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BY JASON BORDOFF, ANTOINE HALFF AND AKOS LOSZ

MAY 2018

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ABOUT THE AUTHORS

Jason Bordoff is a former senior director on the staff of the National Security Council and special assistant to President Obama. He is now a professor of professional practice in international and public affairs and the founding director of the Center on Global Energy Policy at Columbia University's School of International and Public Affairs.

Antoine Halff is a Senior Research Scholar and Director for Global Oil Markets at the Center on Global Energy Policy, Columbia University, having previously served as chief oil analyst of the International Energy Agency (IEA). Prior to that, Halff was lead industry economist at the US Energy Information Administration and head of commodities research at brokerage firm Newedge.

Akos Losz is a senior research associate for the Center on Global Energy Policy. Prior to joining Columbia, Losz was senior analyst at Douglas-Westwood. Previously, he worked on the strategy-development team of MOL Group, a Hungary-based international energy company.

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EXECUTIVE SUMMARY

The realities of the modern oil market have thrown into question the need for the US emergency oil stockpile. For more than 40 years, the US Strategic Petroleum Reserve (SPR) has existed as a buffer between US oil markets and global supply shocks. A byproduct of the 1973–1974 oil embargo, the SPR was born in an age when US crude production was in decline, imports were rising, and the oil market was dominated by the Organization of Petroleum Exporting Countries (OPEC). Over the intervening years, the reserve was tapped only a handful of times as the oil market has grown much larger, deeper, more liquid, and better integrated and thus more able to address shortfalls of various magnitudes that previously would have caused greater pain for oil-importing countries. In regard to US national oil supply security, however, perhaps the greatest change has been the boom in domestic production over the past decade due to hydraulic fracturing of shale and other tight oil deposits.

The new US energy fortune has thus given rise to a view that the SPR—which formerly enjoyed wide bipartisan support—could be sold off to plug spending holes without creating significant energy security risks. The US Congress has already passed several measures to significantly pare down the size of the SPR through a series of drawdowns staggered over the coming decade. The emerging and important discussion over whether the SPR has become too large or altogether useless, or whether it should be kept whole, prompted the Center on Global Energy Policy at Columbia University's School of International and Public Affairs to research how the SPR fits into the modern oil market—and indeed the wider global energy system—and whether the United States would benefit from modifying or eliminating it.

In short, the paper finds the following:

- While the circumstances that led to the creation of the SPR may no longer prevail, oil market conditions are highly unpredictable. Decisions to sell off the SPR to fill near-term budget holes unrelated to energy security are shortsighted and fail to take into account the formidable increase in supply risks to the global oil market, as well as the large uncertainties about the future oil supply outlook, such as the magnitude and duration of the US shale boom.
- The evolution of global oil markets since the 1970s has given rise to new types of energy security risks. Rather than physical shortfalls, the risks against which the SPR protects today are oil price spikes that affect US energy prices regardless of the US level of import dependence. While the government's role is not to guarantee price stability, emergency stocks could smooth economically harmful price spikes until markets are able to adjust.
- A repurposed SPR can not only protect from supply disruptions from geopolitical turmoil but increasingly also provide a buffer against extreme weather events, the likelihood of which will only rise due to global climate change.
- Strategic stocks remain valuable as a tool of international cooperation and soft power. They also enhance America's ability to take foreign policy actions that may adversely

affect oil markets, such as the recent decision to reimpose oil sanctions on Iran.

- A possible transition away from oil in the global energy system strengthens rather than weakens the case for holding strategic stocks, as the period of transition itself is likely to be uneven, disorderly, and volatile.
- The debate over the fate of the SPR should not be limited to a binary choice between keeping it whole or liquidating the reserve; rather, it ought to focus on how to leverage the SPR more efficiently—and how to make it pay for itself.
- The evolution of global oil markets has created new opportunities to reduce SPR operating costs and increase SPR benefits through upgraded inventory management practices and the possibility of joint stockpiling with major oil producing and consuming countries.
- The case for replacing strategic crude stocks with refined product reserves is not straightforward in the United States. Managing variances in product demand may be best left to market participants in America, although there is a case for product reserves in certain regions of the country that are particularly vulnerable to fuel supply disruptions, such as the Southeast.
- The effectiveness of the SPR would be enhanced by more rapid use in the face of supply disruptions and by a clearer understanding in advance of emergencies arising both within the US government and between the United States and its partners—IEA and otherwise—about the purpose of and criteria for using the SPR.
- The SPR, held by the United States for nearly a half century, is a formidable national security asset with favorable characteristics compared to similar stockpiles in other parts of the world. Given the high degree of uncertainty about the future of both US and world supply and demand and the value of the SPR in a changed oil market, the burden of proof rests with those who wish to sell it off. It should not be squandered away without careful study of its potential value in today's new and rapidly evolving oil market environment.

INTRODUCTION

The last few years have offered a reminder, if any was needed, that oil markets are no stranger to volatility. From OPEC's reported demise to OPEC's resurgence, the rapid fall and rise again of US shale, and the ebb and flow of geopolitical risk, oil has been on a rocky ride. After industry leaders and experts declared that the days of cheap oil were over—"$100 per barrel is becoming the new $20," explained one top oil CEO in 2014[1]—consensus shifted to a view that oil prices would remain "lower for longer"[2] before sharply rising again in the last few months. Each day brings yet another reminder of risks to oil prices, with oil markets tight, OPEC nations signaling they intend to continue supporting prices beyond $80 per barrel, President Trump canceling the Iran nuclear deal, Venezuelan production in freefall, and geopolitical risks rife from Syria to Libya and beyond.

At the same time and despite these apparent risks, calls abound to sell off the strategic stockpile of oil the United States has held for over 40 years. The US Congress has already passed several measures to significantly pare down the size of the SPR through a series of drawdowns staggered over the coming decade. The Trump administration's initial budget proposal for fiscal year 2018 recommended slashing the size of the SPR by half.

More than by a careful examination of the issue at hand, these decisions appear driven primarily by a need to plug holes in the US federal budget. Inspired by the need to raise cash, could America inadvertently undermine its longer-term interests and end up squandering a valuable asset? A needed policy debate about the SPR has begun, but it remains in its early stages and has yet to be factored into policy decisions.

Sweeping changes in US and global oil markets call for a rethink of the SPR, an institution born of the first oil shock of 1973 and rooted in a vastly different oil market than today's. The perceived redundancy of the SPR reflects a mood swing in policymaking circles. Until recently, the SPR enjoyed wholehearted support from Congress and successive administrations as a tool of energy security that helped shield the US economy from the adverse consequences of oil shortages. Admittedly, the SPR had its critics, but those came from a relatively narrow fringe for the most part. Today, the idea that the SPR is too large or even altogether useless has moved to the mainstream and is gaining traction. Fundamental changes have reshaped the global oil market as a whole during the four and a half decades since the creation of the SPR in ways that seem to call into question the traditional calculus of energy security.

Perhaps nowhere have these changes been more breathtaking than in the US oil patch. The US shale revolution has triggered a surge in domestic supply that has drastically cut US net oil import requirements, thus reducing US exposure to the risk of physical supply shortfalls from other oil-producing nations. At the same time, the oil market has become larger, deeper, more liquid, and better integrated—and it is presumably better able to respond to disruptions and correct market imbalances on its own, without government intervention. US exposure to supply disruptions thus appears twice reduced: not only has rising shale oil supply cut US import dependence, but global markets have also become more resilient and disruption

proof. That could make maintaining large US strategic reserves not just superfluous but even counterproductive, a form of market distortion both costly and unhelpful—hence calls to liquidate part, if not all, of the reserve.

Compelling as this view might seem, counterarguments abound. First, history has shown how little certainty there is in oil markets. Time and again, expert opinion has proven incorrect. The shale success story is a case in point. Having surprised on the upside, shale oil could again defy expectations, this time on the downside. Considerable uncertainty remains about its long-term scope, longevity, and price responsiveness. The oil demand outlook—and thus the outlook for US oil import dependence—is equally murky. While there are growing expectations that new trends in road transportation will soon bring global oil demand to an inflection point, the range of long-term oil-demand forecasts remains staggeringly wide.

Similarly, the fact that oil embargoes like the one seen in 1973 have not recurred does not necessarily preclude future attempts at doing so. While oil-producing nations appear to have renounced the oil weapon for the time being, that could change in the future. Few would have predicted the current resurgence of protectionism, nationalism, and populism around the globe or the rekindling of a new "cold war" between Russia and the West, for example.

New market conditions have also brought forth new types of risks altogether. In many ways, supply risks have increased, not decreased, and in an integrated world oil market, supply disruptions affect US and global prices, regardless of how import dependent we are.

Extreme-weather risks to supply, including to US production, are on the rise due to climate change. Political upheaval has engulfed several oil-producing countries since the onset of the Arab Spring, leading to supply disruptions whose market impact would likely have been far more severe absent a concomitant surge in US shale output. Many more producing countries could be at risk, a prospect that could be further aggravated by the spending shortfall resulting from a protracted period of relatively low oil prices. State failure or prolonged upheaval is of potentially larger concern for oil-importing countries than the targeted political weaponization of oil exports by sovereign governments in full control.

In the oil market, things are not always as they appear. Due to the cyclicality of the oil market, a perception of abundance can be a precursor to an oil crisis. The price downturn caused by rising inventories in 2014–2016 has already led to a multiyear low in capital expenditures. While some deceleration was to be expected as service costs deflate in a soft market, that does not explain all the underinvestment. Several major oil-producing countries face steep oil production declines due to a prolonged period of low investments. Looking forward, speculation about peak oil demand and stranded assets could set the stage for a bumpy, disorderly energy transition if it led to underinvestment, supply shortfalls, and price spikes. Rather than leading to an overabundance of supply, expectations of peak demand could thus paradoxically lead to a renewed threat of supply shocks.

Finally, the globalization and financialization of the oil market over the last 45 years has had a double-edged impact. While globalization allows market forces to respond quickly to imbalances, it also creates new contagion risks and exposes all market participants to the threat of volatility and price shocks. In an increasingly turbulent world, no country is an energy

island—regardless of how much or little oil it imports.

In view of these new threats, the SPR could be described as either too small or too big, depending on what problem the SPR aims to solve and what one's theory is about how to use the reserve. In conjunction with the strategic oil reserves of other countries, the SPR could—through coordinated action with allied governments—prove a valuable tool for managing emerging oil risks. The SPR could effectively be repurposed as an energy-transition tool, an extreme-weather insurance policy, and an arm of US energy diplomacy. As far as strategic reserves go, the US SPR offers considerable advantages: its salt caverns are some of the lowest-cost petroleum storage facilities in existence and sit at the heart of what may be the largest and most connected petroleum storage and shipping hub in the world. The vast storage capacity of the SPR caverns is a valuable asset that ought to be better leveraged, not squandered.

Improved management techniques could further cut costs. While the benefits of the SPR (in terms of preventing a supply disruption or blunting its impact) are hard to quantify and partly intangible, its current costs are easier to assess. Maintenance and operational costs associated with the SPR, as well as the opportunity cost of holding up large amounts of capital in oil reserves, have spurred calls to reduce this burden by cutting the reserve down to size. Yet since the creation of the SPR, the growing depth, breadth, and sophistication of the global oil market has provided governments with the market tools to lower these expenditures. Better still, the US SPR is a formidable asset that could, under the right conditions, be turned into something of a profit center. Insufficient attention has been paid to the opportunity to reduce SPR operating costs and increase SPR benefits through upgraded inventory management practices and other innovations. The United States should also explore the potential, beyond the existing sharing agreement among International Energy Agency (IEA) members, for partnering in joint stockholding schemes with both major exporting countries, such as the Gulf Arab producers, and major consumer nations, like India and the ASEAN countries.

The debate over the fate of the SPR should not be limited to a binary choice between keeping it whole or cutting it down to size. Rather, it ought to focus on how to best repurpose the SPR to address the myriad new threats facing oil consumers and the global economy. This must include new forms of financing the SPR and the possibility of joint stockpiling with both oil producers and consumers. At a time of uncertainty about future supply and demand and elevated risks to markets and future investment, the very possibility of an uneven energy transition strengthens rather than weakens the case for the SPR. While the evolution of oil markets has led to the emergence of new energy security risks, it has also created new opportunities for innovation in risk management and SPR design. It is essential for the SPR to catch up with the transformation of the global energy landscape, rather than simply disband.

THE CURRENT POLICY DEBATE ABOUT THE SPR

The US Strategic Petroleum Reserve (SPR), an institution born of the first international oil supply shock of 1973, is being raided for cash. At its peak in 2009–2011, the reserve held about 727 million barrels of crude oil in multiple underground caverns in Texas and Louisiana. At the time of writing in early 2018, it was down to 664 million barrels. Since 2015, the US Congress has enacted five pieces of legislation calling for the sale of SPR oil.[3] These include the Bipartisan Budget Act of 2015, which authorized the sale of 58 million barrels from the SPR from FY 2018 to 2025 and another $2 billion worth of oil (equivalent to about 32 million barrels in the Energy Information Administration's estimate) between FY 2017 and 2020; the Fixing America's Surface Transportation (FAST) Act of 2015, calling for the sale of 66 million barrels from FY 2023 through 2025; the 21st Century Cures Act of 2016, which mandates the drawdown of 25 million barrels from FY 2017 to 2019;[4] the latest tax bill, which sells 7 million barrels;[5] and the Bipartisan Budget Act of 2018, enacted in February 2018, which mandates the sale of 100 million barrels between 2022 and 2027.[6] Taken together, these authorized sales will reduce the size of the SPR to around 410 million barrels by the end of 2027.[7]

These drawdowns of the SPR occur at a time when other countries are investing billions of dollars into building their own strategic oil reserves. All members of the IEA—a multinational organization created at the same time as the US SPR, also in response to the 1973 Arab oil embargo—are required by IEA rules to hold oil reserves covering 90 days of net petroleum imports to be collectively tapped in the event of a supply disruption. The IEA today counts 30 member countries, of which the latest to join the organization is Mexico (joined February 17, 2018). In addition, nonmember countries, taking their cue from the IEA, have been establishing reserves of their own. China, which has become the world's largest net oil importer, has developed a vast network of strategic reserve facilities at multiple locations, holding an estimated 275 million barrels as of mid-2017.[8] India, another fast-growing major net importer of oil, is also in the process of building its own SPR.[9] Other countries are following suit, including Thailand, Vietnam, Indonesia, Myanmar, and Laos.[10]

Changes in both the international oil market and the US energy landscape warrant a thorough reexamination of the rationale, purpose, and use of the US SPR. The conditions that prevailed at the time of the creation of the SPR no longer exist. Oil markets have matured and become more globalized and sophisticated than could have been imagined 45 years ago. Physical trading is no longer confined to long-term bilateral supply agreements but include spot deals and term contracts, both of which are backed by a deep, highly liquid futures market that did not exist in the 1970s. For the first time in the history of the oil industry, the future of oil in the global fuel mix and the world economy is not assured. Oil, although still the most actively traded commodity and the leading source of energy by far, might not continue to play that role in the future: its place in the US and global fuel mix may undergo dramatic change as electric vehicles gain acceptance and expand their share of the transportation market, aided by technological advances and climate and environmental policy. Perhaps most importantly, the US supply outlook has changed beyond recognition in the wake of the shale revolution. With the United States boasting the fastest growth in domestic production ever recorded by a

single country in oil history, its import dependency is in decline, and it will likely become a net oil exporter at some point within the next decade.[11]

These changing market conditions call for a rethinking of US energy security policies and an examination of whether the US SPR remains "fit for purpose." Vast amounts of capital are tied up with the strategic reserves; the crude oil in the SPR in January 2018 was worth an estimated $42 billion at market prices. Keeping the SPR also entails maintenance expenditures totaling about $170 million annually.[12] The US SPR comes not only with benefits but also substantial costs, both of which fluctuate as a result of shifts in underlying economic and oil market trends. Whether the balance of costs and benefits supports keeping the SPR whole or calls for adjustments is a legitimate, necessary, and even urgent question. Recent decisions to draw down the SPR and monetize its crude stockpiles have not been supported by any substantial policy debate or serious analysis, however, despite calls to the contrary.[13] Legislative measures to sell down the SPR were not passed following a thorough examination of their rationale but rather out of expediency, as a way to plug budget holes. Arguments on both sides have remained relatively unexamined and unchallenged, often failing to account for the real and dramatic ways in which the global oil market has changed in recent years. The current debate focuses too much on whether the SPR should be kept whole, reduced, or altogether eliminated, not on how it should be used, what mix of crude and products it should hold, or other ways in which the SPR could be used as a security asset more effectively.[14]

The stakes are high. Despite changes in the role of oil in the economy and the energy fuel mix, oil continues to play a vital role in transportation and in the functioning of the global economy. Talk of peak oil demand notwithstanding, global oil consumption grew rapidly last year. Supply disruptions can still cause significant moves in the price of oil, and oil price swings, in turn, can have a profound impact on the economies of both producing and consuming countries. While the current design of the SPR may no longer be optimal, the risk is high that simply selling it down will leave the United States worse off and come with adverse unintended consequences.

Rather than simply reducing the SPR's size, the United States might do better by reconsidering the SPR's value in light of how the global energy market has changed. While selling oil from the reserve might raise short-term cash, it could also effectively squander a valuable asset and a potent policy tool. Given the potential consequences of selling off the SPR now and regretting the decision later, it is both prudent and responsible to undertake careful analysis before liquidating the SPR for budgetary expediency. To date, advocates of downsizing have patently failed to do so.

In this paper, we set out to examine whether the SPR remains fit for its intended purpose. We investigate whether changes in the underlying oil market structure reduce the need for the SPR or, conversely, signal new potential uses for the SPR, which might justify maintaining strategic reserves, despite America's sharply reduced oil import dependence in recent years. Finally, we attempt to look beyond the binary choice of keeping the SPR whole or getting rid of it, and we consider potential improvements in SPR management to reduce the costs and maximize the value of strategic reserves.

A BRIEF HISTORY OF THE STRATEGIC PETROLEUM RESERVE

The creation of the US SPR is rooted in the harsh realities of the 1970s: the quickened pace of US net oil import growth after 1970, the abolition of import quotas by President Nixon in 1973, and the political weaponization of oil exports by leading oil-producing countries of the Middle East during the Yom Kippur war in 1973.

The first signs of an oil supply crunch in the United States began to show in 1970, the same year US oil production peaked at 10 million barrels per day (a record likely to be broken in 2018). Throughout the 1960s, US oil consumption rose rapidly, driven by strong economic growth, suburbanization, and the proliferation of large, inefficient passenger vehicles.[15] Facing rising import levels that challenged US suppliers, President Eisenhower imposed oil import limits in 1959. Still, by the early 1970s, imports were rising, as were warnings about potential brownouts, blackouts, and fuel rationing.[16]

In March 1971, the Texas Railroad Commission (TRC) was forced to lift its production quota, thus eliminating US spare capacity and allowing all-out production for the first time in a quarter century. The chairman of the TRC called this milestone "a damned historic occasion."[17] As oil production headed into its long decline and demand showed no signs of slowing, it was clear that imports would have to make up a larger portion of US supply. In recognition, import quotas began to be eased, and imports as a share of total oil consumption nearly doubled from 1967 to 1973.

At the same time, the economy was experiencing worrying levels of inflation and high levels of unemployment.[18] With political pressure mounting and an election looming, President Nixon imposed price controls, including on oil, in 1971. What began as a temporary price freeze turned into a program of various price- and wage-control measures that persisted for the next three years.[19]

In the early 1970s, most Americans were unaware that the United States imported any oil at all. Gradually, that complacency began to ebb, and reality set in. The phrase "energy crisis" first began to emerge in that period as part of the American political vocabulary.[20] In April 1973, President Nixon delivered his first-ever presidential address on energy. "If present trends continue unchecked, we could face a genuine energy crisis," he warned Congress. The crisis arrived sooner than he expected.

On October 6, 1973—the day of Yom Kippur, the holiest of Jewish holidays—Israel's Arab neighbors launched an attack on the Jewish state. Taken by surprise, the Israelis quickly found themselves in a desperate situation. Prime Minister Golda Meir warned President Nixon that the survival of the Jewish state hung in the most precarious balance.[21] The United States came to Israel's aid, supplying it with much-needed military assistance. Arab nations retaliated by using oil as a weapon.

King Faisal had warned of this in the summer of 1973, telling Newsweek that "Saudi Arabia would use its oil as a political weapon if the United States continued to support Israel's

policy of aggression against the Arab world."[22] On October 17, 1973, the oil ministers of the Organization of Arab Petroleum Exporting Countries (OAPEC) met in Kuwait to discuss the conflict with Israel. They agreed to cut production 5 percent from the September level and to keep cutting by 5 percent in each successive month until their objectives were met. Some countries, including Saudi Arabia, started with a more severe 10 percent cut.[23]

On October 19, Nixon announced a $2.2 billion military aid package for Israel. The next day Saudi Arabia cut all oil exports to the United States, the Netherlands, Portugal, South Africa, and Rhodesia (modern-day Zimbabwe) for helping Israel.[24] In December 1973, another OAPEC meeting in Kuwait cut oil production by 25 percent.

The Arab oil embargo jolted the energy system, taking 5 million barrels per day (b/d) off the world market at a time when demand was growing at an annual rate of 8 percent. This shocked America and shook the nation to its core. By the time the embargo was lifted in March 1974, oil prices had quadrupled to $12 per barrel. Domestic price controls and the associated allocation system severely worsened the shortages, leading to long lines at the gasoline pump.

In response, Congress passed and President Ford signed the Energy Policy and Conservation Act (EPCA) of 1975. Among other provisions, it authorized the creation of a Strategic Petroleum Reserve of up to one billion barrels "for the purpose of reducing the impact of disruptions in supplies of petroleum products or to carry out the obligations of the United States under the international energy program." The EPCA defines the circumstances under which the SPR may be used. A full or a limited drawdown of the SPR must be authorized by the president, while the secretary of energy has the authority to release oil from the reserve for the purpose of conducting test sales and exchanges (see appendix).

The IEA,[25] established by the United States and a group of 15 other major oil-importing countries, is another byproduct of the 1970s oil crisis. As a member of the IEA, the United States is required to hold stocks of crude oil or petroleum products equivalent to 90 days of net imports for use in emergency situations.[26] These stocks can be held either in private inventories or directly by the government. The United States meets its IEA obligation solely through the public crude stockpile held in the SPR.[27]

Throughout its more than four-decade history, the SPR grew in phases and reached its 750 million barrel design capacity by 1991, before the available storage capacity was gradually reduced to the current 713.5 million barrels following the closure of various SPR facilities over the years.[28] The administration of George W. Bush was ultimately unable to persuade Congress to double the size of the SPR to 1.5 billion barrels,[29] and its more "modest" ambition (enshrined in the Energy Policy Act of 2005) to expand the size of the SPR to its originally intended 1 billion barrels was eventually abandoned in 2011.[30] The amount of oil stored in the SPR reached a peak at nearly 727 million barrels at the end of 2009 and remained at this level through mid-2011 before dropping permanently below 700 million barrels later that year following the SPR release coordinated among IEA countries in response to the loss of Libyan supply during the Libyan civil war. As of January 2018, the SPR contained 664 million barrels of crude oil in salt caverns at four sites in Louisiana and Texas.[31]

SELLING DOWN THE SPR

A decade ago, with US import dependence and oil demand rising, policymakers sought to increase the size of the SPR. In recent years, however, the pendulum has swung back, and the predominant legislative mood is now toward a smaller SPR.

The US Congress has enacted five pieces of legislation since 2015 that mandated oil sales from the SPR to other national programs, including the modernization of the reserve (see table 1).[32]

The Bipartisan Budget Act of 2015 authorized the sale of 58 million barrels from the SPR from FY 2018 to 2025 (Section 403) and an additional $2 billion worth of oil (about 32 million barrels, according to the Energy Information Administration's latest estimate)[33] from between FY 2017 and 2020 to finance the modernization of the SPR (Section 404).

The Fixing America's Surface Transportation (FAST) Act of 2015 requires the drawdown and sale of another 66 million barrels from FY 2023 through 2025.

The 21st Century Cures Act of 2016 mandated the drawdown of a further 25 million barrels from the SPR between FY 2017 and 2019.[34]

The recent tax bill passed narrowly by Congress sold a further 7 million barrels of crude oil from the SPR, a last-minute maneuver to raise the funding necessary under Senate procedures to include the provision opening the Arctic National Wildlife Refuge (ANWR) to drilling.[35]

And finally, the Bipartisan Budget Act of 2018, which was enacted in February 2018, has mandated the sale of 100 million barrels from the SPR between 2022 and 2027. Of this amount, 30 million barrels are to be sold during the four-year period between FY 2022 and 2025 and another 70 million barrels during FY 2026 and 2027.[36]

Taken together, these authorized sales totaling about 288 million barrels will reduce the size of the SPR to just below 410 million barrels by the end of 2027 from 695 million barrels at the beginning of 2017 (see figure 1).[37]

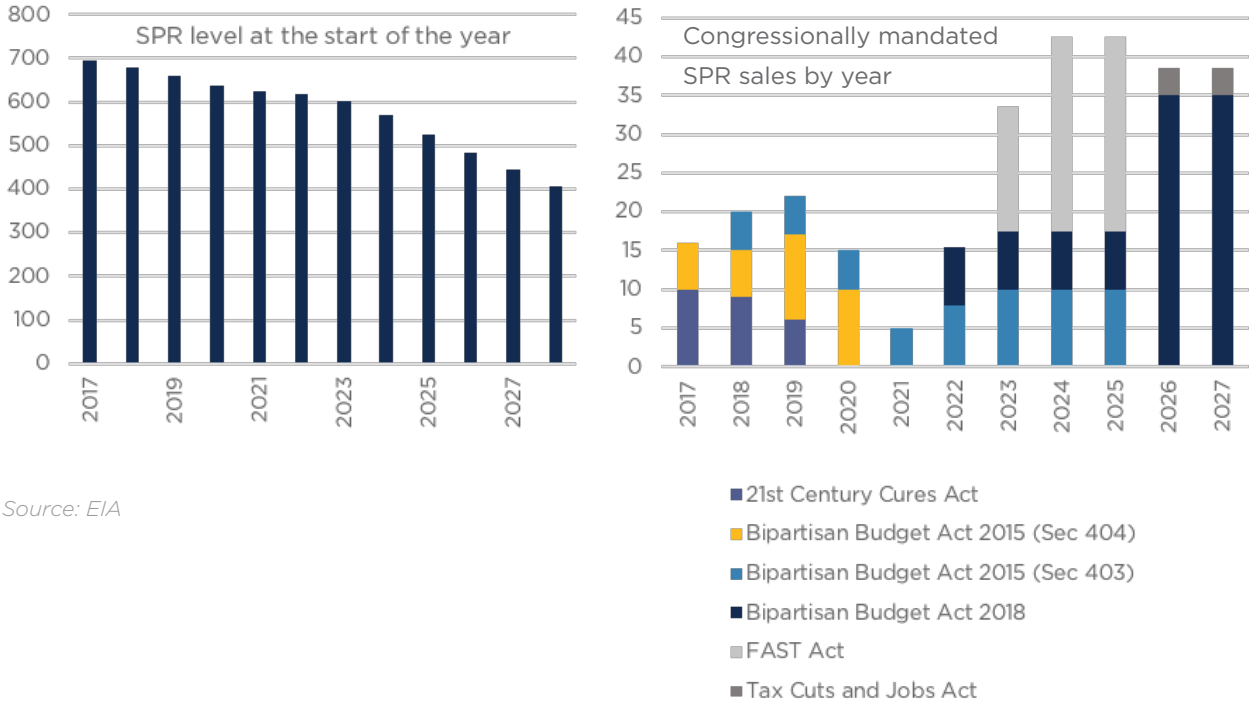
Aside from the sale to raise $2 billion for SPR modernization, all the above sales were motivated by a desire for revenue to pass legislation unrelated to energy. Even staunch defenders of the SPR have at times found its easy source of revenue too tempting to pass up. As the debate was underway in 2015 over how to offset a shortfall in funding the highway trust fund, Senate Energy Committee Chairman Lisa Murkowski warned, "The SPR is not an ATM. It certainly is not the petty cash drawer for Congress."[38] She subsequently spearheaded the sale of 7 million barrels to enable the opening of ANWR.

Table 1: Congressionally mandated SPR sales

Act of Congress or proposal	Year enacted	Total amount to be sold	Sale period
Bipartisan Budget Act of 2015, Section 403	2015	58 million barrels	FY 2018–FY 2025
Bipartisan Budget Act of 2015, Section 404	2015	~32 million barrels*	FY 2017–FY 2020
Fixing America's Surface Transportation Act	2015	66 million barrels	FY 2023–FY 2025
21st Century Cures Act	2016	25 million barrels	FY 2017–FY 2019
Tax Cuts and Jobs Act	2018	7 million barrels	FY 2026–FY 2027
Bipartisan Budget Act of 2018	2018	100 million barrels	FY 2022–FY 2027
* This figure assumes an average sale price of $62.5 per barrel			

Source: CGEP based on EIA and other public sources

Figure 1: Strategic Petroleum Reserve inventories and planned sales (million barrels)



Source: EIA

AN OBSOLETE INSTITUTION?

There is nothing new about fiscal pressures on Capitol Hill and legislative desires to find revenue to pay for other spending priorities. Yet the SPR has long been spared. It is a relatively recent phenomenon that members of Congress argue for shrinking the size of the SPR and deploying the revenue from those sales to other government purposes. What changed? Is the motivation, as Senator Murkowski said, to use the SPR like an ATM? Or might something else have changed that leads policymakers to believe the SPR should be much smaller?

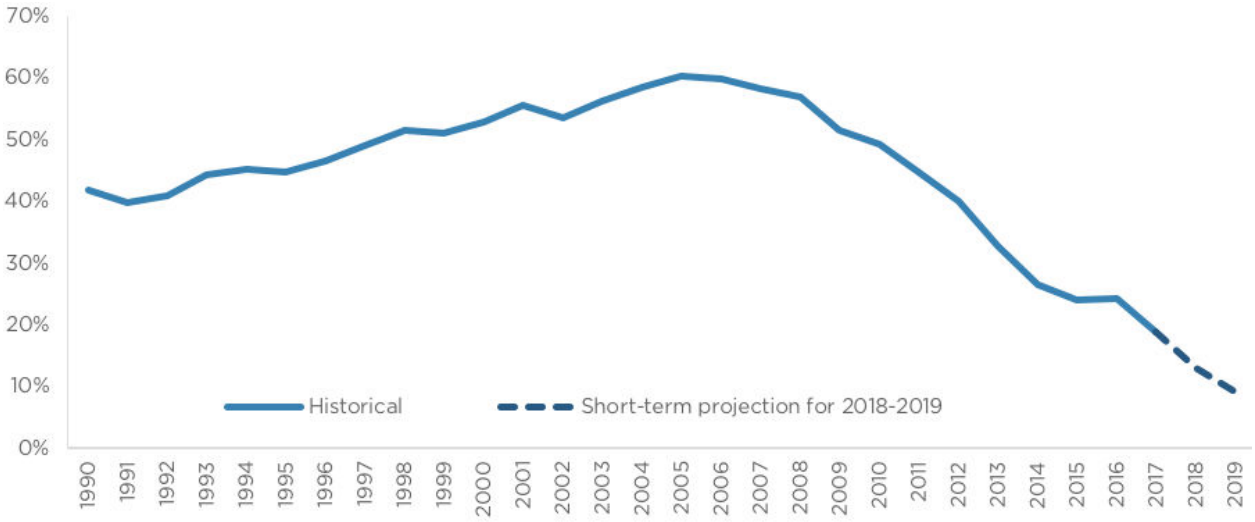
Global oil markets have undergone dramatic change in recent years, driven in part—though not exclusively—by the phenomenal surge in US oil production unlocked by the shale revolution. Based on these shifts in the energy landscape and outlook, several arguments can be made for trimming the size of the SPR. Yet none withstands scrutiny.

Reduced Import Dependence

The stunning turnaround in the US energy outlook due to the shale revolution has changed perceptions about US exposure to disruption risks. Shale extraction technology has unlocked vast reserves of both oil and natural gas. Over the past 10 years, natural gas production has increased by roughly 50 percent, and crude oil production has nearly doubled. In 2005, it was projected that the United States would be importing 27 percent of its gas use in 2015; instead, the United States just became a net natural gas exporter. Net oil import dependence has fallen from around 60 percent to less than 20 percent in the last 10 years (see figure 2). The shale boom has been one of the strongest tailwinds supporting the US economic recovery from the Great Recession, boosting economic activity, lowering energy prices, and delivering large net benefits even after social costs are considered.

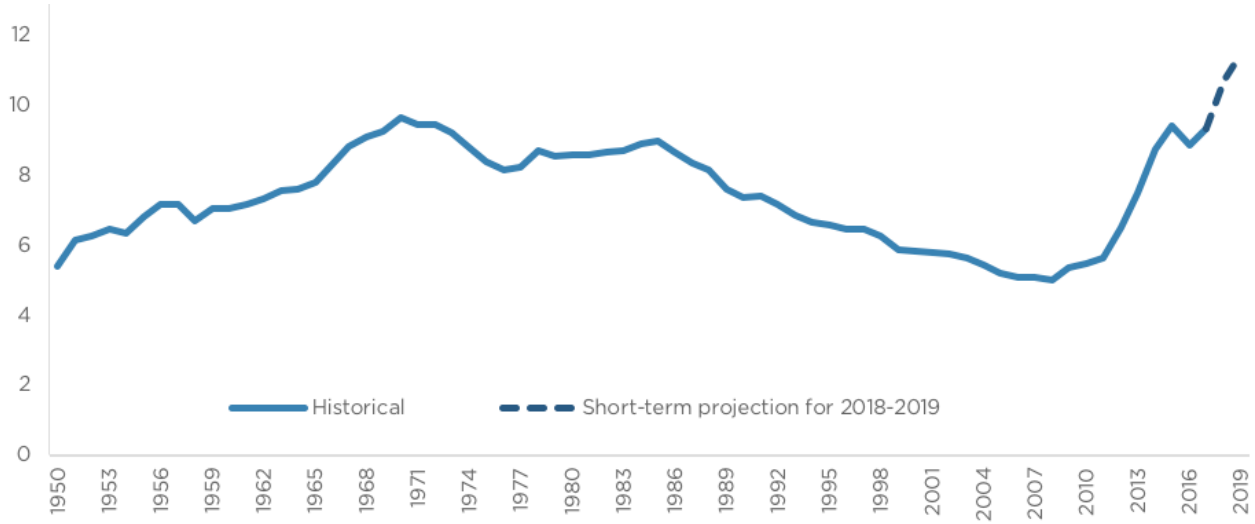
The US Energy Information Administration (EIA) projects that in 2018, average US oil production will exceed 10 million b/d, eclipsing the all-time annual record of 9.6 million b/d set in 1970 (see figure 3). US crude oil exports, which became fully liberalized in 2016, have recently risen to as high as 2 million b/d. Meanwhile the United States moved from being the world's largest importer of refined products, with net imports of 2.5 million b/d as recently as 2005, to becoming the leading product exporter, with net product exports of more than 3 million b/d in 2017. According to the IEA's latest World Energy Outlook, North America as a whole could become a net exporter of crude oil and petroleum products within a few years, while the United States alone could turn into a net petroleum exporter by the late 2020s.[39] The EIA's latest Annual Energy Outlook anticipates the United States to become a net petroleum exporter in 2029 under the reference case and as early as 2020 and 2021 in the agency's "High Oil Price" and "High Oil and Gas Resource and Technology" scenarios, respectively.[40]

Figure 2: US net oil import dependence (% share of net imports in total consumption)



Soure: EIA Short-Term Energy Outlook, April 2018

Figure 3: US crude oil production since 1950 (million b/d)



Soure: EIA Short-Term Energy Outlook, April 2018

By reducing net import requirements, rising domestic oil production has called into question the need to maintain strategic reserves as high as they currently are. One of the effects of the plunge in US net oil imports has been to boost the size of the SPR relative to imports. US strategic reserves now far exceed the IEA's stock cover requirement. As noted above, IEA member countries are required to hold stocks of crude oil or petroleum products equal to at least 90 days of total net petroleum imports. As of early January 2018, the US SPR was sufficient to cover 193 days of net petroleum imports, more than twice the amount required by the IEA. This figure excludes private oil stocks, which could also be used to meet IEA stockholding obligations. This stands in stark contrast to the situation in 2005, when the size of the US SPR fell to a low of just 51 days of net import cover. In October 2005, the US stockholding obligation peaked at 1.2 billion barrels, while the SPR held only 685 million barrels at the time.[41]

The decline in net US oil imports is perhaps the most often cited argument for reducing the size of the SPR. Such calls have come from both Democrats and Republicans alike. For example, in 2012, Austan Goolsbee, former chairman of President Obama's Council of Economic Advisers from 2010 to 2011, argued in a Wall Street Journal op-ed that "there's too much crude in the Strategic Petroleum Reserve," because increases in shale oil production from the Bakken formation in North Dakota and the Permian Basin in West Texas, as well as oil sands production in Canada, had reduced US dependence on imports from outside North America and thus the strategic need for emergency reserves.[42] Similarly, the Trump administration's Office of Management and Budget director, Mick Mulvaney, told reporters that the national security "risk goes down dramatically when we have increased production like today."[43]

In addition to past increases of domestic oil production, future growth projections have also been invoked to argue in favor of reducing the size of the SPR. In a draft budget proposal that would have cut the size of the SPR by half, the Trump administration explained in 2017 that "given the long-term trajectory of domestic energy production and transportation capabilities, a smaller SPR is projected to be able to continue to meet international obligations and emergency needs."[44]

Shale Is the New Swing Supply

Reduced import dependence is not the only way in which rising US domestic oil output could be seen as justifying a rethinking of strategic reserves. The US shale revolution is not just remarkable for the sheer size of the reserves unlocked or the pace of production growth achieved. Shale oil also matters because it is seen as radically different from the rest of the oil industry and following a wholly different business model. Shale oil is generally perceived as more supply elastic than conventional onshore oil or production from large offshore projects. The presumed ability of US shale producers to ramp output up or down relatively quickly in response to price signals or changing market conditions could be seen as a form of insurance against disruption risks, reducing or obviating the need for strategic reserves.

Generally speaking, the oil industry is highly capital intensive and relatively slow moving. Most oil development projects cost billions of dollars and take years to bring into production. The low short-term supply elasticity of conventional oil supply is precisely what makes strategic reserves a desirable hedge against disruption risks.

OPEC spare production capacity is another source of backup supply that can be tapped in the event of a disruption. Saudi Arabia, the world's biggest oil exporter, maintains the largest spare capacity and has historically played the role of "swing" supplier, adjusting production in line with market conditions. Saudi spare production capacity is both an outcome and an enabler of this role of swing producer: nominal spare capacity automatically increases when Saudi Arabia reduces production to support prices or draw down excess commercial inventories and, conversely, decreases when Riyadh ramps up output to fulfil unmet demand or cool overheating markets. There are physical, commercial, and strategic limits to the reliability of Saudi spare production capacity, however. Moreover, the interests of the United States and Saudi Arabia may not always be aligned when it comes to using spare capacity to mitigate price spikes. The SPR has thus proven to be a useful tool in the past, despite the existence of Saudi spare capacity.

The advent of shale oil could theoretically offer another way to mitigate disruptions, however, obviating the need for an SPR. Almost from the onset, the rise of US shale oil supply has spurred speculation that shale could become a new swing supplier or even replace OPEC and Saudi Arabia in that role, albeit as a function of market signals rather than government policy.[45] Unlike other types of oil projects, shale oil production declines steeply after initial production. That means additional investment and drilling are needed to maintain or grow shale production. Shale oil developments require relatively low amounts of initial capital and can be developed in relatively short order, making shale oil highly sensitive to price increases. In contrast with the rest of the industry, which is highly concentrated, the shale oil industry is fragmented and made up of myriad small companies that are nimble, dynamic, innovative, and responsive to market changes. Another distinctive quality of shale projects is their relatively high ongoing costs, which makes shale production sensitive to price declines as well. In the event of a supply disruption and attendant price spike, expectations are that shale players can quickly deploy capital and bring new production online. Conversely, their high exposure to price declines means that they are relatively fast in reducing production in a down cycle.

The response of US crude oil production to the sharp collapse—and subsequent recovery—of oil prices in 2014–2017 illustrates the relative speed at which shale producers can react to shifting market dynamics. Oil prices started to plunge in July 2014 from over $100 per barrel to as low as $30 by February 2016. US crude production initially seemed resilient in the face of falling prices and continued to increase. But after hitting a peak at 9.6 million b/d in April 2015, US production entered a steep decline and eventually fell by about 1 million b/d by September 2016. The decline of US crude production followed the oil price collapse with a roughly nine-month lag. The response of production—led by US tight oil producers—was somewhat quicker during the recovery. Oil prices began to rise in March 2016 and more than doubled from a monthly average low of $30 in February 2016 to nearly $64 by early 2018. Crude production started to recover with a seven-month delay and rose by 1.4 million b/d between October 2016 and the end of 2017.

To be sure, shale oil supply cannot be ramped up quite as quickly as OPEC spare capacity can be activated or SPR stocks can be tapped. But the relatively high supply elasticity of shale oil and the swing potential of shale companies may call for a smaller strategic stock cushion than otherwise. In this view, SPR stocks need to be only so large as to cover the lead time to new shale production.

The End of Oil Is Nigh

In addition to the altered oil supply outlook and the mind-set shift from scarcity to abundance, the longer-term outlook for oil demand is also changing. Electric vehicles (EVs)—aided by supportive government policies—are projected to grow quickly in many countries, and the rapid rise of EVs may seem to pose an existential threat to oil-powered internal combustion engines in the road transport sector. The confluence of two additional technological developments—autonomous driving and shared mobility—has the potential to further reinforce (and magnify) the advantages of EVs over gasoline-powered ones, as fleets of self-driving electric cars are cheaper to operate than either conventional vehicle fleets or privately owned EVs.

With sharp upward revisions of projected EV sales, predictions of peak oil demand have also proliferated in recent years. Though many forecasts still expect the oil demand peak to be decades away,[46] some predict that global oil demand could reach a peak as soon as the late 2020s[47] or early 2030s.[48] The latest annual energy outlook from BP envisions a peak in oil demand by 2035 as a base case. The Boston Consulting Group considers, as part of its oil demand scenarios, several "disruption" cases that could see a declining trend in oil demand starting in 2025 or 2026.[49] With peak oil demand on the horizon, the rationale for keeping large volumes of oil in reserve becomes increasingly tenuous. As Spencer Dale and Bassam Fattouh put it in a recent paper, in our newfound age of oil abundance, it is "better to have money in the bank than oil in the ground."[50]

Some academics,[51] environmentalists, and energy economists argue that the approaching end of the oil age will turn much of the world's oil reserves into stranded assets—well before global oil demand drops to a fraction of today's level several decades from now. That, in turn, could affect reserve valuations around the world.[52] In a future of declining oil demand, the theory goes, large reserves of oil—including government-owned reserves like the SPR—would be more likely to lose value than to appreciate over time. Under such circumstances, it appears only rational to gradually sell off strategic reserves. Moreover, as oil demand declines, the adverse impact of oil price spikes on the US economy wanes, thus also mitigating the value of the SPR to limit price shocks.[53]

Producers Have Buried the Oil Hatchet

The idea of strategic reserves has sometimes been associated with their value as a deterrent against the use of oil as a political weapon. Both the US SPR and the IEA were established in the wake of the Arab oil embargo of 1973 as part of an explicitly defensive agenda against the threat of oil market manipulation by producer countries. The kind of disruptive oil shock that policymakers had in mind and sought to guard against when setting up the IEA and creating a framework for international cooperation among major oil consuming economies was clearly based on the "energy crisis" of the Yom Kippur war. As US secretary of state Henry Kissinger said at the time, enormous wealth transfers from consumer to producer countries as a result of the oil crisis, large-scale recycling of petrodollars in Western economies, and the risk of further supply disruptions put consumer countries, and the world at large, at "enormous risk."[54]

Against this backdrop, Kissinger hailed the "unprecedented agreement to share oil supplies

among principal consumers in the event of another crisis" and the establishment of the IEA as "a historic step toward consumer solidarity, [which]…provides a detailed blueprint for common action should either a general or selective embargo occur."[55]

Historically, it may be argued, strategic reserves have done more than provide oil importers with the means to mitigate the effects of potential supply disruptions and afford them a source of emergency supplies in the event of a politically driven oil shock. Through their sheer existence, strategic stocks have also served as an effective deterrent against cartel-like behavior by raising the cost of an oil embargo for producing countries to prohibitive levels.[56] The establishment of strategic reserves turns the table on the instigators of an oil embargo: while consumers would be sheltered for an extended period of time from the loss of supplies, producers would be hit hard immediately as their export volumes decline without an offsetting price spike.

Assessing the value of the SPR and IEA reserves as a deterrent against the use of oil as a political weapon has always been challenging, as the counterfactual, by definition, cannot be known. If the deterrent value was indeed part of the rationale for maintaining the SPR, however, then it may be argued that such deterrence today seems hardly necessary, and thus the SPR is obsolete. Kissinger's remarks from the 1970s do sound strikingly out of date, and the idea of using oil as a weapon appears negligible today. Saddam Hussein made the last attempt at instigating an Arab oil embargo in 2002 (with Iran and Libya briefly considering participation), but Iraq's unilateral suspension of exports to Western countries quickly ended in failure.[57] In the 2000s, Crown Prince Abdullah, the de facto ruler of Saudi Arabia at the time, explicitly renounced the use of oil as a political weapon.[58] While the IEA and the US SPR may deserve some credit for this new reality, other factors likely played a role as well. Regardless of intent, changes in the geographic distribution of oil supply and the functioning of the oil market mean that Saudi Arabia and other producers probably lack the market power to impose an embargo today. The market share of Arab oil producers as a whole has declined, with both the United States and Russia now rivaling Saudi Arabia in production volumes. Outside the Middle East and Russia, no single producer commands enough market share to unilaterally declare an oil embargo against IEA member states, including the United States. In addition, the development of an integrated global oil market since the 1970s suggests that oil could be rerouted from other sources in the event of a disruption, albeit not without some price effects.

MISGUIDED CRITICISMS

The US and global oil markets have undoubtedly undergone a profound transformation since the creation of the SPR. These changes, as shown above, at least call into question the value of the SPR, raising the need for a reexamination of the strategic reserve and of its suitability to address the type of energy security risks facing the United States today. They have not, however, removed all risks from the energy market nor obviated the benefits of the SPR. While old threats may have faded, new ones have also emerged. Any plan to reduce the size of the SPR, let alone eliminate it, must take into consideration not only whether the above rationales for downsizing the SPR are valid but also the new types of risks that might have appeared since the creation of the SPR.

In this section, we explain why the arguments against the SPR in the prior section do not withstand scrutiny. We argue that changes in market conditions have not fully eliminated the original risks that the SPR was designed to protect against, nor have they completely eroded the SPR's ability to fulfill that role. In the subsequent section, we argue that recent developments in the United States and global energy markets have created new types of risks, which may have only made the SPR more beneficial.

The rise of the US shale oil industry, remarkable as it may be, must not obscure the enormous uncertainty that clouds the outlook for future oil supply, both in the United States and globally. The poor track record of oil market forecasters is well known. Forecasting accuracy is only likely to get worse in the age of shale oil and decarbonization as uncertainties increase on both the supply and the demand side.

On the supply side, the shale revolution may have replaced old concerns about energy scarcity with a sense of abundance. Shale extractive technologies are still in their infancy, however, and the long-term economics of shale projects remain untested.

The demand outlook is equally cloudy. Despite mounting speculation about peak oil demand, it is far too early to predict the end of oil—or even the end of US oil import dependence. Betting on perpetual US energy self-reliance is a risky gamble.

Even if the United States were to become fully self-sufficient as far as its oil needs are concerned, that would not insulate it from the risk of oil supply disruptions. As the United States is becoming increasingly "energy independent" on a net basis, it is also becoming ever more closely integrated with the global oil market at the same time. Rising domestic output does nothing to diminish US linkages with world energy markets. On the contrary, the globalization of oil and energy markets has heightened the energy interdependence of the United States and the rest of the world. Increased physical and financial linkages between oil producers and importers have heightened the nation's vulnerability to disruption risks both at home and abroad in important ways. Although this may not have been its founders' original intent, the SPR is a highly valuable tool to manage those risks.

Oil Market Integration and Contagion Risks

The argument that the SPR is less necessary because US oil import dependence has fallen does not withstand scrutiny. Although it is true that lower imports mean the US can comply with its 90-day IEA obligations with a smaller SPR, days of import cover is not the right metric to assess the optimal size of the SPR.

In a globalized oil market, the real risk of an oil supply disruption to the US economy does not lie in the physical barrels that may be kept from reaching the United States but rather in the financial and economic ripple effects of price shocks. In the 1970s, oil price controls existed in the United States, and most internationally traded oil was sold under long-term contracts. A disruption in contracted shipments could result in a physical shortage for buyers because neither strategic and commercial stockpiles nor a large spot market existed at the time. In the intervening years, the oil market has become the largest and most liquid commodity market in the world with vibrant futures markets. The vast majority of globally traded oil is bought and sold at a price indexed to benchmark crude prices and mature pricing hubs in regions including Europe (Brent), the United States (WTI), and the Middle East (Dubai).[59]

Since the oil shocks of the 1970s, the oil market has become globally integrated and tightly interconnected. A deep and highly liquid futures market has developed, which was nonexistent when the SPR was created. Price formation has thus moved from "posted prices" set by oil companies to indexation on market-determined oil futures. As a result of these changes, supply disruptions are far less likely today to result in lasting physical shortfalls in any given consuming market and more likely to cause price increases everywhere. Given how the market has changed, the SPR could be used to mitigate those risks and control the adverse effects of price shocks on the global economy.

Leveraging strategic reserves to smooth out disruption impacts would not entail turning the SPR into the world's Central Bank of oil, a misguided idea at any rate.[60] Rather, SPR drawdowns could, under certain circumstances, minimize the economic damage of oil price shocks by smoothing economically painful price spikes until commercial actors arbitrage disruption-driven imbalances and reallocate supply. The globalization and financialization of oil markets suggest a repurposing of the SPR as a tool of price management—a different use than intended by its founders but perhaps a no less important one. It has even been suggested that SPR drawdowns could be automatically triggered by shifts in the futures curve.[61]

There is a significant moral hazard involved in using SPR oil for purposes that might be better served by private-sector entities, however. To the extent that an SPR release smooths a price spike stemming from a supply disruption, it also mutes the price signal that would induce more supply and reduce demand. There is a tradeoff between the government's use of strategic stocks to cushion price spikes and the ability of those price spikes to resolve the disruption that caused the price spike in the first place. Automatic drawdowns of SPR stocks triggered by predetermined price signals would be worse, defeating the purpose of strategic reserves if these releases became entirely predictable and could be anticipated by market participants. Secure in the certainty of SPR draws at given price triggers, private entities would be incentivized to reduce their storage costs and cut their own commercial stocks to levels below what would otherwise be considered prudent.

Despite these risks, using the SPR for price management purposes recognizes that reduced oil import dependence does not fully insulate the United States from the adverse effects of international supply disruptions. Crude oil and refined product prices in the United States will still rise as a result of global supply disruptions even if we import less. Since the creation of the IEA in 1974 and the US SPR in 1975, the global oil market has become considerably more integrated and interdependent. In the event of a supply disruption, the United States, despite its lower net import requirements, would still see prices rise at the pump.

Although this may not have been its intended use, the SPR can help manage such financial and economic risks by offering the United States, and its partners through the IEA's coordinated emergency response, the option of adding liquidity to the oil market in the event of a disruption, regardless of where it may occur. Indeed, the mere expectation that the government may use the SPR could itself mitigate long trade positions and thus price spikes. In 2012, for example, the Obama administration's signaling to markets that it might use the SPR if oil prices reached $120 per barrel gave pause to traders taking long positions and put a soft lid on prices.

All this is not to say that oil import reductions do not matter. Lower net oil imports do not reduce the exposure of the US macroeconomy to oil price shocks, however. Because the oil market is global, a price spike hits consumers at the pump regardless of whether the US imports any oil at all. But the effects on the US economy overall are more muted as more of that increased consumer spending circulates within the economy rather than flowing overseas. Based on past experience, an oil price collapse of the magnitude seen in 2014–2015 would have been expected to boost US GDP by around 1 percentage point.[62] Instead, the US economy saw almost no benefit from the oil price collapse because the boost to consumer spending was almost entirely offset by a reduction in oil-related investment.[63] Conversely, a rise in the price of oil, as we are seeing today, will have less of an effect on GDP if the United States imports less—although the offsetting effects on oil sector investment may be asymmetrical. That is, oil price increases, even as they hurt consumer wallets, may do less to spur oil sector investment than oil price falls do to harm oil sector investment, given constraints on labor supply and infrastructure that limit the rise in investment from higher oil prices in ways that do not limit the fall in investment from lower oil prices.

Still, even if the United States produced all the oil it consumed, a price shock would still cause pump prices to rise, so oil price shocks still have significant distributional impacts, which matter from both an economic and political standpoint. Additionally, even if the GDP effect of higher oil prices is lower because imports are reduced, there is an adverse macroeconomic impact from oil price volatility itself. Sharp swings in oil prices can reduce confidence, create uncertainty, and deter consumer spending and business investment. Excessive oil price volatility can also undermine industrial production, and—under some circumstances—it can lead indirectly to higher inflation and unemployment rates.[64] While it is not the government's job to achieve oil price stability, using strategic stocks to shave peaks and smooth prices until the private sector can adjust to rapid and severe supply disruptions yields economic gains.[65]

Uncertainty around the Responsiveness and Longevity of US Shale

The basis for many calls to sell off the SPR is the US shale boom, but there is reason to be cautious about its future and skeptical of claims that the short-cycle nature of shale makes it a new swing supplier able to balance oil markets. Despite breathless claims after the oil price collapse in late 2014 that OPEC was dead and shale could now balance oil markets,[66] neither claim seems valid as oil prices approach $80.

In his 2007 State of the Union address, President George W. Bush called for doubling the size of the SPR, part of a set of actions to enhance US energy security in the face of rapidly rising petroleum imports. While 11 years is not a long time, the US energy landscape has changed dramatically. And the lesson today is to be cautious about selling off a national security asset the United States has held for over 40 years because of confidence in the new US energy outlook that may yet prove misplaced.

Optimism about the outlook for US oil production and shale supply growth looks well justified by the experience of the last few years, but confidence in the future role of the United States as an energy superpower should not lead to complacency.

Oil production forecasts are inherently uncertain. Shale oil, although it differs in important ways from the rest of the industry, is no exception. In fact, there is, in many ways, more uncertainty around the outlook for shale oil than for conventional oil or deepwater projects. Moreover, despite its short-cycle nature, shale is not swing supply. It takes at least 6–12 months for US shale to respond to price changes. It cannot quickly respond to market disruptions the way true spare capacity can, defined by the EIA as the ability to bring new supplies to market within 30 days and sustain output for at least 90 days.[67] Moreover, recent changes in the shale industry could lead to decreased elasticity in the future. In a bid to reduce costs and improve profitability, shale production has become more capital intensive. Projects are getting more complex. Lead times are getting stretched. To reduce drilling costs and boost productivity, shale operators are moving from small single-well pads to much larger pads that can support as many as 12 interconnected wells stretching across multiple leases. Shale companies are devoting considerable efforts to consolidate their leases and bring adjacent parcels under common management. These efforts can bring the development of shale production projects from a matter of a few months to up to two years. While this is still less than most conventional oil projects, this is nevertheless reducing the ability to ramp up output quickly in response to price hikes or supply disruptions.

Beyond the limits of shale as swing supply, there remains great uncertainty about the magnitude and longevity of this new shale phenomenon. At the time of writing in April 2018, the latest forecasts of US crude oil supply from the EIA called for steep growth of 1.4 million b/d in 2018, and the IEA forecast growth of 1.5 million b/d if natural gas liquids (NGLs) are included. The IEA's World Energy Outlook 2017 reckons that by the mid-2020s, "the United States becomes the world's largest liquefied natural gas (LNG) exporter and a few years later a net exporter of oil…factoring in extra volumes from Canada and Mexico, North America emerges as the largest source of additional crude oil to the international market."[68] Projections by the IEA and the EIA are often taken as a benchmark by oil market participants, and they do capture the consensus view of the day. Experience suggests that their accuracy

is less than infallible, however. Both institutions were slow to recognize the true potential of shale oil and underestimated US shale supply growth for years. More recently, institutional forecasters, having long underestimated shale production, started overestimating it. Shale supply through much of 2017 came in significantly below EIA projections. In late 2017, however, output from shale formations once again raced ahead of forecasts.

Since the beginning of the shale revolution, the shale oil industry has consistently surprised market participants. Oil forecasting in general is highly uncertain. Shale oil forecasting is even more so due to the relative novelty of the industry. Shale oil industry participants are still on a learning curve as shale extraction technologies evolve and production costs keep fluctuating, making projections a moving target. How much additional technology improvement ought to be factored into forecasts is unclear.[69] Uncertainty shrouds every way in which the shale revolution has upended oil markets: its impact on reserve estimates, its price responsiveness, implications for global trade flows and US energy balances, and its impact on the business model of oil companies. The bottom line is that continued steep growth in US shale oil supply, as likely as it might appear today, cannot be taken for granted. There are a number of factors that can cause US shale production to fall short of expectations and become more rigid and less price elastic over time than it has been so far. The most important such factors are summarized below.

Changes in productivity: Optimism about future production has been largely driven by efficiency gains and cost decreases achieved by shale producers since the 2014 oil price collapse. How sustainable these gains will prove is difficult to gauge. Broadly speaking, cost and performance improvements reflect a mix of structural and cyclical factors, including long-term technological advances; short-term cyclical cost declines; and the impact of high-grading, or focusing activity on the "sweet spots" of the most prolific plays with the best rigs and crews. The pace of production growth could slow in the event of a rebound in oil service costs or if low-grading (moving to less prolific or geologically favorable plays) offsets the impact of technological improvements. The respective role of these three factors in productivity gains is a matter of debate. In a study of the Bakken shale formation, Justin Montgomery and Francis O'Sullivan of the Massachusetts Institute of Technology estimated that technological advances only accounted for about half of the reported improvement in productivity, far less than assumed in some EIA projections. In a response, Marianne Kah of the Columbia University Center on Global Energy Policy refuted MIT's study, arguing that the authors' chosen metric—the initial well production (or IP) rate—is not the best proxy for assessing productivity gains, and the analysis specifically excluded structural improvements like the reduction of drilling days, which have benefitted the economics of tight oil plays without increasing initial production rates at the same time.[70] In the first half of 2017, production growth in the Permian Basin, the fastest-growing formation in 2016, fell far short of analyst projections and producer targets, a result blamed in part on congestion and cost reinflation. In late 2017, production surprised on the upside again.

Changes in environmental regulations: Public opposition to fracking is on the rise.[71] Environmental groups, some of which initially supported shale gas for its ability to displace coal, are increasingly aligned in opposition to shale. While there are real and important risks to manage, some opposition is more ideological than fact based[72] yet nevertheless resonates

with a portion of the public. A number of US states—namely, New York, Maryland, and Vermont—have banned fracking altogether.[73] In Oklahoma, a traditional oil state where fracking is widespread, an increased incidence of seismic tremors and minor earthquakes has been associated with the disposal of wastewater from fracking sites, and recent activity suggests hydraulic fracturing itself may trigger seismic activity.[74] The number of earthquakes has fallen since state regulators imposed stricter limits on wastewater disposal in 2016 and 2017.[75]

In the 2016 Democratic primary, Senator Bernie Sanders supported a ban on fracking. Even former secretary of state Hillary Clinton, who refused to support a ban on fracking, felt pressured to note that once her conditions for production were put in place, "there will [not] be many places in America where fracking will continue to take place."[76] In the next presidential primary, it seems likely that there will be even greater opposition to shale among Democrats. Hostility to fracking is increasingly bipartisan too, with anti-fracking sentiment gaining ground among Democrats and Republicans alike.[77]

Opposition to fracking is exacerbated by the broader anti-oil "leave it in the ground" movement. Even in the absence of any major incident, anti-shale sentiment appears to be on the rise. Should an accident occur, supply growth could suffer a setback—either because strict new regulations or bans curtail the scope of activity or because a regulatory backlash raises compliance costs for operators, thus undermining shale economics and diminishing the prospects of future production growth. Growing environmental opposition to new hydrocarbon infrastructure may also stymie shale growth, as new oil infrastructure as well as gas infrastructure will be needed to accommodate the projected growth rates of shale in the coming years.

Industry consolidation: The US shale sector is more fragmented than the rest of the oil industry. This industry structure has proved highly conducive to rapid production growth in the past. Small, dynamic, highly leveraged shale oil companies have exhibited great agility and been incentivized to increase production at all costs. Following the oil 2014–2016 price collapse, however, the industry has undergone a period of consolidation and increasingly prioritized cost control, capital discipline, and profitability over production growth. The efficiency gains and cost savings that have been achieved during the down cycle may come at the expense of nimbleness among independent producers, as projects have become larger and now require longer lead times and higher initial capital expenditures. Consolidation is likely to continue and could bring further economies of scale, facilitating larger, higher-cost, and even more complex projects. Some oil firms may seek to avoid sharp volatility in production volumes, given the costs of rapidly laying off and rehiring workers and idling rigs and equipment only to quickly redeploying them. Larger companies with stronger balance sheets may be better positioned to weather price spikes and troughs with less impact on production levels. As the shale industry continues to mature, the high degree of supply elasticity that seemed so distinctive of shale companies at the onset may start to wane, reducing the ability of shale oil to respond quickly in the event of a disruption.

Cost of capital: Rapid shale production growth has benefited from abundant financial liquidity and record-low interest rates in the wake of the Great Recession. A ramp-up in interest rates as the economic recovery gains momentum could adversely affect the availability and cost of capital.[78]

Limits to the price responsiveness of US shale: Despite talk of a "two-speed" oil industry and speculation about the potential swing role of US shale oil production, there are clear limits to the shale industry's price responsiveness. These have been amply demonstrated both in the market downturn, in the wake of the oil price collapse, and again on the upside, following OPEC's return to supply management and the subsequent oil price recovery. Changes in the structure of the shale oil industry could further reduce the price elasticity of US shale. Although the cost structure and business model of the shale oil industry make it more price sensitive in the short run than conventional or deepwater oil production, variations in shale oil supply reflect the lagged effect of investment decisions of myriad industry participants and thus cannot come close to matching the release of strategic reserves or the activation of OPEC spare production capacity.

This section is not meant to argue that US shale projections are exaggerated. On the contrary, experience and evidence to date suggest that shale output may well surprise to the upside again. The point is rather to caution against excessive confidence in the outlook that would justify selling a security asset the US has held for nearly a half century.

The Oil Age Is Not Over Yet

Arguments that the SPR's value is declining because the end of the oil age looms should be met with a healthy dose of skepticism. The IEA projects rapid growth in the share of new vehicles sold that is electric, with EVs comprising 15 percent of the global fleet by 2040. Still, oil consumption is expected to rise through 2040 on the back of continued increases in demand for freight, aviation, shipping, and petrochemicals. In the past, the IEA has shown a tendency to underestimate the growth of some clean energy technologies, so this projection, too, could turn out to be overly conservative. But even with more rapid EV growth rates, oil demand still rises in other sectors, unless there are breakthroughs that allow substitute fuels to be used in trucking and other parts of transportation, as well as more rapid improvements in the fuel efficiency of internal combustion engine (ICE) vehicles. EVs alone are unlikely to lead to peak oil demand without these additional sources of demand reduction. As IEA executive director Fatih Birol recently explained at Columbia University,[79] holding all else constant, even if one out of every two cars sold from now on were electric, oil demand would still rise through 2040.

Furthermore, reductions in demand for a given type of fuel in a given application, sector of economic activity, or region may not necessarily result in oil demand contraction overall. Fuel switching from high-sulfur residual fuel oil (HSFO) to liquefied natural gas (LNG) in the marine transportation sector, for example, might not result in a net reduction in overall oil demand but simply shift distressed HSFO barrels from ocean-going vessels to onshore power plants if depressed HSFO prices create an economic incentive to do so.[80] Similarly, ICE vehicles displaced by electrification in China or OECD countries could find new markets in the emerging economies of Africa or Latin America. Rapid EV penetration may also face hurdles such as the deployment of charging infrastructure in electricity-deficient emerging markets, as well as the challenge of scaling up EV and battery production at a reasonable cost.

To place the oil-market impact of disruptive technologies such as EVs in a broader

perspective, the Center on Global Energy Policy at Columbia University has undertaken a major research initiative on peak oil demand. Far from looking at each sector in isolation or extrapolating from discrete developments in specific market segments, this ongoing effort promotes a holistic, cross-cutting approach to oil demand focused on the "whole barrel." While it is too early to offer definitive findings, an early takeaway has been to highlight the degree of opacity and complexity characterizing oil demand drivers and the persistent uncertainty of future oil demand trends.

Perhaps even more importantly, the question of when oil demand will peak may be beside the point. Even if electrification, fuel efficiency, and other substitutes bring about a peak in oil demand, oil consumption would likely contract gradually, not overnight. As a result, oil will continue to be an important part of the US and global economy for decades to come, and thus oil price spikes will continue to be important policy concerns. Indeed, as discussed later in this paper, the possibility of peak oil demand and a gradual transition away from oil could increase, not decrease, the need for strategic stocks given the detrimental impact of the impending energy transition on investment, capital costs, and oil price volatility.

REPURPOSING THE SPR

The SPR as an Energy Transition Tool

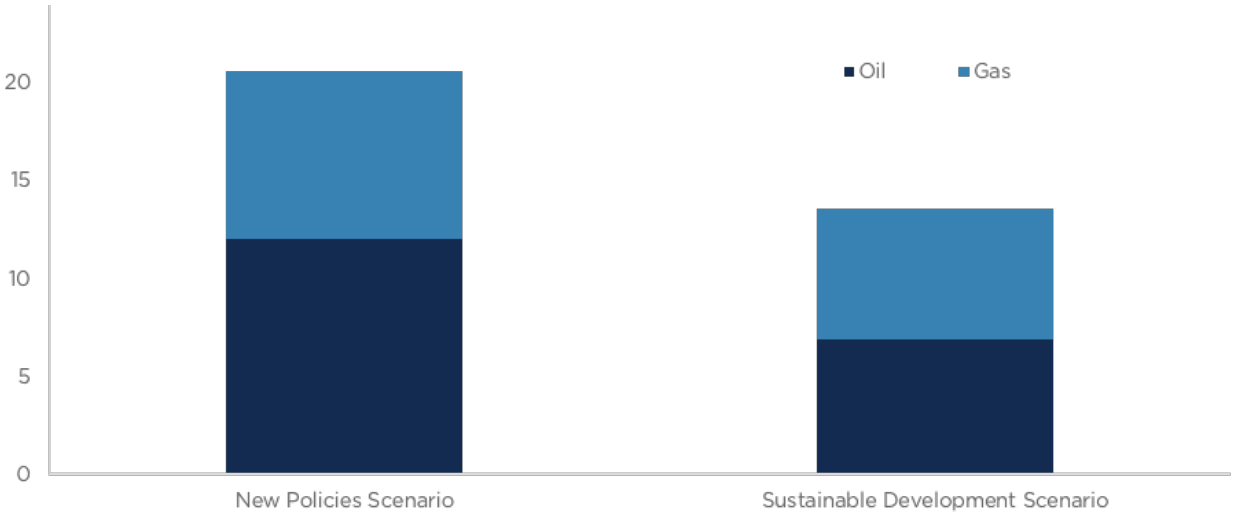
Even if oil demand were to begin declining as part of an energy transition, the widespread belief that the SPR would necessarily lose value does not withstand scrutiny. In fact, the decarbonization of the economy and the transition to a cleaner fuel mix would greatly increase the need for strategic oil reserves.

The transition away from the oil economy is likely to be a period of great volatility in oil markets, with potentially damaging effects for the US economy and social stability. Expectations of peak oil demand are already causing shifts in investments in the energy sector. Concerns over stranded assets are leading some major institutional investors to move away from the oil sector. Oil companies themselves are reexamining their portfolios and redirecting investment flows at the expense of the oil sector.

While a transition away from oil, were it to occur, would necessarily involve less investment in oil over time, the transition itself will be messy and uncertain. Currently, global oil supply declines at a rate of roughly 5 percent of world production per year. That means trillions of dollars of new investment is needed to bring 5 million b/d of new supply to the market even if oil demand does not grow at all. Expectations of declining oil demand, however, and uncertainty about the pace of transition may well deter investors. Suppose oil demand growth is flat next year—and the year after and the year after that. There will be breathless headlines around the world about how peak oil demand has been reached and projections about oil's impending decline. That may be true, but there will still be a huge amount of uncertainty about oil's path. More likely, the transition will be messy and unclear. Growth may stagnate and then resume again—just as global greenhouse gas emissions did over the past four years. GHG emissions were flat for three years, leading countless analysts to proclaim emissions had "decoupled" from growth, until, in response to strong economic growth, emissions rose again in 2017. Demand may rise through periods of growth and decline, even if the longer-term trend turns down. Yet that may mean periods of both oversupply and undersupply on the path toward a shift away from oil decades from now. And uncertainty about growth, expectations—and possibly excess hype—about oil's decline, and investor pressure may cause an excessive pull back in investment.

The pace of decline is highly uncertain. Moreover, as figure 4 shows, even if the world meets the target of limiting temperature rise to 2 degrees Celsius, which would mean a rapid decline indeed relative to our current trajectory, the world will still need trillions of dollars of new investment to offset decline rates. The IEA projects that $21 trillion of investment is needed in the oil and gas sector given the current outlook,[81] and even in a 2-degree scenario, some $14 trillion would still be needed.[82]

Figure 4: Cumulative oil and gas supply investment in 2017–2040 (2016 $ trillion)



Soure: IEA World Energy Outlook 2017

Yet the change in perception from a growing to a dying industry may mean a sharp cutback in investment, falling oil firm equity values, and higher costs of capital. If not properly managed, that underinvestment relative to demand could lead to periods of undersupply, tight markets, and price spikes during that period of energy transition. The SPR's value in a period of uncertain energy transition is likely to be enhanced even if the longer-term trend is toward lower demand. As a result, there is a high risk that the industry will divest faster than the energy transition, leading to disruptive shortfalls. Expectations of peak oil demand could become disruptively self-fulfilling.

The energy transition could also heighten the risk of instability in key producer countries, leading to dramatic supply shortfalls. On the face of it, OPEC countries, by virtue of being the lowest-cost producers, should be better able to withstand the effect of reduced demand than others. This, however, does not take into account their social spending requirements, which more often than not can be met only through oil export revenues. Should high-cost producers be driven out of the market by reduced demand, there is a high risk that oil prices would plunge to a level that would undermine the social stability of low-cost producers.

Supply risks associated with the energy transition cannot be satisfactorily addressed by the private sector. Decarbonization policies make it incumbent upon large consumer countries to maintain substantial reserves to manage supply volatility and help bridge the gap as consumers transition toward a cleaner fuel mix. Far from being made obsolete by the energy transition, strategic reserves are, in fact, a critical transition tool.

Weather Insurance and Soft Power

Historically, the SPR was aimed at global oil supply disruptions, but increasingly strategic stocks, at home and abroad, may be tapped to address disruptions resulting from severe weather. While self-sufficiency is no guarantee against the price impact of a supply shortfall elsewhere, neither is it an insurance against the risk of a disruption at home. In recent years, some of the most severe supply disruptions suffered by the United States have come not from abroad but from extreme weather events and their effects on the domestic upstream, midstream, and downstream oil sectors. The 2005 hurricane season, with its crippling impact on US Gulf of Mexico crude oil production and, more importantly, on the Gulf Coast refining and pipeline system, is a case in point. Relief in that case came not from America's own emergency reserves but shipments from elsewhere, including other IEA countries. Hurricanes Gustav and Ike in 2008 were equally—if not even more—damaging to the Gulf Coast refining complex.[83] Hurricane Sandy in 2012 caused widespread disruptions in product supply on the US East Coast. Flooding associated with Hurricane Harvey in 2017 idled refineries in Texas and shut in shale oil production from the Eagle Ford.

The incidence of extreme weather events is widely expected to increase due to changes in sea levels and temperatures and shifts in ocean currents and wind patterns caused by global warming.[84] In the event of a weather-driven oil supply disruption, relief is likely to come from abroad. This highlights the increased relevance of international cooperation for US energy security. As far as energy is concerned, no country, no matter what its production might be, is an island.

Keeping the SPR is necessary to be part of an international consortium of countries bound by a pledge of mutual assistance. US leadership has been key to the establishment of this alliance. To abdicate or undermine it on grounds of reduced import dependency would severely undermine US interests and the integrity of this international system at a time when it is being expanded to include large non-IEA consumers like China and India.

The increased incidence of extreme weather events only heightens the risk of further domestic disruptions, and hence US dependence on outside help, at times of crisis. Changes in weather patterns, rising sea levels, and the growing complexity and interdependence of the US energy system all raise the risks of future supply disruptions. Maintaining a robust domestic strategic reserve assures that we will also have access to the crude oil and oil products in other countries' strategic reserves when we need to access them because of domestic disruptions.

While US domestic supply risks are increasing, so are those of America's allies, for the same reasons. The larger America's strategic reserves are, the greater the ability to assist other nations and benefit from their stocks in return. The SPR is a powerful tool of international cooperation, which both enhances the United States' ability to rely on partner countries for support in the event of an emergency and, conversely, it incentivizes US partners to maintain good relations with Washington to secure access to its strategic reserves. Although rising domestic output has nominally lowered US storage obligations under IEA rules, maintaining a large reserve above the 90-day requirement is a source of American soft power that ought to be preserved.

Maintaining the SPR—even if the US imports little or no oil—is the price of membership in an international sharing arrangement that continues to benefit the US, given the growing risk of domestic supply disruptions. Against these domestic supply risks, America's reduced import dependence provides no protection whatsoever.

The Changing Nature of Political Risk to Oil Supplies

While producers claim to have buried the oil hatchet and the threat of oil being used as a political weapon has seemingly diminished, the risk of major disruptions from producer countries remains high, perhaps even more so than in the past. Whereas in the past the risk to oil supply was that sovereign governments of producer countries would deliberately withhold exports for political gain, today the bigger risk is that these governments lose control and their countries become failed states.

The last few years have seen several oil supply disruptions due to political turmoil and state failure. These include Syria, Yemen, Libya, and to some degree Iraq. Today Venezuela is suffering accelerating production declines and teetering on the brink of economic collapse. A total loss of Venezuelan supply cannot be ruled out.

No amount of strategic reserves can provide a long-term substitute for a protracted loss of production from a major exporting country. Supply disruptions due to war or civil war tend to be long lasting. Libyan production fell to a trickle during the 2011 civil war and has yet to fully recover to the prewar level of 1.6 million b/d. Current production hovers around 1 million b/d, and effective production capacity is estimated to have been cut to 1.2 million b/d. Most of Syria's and Yemen's production remains offline—prior to the 2011 Arab Spring, the two countries produced close to 400,000 and 300,000 b/d, respectively. Venezuelan production has plunged from around 3 million b/d as recently as 2008 to 1.5 million b/d by December 2017 and is likely to keep falling. Given the uncertain economic and political outlook of Saudi Arabia, the possibility of a prolonged loss of Saudi supply cannot be totally ruled out in the future. A Saudi disruption scenario would be particularly worrisome since it would take out both a large chunk of existing supply and the bulk of the available OPEC spare capacity.

In a way, the risk of severe geopolitical disruption reveals why the SPR is either way too big or way too small in its current form. The SPR need not contain 500–700 million barrels to mitigate a weather-related or other localized disruption of one to two weeks in duration. At the same time, 500–700 million barrels, even in partnership with other IEA countries, may be inadequate to replace the loss of a major oil-producing country or a blockade of the Straits of Hormuz for weeks or months. But while US domestic supply could not be expected to make up for a loss of supply due to political turmoil in a major exporting country, SPR stocks could provide partial relief for a limited period of time to smooth severe and economically harmful price spikes as the market adjusts. The SPR could play a major role in providing a temporary bridge to help the US economy (and other consumer economies) adjust to a new world of lower supplies. In the event of a major supply shock, it would take time for both supply and demand to adjust to the new realities.

RIGHT-SIZING THE SPR

On the face of it, the SPR is both too big and too small. Benchmarked against US net oil imports and in view of rising domestic production, its current size may be deemed excessive by conventional standards. Even to address short-term disruptions in most producer countries or from severe weather events, it need not be as large as it is. That is because the likelihood of large supply disruptions that persist over time is quite low, which is why the Department of Energy's SPR study found diminishing returns to the SPR above roughly 600 million barrels.[85] Compared to the new threats facing the United States and global oil markets, however, it may be seen as insufficient. In the face of a large supply shortfall due to political turmoil in a major producer country, the current SPR would only provide a thin safety cushion. For example, current reserves and drawdown capacity would not be sufficient to make up for a suspension in Saudi oil exports. Combined with drawdowns from Japan, China, and other reserve holders, however, it could still go a long way toward mitigating the scope of economic disruption that would result from such a large-scale event.

Right-sizing the SPR is a tricky exercise. While assessing the costs of the SPR is relatively straightforward, measuring its benefits is more difficult. The deterrent value of the SPR is hard to gauge since the counterfactual cannot be known. The optimal size of the SPR for both deterrent and precautionary purposes is unclear. As explained below in greater detail, past releases show a clear benefit of releasing strategic oil in some cases, as in the IEA coordinated action of September 2005 (where strategic reserves from outside the United States were tapped to make up for hurricane disruption in the US Gulf Coast), and less quantifiable benefits in other cases (as in the IEA collective action of June 2011). To some extent, the problem of assessing the right price to pay for the SPR can be compared to that of pricing an insurance policy. The SPR is, in effect, an insurance policy against so-called fat-tail risks—low-probability, high-impact events affecting global oil supply. The calculation of a risk-appropriate premium depends both on the probability assigned to a potential disruption and on the estimated cost of its consequences. In the case of the SPR, the problem is further complicated by the fact that the policy does not entail a purely financial allocation of capital but also the maintenance of physical stocks. A cost-benefit analysis must thus take into account not only an assessment of financial factors involved but also an evaluation of the market impact of releasing various amounts of stocks under different scenarios.

Not surprisingly, there is no widely accepted scientific methodology for right-sizing the SPR. The current size of the SPR is a result of political compromise more than anything else. The SPR was conceived in the 1970s in an age of oil embargoes and powerful cartels, as well as price controls,[86] export bans, and growing dependence on imported crude oil in the United States. The current capacity of the SPR is more a result of bureaucratic fights and compromises than of any kind of "smart design," and recent calls for right-sizing the reserve—at least in part—reflect a desire to optimize the size of the SPR with robust quantitative methods in light of today's radically altered oil market conditions. While there have been repeated efforts from the beginning to apply formal cost-benefit analysis to the SPR, quantifying the actual net public benefits of the reserve is fraught with challenges and uncertainties.

Elusive Costs and Benefits

The theoretical case for public stockpiling rests on the notion that private companies hold less than optimal levels of petroleum stocks, because they do not bear the full social costs of damaging price spikes and cannot capture the full economic benefits of releasing oil during such events.[87] To put it in another way, private stockholders are not properly compensated for holding enough petroleum stocks to provide adequate insurance to society against economically damaging oil shocks. With the clear presence of a market failure, it is highly plausible that the SPR, indeed, provides net benefits to the public, but quantifying these benefits is not without its challenges.

The analytical tools to estimate the costs and benefits of the SPR underwent significant evolution from the simple two-period models used in the early days[88] to the stochastic dynamic programming models developed in the 1980s[89] to the Monte Carlo simulation models used today.[90] A state-of-the-art cost-benefit model is described in detail in the US Department of Energy's long-term strategic review of the SPR, which was prepared for Congress in August 2016.[91] But even today's more sophisticated tools rely on a number of assumptions that are highly problematic—and subject to a significant degree of uncertainty.

Apart from a few standard assumptions about oil prices, future supply and demand trajectories, discount rates, OPEC spare capacity, and a host of other variables, the most problematic inputs to the DOE's 2016 cost-benefit model[92] include the probability distribution of future oil supply disruptions, the price elasticity of oil demand, and the sensitivity of GDP to oil price increases. Each of these variables is highly uncertain, and our estimates of the costs and benefits of the SPR will greatly depend on the choice of inputs from a wide range of plausible values.

The short-term price elasticity of oil demand determines how much oil prices would increase in response to a supply disruption of a given magnitude. The DOE's cost-benefit model uses an elasticity estimate that changes with the size and duration of the disruption, progressively reducing the oil price impact of supply shocks as the disruption size and duration increases. However, there is a very wide range of estimates in the academic literature (a recent paper by Federal Reserve economists surveyed 30 studies and found that short-run price elasticity of demand estimates fall within the −0.9 to −0.03 range with the majority of estimates falling between −0.3 and −0.1),[93] and given the limited number of empirical observations, our understanding of nonlinear price responses in the event of truly large-scale disruptions is even less comprehensive.

The oil price sensitivity of GDP provides estimates of the economic damage that an oil price spike would inflict (and SPR releases could help avoid), and the numbers used in any model are—once again—necessarily arbitrary, given the wide range of estimates[94] and the possibility of out-of-sample events, which are not captured in empirical studies at all.

Finally, the probability distribution of various types of oil supply disruptions in the DOE model is based on the assessment of an expert panel,[95] and it is revised periodically. This risk assessment focuses solely on geopolitical, military, and terrorism-related disruptions outside the United States (while domestic and weather-related disruptions are specifically excluded

from the analysis). The latest such assessment, for example, estimates that the likelihood of a short-term geopolitical disruption causing a net supply shortfall of more than 5 million b/d at any time over the next 10 years is about 42 percent.[96] The main problem with such expert estimates is that even for short-term horizons, they were proven to be little more accurate than random guessing,[97] and making accurate predictions of political events over long-term horizons is all but impossible.[98] The expert estimates used in the DOE model are made for a period of 10 years, and the probabilities are extrapolated for 25 years into the future.[99]

A further challenge of fully assessing the costs and benefits of the SPR is the fact that some of the benefits of the reserve may be intangible—and thus very difficult to quantify. These may include the deterrence of oil embargos, the incentive to faster deployment of OPEC spare capacity, greater optionality in US foreign policy choices toward oil-rich adversaries, and the added energy security benefits of being part of the IEA's emergency response mechanism, among other things.[100]

While making reasonable—if sometimes arbitrary—assumptions may be necessary for regulatory compliance (to quantify the costs and benefits of federal programs for regulatory impact assessments, for example), the results in the case of the SPR are probably too crude to inform a related decision:[101] optimizing the size of the strategic petroleum reserve.

What's the Right Size for the SPR?

Despite efforts from the start to subject the SPR to formal cost-benefit analysis, its current size is more a result of circumstance than of careful optimization based on economic analysis. The original statute (the Energy Policy and Conservation Act of 1975) called for the establishment of a strategic petroleum reserve of up to one billion barrels, and the detailed implementation plan submitted to Congress in 1976 established interim targets of 150 million barrels by the end of 1978 (Phase I) and 500 million barrels by the end of 1982 (Phase II).[102] Incidentally, the 500-million-barrel medium-term target was roughly equivalent to 90 days of net US imports at the time, the amount prescribed under the IEA's emergency response mechanism.[103] The federal government started acquiring storage sites and filling the reserve in 1977, but crude purchases were soon suspended (with only about 92 million barrels in storage) as oil prices spiked after the Iranian revolution in 1979.[104]

The SPR was subject to fierce bureaucratic battles between the Office of Management and Budget (OMB) and the SPR office (housed within the Federal Energy Administration and later within the Department of Energy) in the early years of the program, as the initial delays and cost overruns prompted repeated attempts by the OMB to limit the size of the SPR.[105] As a result of these early hiccups, President Carter only authorized funds for Phase III of the program, which would take the SPR capacity to 750 million barrels in its 1979 budget plan, and the OMB managed to delay funding for this expansion until 1982.[106]

The SPR only reached its medium-term target of 500 million barrels in 1986 and completed the Phase III expansion of the program in 1991. The Energy Policy Act of 2005 during the administration of George W. Bush directed the DOE to expand the SPR to its congressionally authorized 1 billion barrel capacity, and Bush called for doubling its size to 1.5 billion barrels in his 2007 State of the Union address, but the expansion plan was eventually canceled when

Congress rescinded funding for the SPR expansion in 2011.[107]

Meanwhile, the 750 million barrels of available SPR capacity gradually eroded to 713.5 million barrels today following the decommissioning of two smaller storage sites during the 1990s and the closure of two SPR caverns at the remaining sites in 2014.[108] The amount of oil stored in the SPR reached a peak level of 727 million barrels in December 2009–2011 and remained relatively stable between 690 and 696 million barrels between 2011 and 2016, before being eroded in early 2017 by future sales authorized by Congress.

As the above discussion indicates, the initial stage of SPR development (namely, its expansion to 500 million barrels) was largely guided by IEA requirements. However, the subsequent evolution—and the current size—of the reserve is more a reflection of political compromises and perceptions of import and domestic supply levels than of conscious design. To the extent economic analysis was used in the early debates about the appropriate size of the SPR, its primary purpose was to support the political objectives of one side or the other in the ensuing budgetary battles. Although Congress required the DOE to prepare a comprehensive assessment of SPR costs, benefits, and various size options in 2015,[109] this analysis has hardly informed the more recent proposals to reduce the size of the SPR to as little as 260 million barrels,[110] as the DOE concluded that the government should not reduce the size of the reserve below 530 million barrels without first conducting further in-depth analysis.[111]

That finding was based not on a clear cost-benefit analysis that 530 million barrels was analytically the right volume but rather on the statutory implications of going below 530 million barrels for the president's authority to release the SPR. The DOE during the Obama administration had been resisting further congressional SPR sales by warning that the president's authority to use the SPR would be restricted if it were to drop below 530 million barrels.[112] That is because Section 161(h) of the EPCA allows the SPR to be drawn down for cases other than a severe supply disruption as long as the reserve is not drawn below 500 million barrels. In its modeling, the DOE assumed that the SPR could be drawn down for a 1-million-barrel supply loss when the SPR was greater than 500 million barrels but only for a 2-million-barrel threshold below 500 million barrels. The finding that the SPR should not fall below 530 million barrels (allowing a margin to release up to 30 million while still not falling below the 500 million threshold) is thus a function of how the EPCA is written, not a comparison of costs and benefits of the SPR at different levels.

While it is possible in theory to optimize the size of strategic reserves,[113] it is easy to understand why economic analysis played a relatively limited role in the decisions concerning the size of the SPR over the decades, given the enormous uncertainties around oil prices, elasticities, and disruption probabilities—all key inputs to a sophisticated optimization model. An early version of the stochastic dynamic programming models developed in the 1980s, for example, concluded that the "optimal" size of the SPR could be anywhere between 0.8 and 4.4 billion barrels, depending on the DOE's assumptions.[114] Real-time optimization (in response to sudden oil price changes, for example) is even more challenging, given the logistical, regulatory, and budgetary constraints that limit substantial SPR sales or purchases on short notice.

The truth is that the SPR does not lend itself easily to rigorous cost-benefit analysis and

optimization. From a public policy point of view, the SPR is more akin to an insurance policy, where a fixed payment is made to avoid a small probability of a significant loss in the future.[115] Just like in insurance, the costs of the policy are known and relatively certain, but the benefits only accrue if a loss event actually occurs. The decision of what type of insurance—if any—the United States needs against oil supply disruptions and price shocks should depend entirely on our risk tolerance and preferences as a society and will ultimately have to be a public policy decision.

Moreover, the effectiveness of the SPR depends on far more than simply its size. It needs to have the right mix of crudes and products.[116] It needs to have the necessary infrastructure so that releases can impact the global market.[117] And it needs to have a clearer and more analytically based usage policy. Today, policymakers—often without detailed knowledge of or experience in oil markets and without the ability to consult those with such expertise because of the market-sensitive nature of SPR deliberations—are left to evaluate whether to release the SPR without clear metrics to assess the rationale for a release. The lack of a clear analytical framework also exacerbates the risk that political considerations play an outsized influence in SPR releases.

OPTIMIZING THE SPR

There is a high degree of uncertainty about the ideal size of the SPR, as discussed previously. The cost-benefit analysis depends on a number of assumptions and, importantly, on the level of risk tolerance of the decision makers. If the likelihood of severe oil supply disruptions is lower, then the incremental SPR barrel is less valuable. Just as the risk of Hurricane Sandy is lower than the risk of minor flooding, the question for policymakers is how much "insurance" they want to buy against extreme oil supply disruption events. There is no "right" answer to the question of how big the SPR should be.

The decision of how to size the SPR can also be affected by other considerations such as strategies to reduce the cost of the SPR while simultaneously maximizing its benefits. In other words, the appropriate question for policymakers should not be seen in terms of a binary choice between keeping the SPR whole or reducing it (or eliminating it altogether). The SPR, including both the actual oil reserves and the storage facilities holding them, is a valuable asset. The question should not be whether to keep it or liquidate it but rather how to leverage it more efficiently—and how to make it pay for itself.

Current plans to sell off part of the SPR typically see the reserves as an opportunity cost: the reserves tie up significant amounts of capital (in addition to generating maintenance costs) that could be better used elsewhere. While there is value in stored oil, this view misses the opportunity cost of disposing of the reserves: drawing down the reserves essentially squanders the huge commercial and strategic value of the storage capacity of the SPR caverns. For emerging-market nations currently in the process of establishing their own strategic reserves, building the required storage capacity is a formidable hurdle.

Inventory monetization, joint stockholding, and the internationalization of the US SPR are only a few possible ways in which America could reduce the costs and increase the benefits of its strategic stocks. All require further study beyond the scope of this paper but are worth considering as ways to optimize the SPR's value and lower its costs.

Self-Financing

Stockpiling oil—publicly or privately—is a costly business; the operating costs of SPR facilities alone amounted to about $174 million in 2014, the latest year when detailed accounts of SPR operations are available.[118] Inventory monetization is a relatively simple method to extract value from unused inventories, which is routinely used by private market participants across the oil and gas supply chain. Using a risk-free approach, the federal government could cover the entire operating cost of the current SPR capacity by monetizing a relatively small portion of the crude oil in strategic storage.

Based on the shape of the futures curve in mid-December 2017, the government could lock in a roughly $2.5 per barrel backwardation in the curve a year into the future by selling crude (on paper) in December 2017 at today's higher prices and buying an equivalent amount

for December 2018 at the lower forward price. Subtracting transaction costs and the bid-ask spread that a derivative trader would demand as compensation would still leave the government with more than $2 of net profit on every barrel transacted in this manner.

In the opinion of some oil traders,[119] the federal government could monetize between 50 and 100 million SPR barrels each year without materially impacting market liquidity and compressing 12-month time spreads in the futures market. This would be more than enough to cover the operating and maintenance cost of the SPR.

Joint Stockholding

Japan and South Korea have found innovative ways to manage and reduce the costs of strategic costs: they rent out storage capacity at some of their strategic tank farms at discounted rates to Middle Eastern exporters, in exchange for first drawing rights by the host country in case of emergency. Oil held under joint stockholding agreements can thus be classified as both commercial and strategic storage, offering advantages for both parties.[120]

Kuwait and South Korea signed the first Middle East–Northeast Asia joint stockpiling deal in 2006. Several similar deals have followed, by which the national oil companies of Saudi Arabia, Kuwait, and the UAE have stored crude in South Korea and Japan. In December 2016, India struck a similar agreement with the UAE.

Joint oil stockpiling agreements achieve two objectives simultaneously. On the one hand, net oil-importing countries enhance their respective SPR at low cost by not buying crude oil up front but retaining the preemptive right to purchase it in case of a disruption. On the other hand, oil exporters enjoy free or cheap storage facilities within close proximity to large consuming countries and can take advantage of the flexibility of having short-haul crude on offer to both their term contract clients and to other crude oil refiners that are not term clients. As Tilak Doshi and Sammy Six have noted, "Joint oil stockpiling offers a platform for opportunistic access to Asian spot markets, an important consideration…in the current low oil price environment."[121]

Despite rising domestic crude production, the United States remains a substantial gross importer of crude oil. That is because some of its largest refineries were configured to run relatively heavy sour crude grades for which no equivalent grades are produced domestically on a large enough scale. Gulf Coast refineries import large amounts of heavy and extra-heavy Venezuelan and Mexican crude, as well as medium sour grades from Iraq and Saudi Arabia. Midwestern refineries largely run on Canadian heavy crude oil piped across the border. For the United States, concluding a joint stockpiling agreement with a Middle Eastern exporter would be a break from tradition. Saudi Arabia does, however, have a track record of prepositioning crude oil in Caribbean storage terminals. Given the considerable risks to Venezuelan oil supply today, entering into a joint stockpiling agreement with Saudi Arabia at SPR facilities might make good commercial sense. Striking a mixed commercial-strategic deal for prepositioning of Canadian crude at SPR caverns in the US Gulf might also make sense under the right conditions.

Internationalizing the SPR

While the joint stockpiling agreements signed by Japan, South Korea, and India with Middle Eastern oil exporters offer an interesting model, other innovations may be considered that would expand this model to joint stockpiling between oil importers. For Asian countries, building strategic storage facilities is an expensive proposition and a considerable hurdle to establishing strategic reserves. The United States may consider making its SPR storage capacity and strategic crude stocks available to third countries such as India or ASEAN nations for use in an emergency. If the SPR is to be used to manage price risks rather than to plug a physical hole in US oil supply, then the ownership of the stocks becomes a secondary consideration. Furthermore, if the ultimate beneficiaries of SPR draws are third-party nations (whether directly or indirectly, by redirecting to other countries shipments that would otherwise have been United States bound), then those recipient nations might as well be the original owners of the stocks.

Thanks to rising domestic shale output, the United States is on track to become the world's leading energy superpower in many ways. The US Gulf Coast is already emerging as the world's biggest energy hub supported by a dense network of import and export terminals and associated facilities.[122] In just a few years, the United States has turned from the world's largest importer of refined products to its larger exporter. Crude exports recently reached 2 million b/d. LNG exports are on the rise. Far from making the SPR irrelevant, this growing energy "dominance" provides the United States with the opportunity to turn its SPR into yet another tool of energy influence, at the service of both its commercial reach and its soft power. The globalization of the oil markets, led by the United States, calls for the internationalization of energy security and the globalization of strategic reserves. Thanks to its vast, unmatched SPR storage capacity, the United States is well positioned to support international efforts to stabilize oil markets. Moreover, the United States benefits from this international cooperation through the volumes other nations contribute to smoothing price spikes that US consumers would otherwise face. And the United States benefits from the ability to call on partners' strategic supplies when our own production or infrastructure is disrupted, as seen during Hurricanes Katrina and Rita.

Product Reserves

Unlike most of its IEA partners, the United States holds most of its strategic petroleum reserve in the form of crude oil. Two tiny product reserves, the 2-million-barrel Northeast Home Heating Oil Reserve (NEHHOR) and the 1-million-barrel Northeast Gasoline Supply Reserve (NGSR), were established on the US East Coast in 2000 and 2014, respectively. It has been argued that the United States would benefit from shifting more of its SPR stocks from crude oil to products, as Japan did after the Great Earthquake and Tsunami of 2011 and in line with the prevalent European model of strategic oil reserves.[123] While holding higher product inventories could in theory help it respond swiftly to domestic disruptions (weather-driven or otherwise) and bridge the initial short-term supply gap until market mechanisms correct temporary imbalances, the case for product reserves in the United States is not straightforward.

Holding product inventories for short-term "surgical" stop-gap purposes carries a greater moral hazard risk than carrying crude reserves to address major disruptions. There is a significant risk that industry and market participants would perceive the existence of local government-owned product stocks held for such a specific purpose as relieving them of the responsibility of carrying adequate precautionary stocks. A product reserve would thus in effect simply shift product inventories from the private to the public sector. The reserves would become for all practical purposes a form of subsidy provided to industries at taxpayers' expense without clear public benefit. Product stocks also carry a higher risk of being used for political purposes when politicians are worried about high pump prices, given the more direct, local nature of their impact on gasoline prices.

On a per-barrel basis, holding distributed product reserves would entail much greater costs for the government than holding the current crude SPR in salt caverns. Product stocks would likely have to be held at above-ground tanks leased from storage operators or at government-owned facilities that would have to be constructed for that purpose at great expense. Both the construction costs and the operating costs of a substantial product reserve would considerably exceed the range of current SPR expenditures.

During the energy transition, a complicating factor in holding product stocks would be the uncertain future composition of the demand barrel. The considerable uncertainty that clouds the outlook for oil demand in general is arguably even greater when it comes to the distribution of demand by type of refined products. Although discussions of peak oil demand have so far largely focused on passenger vehicles, those only account for roughly one quarter of global demand (albeit a higher share in the United States). Other sectors of economic activity and types of energy consumption could in fact experience a faster reduction in oil demand than passenger cars. Whether peak demand would likely cause gasoline or diesel consumption to fall first is a matter of speculation. Investments in large inventories of gasoline, jet fuel, marine bunkers, or diesel could end up being misplaced depending on the specific trajectory of demand for those products. The refining system would presumably have more flexibility to address shifts in the composition of the demand barrel than the administration of the SPR. Given the massive refining capacity of the United States and the refining industry's long experience in adjusting product yields to market conditions, managing variances in product demand is presumably best left to market participants. As the world's largest net exporter of refined products, and indeed one of the very few IEA member countries (with the Netherlands, but on much greater scale) to be a large product exporter, the United States would presumably not derive the same benefits from holding its emergency oil stocks in the form of refined products as most of its IEA partners.

Although the Obama administration created a refined product reserve in the Northeast, there was much disagreement within the administration about the merits of product reserves, including for the reasons above. In 2011, the Department of Energy carried out an extensive study of the costs and benefits of building a refined product reserve in the Southeast. This was motivated by several experiences in the last decade when pump prices soared and some localities faced shortages after hurricanes or pipeline outages because the Southeast is dependent on refined product supply from the Gulf Coast transmitted via the Colonial pipeline. A hurricane that wipes out Gulf Coast refining capacity or a pipeline outage can have

severe impacts on the US Southeast. This was evident last year when the Colonial pipeline shut down after Hurricane Harvey. The DOE's 2011 study was never finalized and published, but the draft found the benefits of a refined product reserve would outweigh the costs and that such a reserve would reduce the average gasoline price rise by 50–70 percent in the weeks after a hurricane.[124] In 2015, the DOE again studied the feasibility of a product reserve in the Southeast and West Coast. The DOE again did not finalize the results of that study or publish them. Because consensus could not be reached in the administration, the conclusions were excluded from the DOE's 2016 review of the SPR.[125]

LESSONS LEARNED FROM PAST SPR RELEASES

Evaluating the effectiveness of the SPR requires not only an evaluation of the arguments proffered for and against it but also an actual assessment of the evidence to date with actual uses of the SPR.

US presidents under the Energy Policy and Conservation Act of 1975 have directed three major releases from the SPR to date: during the 1991 Gulf War, during Hurricane Katrina in 2005, and in the aftermath of the Libyan civil war in 2011. Each of these releases took place as part of a coordinated action among IEA member states. Given the lack of counterfactual evidence, it is difficult to evaluate past uses of strategic reserves with any degree of certainty. But to the extent it is possible to draw conclusions from the historical experience, the record of previous SPR releases in terms of timeliness, effectiveness, and overall market impact appears mixed at best.

1991 Desert Storm

The first major SPR release was authorized on January 16, 1991, by President George H. W. Bush on the eve of Operation Desert Storm, the US-led military campaign against Iraq. As part of a coordinated emergency plan adopted under the auspices of the International Energy Agency, IEA member states agreed to make available up to 2.5 million b/d of additional oil to the market for a period of 30 days—2.0 million b/d in the form of releases from strategic stocks and 0.5 million b/d in the form of various demand side measures and fuel switching. Within this framework, the United States agreed to draw down up to 1.125 million b/d—or a total of 33.75 million barrels—from its SPR and ship it to buyers within a 45-day delivery period. The Gulf War ended relatively swiftly, and US bidders ended up buying only 17.3 million barrels—about half the amount offered—from the SPR sale. By the time the last of the SPR shipments were delivered to buyers in April 1991, hostilities had been ended for more than a month.

In the assessment of the US Department of Energy, the "partial drawdown…help[ed] restore stability to world oil markets during the Persian Gulf War."[126] However, some critics of the SPR believe that the 1991 release came much too late and had little actual impact on global oil market dynamics.[127]

The initial oil supply shock that caught markets by surprise—and led to a doubling of oil prices in short order—occurred more than five months before the United States and its partners authorized the release of oil from the SPR. In response to the Iraqi invasion of Kuwait on August 2, 1990, the UN Security Council adopted an immediate trade embargo within days, resulting in a supply disruption of about 4.3 million b/d from Iraq and Kuwait combined.[128] This represented a 7 percent supply loss at the time, and the 1990–1991 episode ranks among the most severe oil supply disruptions to this day.[129] In addition to the physical loss of Iraqi and Kuwaiti crude from the global market, Saddam Hussein's regime also threatened to attack oilfields in Saudi Arabia shortly after the UN embargo.[130]

Oil prices responded sharply to the geopolitical turmoil in the Persian Gulf. WTI prices

averaged $17 in June 1990, the last month before tensions started to flare up,[131] but shot up to $34 in September and $36 in October, before subsiding to $27 by December 1990. Daily spot prices occasionally surpassed $40 as Iraq escalated its threats against Saudi Arabia throughout the crisis. Though the 1990 oil shock was much shorter and much less severe than the oil crises in 1973 and 1979, it nevertheless contributed to a US recession in 1990–1991[132] and weakened economic activity across the OECD.[133]

The primary reason why the oil price spike subsided by the end of 1990 was the ability of Saudi Arabia and other members of OPEC to ramp up production substantially following the deep production cuts of the 1980s. Saudi crude production increased from 5.4 million b/d in July to 8.4 million b/d by December 1990.[134] Other members of OPEC added another 1.5 million b/d of production between July and December 1990, almost completely offsetting the production losses from Iraq and Kuwait.[135] Subdued demand amid a weak global economy also played a role in restoring the market balance in the second half of 1990.[136]

At the same time, the decision whether to release oil from the SPR to mitigate the initial oil supply shortfall in 1990 dragged on for months. The long delay between the actual outage starting in August 1990 and the announcement of the actual release in January 1991 was partly due to the time-consuming process of coordination among IEA member states and in part due to the reluctance of the George H. W. Bush administration to use the SPR solely to mitigate price increases in the absence of actual physical shortages in America.[137] This pattern of delay due to IEA coordination and internal deliberations would repeat itself and undermine the effectiveness of SPR releases. According to one ex-post analysis of the 1990 oil crisis, it became clear only "during the fall of 1990 that in a decontrolled market, physical shortages are less likely to occur," and the "expression of supply shortages comes in the form of higher prices" instead.[138] Other contemporary arguments against an SPR release emphasized the need to preserve the SPR for a potentially longer and bigger supply disruption and the ability of OPEC to make up for the shortfall thanks to its vast spare capacity at the time.[139]

The immediate price response to the announcement of the SPR release appears very sharp; WTI prices dropped more than $10 (from $32 to $21) in a single day following the announcement and remained relatively stable in the $20–$25 range throughout the US-led military campaign.[140] While the announcement probably had an initial psychological effect, contemporary commentators attributed the sharp oil price drop in late January 1991 to other factors—namely, to "optimistic reports about the allied forces' crippling of Iraqi air power and the diminished likelihood, despite the outbreak of war, of further jeopardy to world oil supply."[141] A recent simulation by Newell and Prest indicates that the 1991 SPR release led to a statistically significant—albeit short-term—reduction in prices and backwardation. However, the authors note that it is difficult to distinguish the oil market impact of the actual SPR release from that of the swift end to the Gulf War.[142]

The overall assessment of the 1991 SPR release is mixed. The decision to use strategic reserves came months after a severe initial oil supply shortfall and price spike, at a time when additional supply from OPEC had already replaced the missing barrels in full. The relatively subdued demand for SPR barrels indicates that there was no physical shortage of crude oil at any point during the US-led war against Iraq. By the time the last of the SPR shipments was delivered

to US buyers, the Gulf War had been over for weeks. The observed price impact immediately after the release was significant, but it is hard to attribute the January 1990 price drop solely to the SPR release, as the quick conclusion of the war could soon have pushed prices down to prewar levels even in the absence of an SPR release. If the Bush administration wanted to avert a damaging price spike and a prolonged recession in 1990, then an SPR announcement could have been much more effective in August 1990 during the early days of the crisis.[143]

2005 Hurricane Katrina

The second presidentially directed SPR release took place in the aftermath of Hurricane Katrina in September 2005. Hurricane Katrina swept through the Gulf of Mexico and the US Gulf Coast in late August 2005 and caused extensive damage to offshore oil and gas facilities, oil storage terminals, pipelines, refineries, and electricity networks. In the immediate aftermath of Katrina, almost the entire 1.5 million b/d of oil production remained shut down in the US Gulf of Mexico, which accounted for 28 percent of US production at the time.[144] More importantly, the hurricane also disrupted 2.5 million b/d of refining capacity along the US Gulf Coast (14 percent of the total),[145] and a number of key crude and product pipelines, including the Colonial system,[146] which supplies much of the US East Coast with refined petroleum products.[147] Gasoline prices spiked within days of the landfall, and in some regions along the Atlantic Coast, pump prices increased by as much as 60–70 cents per gallon (or about 25 percent).[148]

Oil prices were already on an upward trajectory during much of 2005, so the oil price response was somewhat muted during Katrina. WTI prices averaged $59 in the month before the hurricane hit the US Gulf Coast and $65 on the week before the August 29 landfall in Louisiana. WTI prices briefly touched $70 in the days after the devastation but quickly returned to the $63–$66 range in the weeks after the disaster and below $60 by November 2005.

This time, the administration of President George W. Bush responded very quickly to the disruption. Within 24 hours of Hurricane Katrina's landfall, the Department of Energy approved emergency oil loans (which are repayable in kind) totaling 9.8 million barrels to refineries whose crude supply had been disrupted.[149] In addition to the emergency loans, President George W. Bush authorized a formal SPR drawdown on September 2, only four days after the landfall. On September 6 the US Department of Energy offered 30 million barrels of SPR crude for sale, of which 11 million barrels were eventually purchased by buyers. Together with the emergency loans, the SPR released 20.8 million barrels during this episode.

The SPR release was once again part of a coordinated emergency response with the IEA. The organization, as a whole, agreed to make up to 60 million barrels of oil available to the market (inclusive of the 30 million barrels of crude offered from the US SPR), in the form of both crude oil and refined products. Other IEA member states eventually sold 8.8 million barrels of crude oil and 18.5 million barrels of refined products, much of which ended up in the US East Coast.[150] Much of the IEA-released product stocks ended up in the US East Coast, where a large proportion of the fuel supply normally comes from Gulf Coast refineries.[151]

Of the three presidentially directed SPR releases analyzed here, the 2005 SPR sale is generally considered the most successful. The response to the disruption came quickly and in full coordination with the IEA, which proved critical in meeting looming fuel shortages in the US

East Coast in particular. The crude and product volumes that were released as part of the 2005 sale started to hit the market in late September, around the same time when Hurricane Rita once again disrupted the oil supply infrastructure along the Gulf Coast on a scale similar to Katrina. Perhaps thanks to the well-timed intervention, Hurricane Rita had no discernible impact on the oil price, and the gasoline price spikes were much more muted than during Katrina even in the most vulnerable areas on the US East Coast.

At the same time, the 2005 release also highlighted some of the shortcomings and vulnerabilities of the SPR itself. Crude oil proved less useful than refined products in an emergency where refineries and product pipelines are also disrupted. As one ex-post analysis put it, "If the SPR system contained petroleum products, in addition to crude oil, it is likely that the subsequent increase of petroleum product prices would have been much smaller."[152] Due to the concentration of the SPR sites along the hurricane-prone Gulf Coast region, the SPR itself turned out to be vulnerable to weather damage. Two of four SPR sites were shut down for extensive periods due to flooding and power outages during both Katrina and Rita, though this did not prevent the DOE from proceeding with the scheduled SPR sales, as some SPR sites remained operational during both major hurricanes.[153] The 2005 release also underlined the importance of international cooperation and the energy security benefits of participating in the IEA's emergency response mechanism.

2011 Libyan Civil War

The third major SPR release was authorized by President Obama in June 2011 in response to the oil supply disruptions following the Libyan civil war. By February 2011, the Arab Spring revolutions reached Libya, a major oil producer in North Africa with a total production of about 1.6 million b/d before the uprising. As the country descended into a bloody civil war and NATO launched air strikes against the Qadhafi regime, Libya's crude production dropped to around 0.2 million b/d by April and to close to zero by the summer of 2011.

The vast majority of Libya's crude output was of light sweet quality, and prior to the civil war, Libya had been one of the main providers of this high-quality crude oil to Southern European refineries, notably in Italy and Greece. When Libya's production collapsed in 2011, those refineries found it prohibitively expensive to replace Libyan barrels with heavier, higher-sulfur grades that were available from other suppliers at the time.[154] As a consequence of the Libyan production outage, the price of Brent—another light sweet grade—rose especially steeply, from an average of $104 in February to $123 in April. At the same time, light-heavy spreads widened considerably, and the futures curve shifted into a steepening backwardation, indicating that market participants perceived a temporary supply shock to the system.

A US diplomatic push for a coordinated release of strategic stocks started in March 2011, but the lack of consensus among IEA member states on the need for an emergency response prolonged the negotiating process by months. The IEA ultimately justified the coordinated action on the grounds that it could help mitigate damaging oil price spikes in the second half of 2011. Of particular concern was the possibility of further market tightening and price increases in the third quarter of 2011, once refineries returned from seasonal maintenance and demand picked up during the summer driving season.[155] The failure of OPEC to agree

on a production hike at the organization's quarterly meeting in early June provided further ammunition to the IEA to justify a market intervention,[156] even though Saudi Arabia had decided days after the failed OPEC meeting to unilaterally raise production by 0.7 million b/d to 10 million b/d by July 2011.[157]

In a format similar to prior coordinated actions, the IEA announced on June 23, 2011, that the organization would release a total of 60 million barrels of crude oil and refined products, of which 30 million barrels would be offered for sale from the US SPR. On the same day, President Obama directed a drawdown of the SPR,[158] and the DOE offered 30 million barrels of light sweet crude to prospective buyers. Contrary to previous SPR sales, this release was oversubscribed, and the DOE eventually accepted bids for a total of 30.64 million barrels.[159] Deliveries were completed by the end of August 2011. The sale of the other 30 million barrels offered by IEA partners turned out to be less successful. By one estimate, only about 8 million barrels of crude oil and refined products from IEA stocks were eventually sold, mainly because two-thirds of the IEA barrels were made available via reduced stockholding requirements for industry participants with no obligation to actually sell industry stocks.[160]

The assessment of the effectiveness of the 2011 SPR release is, once again, mixed. The immediate effect of the announcement in June on spot and long-dated futures prices was measurable but very short lived. Brent prices dropped from $114 to $105 within two days following the announcement of the release on June 23, but prices were back above $110 in less than a week and soon increased further, at times approaching $120 by in early July.[161] The impact on long-dated futures prices was similarly transient. The price drop lasted merely a week on the far end of the futures curve before long-term prices returned—and then exceeded—pre-announcement levels.[162] The slight moderation of Brent prices in the second half of 2011 (from an average of $117 in Q2 2011 to $113 in Q3 and $109 in Q4) could, in theory, be construed as a result of the coordinated SPR release. But in reality, this downward shift of Brent prices was more likely driven by other dynamics, notably an increase in Saudi production, the partial return of Libyan barrels to the market, and lower demand expectations amid concerns about the health of the global economy. Even the IEA's own assessment attributed merely a short-term market impact to the coordinated release, which, according to IEA deputy executive director Richard Jones, "played at least a partial role in helping avoid a damaging price spike during summer 2011."[163]

The measure had a somewhat more lasting effect in tightening light-heavy price spreads and relieving the actual light sweet crude shortage in the European refining system for several months. Ex-post analyses indicate that most of the light sweet crude that was released from the US SPR was not merely transferred to private storage. Instead, the SPR crude was primarily taken by domestic refiners in the United States, while American light sweet crude imports (mainly from West Africa) were displaced from the domestic system and redirected to Europe.[164]

While the release of light sweet crude oil from the US SPR appears to have been at least moderately successful in preventing more damaging oil price spikes and throwing a lifeline to struggling refiners in Europe,[165] the actions taken by other IEA members had little discernible impact on the market. As discussed previously, about two-thirds of the oil that other IEA

members made available came in the form of reduced stockholding obligations of refined products.[166] European refineries were thus allowed to sell some of their mandated stocks in the open market, but they were highly reluctant to release more products at a time when refining margins were already depressed and fuel demand was chronically weak due to the unfolding euro crisis.[167]

In some regards, the lessons from the 2011 release are the exact opposite of those from 2005. During Hurricanes Katrina and Rita, US crude from the SPR proved of relatively little value, as refineries and pipelines were also disrupted along the US Gulf Coast. The main bottleneck was refined product supply along the East Coast, and product stocks released by IEA partners played a key role in addressing these shortages. During the Libyan civil war in 2011, the primary shortage was in light sweet crude, which the US SPR was well positioned to replace, while the IEA product stocks that were made available as part of the release in addition to light sweet crude were of little use for market participants.[168]

The Libyan experience is also instructive of another benefit the SPR offers. Because the Obama administration pushed the IEA to use the SPR, despite other IEA countries' reluctance, in a situation in which its necessity and impact were highly debated, the market perceived that the Obama administration may be "trigger happy" when it came to the SPR. The Obama administration saw little reason to dispel this perception. Indeed, the following summer in 2012—an election year—many analysts were led to believe that the United States might release oil from the SPR if prices broke $120 per barrel. In the summer of 2012, both the G-20 and the G-7 issued statements, which signaled that they might tap strategic stocks if necessary.[169] Policymakers sent numerous other signals to this effect, as well, such as the reported conversation in March 2012 between President Obama and UK prime minister David Cameron about using oil stocks.[170] This experience demonstrates how the very existence of the SPR and perceptions about its potential use can affect prices by tempering the enthusiasm of some market participants to take long positions in the oil market.[171] And the impact of those perceptions and how they could be shaped by subtle signals from the administration is something policymakers are well aware of.

Taken together, the experience with these three SPR releases is mixed. But a lesson that comes across clearly from all is that in order to be effective, SPR releases should be rapid, and the mix of petroleum released should be targeted to the nature of the disruption. Speed requires ongoing collaboration and exercises among IEA and non-IEA members, as well as a shared understanding of the SPR's purpose. It also requires building expertise in oil markets within the administration.

CONCLUSION

Sweeping changes in the US and global oil markets call for a reexamination of the US Strategic Petroleum Reserve, an institution born of the first oil shock of 1973, which was rooted in a vastly different oil market than today's. So far, the policy debate around the SPR has been narrowly limited, yet far-reaching decisions have already been taken to sell off much of the reserve over a 10-year period.

These decisions are shortsighted and could prove detrimental to US interests and the global economy. They are based on the expectation of continued increases in US oil supply, a commonly held view that extrapolates from recent trends but that remains uncertain. They ignore the significant increases in supply risks facing both US and global markets. Those include, but are not limited to, political turmoil or state collapse in major oil producing nations; the increasing likelihood of catastrophic extreme-weather events capable of crippling production in the United States and elsewhere; and the potential for a disorderly energy transition away from oil, if concerns over stranded assets and peak demand lead to underinvestment in production capacity, supply shortfalls, and disruptive price spikes.

While US net crude import requirements have been declining, the SPR remains a useful buffer. Although this was not the intent of its founders, the SPR holds great promise as an energy-transition resource to help smooth out a potentially bumpy decarbonization path and cushion against extreme weather events, the likelihood of which will only rise due to global climate change. Its vast caverns and the stocks held in them constitute a highly valuable asset that ought not to be squandered. They could be used as an economic tool to help manage oil price shocks and as a tool of energy diplomacy to exercise soft power and project international influence. The SPR is as unique and distinctive of the United States as the strength and agility of its shale industry.

Assessing the right size of the US SPR is, in some ways, an impossible task. Although many think of it as too large when measured against the conventional benchmark of US net import requirements, it could equally be described as too small compared to the scope of the emerging threats facing the US and global oil markets. While the opportunity cost of holding SPR barrels is high, the question of the right size of the SPR would be less important if the costs of maintaining it could be significantly reduced.

Rather than focusing on monetizing the strategic reserve, a one-time gain offset by the cost of squandering the storage asset represented by the SPR sites, policymakers should concentrate instead on ways to make more out of the SPR and better leverage this highly valuable asset. Since the 1973 oil shock that led to its creation, US and global oil markets have become deeper and broader, more global, and more sophisticated. These changes in market conditions do not call for the liquidation of the SPR but rather for improvements in SPR management. Policymakers ought to focus on ways to manage the SPR efficiently, minimize its operating costs, and enhance its value as a tool of international cooperation and instrument of soft power.

Several pathways to enhance SPR management ought to be explored. The entire SPR maintenance and operational budget could be self-financed by the monetization of SPR inventories through simple management techniques familiar to oil traders and commercial operators. Additionally, the United States may consider entering into joint stockpiling agreements with oil exporters from the Middle East and elsewhere. Finally, the United States could consider leasing SPR storage capacity to major oil-importing countries such as India or ASEAN nations, many of which have been slow to build their own reserves due to the high initial cost of building storage capacity.

To be effective, the US government should develop an SPR policy that articulates its philosophy around the use of the SPR—what risks the SPR is aimed at addressing and what metrics the government should consider when determining whether to release stocks. This may reasonably change from administration to administration, to a degree, and each new administration should undertake the exercise. Ideally this should be publicly communicated, although there may be arguments for leaving markets and other producer countries uncertain about an administration's strategy of SPR use. Even if not articulated publicly, it should be openly and directly discussed with other IEA members to build shared understanding of the value and purpose of strategic crude and product stocks and thus allow for swifter action than we have seen in the past to respond to disruptions. The speed of SPR actions is perhaps the best indicator of the effectiveness of a release.

Oil supply disruptions lead to economic harms, the social costs of which no individual oil firm has an incentive to safeguard against. Thus, a market failure exists that justifies the role of government in offsetting supply disruptions. Ultimately, the question facing policymakers is this: Would the one-off proceeds from SPR oil sales and the associated cuts in maintenance and capital costs more than offset the heightened risk exposure of reducing or eliminating the SPR? And how might that tradeoff look different if better management could trim the SPR's already low operating costs? While the answers to those questions may not all be straightforward, certainly neither is the case for liquidating the reserve. Given the level of ambiguity about future oil market trends, the changing nature of supply risks to the oil market, and the risk of increased volatility in a period of a highly uncertain energy transition, policymakers would be well advised to proceed with caution rather than sell off the nation's oil security arsenal.

APPENDIX

The Energy Policy and Conservation Act of 1975 (EPCA) defines the circumstances under which the SPR may be used.[172] Generally, there are three possible types of drawdowns envisaged in the EPCA:

- Full drawdown: Section 161(d) of the EPCA provides the president with full drawdown authority to respond to a "severe energy supply interruption" or to meet US obligations toward the IEA.
- Limited drawdown: Section 161(h) of the EPCA grants the president limited drawdown authority to prevent or address a less severe "domestic or international energy supply shortage" that is nevertheless "of significant scope or duration." This authority is limited to a release of no more than 30 million barrels for a maximum of 60 days, and it is subject to a requirement of keeping at least 500 million barrels in the SPR.
- Test sale or exchange: Section 161(g) of the EPCA provides authority to the secretary of energy to conduct a test sale or exchange as part of the continuing evaluation of drawdown and sales procedures. This authority is limited to a release of no more than 5 million barrels.

NOTES

1. Zain Shauk, "Chevron CEO Says $100 a Barrel Is the New $20," FuelFix, March 4, 2014, https://fuelfix.com/blog/2014/03/04/chevron-ceo-says-100-a-barrel-is-the-new-20/.
2. Jacob Gronholt-Pedersen, "Lost Decade in Oil Industry Reinforces 'Lower for Longer' Prices: Goldman Sachs," Reuters, August 6, 2015, https://www.reuters.com/article/us-market-oil-goldman/lost-decade-in-oil-industry-reinforces-lower-for-longer-prices-goldman-sachs-idUSKCN0QB0OQ20150806.
3. US Government Accountability Office, "Strategic Petroleum Reserve: Preliminary Observations on the Emergency Oil Stockpile," November 2, 2017, pp.4–5, https://www.gao.gov/assets/690/688104.pdf.
4. US Energy Information Administration, "Strategic Petroleum Reserve Sales Expected to Start This Month," January 26, 2017, https://www.eia.gov/todayinenergy/detail.php?id=29692.
5. "An Act to Provide for Reconciliation Pursuant to Titles II and V of the Concurrent Resolution on the Budget for Fiscal Year 2018," H.R. 1, Section 20003, 115th Cong. (2017). Also see Timothy Gardner, "Drilling in Alaska Refuge Likelier as Senate Clears Tax Bill," Reuters, December 2, 2017, https://www.reuters.com/article/us-usa-alaska-oil/drilling-in-alaska-refuge-likelier-as-senate-clears-tax-bill-idUSKBN1DW0KH; and Brian Dabbs, "Congress Drills for More Revenue in Petroleum Reserve," National Journal, November 30, 2017, http://energypolicy.columbia.edu/sites/default/files/pictures/Congress%20Drills%20for%20More%20Revenue%20in%20Petroleum%20Reserve.pdf.
6. "Bipartisan Budget Act of 2018," H.R. 1892, Section 30204 (a) (1), 115th Cong. (2018).
7. US Energy Information Administration, "Recent Legislation Mandates Additional Sales of U.S. Strategic Petroleum Reserve Crude Oil," February 21, 2018, https://www.eia.gov/todayinenergy/detail.php?id=29692https://www.eia.gov/todayinenergy/detail.php?id=35032.
8. Meng Meng and Ryan Woo, "China Accelerates Stockpiling of State Oil Reserves over 2016/17," Reuters, December 29, 2017, https://www.reuters.com/article/china-crude-reserves/update-2-china-accelerates-stockpiling-of-state-oil-reserves-over-2016-17-idUSL4N1OT2HF.
9. International Energy Agency, "Oil 2017," 2017, pp.125–126.
10. International Energy Agency, "Energy Supply Security 2014: Emergency Response of IEA Countries," 2014, pp.509.
11. See, for example, US Energy Information Administration, "Annual Energy Outlook 2018," February 6, 2018, pp.53, https://www.eia.gov/outlooks/aeo/pdf/AEO2018.pdf.

12. US Department of Energy, "Strategic Petroleum Reserve Annual Report for Calendar Year 2014," Report to Congress, December 2016, pp.30, https://energy.gov/sites/prod/files/2017/02/f34/2014%20SPR%20Annual%20Report.pdf.

13. Jason Bordoff, "Testimony before the Senate Committee on Energy and Natural Resources," October 6, 2015, https://www.energy.senate.gov/public/index.cfm/files/serve?File_id=6ffc0bd9-49b8-485d-b961-439ac6b38bd2.

14. Calls for the establishment of strategic products reserves constitute a notable exception. One of the latest such appeals is Phillip Cornell, "Strategic Oil Product Stockholding: International Experience and American Prospects," Atlantic Council, March 2018, http://www.atlanticcouncil.org/images/Strategic_Stockholding__web_031218.pdf.

15. Daniel Yergin, The Prize: The Epic Quest for Oil, Money, and Power (New York: Simon & Schuster, 1991), pp.548.

16. "Man-Made Fuel Crisis," New York Times, October 2, 1970, https://www.nytimes.com/1970/10/02/archives/manmade-fuel-crisis.html.

17. Robert McNally, Crude Volatility: The History and the Future of Boom-Bust Oil Prices (New York: Columbia University Press, 2017), pp.105.

18. Yergin, The Prize, pp.549.

19. Jason Bordoff and Trevor Houser, "Navigating the U.S. Oil Export Debate," Center on Global Energy Policy, January 2015, pp.11, http://energypolicy.columbia.edu/sites/default/files/Navigating%20the%20US%20Oil%20Export%20Debate_January%202015.pdf.

20. Yergin, The Prize, pp.572.

21. Ibid., pp.586.

22. Bruce Riedel, Kings and Presidents: Saudi Arabia and the United States Since FDR (Washington, DC: Brookings Institution Press, 2017), pp.51.

23. Yergin, *The Prize*, pp.607–608.

24. Ibid., pp.613.

25. The IEA is an international energy forum established in 1974 to help its member states respond to major oil supply disruptions. Its original 16 founding members included Austria, Belgium, Canada, Denmark, Germany, Ireland, Italy, Japan, Luxembourg, the Netherlands, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. Norway has participated in the work of the IEA under a special agreement since 1974. The IEA currently has 30 member nations, including Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. Chile is a candidate country. IEA member states are committed to

holding reserves of oil or refined products equaling 90 days of net petroleum imports and to release these reserves, utilize demand restraint measures, and participate in the allocation of oil deliveries among IEA countries in the event of oil supply disruptions. Source: US Government Accountability Office, "Strategic Petroleum Reserve: Preliminary Observations," pp.2.

26. International Energy Agency, "Agreement on an International Energy Program," amended February 17, 2018, pp.5, http://www.iea.org/media/about/iep.pdf.

27. US Government Accountability Office, "Strategic Petroleum Reserve: Preliminary Observations," pp.5.

28. In 1996, the Department of Energy unexpectedly decommissioned the Weeks Island SPR site, which had fractured and was in imminent danger of collapse. See US Senate, Committee on Governmental Affairs, Permanent Subcommittee on Investigations, "U.S. Strategic Petroleum Reserve: Recent Policy Has Increased Costs to Consumers but Not Overall U.S. Energy Security," 108th Cong., 1st Session, March 5, 2003, pp.13, https://www.hsgac.senate.gov/imo/media/doc/REPORT%20-%20U.S.%20Strategic%20Petroleium%20Reserve%20(March%202003).pdf.

29. Chris Baltimore and Tom Doggett, "Bush Wants to Double U.S. Emergency Oil Stockpile," Reuters, January 23, 2007, https://www.reuters.com/article/us-energy-usa-spr/bush-wants-to-double-u-s-emergency-oil-stockpile-idUSN2328108920070124.

30. US Department of Energy, "SPR Quick Facts and FAQs," accessed on May 1, 2018, https://energy.gov/fe/services/petroleum-reserves/strategic-petroleum-reserve/spr-quick-facts-and-faqs#Q7.

31. In addition to the SPR, the US government maintains emergency reserves of 1 million barrels of heating oil and 1 million barrels of gasoline, both located in the Northeast. These reserves were set up by the US Department of Energy in the aftermath of Hurricane Sandy in 2012 and are managed by the DOE's Office of Petroleum Reserves alongside the SPR. For further details, see https://energy.gov/fe/services/petroleum-reserves.

32. US Government Accountability Office, "Strategic Petroleum Reserve: Preliminary Observations," pp.4–5.

33. US Energy Information Administration, "Recent Legislation."

34. US Energy Information Administration, "Strategic Petroleum Reserve Sales."

35. "An Act to Provide for Reconciliation," H.R. 1, Section 20003, 115th Cong. (2017); Gardner, "Drilling in Alaska"; and Brian Dabbs, "Congress Drills."

36. "Bipartisan Budget Act of 2018," H.R. 1892, Section 30204 (a) (1), 115th Cong. (2018).

37. US Energy Information Administration, "Recent Legislation."

38. John Kemp, "U.S. SPR Oil Sale Before Strategic Review Would Be a Mistake," Reuters, July

27, 2015, https://www.reuters.com/article/us-usa-spr-review-kemp/u-s-spr-oil-sale-before-strategic-review-would-be-a-mistake-kemp-idUSKCN0PY25C20150727.

39. International Energy Agency, "World Energy Outlook 2017," November 14, 2017, pp.193–194.

40. US Energy Information Administration, "Annual Energy Outlook 2018," pp.53.

41. Additionally, the United States must be able to contribute to an IEA collective stock action—either through stock release or demand restraint—based on its share of oil consumption. As of November 2017, the United States must be prepared to contribute 44 percent of the barrels released in an IEA coordinated response. See US Department of Energy, "Long-Term Strategic Review of the U.S. Strategic Petroleum Reserve," Report to Congress, August 2016, pp.7, https://energy.gov/sites/prod/files/2016/09/f33/Long-Term%20Strategic%20Review%20of%20the%20U.%20S.%20Strategic%20Petroleum%20Reserve%20Report%20to%20Congress_0.pdf.

42. Austan D. Goolsbee, "There's Too Much Crude in the Strategic Petroleum Reserve," Wall Street Journal, April 10, 2012, https://www.wsj.com/articles/SB10001424052702303772904577733537270836459 2.

43. Matt Egan, "Trump Wants to Sell Half of Emergency US Oil Reserve," CNN Money, May 23, 2017, http://money.cnn.com/2017/05/23/investing/strategic-petroleum-reserve-trump-budget-us-emergency-oil/index.html.

44. White House Office of Management and Budget, "The Budget for Fiscal Year 2018: Department of Energy," March 23, 2017, pp.388, https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/budget/fy2018/doe.pdf. Also see White House Office of Management and Budget, "2018 Major Savings and Reforms," May 23, 2017, pp.133, http://www.whitehouse.gov/sites/whitehouse.gov/files/omb/budget/fy2018/msar.pdf.

45. Ed Morse, "US Set to Become Swing Oil Supplier," Financial Times, February 14, 2018, https://www.ft.com/content/49354866-117d-11e8-8cb6-b9ccc4c4dbbb. Also see Jim Krane and Mark Agerton, "OPEC Imposes 'Swing Producer' Role upon U.S. Shale: Evidence and Implications," International Association for Energy Economics, Third Quarter 2015, pp.17–20, https://www.bakerinstitute.org/media/files/files/c9c84c75/CES-Krane-Agerton-2015EnergyForum3qtr.pdf.

46. Spencer Dale and Bassam Fattouh, "Peak Oil Demand and Long-Run Prices," Oxford Institute for Energy Studies, January 2018, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2018/01/Peak-Oil-Demand-and-Long-Run-Oil-Prices-Insight-25.pdf. Also see International Energy Agency, "World Energy Outlook 2017," pp.94–95.

47. Ron Bousso and Karolin Schaps, "Shell Sees Oil Demand Peaking by Late 2020s as Electric Car Sales Grow," Reuters, July 27, 2017, https://www.reuters.com/article/us-oil-demand-shell/shell-sees-oil-demand-peaking-by-late-2020s-as-electric-car-sales-grow-idUSKBN1AC1MG.

48. Alex Longley, "BofA Sees Oil Demand Peaking by 2030 as Electric Vehicles Boom,"

Bloomberg, January 22, 2018, https://www.bloomberg.com/news/articles/2018-01-22/bofa-sees-oil-demand-peaking-by-2030-as-electric-vehicles-boom.

49. Christopher Brognaux, Eric Boudier, Esben Hegnsholt, and Anders Porsborg-Smith, "The Multiple Paths to Peak Oil Demand," Boston Consulting Group, July 21, 2017, https://www.bcg.com/publications/2017/energy-environment-upstream-oil-gas-multiple-paths-peak-oil-demand.aspx.

50. Dale and Fattouh, "Peak Oil Demand,"pp. 6–7.

51. James Arbib and Tony Seba, "Rethinking Transportation 2020–2030: The Disruption of Transportation and the Collapse of the Internal-Combustion Vehicle and Oil Industries," RethinkX, May 2017, https://static1.squarespace.com/static/585c3439be65942f022bbf9b/t/59f279b3652deaab9520fba6/1509063126843/RethinkX+Report_102517.pdf.

52. Mark Carney, "Breaking the Tragedy of the Horizon: Climate Change and Financial Stability," Speech given at Lloyd's of London, Bank of England, September 29, 2015, https://www.bankofengland.co.uk/-/media/boe/files/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability.pdf?la=en&hash=7C67E785651862457D99511147C7424FF5EA0C1A.

53. Jason Bordoff, "Political, Economic Responses to High Oil Price No Longer in Lockstep," The Hill, April 25, 2018, http://thehill.com/opinion/energy-environment/384802-political-economic-responses-to-high-oil-price-no-longer-in.

54. Henry Kissinger, "The Energy Crisis: Strategy for Cooperative Action," in The Arab Oil Weapon, eds. Jordon J. Paust and Albert P. Blaustein (New York: Oceana Publications and Leiden: A. W. Sijthoff, 1977), pp.196–197.

55. Ibid., pp.200–201.

56. Michelle Billig Patron and David L. Goldwyn, "Managing Strategic Reserves," in Energy and Security: Strategies for a World in Transition, 2nd edition, eds. Jan H. Kalicki and David L. Goldwyn (Washington, DC: Woodrow Wilson Center Press, 2013), pp.464–482.

57. Ewen MacAskill and Terry Macalister, "Saddam Chokes Off Oil to Put Pressure on West," Guardian, April 9, 2002, https://www.theguardian.com/world/2002/apr/09/iraq.oil.

58. The White House, "President Bush Meets with the Crown Prince of Saudi Arabia," April 25, 2002, https://georgewbush-whitehouse.archives.gov/news/releases/2002/04/20020425-4.html.

59. Bordoff and Houser, "Navigating," pp.47.

60. Jason Bordoff, "The Strategic Petroleum Reserve: A Policy Response to Oil Price Volatility?," Council on Foreign Relations, June 15, 2016, https://www.cfr.org/blog/strategic-petroleum-reserve-policy-response-oil-price-volatility.

61. Richard Newell and Brian Prest, "Informing SPR Policy through Oil Futures and Inventory

Dynamics," Resources for the Future, November 2, 2017, http://www.rff.org/files/document/file/RFF%20WP-17-19.pdf.

62. US Council of Economic Advisers, Economic Report of the President 2016, US Government Publishing Office, February 2016, pp.55–58, https://obamawhitehouse.archives.gov/sites/default/files/docs/ERP_2016_Book_Complete%20JA.pdf.

63. Christiane Baumeister and Lutz Kilian, "Lower Oil Prices and the U.S. Economy: Is This Time Different?," Brookings Papers on Economic Activity, Fall 2016, https://www.brookings.edu/wp-content/uploads/2016/09/5_baumeisterkilian.pdf.

64. Zoheir Ebrahim, Oliver Inderwildi, and David King, "Macroeconomic Impacts of Oil Price Volatility: Mitigation and Resilience," Frontiers in Energy, vol. 8, issue 1 (2014), pp.5–9, https://link.springer.com/article/10.1007/s11708-014-0303-0.

65. See, for example, Carmine Difiglio, "Oil, Economic Growth and Strategic Petroleum Stocks," Energy Strategy Reviews, vol. 5 (2014), pp.55, https://ac.els-cdn.com/S2211467X14000443/1-s2.0-S2211467X14000443-main.pdf?_tid=da700be4-df60-11e7-bc48-00000aab0f01&acdnat=1513099453_a62d4dbb75178b3199ea5ab2af53abbc. Also see Jason Bordoff, "Why the U.S. Shouldn't Sell Off the Strategic Petroleum Reserve," Wall Street Journal, November 13, 2017, https://blogs.wsj.com/experts/2017/11/13/why-the-u-s-shouldnt-sell-off-the-strategic-petroleum-reserve/.

66. Alan Greenspan, "OPEC Has Ceded to the US Its Power over Oil Price," Financial Times, February 19, 2015, https://www.ft.com/content/92ab80e4-b827-11e4-b6a5-00144feab7de.

67. US Energy Information Administration, "What Drives Crude Oil Prices: Supply OPEC," accessed on May 1, 2018, https://www.eia.gov/finance/markets/crudeoil/supply-opec.php. However, in June 2015, the International Energy Agency loosened its own definition of OPEC spare capacity from capacity that can be reached "within 30 days and sustained for 90 days" to capacity available "within 90 days and sustained for an extended period." The change was thought to better reflect the reality of operational constraints and unavoidable lags on the field. International Energy Agency, Oil Market Report, June 11, 2015, pp.17.

68. International Energy Agency, "World Energy Outlook 2017," pp.26.

69. Ed Crooks, "A Lasting Oil Alliance," Financial Times, January 25, 2018.

70. Marianne Kah, "Uncertainties in Forecasting US Tight Oil Production," Center on Global Energy Policy, January 25, 2018, http://energypolicy.columbia.edu/sites/default/files/pictures/CGEP_Uncertainties%20in%20Forecasting%20US%20Tight%20Oil%20Production_0.pdf.

71. See, for example, Frank Newport, "Americans Tilt toward Protecting Environment, Alternative Fuels," Gallup, March 15, 2017, http://news.gallup.com/poll/206159/americans-tilt-toward-protecting-environment-alternative-fuels.aspx; also see Gallup News, "Topics A to Z: Energy," accessed on May 1, 2018, http://news.gallup.com/poll/2167/energy.aspx.

72. Daniel Raimi, The Fracking Debate: The Risks, Benefits, and Uncertainties of the Shale Revolution (New York: Columbia University Press, 2017).

73. John Hurdle, "With Governor's Signature, Maryland Becomes Third State to Ban Fracking," StateImpact Pennsylvania, April 4, 2017, https://stateimpact.npr.org/pennsylvania/2017/04/04/with-governors-signature-maryland-becomes-third-state-to-ban-fracking/.

74. David Wethe, "A New Breed of Fracking Quakes Emerges," Bloomberg, February 9, 2018, https://www.bloomberg.com/news/articles/2018-02-09/new-breed-of-fracking-earthquakes-sends-warning-to-oil-drillers.

75. Liz Hampton, "Oklahoma Regulator Issues New Directive to Curb Quakes," Reuters, February 24, 2017, https://www.reuters.com/article/us-oklahoma-quakes-regulator/oklahoma-regulator-issues-new-directive-to-curb-quakes-idUSKBN1632GH; Liz Hampton, "Oklahoma Regulators Target More Disposal Wells Following Cushing Quake," Reuters, November 8, 2016, https://www.reuters.com/article/us-oklahoma-quake/oklahoma-regulators-target-more-disposal-wells-following-cushing-quake-idUSKBN1332TS.

76. Valerie Volcovici, "Clinton's Pledge to Curtail Fracking Falls on Unconvinced Ears," Reuters, March 7, 2016, https://www.reuters.com/article/us-usa-election-fracking-idUSMTZSAPEC38PAFFSL.

77. Art Swift, "Opposition to Fracking Mounts in the U.S.," Gallup, March 30, 2016, http://news.gallup.com/poll/190355/opposition-fracking-mounts.aspx.

78. Amir Azar, "Reserve Base Lending and the Outlook for Shale Oil and Gas Finance," Center on Global Energy Policy, May 2017, http://energypolicy.columbia.edu/sites/default/files/CGEPReserveBaseLendingAndTheOutlookForShaleOilAndGasFinance.pdf.

79. Fatih Birol, "Keynote Conversation" (2018 Columbia Global Energy Summit, Columbia University, New York, NY, April 19, 2018), http://energypolicy.columbia.edu/events-calendar/2018-columbia-global-energy-summit-0.

80. See, for example, Akos Losz, "Uncertainty Ahead: The Outlook for LNG Demand in the Marine Transportation Sector," Natural Gas World, April 30, 2018, https://www.naturalgasworld.com/ggp-uncertainty-ahead-the-outlook-for-lng-demand-in-the-marine-transportation-sector-60813.

81. International Energy Agency, "World Energy Outlook 2017," pp.200.

82. Ibid., pp.100.

83. Cornell, "Strategic Oil," pp.21.

84. Intergovernmental Panel on Climate Change, Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (Cambridge and New York: Cambridge University Press, 2012), pp.7, https://www.ipcc.ch/pdf/special-reports/srex/SREX_Full_Report.pdf.

85. US Department of Energy, "Long-Term Strategic Review," pp.79, pp.104.

86. For a brief overview of the history of oil price controls in the United States, see Bordoff and Houser, "Navigating," pp.11.

87. David L. Weimer and Aidan R. Vining, "Cost-Benefit Analysis in a Bureaucratic Setting: The Strategic Petroleum Reserve," in Policy Analysis: Concepts and Practice, 4th edition (Upper Saddle River, NJ: Pearson Prentice Hall, 2005), pp.426–451, http://s3-euw1-ap-pe-ws4-cws-documents.ri-prod.s3.amazonaws.com/9781138216518/student/SPR_Case_4th_Edition.pdf.

88. Thomas J. Teisberg, "A Dynamic Programming Model of the U.S. Strategic Petroleum Reserve," Bell Journal of Economics, Autumn 1981, pp.526, http://www.jstor.org/stable/pdf/3003570.pdf.

89. Weimer and Vining, "Cost-Benefit Analysis," pp.14–15.

90. US Department of Energy, "Long-Term Strategic Review," pp.70–76.

91. Ibid.

92. Ibid.

93. Dario Caldara, Michele Cavallo, and Matteo Iacoviello, "Oil Price Elasticities and Oil Price Fluctuations," Board of Governors of the Federal Reserve System, International Finance Discussion Papers No. 1173, July 2016, pp.13, https://www.federalreserve.gov/econresdata/ifdp/2016/files/ifdp1173.pdf.

94. US Department of Energy, "Long-Term Strategic Review," pp.76.

95. Phillip C. Beccue and Hillard G. Huntington, "An Updated Assessment of Oil Market Disruption Risks," Stanford University Energy Modeling Forum, Final Report EMF SR 10, October 2016, pp.6–7, https://web.stanford.edu/group/emf-research/docs/special_reports/EMF_SR10.pdf.

96. "Short term" is defined as lasting less than six months. Disruption size refers to supply shortfall net of offsetting factors, such as deployment of available spare capacity. See Beccue and Huntington, "An Updated Assessment," pp.2.

97. See, for example, Philip E. Tetlock, Expert Political Judgement: How Good Is It? How Can We Know? (Princeton: Princeton University Press, 2005).

98. Daniel Kahneman, "How to Win at Forecasting: A Conversation with Philip Tetlock," Edge, December 6, 2012, https://www.edge.org/conversation/win-at-forecasting.

99. US Department of Energy, "Long-Term Strategic Review," pp.75.

100. Ibid., pp.82–84.

101. The size of the reserve is optimal when the present value of its total costs equals the

present value of its total benefits.

102. Weimer and Vining, "Cost-Benefit Analysis," pp.3.

103. Ibid., pp.15–16.

104. Ibid., pp.4.

105. Ibid., pp.4–6, pp.15–23.

106. Ibid., pp.22.

107. US Department of Energy, "SPR Quick Facts and FAQs," accessed on May 1, 2018, https://www.energy.gov/fe/services/petroleum-reserves/strategic-petroleum-reservespr-quick-facts-and-faqs#Q7.

108. US Department of Energy, "Long-Term Strategic Review," pp.5.

109. The assessment was required under the Bipartisan Budget Act of 2015, one of the congressionally mandated initiatives to sell down the SPR.

110. Steven Mufson and Chris Mooney, "Trump Seeks to Sell Off Half of the Strategic Petroleum Reserve," Washington Post, May 22, 2017, https://www.washingtonpost.com/news/energy-environment/wp/2017/05/22/trump-seeks-to-sell-off-half-of-the-strategic-petroleum-reserve/?utm_term=.d7637cefd282.

111. US Department of Energy, "Long-Term Strategic Review," pp.103–104.

112. Ibid., pp.103

113. Bai et al. provide one possible model formulation similar to the one discussed in the context of the SPR cost-benefit analysis earlier in this section. See Y. Bai, P. Zhou, D. Q. Zhou, F. Y. Meng, and K. Y. Ju, "Desirable Policies of a Strategic Petroleum Reserve in Coping with Disruption Risk: A Markov Decision Process Approach," Computers & Operations Research, vol. 66 (2016), pp.58–66, https://www.sciencedirect.com/science/article/pii/S030505481500194X.

114. Weimer and Vining, "Cost-Benefit Analysis," pp.21.

115. Ibid., pp.7.

116. See, for example, Cornell, "Strategic Oil."

117. See Bordoff, "Testimony."

118. US Department of Energy, "Strategic Petroleum Reserve Annual Report for Calendar Year 2014," Report to Congress, December 2016, pp.5, https://www.energy.gov/sites/prod/files/2017/02/f34/2014%20SPR%20Annual%20Report.pdf.

119. Based on conversations with industry participants.

120. Tilak Doshi and Sammy Six, "Joint Oil Stockpiling between Middle East Exporters and Northeast Asian Importers: A Winning Formula?," KAPSARC, April 2017, pp.3, https://www.kapsarc.org/wp-content/uploads/2017/06/KS-2017-DP06-Joint-Oil-Stockpiling-between-Middle-East-Exporters-and-Northeast-Asian-Importers.pdf.

121. "Assuming a crude oil price of around $40/barrel (bbl), 5 percent interest cost of carry and an equal division of the carrying cost savings with the host government, the ME NOC could gain $9 to $18 million a year if it enjoyed 50 percent of the cost savings in storing 15–30 million barrels (MMbbl)," the authors of the study noted. "The host NEA country saves about $2.00/bbl in carrying costs while retaining the pre-emptive right to buy the stored oil during oil supply emergencies. If 15–30 MMbbl are stored, the NEA country would save an estimated $31.5 million to $63 million per year." See Doshi and Six, "Joint Oil Stockpiling," pp.3.

122. Edward L. Morse, "US Set to Become Swing Oil Supplier," Financial Times, February 14, 2018, https://www.ft.com/content/49354866-117d-11e8-8cb6-b9ccc4c4dbbb.

123. Cornell, "Strategic Oil," pp.3–4.

124. US Government Accountability Office, "Strategic Petroleum Reserve: Preliminary Observations," pp.21.

125. US Government Accountability Office, "Strategic Petroleum Reserve: Preliminary Observations."

126. Daniel J. Weiss, "Eight Reasons to Release Oil from the Strategic Petroleum Reserve," Center for American Progress, July 14, 2008, https://www.americanprogres.org/issues/green/news/2008/07/14/4729/eight-reasons-to-release-oil-from-the-strategic-petroleum-reserve/.

127. Jerry Taylor and Peter Van Doren, "The Case against the Strategic Petroleum Reserve," CATO Institute, Policy Analysis No. 555, November 21, 2005, pp.10, https://object.cato.org/sites/cato.org/files/pubs/pdf/pa555.pdf.

128. International Energy Agency, "Oil Supply Security: Emergency Response of IEA Countries," 2007, pp.19, pp.371, https://www.iea.org/publications/freepublications/publication/oil_security.pdf.

129. International Energy Agency, "Energy Supply Security: Emergency Response of IEA Countries," 2014, pp.20, https://www.energy.gov/sites/prod/files/2016/08/f33/IEA%20Emergency%20Response%20of%20IEA%20Countries_2014.pdf.

130. John F. Burns, "Confrontation in the Gulf: Iraqis Threaten to Attack Saudis and Israelis If Nation Is 'Strangled' by Embargo," New York Times, September 24, 1990, https://www.nytimes.com/1990/09/24/world/confrontation-gulf-iraqis-threaten-attack-saudis-israelis-if-nation-strangled.html?pagewanted=all.

131. Youssef M. Ibrahim, "Iraq Threatens Emirates and Kuwait on Oil Glut," New York Times,

July 18, 1990, https://www.nytimes.com/1990/07/18/business/iraq-threatens-emirates-and-kuwait-on-oil-glut.html.

132. Leonard Silk, "The Board Impact of The Gulf War," New York Times, August 16, 1991, https://www.nytimes.com/1991/08/16/business/economic-scene-the-broad-impact-of-the-gulf-war.html.

133. Michael M. Hutchison, "Aggregate Demand, Uncertainty and Oil Prices: The 1990 Oil Shock in Comparative Perspective," Bank for International Settlements Economic Papers, No. 31, August 1991, pp.62, https://www.bis.org/publ/econ31.pdf.

134. US Energy Information Administration, EIA Monthly Energy Review, February 26, 2018, https://www.eia.gov/totalenergy/data/monthly/#international.

135. Ibid.

136. James Tanner and Allanna Sullivan, "Waves of U.S. Planes Attack Iraq as War Breaks Out in Persian Gulf—a Major Oil Glut Offers a Cushion; Reserve Is Tapped," Wall Street Journal, January 17, 1991.

137. Anthony Andrews and Robert Pirog, "The Strategic Petroleum Reserve: Authorization, Operation, and Drawdown Policy," Congressional Research Service Report for Congress, June 18, 2012, 11, https://fas.org/sgp/crs/misc/R42460.pdf.

138. Ibid.

139. Difiglio, "Oil," pp.55–56.

140. US Energy Information Administration, accessed on May 1, 2018.

141. Robert Bamberger, "Strategic Petroleum Reserve," Congressional Research Service Issue Brief for Congress, May 31, 2005, pp.10, https://fas.org/sgp/crs/misc/IB87050.pdf.

142. Newell and Prest, "Informing SPR Policy," pp.14–15.

143. Difiglio, "Oil," pp.55.

144. US Department of Energy, Office of Electricity Delivery and Energy Reliability, "Comparing the Impacts of the 2005 and 2008 Hurricanes on U.S. Energy Infrastructure," February 2009, https://www.oe.netl.doe.gov/docs/HurricaneComp0508r2.pdf.

145. Jad Mouawad and Simon Romero, "Hurricane Katrina: The Oil Supply; Gas Prices Surge as Supply Drops," New York Times, September 1, 2005, http://query.nytimes.com/gst/fullpage.html?res=9D00E2DA1731F932A3575AC0A9639C8B63&pagewanted=all; and US Department of Energy, "Comparing the Impacts," pp.21–22.

146. Lawrence Kumins and Robert Bamberger, "Oil and Gas Disruption from Hurricanes Katrina and Rita," Congressional Research Service Report for Congress, April 6, 2006, pp.3, http://www.au.af.mil/au/awc/awcgate/crs/rl33124.pdf.

147. US Department of Energy, "Comparing the Impacts," pp.40, 44.

148. US Energy Information Administration, EIA Weekly Retail Gasoline and Diesel Prices, March 5, 2018, https://www.eia.gov/dnav/pet/pet_pri_gnd_a_epm0_pte_dpgal_w.htm.

149. US Department of Energy, Office of Fossil Energy, "The Strategic Petroleum Reserve: History of SPR Releases," accessed on May 1, 2018, https://www.energy.gov/fe/services/petroleum-reserves/strategic-petroleum-reserve/releasing-oil-spr.

150. It is worth noting that the most immediate supply response came not from IEA member states but from non-IEA countries in Latin America. The volume of products that IEA member states released is not a full measure of the success of this operation. The IEA announcement of the release also had an important psychological effect and played a key role in calming markets.

151. Andrews and Pirog, "Strategic Petroleum Reserve: Authorization," pp.12.

152. Difiglio, "Oil," pp.55.

153. US Department of Energy, "Comparing the Impacts," pp.33.

154. Blake Clayton, "Lessons Learned from the 2011 Strategic Petroleum Reserve Release," Council on Foreign Relations, September 2012, pp.16–17, https://cfrd8-files.cfr.org/sites/default/files/pdf/2012/09/CFR_WorkingPaper14_Clayton.pdf.

155. International Energy Agency, "IEA Makes 60 Million Barrels of Oil Available to Market to Offset Libyan Disruption," June 23, 2011, https://www.iea.org/newsroom/news/2011/june/iea-makes-60-million-barrels-of-oil-available-to-market-to-offset-libyan-disrupt.html.

156. David Blair, "OPEC Chief Hits at IEA for Releasing Oil," Financial Times, June 27, 2011, https://www.ft.com/content/2c8c1cca-a0e2-11e0-adae-00144feabdc0.

157. Clifford Krauss, "Saudi Arabia, Defying OPEC, Will Raise Its Oil Output," New York Times, June 10, 2011, http://www.nytimes.com/2011/06/11/business/energy-environment/11oil.html.

158. US Department of Energy, "Strategic Petroleum Reserve Annual Report for Calendar Year 2011," Report to Congress, December 2012, https://www.energy.gov/fe/downloads/2011-spr-report-congress.

159. Ibid.

160. Clayton, "Lessons Learned," pp.10.

161. Patron and Goldwyn, "Managing Strategic Reserves," pp.468.

162. Clayton, "Lessons Learned," pp.7–8.

163. John Kemp, "Column: For Policymakers, Lessons from the 2011 Oil Release,"

Reuters, August 30, 2012, https://www.reuters.com/article/us-column-kemp-oil-stockrelease/column-for-policymakers-lessons-from-the-2011-oil-release-kemp-idUSBRE87T0N520120830; and testimony of Richard H. Jones, deputy executive director of the International Energy Agency, US Senate Committee on Energy and Natural Resources, January 31, 2012, pp.3, https://www.energy.senate.gov/public/index.cfm/files/serve?File_id=B31E1AD9-73EB-4BB8-ACD3-354B5E3ED9B7.

164. Daniel Paul Scheitrum, Colin A. Carter, and Amy Myers Jaffe, "Testing Substitution between Private and Public Storage in the U.S. Oil Market: A Study on the U.S. Strategic Petroleum Reserve," Energy Economics, vol. 64 (2017), pp.483-493, https://www.sciencedirect.com/science/article/pii/S0140988315002923.

165. Newell and Prest, "Informing SPR Policy," pp.17; and Clayton, "Lessons Learned," pp.3–4.

166. Clayton, "Lessons Learned," pp.10.

167. Ibid., pp.10–11.

168. Ibid., pp.10–12.

169. Richard Swann, "G7 Urges Oil Supply Boost, Says Ready to Call for IEA Action," Platts, August 29, 2012, https://www.platts.com/latest-news/oil/london/g7-urges-oil-supply-boost-says-ready-to-call-8674832.

170. Guy Chazan et al., "Crude Tumbles as Leaders Discuss Supplies," Financial Times, March 15, 2012, http://www.ft.com/intl/cms/s/0/20e8687a-6ebd-11e1-afb800144feab49a.html#axzz3nVdtfjsk; and Matt Falloon and Jeff Mason, "Obama, UK's Cameron Discussed Tapping Oil Reserves: Sources," Reuters, March 15, 2012, http://www.reuters.com/article/2012/03/15/us-obama-energy-spr-idUSBRE82E00P20120315.

171. John Kemp, "IEA Takes Aim at Oil Speculators with Stock Release," Reuters, June 23, 2011.

172. US Department of Energy, "Strategic Petroleum Reserve Annual Report," pp.15.

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