

# White Knight or White Elephant: Evaluating the U.S. Special Petroleum Reserve (SPR)

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## Overview

As economists, we put much faith in the efficacy of markets to produce and allocate the goods we cherish. In a perfect economic world, producers will hold inventories for various reasons. If demand and costs are known with a fair degree of certainty, producers may be buying and selling in batches and may need a certain amount of inventory just to function. They may want to have stocks to smooth production when sales of their products are seasonal or cyclical. They may hold more inventories to be able to take advantage of economies of scale in purchases or sales. In a more realistic stochastic world, where demand and costs are uncertain, additionally producers may want to hedge to avoid price increases for storeable inputs they purchase, and they may want to hold speculative stocks of storeable products they sell to take advantage of price spikes. These benefits of inventories will need to be weighed against the cost of inventories including purchase, holding, and stockout costs.

In our perfect economic world with increasing expected marginal costs and decreasing expected marginal benefits, producers that are maximizing the expected net benefits of inventories will 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 draw down 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 allocation during a disruption? The problem arises, if we believe there are negative externalities involved with an oil disruption such as losses of output on the wider macro economy. Then private producers will not consider this effect in their decisions and they may not hold the correct amount of inventories (For a discussion of such potential externalities see Bohi and Toman (1997)). With such a market failure, there may be a call for the government to step in and provide more inventories in the form of strategic petroleum reserves. As such, numerous countries including the IEA members, as well as major oil importers like China have set up such reserves.

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. The first oil found a home in the darkness of its caverns on July 21, 1977. Although 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), we know of no attempt to evaluate whether such SPRs were a good investment and whether the government had superior abilities to manage a disruption. Our contribution in this paper is to provide such an evaluation by modeling the net benefits of the SPR over its history. We will model the optimal fill and drawdown rate with perfect foresight as a benchmark, and compare it to a model that optimizes with no foresight as well as compare them to the actual fill and draw down rate. Fig. 1 indicates drawdowns and fills by showing actual stocks over time.

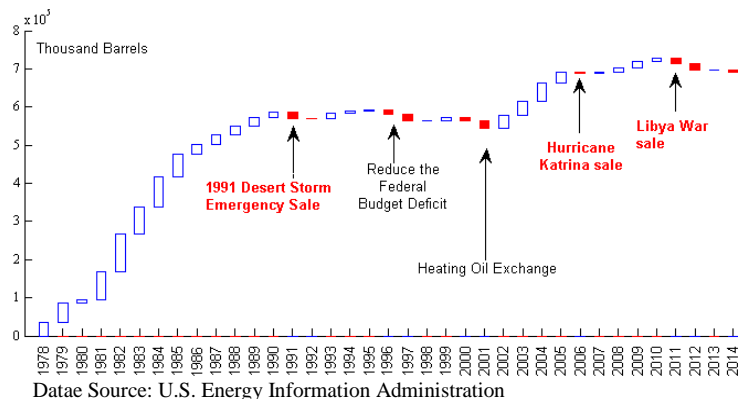


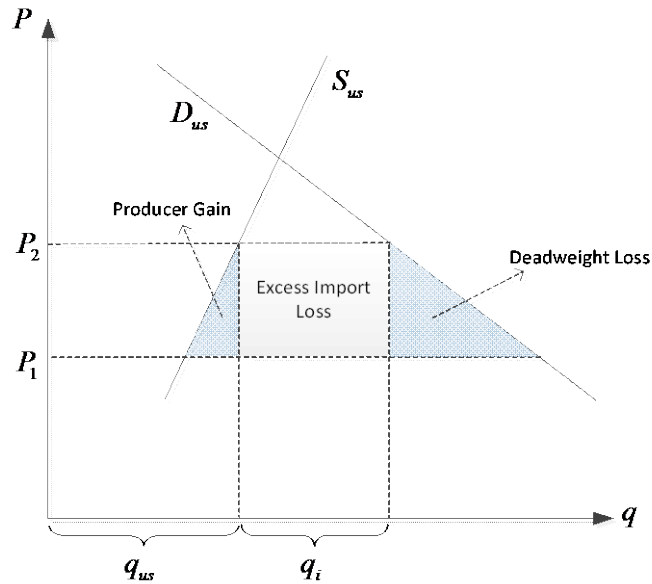
Fig 1. U.S. SPR filling up and drawdown, 1978~2014.

## Methods

To evaluate the reserves, we consider the net present value of the costs of oil disruptions including the investment in the reserve over its life beginning in 1977. The SPR net cost consists of oil purchases ( $c^f$ ), facilities construction ( $c^c$ ) and management ( $c^m$ ) minus the sales revenue from any drawdown ( $r_s$ ). We write its net present value ( $C$ ) with  $\gamma$  equal to the discount rate as

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

The above SPR costs are quite straight forward and well documented but the costs of a disruption are much less straight forward. A disruption may induce economic losses in two categories, the direct losses in the market as illustrated for a simple market in the figure below and the indirect externalities.



The net direct loss equals the loss in consumer surplus ( $P_2bdP_1$ ) minus the gain in domestic producer surplus ( $P_1acP_2$ ). The net loss in consumer surplus can be further divided into the excess import loss (abec, which we call  $\Delta c_t^i$ ) and the deadweight loss (bde, which we call  $\Delta c_t^d$ ). The indirect costs are the macroeconomy adjustment loss ( $c^a$ ). The net present value of the disruption cost is then

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

Our objective function is  $C + R$ , which we seek to minimize. by choosing the optimal fill and draw down rates using dynamic programming or stochastic dynamic programming. depending on the case.

## Results

Our model results will show the optimal acquisition and drawdown rate for the SPR as well as the net present value of the cost under each modeled scenario for the three official drawdowns: 1991 Gulf war, 2005 Hurricane Katrina, and 2011 Libya war. We compare our model discounted costs with what our model indicates costs would be under the actual U.S. SPR policy implemented. Sensitivity tests on key parameters such as the discount rate, disruption probability function, demand elasticity, and elasticity of Gdp with respect to oil price changes should give us some boundary conditions of SPR benefits and costs and suggest needed model refinements and areas for further work.

## Conclusions

The study considers the question of whether the U.S. SPR was a good investment (white knight) or a waste of money (white elephant). Although a case can be made for the externalities, we want to determine whether a case can be made that the government can better deal with a disruption than the market. By comparing model results with the actual policy implemented, we hope to shed some light on whether billion dollar policies really can out perform the invisible hand of the market.

## References

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