Informing SPR Drawdown Policy Using Futures Strips

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Summary

We will explore how the time profile of futures prices for crude oil and gasoline can inform the optimal use of the Strategic Petroleum Reserve (SPR). There is very little economic research guiding government policy on this issue, and the studies that do exist are quite old and outdated because they lacked futures data and the computational power to incorporate this relationship into models of SPR management. This research will help policymakers determine when to release SPR reserves based on economic principles informed by market prices.

The research team will consist of Dr. Richard Newell and Brian Prest. Richard Newell is the Gendell Professor of Energy and Environmental Economics at the Nicholas School of the Environment of Duke University. Brian Prest is a Ph.D. student in Duke's University Program in Environmental Policy, concentrating on energy and environmental economics.

1 Motivation and Approach

The notion that the SPR is for addressing physical shortages is outdated. In a globally integrated market, the SPR primarily addresses the economic impacts of price shocks– both its macroeconomic and distributional effects. If the goal of the SPR then is to dampen or eliminate price shocks associated with supply disruptions, how do policymakers decide whether a particular situation warrants release and how large it should be, given that simply counting barrels is insufficient?

This is complicated by the need to distinguish short term shocks that may be moderated by an SPR release from longer term supply changes for which an SPR release would likely be ineffective. There is also the need to measure the magnitude and expected longevity of shocks to prioritize SPR use, knowing that government stockpiles will only be used infrequently and often in times of significant uncertainty and possibly crisis. Another concern on the part of energy policymakers is the relative value and magnitude of strategic stocks maintained as crude oil versus refined products, such as gasoline or fuel oil.

There is very little economic research directed to guiding government policy on the optimal size and use of strategic fuel reserves. Most research that does exist is based

on theoretical or closely related simulation models. For example, Teisberg (1981) and Chao and Manne (1983) use stochastic dynamic programming models to determine optimal SPR acquisitions and releases. But these models are limited by computational constraints to small state spaces and strong assumptions about the size and persistence of shocks. In reality, the persistence of shocks matters greatly to policy and should not simply be fixed by assumption.

In contrast to prior literature, we propose to investigate the use of the time profile of oil and gasoline futures prices as an indicator of the degree of distress in these markets and how markets expect this distress will evolve over time. This in turn can be used to guide policy on SPR releases. Specifically, we propose to analyze how the historical shapes of futures price strips are associated with market disequilibrium and to what degree SPR releases may be able to mitigate this distress. We also propose to analyze how the information contained in the futures strip can be incorporated into policy decisions through its incorporation into a stochastic dynamic programming model of strategic reserve decisionmaking. We believe this will be a significant contribution to prior research on the topic as well as to SPR policymaking.

2 Illustration of Historical Futures Strips

Figure 1 illustrates the utility of the futures strip as an indicator of short term market distress.[1] The figure shows the price of crude oil over time (in blue) along with the futures strip (in red) during major events (supply disruptions and SPR releases). The green vertical lines indicate major SPR releases. The bottom panel shows the 12-month spread in percentage terms.[2] During times of market distress, the futures strip exhibited significant backwardation because a near-term disequilibrium is expected to resolve itself over some period of time.

For example, in the months leading up to the First Gulf War, near-dated crude oil futures prices rose much more than long-dated futures did, and the futures curve switched from significant contango to significant backwardation. At that time, the 12-month spread swung dramatically from +27% to −32%. Subsequent to the U.S. military actions and the SPR release in February 1991, the spread shrunk to −4% at the end of the month, close to the long-term average of −2% over the entire period from January 1989 to October 2015.

As the graph shows, the shape of the futures curve appears to be a good indicator of market disequilibrium. While we did not see strong backwardation in crude oil during Hurricanes Katrina and Rita (another episode leading to an SPR release), this is not surprising because the impact of those hurricanes was primarily on U.S. refining output. As a result, the effect of the hurricanes was primarily felt in gasoline markets: plotting of the gasoline futures strip during that time (not shown) reveals sharp backwardation with spreads exceeding −20%.

[1] The graph depicts West Texas Intermediate (WTI) prices and spreads until 2010. Beginning in 2010, we show Brent prices and spreads. We switch because WTI is a more liquid market in early years. This choice has little impact on the graph, however, because of the near-perfect correlation between WTI and Brent prices prior to 2010.

[2] The spread is calculated as the 12 month price minus the prompt month price, divided by the prompt month price.



Figure 1: Crude Oil Prices, Futures, and Spreads

3 Relation to Literature

The literature on SPR management dates back to the late 1970s and early 1980s–the years following the oil shocks of the Arab oil embargo, the Iranian Revolution, and the establishment of the reserve. As a result, the literature has two major limitations that this research will advance.

First, the early literature did not have access to the information provided by oil futures markets because those markets simply did not exist at the time. Nearly all of the SPR literature was written before basic, short-run oil futures markets were established in 1983. Long-dated contracts (up to 18 months to delivery) did not appear until 1989. The establishment of long-dated contracts creates more information about expected future spot prices, to which the existing literature did not have access.

Second, the early literature made strong modeling assumptions due to limited computational resources available at the time. Since optimal SPR management is a complicated dynamic problem, it often requires numerical methods to solve. Limited computational resources in the 1970s and early 1980s required researchers to greatly simplify their models. For example, Teisberg (1981) uses a stochastic dynamic programming model of SPR releases. Presumably due to computational constraints, that paper only allowed for two states of the world: "normalcy" and "disruption" of an assumed amount of production. Similarly, Chao and Manne (1983) also use dynamic programming, assuming three states. Modern computing resources allow us to consider more realistic models with larger state spaces and more nuanced correlation structures of sequences of supply shocks.

Further, our study would build on the lessons learned from Teisberg (1981) and Chao and Manne (1983). Those studies illustrate that releasing reserves is more desirable when the disruption is likely to be temporary. But they did not explore how to determine the probabilities of persistence in practice (rather, the authors assumed transition probabilities). In reality these probabilities are difficult to gauge and clearly not constant, making actual decisions more complicated.

We plan to explore how these transition probabilities and hence optimal policy can be informed by the shape of the futures price strip. In particular, in a stochastic dynamic programming framework, the choice of whether to release reserves today depends on the persistence of current shocks and expectations about future shocks. For example, it may not be optimal to release reserves following a large supply disruption if the disruption is likely to become even worse in the future, which in turn would be indicated by a rising futures strip. Formally, this appears in a dynamic programming model through the conditional probability distribution of future supply shocks, over which the decisionmaker must integrate when forming expectations. Our central point is that the shape of the futures strip can inform the decisionmaker's assessment of this probability distribution and hence guide optimal management.

We also plan to incorporate oil price forecasting methods based on futures prices in our modeling. This relates to the literature by Hamilton and Wu (2014) and Baumeister and Kilian (2014), which uses futures curves to recover expected future spot prices based on risk premia.

References

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Conflict of Interest Statement. The research team does not believe it has any conflict of interest relevant to the proposed research. Richard Newell nonetheless notes relevant relationships with international organizations: He is the PI on a research grant on energy outlooks from the International Energy Forum (IEF, an international organization for IEA-OPEC dialogue) and he is on the International Advisory Council of KAPSARC (an independent, non-profit research institution based in Saudi Arabia).