inflation.