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An updated assessment of oil market disruption risks☆

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ABSTRACT

The probability of the size and duration of another oil disruption is critical to estimating the value of any policies for reducing the economic damages from a sudden oil supply disruption. The Energy Modeling Forum at Stanford University developed a risk assessment framework and evaluated the likelihood of one or more foreign oil disruptions over the next ten years. Leading geopolitical, military and oil-market experts provided their expertise on the probability of different events occurring, and their corresponding link to major disruptions in key oil market regions. The study evaluated 5 primary regions of production: Saudi Arabia, Other Persian Gulf, Africa, Latin America, and Russian / Caspian States. Disruptions are defined as being net of offsets (e.g., OPEC spare capacity), with the notable exception that the SPR is not included as a source of offsets. At least once during the 10-year time frame (2016–2025), there exists approximately an 80% probability of a net (of offsets) disruption of 2 MMBD (million barrels per day) or more lasting at least 1 month.

1. Introduction

Measuring energy security vulnerability has been the focus of a growing line of research, e.g., see Gupta (2008) and Cohen et al. (2011). Perhaps one of the most direct measures is the probability of another oil disruption. This risk is critical to the estimated value of energy security policies, such as the existence of the U.S. Strategic Petroleum Reserve (SPR) and its desired size. And yet, various estimates of the risk of comparable disruptions during the 1990s varied by as much as a factor of five (Leiby and Bowman, 2003). This disparity in results reflects that analysts use fundamentally different approaches and assumptions in evaluating these risks. An additional problem is that there is no consistency in developing these estimates over time. Estimates that change over time should reflect shifts in actual conditions influencing the true probability of a disruption rather than who conducts the study and with which approach.

The Stanford Energy Modeling Forum has assessed oil disruption risks twice in the past 20 years (Huntington et al., 1997; Beccue and Huntington, 2005). Recent changes in world geopolitical events, tensions in other parts of the world, and energy markets (oil price decreases), along with the dramatic surge in North American tight oil supplies from shale formations, have renewed interest in understanding the risk of major oil disruptions. This fact, together with pressure to understand the value of the Strategic Petroleum Reserve has prompted considerable interest to update the risk assessment to reflect current conditions. Responsible policymaking requires a quantitative and thoughtful evaluation of these important risks and overall energy security.

This paper describes an updated analysis of global oil disruptions that was organized recently by the Stanford Energy Modeling Forum. First, it develops (regional) scenario analyses based upon an expert group's exhaustive determinants of oil market disruptions and their potential duration and size. Given the complexity and uncertainty regarding the potential events, the experts attach probabilities associated with the risks. Thus, policy makers are provided information on the relative likelihood and severity of potential disruptions for decision making purposes. Second, the expert risk assessment was conducted not as the summary of responses from an independent survey of experts, but as a structured exercise among the experts.

The effort set out to accomplish three objectives:

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

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analyses.

The focus of this paper will be on explaining the methodology and critical factors included in the risk assessment, because the authors believe that it represents a promising research direction that can provide considerable value if it is repeated as geopolitical, military and oil-market conditions change. Readers are referred to U.S. Department of Energy (2016) for how these inputs are used for evaluating the Strategic Petroleum Reserve and to Brown and Huntington (2013, 2015), and more recently Brown (2018), for how they are combined with other research to address energy security policies.

The disruptions included in this study represent both "random" shocks initiated by external geopolitical factors as well as "strategic" shocks induced by governments seeking economic gains as initially proposed by LaCasse and Plourde (1995). Geopolitical shocks predominate in these oil expert's opinion and include the Venezuelan oil strikes in 2003 and civil war-driven outages in Libya in 2010 as past historical examples. Principal focus will be placed on certain large oil producing regions with exposure to geopolitical unrest, in order to recognize a wide divergence in political stability and importance to oil markets among countries. Policy-driven cutbacks like the 1973 oil embargo initiated by OPEC members play a more minor role. Moreover, these latter actions focus on situations where oil-producers are seeking to earn higher revenues under relatively balanced market conditions rather than on efforts to prevent even lower prices during excess supply conditions, such as the recent OPEC agreement to curtail production after the oil price collapse in 2014.

Before discussing the detailed results of the risk assessment, we begin by describing the approach and review the key inputs developed by the experts. We conclude with comparisons from past studies, and a discussion of issues to consider for future assessments.[1]

2. Policy motivation

Studies on the *expected* costs of oil disruptions are often based upon three critical sets of information: the probability of another disruption of various sizes, the effect of these disruptions on the oil price, and the economic consequences flowing from the price escalation (Brown and Huntington, 2013, 2015; Hedenus et al., 2010; Greene, 2010; Greene and Liu, 2015).

This paper describes a risk assessment that is part of a larger U.S. Department of Energy (2016) project to evaluate the benefits and costs of maintaining, expanding and using public oil stockpiles. It addresses only one of many critical issues in the SPRO analysis. By itself, it does not determine what the appropriate strategy should be. Nor does it cover all the important considerations that influence those decisions. In particular, given the limited time and resources for the project, this assessment limits its focus in the following ways:

1. The working group focused on geopolitical events leading to disruptions in global oil supply. Governments hold public oil stockpiles primarily to offset sudden lost production in the world oil market, thereby limiting price escalation during such events.
2. Participants discussed such developments as hurricanes, pandemics and cyber-attacks, but many of the most serious possibilities would have major implications for wellbeing that extend well beyond oil supplies. Only if these events were focused on oil production, pipelines and shipping would they have more serious implications for maintaining and using public oil stockpiles.
3. The study did not evaluate all major supply regions, but only those areas where geopolitical and military unrest were most pronounced. The five regions selected and their associated countries included more than 60% of total world oil production. The study did not address weather-related disruptions but did include possible cyber-attacks on oil production, transportation and distribution in these selected regions.
4. Due to the limitations on the number of experts who could be elicited in this analysis, the risks may be understated by ignoring weather-related disruptions and cyber-attacks outside of these regions. If further investigation finds that these factors should be included in future evaluations, a risk-assessment approach similar to the one used in this study could be applied to these other events.
5. The project focused on gross oil supply disruptions and any explicit supply offsets from excess oil production capacity from major producing countries.
6. The project excluded inventory responses (drawdowns and increments), including those of public or private oil stockpiles within or outside of the United States.
7. Public stockpile decisions by the United States were excluded because the evaluation focused on the oil market conditions in the absence of any drawdown of the U.S. strategic petroleum reserve. These conditions are most relevant to addressing the issue of whether or not public stockpiles should be used and by how much.
8. The purpose was to assess geopolitical supply risks, and not the responses to, or consequences of, those events (except for the possible use of oil-producer excess capacity). Offsets also excluded any supply or demand response to price changes caused by the oil supply disruptions. These excluded supply adjustments include operating existing fields of conventional oil more intensively or extracting more volumes from oil-shale formations. It also did not address any demand-side adjustments that policymakers might use during a disruption such as forcing carpooling or gasoline rationing. Demand-reduction strategies provide gross benefit by reducing the shock, but they also impose costs by restricting driving patterns and causing citizens to make longer trips. The SPRO already incorporates many of these adjustments in the models used for evaluating the benefits and costs of public oil stockpiles.

Although the main benefits of maintaining and using a public oil stockpile are linked directly to how it influences oil prices, the risk evaluation focuses on physical volumes of oil removed rather than price movements. The models operated by the SPRO use the physical volumes of oil removed as an assumption in order to derive oil price changes, after incorporating all of the market and policy adjustments discussed above.

3. Approach

Formal probabilistic risk assessments[2] have been widely used to analyze a range of topics where:

1. uncertainty is paramount
2. many interrelated factors cause significant complexity
3. information is available from many sources
4. 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

[1] Beccue and Huntington (2016) provide appendices covering an overview of the methodology, event definitions and scales, probability input data collected from the experts, the procedure for evaluating disruption size and overlap between two or more events occurred simultaneously, and a list of historical disruptions. This source also explains the approach for considering the case when a shortfall occurred in more than one region simultaneously and the duration of the supply shock.

[2] Clemen (1996), Edwards et al. (2007), Kahneman et al.(1982), Merkhofer (1987), and Spetzler and Stael von Holstein (1975) provide useful discussions about the methodology for decision/risk analysis and adjustments for potential biases.