Managing the U.S. Special Petroleum Reserve (SPR): Can We Do Better

[Carol Dahl, Colorado School of Mines, 1-303-273-3921, cadahl@mines.edu

Yang Bai, School of Business, Nanjing Normal University, 86-025-85891140, 54190@njnu.edu.cn]

Overview

In a perfect economic world with increasing expected marginal costs and decreasing expected marginal benefits, producers that are maximizing the expected net benefits of inventories will want to hold inventories up to the point where the marginal net benefit of the last unit of inventory equals the marginal net cost. This point should also maximize the social welfare of inventories. In the event of a disruption, a price spike will cause a drawdown of inventories and any remaining disruption will be allocated across markets to the least valued use of the product. So far so good. So why not render onto oil companies a task they do best and let them manage oil inventories and their allocation during a disruption? The problem arises, if we believe there are negative externalities involved with an oil disruption. Such externalities include losses of output on the wider macroeconomy, which private producers will not consider in their decisions and they may not hold the correct amount of inventories. Or private producers may value private risk, which might deviate from social risk. With such a market failures, there may be a call for the government to step in to provide more inventories in the form of strategic petroleum reserves. Numerous countries including IEA members, as well as major oil importers like China, buy into these arguments and have or are developing government strategic reserves or have placed reserve requirements on private companies.

As one of the major IEA members, the U.S. was one of the earliest countries to began an SPR. Its SPR had its genesis in the 1975 Energy Policy and Conservation Act with the first oil injection into the reserve in 1977. Many studies have made a case for such SPRs and tried to model the optimal amount of SPR fill (see Bai et al. (2012) for a review of such studies), but few have evaluated their actual historical effectiveness. In a recent paper, Bai and Dahl (2017), we estimate the actual historical net benefits of the U.S. SPR. on annual data from 1977-2014. Costs include purchase, maintenance, and holding costs for the facility and the oil net of revenue from oil sales, while the benefits include the SPR drawdown that offsets lost social welfare and lost macroeconomic from a distruption. In our base case, we estimated the total real cost of the U.S. SPR to be $214.09 billion (2014$) dollars, whereas the estimated total real benefit from the three official drawdowns in 1991, 2005, and 2011 to be only $120.52 billion, making the actual net benefit negative. In sensitivity testing, this net benefit only became positive when the short run world oil demand is extremely inelastic to oil price, GDP is quite elastic with respect to oil price shocks or we attribute the effect of changes in stocks from the rest of the OECD governments to the U.S. SPR. We were somewhat surprised to find some evidence that changes in private sector stocks might have reduced the benefits from OECD government drawdowns.

Although the SPR seems to have general public support, the charge against drawdowns of "too little, too late" has been heard from both opponents and proponents of the SPR. Although some experimentation and optimization in our previous paper, lend some support to the too little charge, estimating on annual data masks some of the timing issues. For this paper, we propose to redo our estimates of net benefits on monthly data as well as to developing an optimization model to see what an optimal policy might reasonably look like and if the model can outperform the policy makers. Some initial experimentation with alternate drawdown rules such as those for the U.S. Heating Oil Reserve also performed better than the actual discretionary policy. We suspect that had the SPR been functional during the Iranian oil revolution and better managed the numbers would put the SPR in a much more favorable light.

Methods

The strategic petroleum reserve can be used as an emergency response tool when oil importers are confronted with an economically-threatening disruption in oil supply. The target is to maximize the net benefts of reserves. The SPR cost consists of oil purchase (c^f), facilities construction (c^c) and management (c^m). We add up the net investment as

$$C = \sum_{t=1}^{N} (1+\gamma)^{N-t} \left(c_t^p + c_t^c + c_t^m - r_t^s \right)$$

where r_s is the sale revenue of SPR and γ is the interest rate in period t.

A disruption may induce economic losses in two categories, net society loss equal to the loss in consumper surplus from a disruption price increase minus the gain in producer surplus (c_t^w) plus the macroeconomy adjustment loss (c^a). The emergency response to a disruption mainly includes SPR drawdown, releasing industry inventory and surplus production capacity. The SPR drawdown reduces disruption loss by relieving the imbalance of supply and demand and dampening oil price increases. To measure the price effect of SPR drawdown, we proposed a supply-demand equilibrium model. By going through the history of U.S. SPR drawdown, we can examine the benefit (saved economic loss) of SPR by the following equation.

$$R = \sum_{t=1}^{N} (1+\gamma)^{N-t} (\Delta c_t^w + \Delta c_t^a)$$

The functions *R-C* will be estimated on historic monthly data to evaluate actual performance of the reserve and used in a dynamic optimization model to see the optimal fill and drawdown policies

Results

We have already estimated the net benefit of the actual drawdown and fill rate shown in the figure below on annual data that will be redone on monthly data to give us more acurate estimates of actual historical net benefits of the SPR.

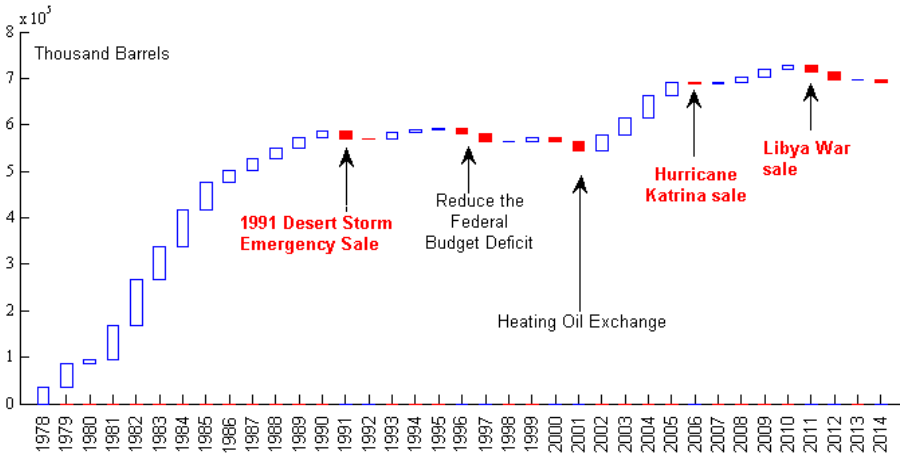

Fig 1. U.S. SPR filling up and drawdown, 1978~2014.

From the figure, we can see the bulk of the fill was done from 1978-1990 and again from 2003 to 2005. There were three official drawdowns: the 1991 Gulf war, 2005 Hurricane Katrina and 2011 Libya war. The dynamic model outputs will provide alternative trajectories. We begin with a counterfactual, where the policy maker knows the actual price and disruptions over the whole planning period and can estimate the effects of their fill and drawdown on price based on assumptions about demand and supply elasticicities. Another is a more realistic case where the model has the same information as the policy maker had at each point in time. We will also consider some alternate rules that would trigger a drawdown without the bureaucratic decision delays.

Conclusions

Even if we strongly believe in a market failure relating to oil supply disruptions, we also need to make the case that the government can provide a superior solution. One can also argue that policy makers are strongly influenced by public perception and political issues and may not provide an optimal solution either. This modeling effort aims to shed more light on if and how the government should manage strategic oil reserves.

References

Bai, Yang and Carol A. Dahl (2017) Evaluating the Management of U.S. Strategic Petroleum Reserve (SPR) During Oil Disruptions, Draft, Nanjing Normal University and Colorado School of Mines.

Bai Y, Zhou D Q, Zhou P, et al. Optimal path for China's strategic petroleum reserve: A dynamic programming analysis. Energy Economics, 2012, 34(4): 1058-1063.