



Measuring oil supply disruptions: A historical perspective^{☆,☆☆}

Hillard G. Huntington

Energy Modeling Forum, Stanford University, 475 Via Ortega, Stanford, CA 94305-4121, United States

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ABSTRACT

An oil supply disruption in OPEC member countries or in the Persian Gulf region may have unusually large effects on crude oil prices because such a disruption may escalate into wider disruptions within these volatile regions. This analysis reviews and updates several past studies to identify specific events that can be linked to oil supply shocks that remove oil production while increasing world oil prices. Using historical data, it finds that a 10% cut in world oil supplies arising from abrupt and large monthly disruptions of OPEC and Persian Gulf crude oil production correlates with a 35–43% increase in inflation-adjusted crude oil prices. The data also reveal that almost all sudden and large oil supply disruptions occurred prior to 2004, which raises some interesting issues about how to interpret the evidence from studies evaluating the impact of future oil disruptions on either prices or the economy.

1. Introduction

The sudden removal of oil production from the Persian Gulf and other major supply sources has led to economic recessions and contributed to the removal of U.S. presidents during the last three decades of the twentieth century (Blinder and Watson, 2016). Current policy-makers remain interested in oil vulnerability even though the energy, macroeconomic, political and military conditions today differ dramatically from these earlier decades.

Despite major expansions in US petroleum supplies, significant world oil supplies are extracted from Persian Gulf and other Middle East supply sources. Growing political and military violence is percolating throughout this region, particularly within the nations that border the Persian Gulf. Although the looming conflict between Iran and Saudi Arabia is a core reason for unsettling this region, interstate conflicts and internal political rivalries are spreading throughout this region in the aftermath of compounding developments: the collapse of the Iraqi state, the revolutionary fervor of the Arab Spring, the emergence of sub-national groups such as ISIS, Al Qaeda and other local militias, and the expanding Russian military support of the Syrian regime. Oil market and military experts polled in a study described by Beccue et al. (2016) thought that the Persian Gulf region would be particularly volatile over the coming decade (2016–2025). According to their estimates, the probability of a net oil disruption (after supply offsets from excess capacity) lasting more than a month that exceeded 2 million barrels per day (MMBD) was higher in Persian Gulf countries outside of Saudi Arabia than in the other four main regions: Saudi Arabia, North Africa/

Africa, Latin America, and Russia with her neighboring Caspian states.

Several recent studies have responded to these conditions by attempting to estimate the value of energy security policies for mitigating the adverse impacts of a future oil disruption (Brown and Huntington, 2013, 2015; Brown, 2018; Krupnick et al., 2017; U.S. Department of Energy, 2016). An important consideration in these studies has been what one means by an oil supply shock and the price escalation one might expect. A critical missing link for policy analysis has been a consistent methodology for identifying major oil supply shocks from previous geopolitical, military or exogenous events. Lacking this benchmark, it is very difficult to evaluate which events lead to an oil supply shock, what their impacts may be, and what possible role, if any, there might be for public policy.

There have been many incidents that have interrupted oil supplies but most have been irritations rather than disruptions causing major widespread damages for oil-consuming nations. If one focuses upon only those supply shifts that have moved oil prices significantly, they have happened relatively infrequently over the last 50 years and most have occurred prior to the 2003 US military buildups in Iraq. This point merits special attention by policy analysts because it underscores that they have only a limited number of historical “experiments” from which to draw conclusions about how serious the impacts from such disruptions may be.

The purpose of the analysis is to update previous estimates of the frequency of sudden and large reductions in crude oil production from either the Organization of the Petroleum Exporting Countries (OPEC) or the Persian Gulf that have raised the inflation-adjusted world crude oil

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E-mail address: hillh@stanford.edu.

price since 1973. It seeks to ascertain the approximate size of the impact on price that might assist policy makers in understanding whether and by how much they should intervene to provide insurance. One reason for evaluating Persian Gulf shocks separately is that events there may have unusually large effects on prices because they may escalate to wider regional conflicts within this politically and militarily volatile region. Unlike a reduction in Nigeria or Venezuela, a Gulf event may have spillover effects on other country production levels either within that major oil-producing region or elsewhere. Moreover, the uncertainty surrounding this spillover may cause larger economic dislocations in energy-consuming nations than would be implied from the simple run-up in crude oil prices themselves. The Iraqi invasion into Kuwait initially had much bigger impact because many oil and military experts were worried about possible future efforts to disrupt the much larger resource base within Saudi Arabia.

After reviewing the related studies in the next section, this analysis describes the conditions for defining an oil shock in Section 3. Section 4 describes data sources for crude oil prices and Persian Gulf production. Section 5 reviews the data for all OPEC members and identifies 10 different supply shocks from the available historical record. It computes price multipliers to these shocks, or the percentage change in price for each one percent reduction in oil production. Section 5 repeats the procedure to identify 12 different Persian Gulf supply shocks. A final section summarizes the key findings and explains why they are relevant to policymakers and policy analysts who are concerned about oil security issues.

2. Previous oil supply shock estimates

Efforts to identify oil supply shocks include both econometric estimates and lists of historical episodes. Kilian (2009), Kilian and Murphy (2012) and Baumeister and Hamilton (2015) are examples of studies that have developed econometric methods for identifying the sources of oil price shocks. These methods are often relatively complex and depend upon some critical assumptions. None have been used to produce published lists of oil supply disruptions that can be easily checked, although potentially one could derive such estimates. Importantly for our purposes, they often focus on any supply disturbance that may mostly miss the important role played by very large oil supply shocks. Oil policy makers appear to be interested mostly in how to respond to very large supply disruptions.

There have been several important efforts to identify geopolitical, military and other external events that could be classified as oil supply shocks. The events, the most likely beginning date, and the estimated gross supply outages are summarized in Table 1. This section reviews these studies but notes that some important efforts have not been updated. This discussion provides a background for developing the methodological approach in Section 3.

2.1. Hamilton

Hamilton (2003) developed a Net Oil Price Increase (NOPI) formulation that many macroeconomic studies have used in estimating the effects of oil price shocks on aggregate economic activity. This series represents an oil price shock as a situation when the oil price moves higher than it has been over recent quarters ranging between one to three years. Unlike the rule developed later in this article, Hamilton's rule does not exclude oil price increases that arise from factors other than oil supply shocks.

To support his use of the NOPI series, he selected five months when major wars or revolutions began and exogenously interrupted crude oil supplies on the world market. He selected these five historical events: Suez crisis (Nov-1956), Arab-Israel war (Nov-1973), Iranian revolution (Nov-1978), Iran-Iraq war (Oct-1980), and Persian Gulf war (Aug-1990). He computed the gross crude oil production shortfalls associated with each event before any offset from increased crude oil production

Table 1

Gross crude oil disruptions (MMBD) in past studies.

Beginning Date	Event	Hamilton	Leiby ^b	IEA
Nov-1956	Suez Crisis	10.1%	2.0	1.5
Jun-1967	Six-Day War		2.0	1.3
Oct-1973	Arab-Israeli War and Arab oil embargo	7.8%	1.6	1.5
Nov-1978	Iranian Revolution	8.9%	3.7	2.3
Oct-1980	Outbreak of Iran-Iraq war	7.2%	3.0	2.6
Aug-1990	Iraqi invasion of Kuwait	8.8%	4.6	2.1
Apr-1999	OPEC (ex. Iraq) cuts production		3.3	
Jun-2001	Iraqi oil export suspension ^a			4.3
Dec-2002	Venezuelan strike		2.0	4.1
Mar-2003	War in Iraq		1.9	5.6
Sep-2005	Hurricanes Katrina/Rita ^a			4.3
Sep-2008	Hurricanes Gustav/Ike ^a			2.0
Feb-2011	Libyan Civil War			2.0

Hamilton's disruptions were reported as % change and have not been converted to MMBD.

^a These disruptions were accompanied by world oil price decreases rather than increases.

^b Leiby events include his large disruptions only, as explained in the text.

from other producing areas. He used these quantitative estimates as an instrumental variable to determine exogenous oil price movements. Exogenous oil price movements were then inserted into equations determining US economic growth. It is important to emphasize his eventual interest in the oil price implications of these events rather than in the gross supply shortfalls themselves. The table shows these shortfall estimates as originally reported as a percent reduction in world oil production rather than as physical barrels removed.

Although his shock estimates were carefully constructed to match exogenous events, his analysis excluded other events that some other petroleum experts have included. Moreover, his list included oil shock episodes only through the end of 1999, the last year in his study. There is no way to extend his list to more recent years without knowing more about how he selected the original five disruptions.

2.2. Leiby

As reported in Beccue and Huntington (2005), Leiby collected information from the U.S. Energy Information Administration to identify start dates for 25 episodes covering war, embargo, internal struggles and accidents. Covering the 1950–2003 period, he judgmentally selected these historical events and computed the size of the gross shortfall (before offsets from other producing areas) in million barrels per day as well as the duration (months) of each one. His original list included many accidents (e.g., Exxon Valdez) and smaller internal struggles in countries like Nigeria that were excluded in other studies discussed in this section. After making his list more comparable by selecting only those disruptions that were at least as large as the Arab-Israeli war in 1973 (greater than 1.5 MMBD), his list (shown in the table) included the same five shocks as Hamilton but also added the Six-Day war in 1967 and the production cuts implemented by all OPEC members except Iraq in 1999.¹

Leiby's analysis was aimed to support the U.S. Department of Energy's management of the U.S. Strategic Petroleum Reserve. Although this group evaluates how public oil stockpiles help to dampen the price impacts stemming from disruptions, there may have been more emphasis on physical disruptions rather than on the price shocks themselves. Nevertheless, the Hamilton and Leiby efforts appear to produce substantially similar results for the larger disruptions.

The major problem with this classification of supply shocks is the

¹ Hamilton probably did not include the 1999 event as an exogenous occurrence, because it may have been induced as a delayed reaction to soft oil market conditions. Nonetheless, world crude oil prices did rise by 17.2% as this event began to unfold.

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