***The Real Costs of US Strategic Petroleum reserves***

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## Overview

The US Strategic Petroleum Reserve (SPR) was born in 1975, with the Energy Policy and Conservation Act. Its value, following the oil crisis of 1973, a time of high and rising crude oil prices, energy shortages, and long lineups at petroleum stations, was unquestioned. More than forty years later, the political and economic environment has changed significantly. US WTI oil prices have fallen to levels as low as $35.00 USD per barrel, and the political landscape has been altered irreparably by fears of climate change, and an evolving geopolitical landscape that leaves North American crude oil reserves at historic highs. Given the changing geopolitical landscape, and volatility in crude oil prices the question remains. "What is the real value of the US Strategic Petroleum Reserve?"

Typically Discounted Cash Flow (DCF) and Net Present Value (NPV) models tend to view large-scale projects such as the Strategic Petroleum Reserve as now-or-never investment opportunities. The entire capital investment is committed up front and the project is evaluated by simply adding up the discounted net present value of future revenue streams (or cash flows). However, Dapena (2003) uses a simple simulation model to illustrate cases where DCF tends to overvalue project economics, whereas Kulitilaka and Marcus (1992) indicate cases were DCF undervalues projects under uncertainty.

Technology and globalization create significant opportunities for growth and expansion, but at the same time require considerable injections of capital. These payments can be viewed as a series of call options on future growth but cannot be valued adequately by traditional DFC methods. In our case, the US government, has the real option to develop long term energy projects such as the US strategic petroleum reserve in stages. By biding their time between the various stages, and waiting until more information is available, the project operator will be able to make production and investment decisions that are ‘more informed,’ and better suited to the economic and political situation that are likely to prevail throughout the project’s lifetime. Indeed, energy literature has long emphasized the value of using the theory of irreversible investment under uncertainty (See for example Dixit and Pindyke, 1994) to quantify the ‘option-like’ characteristics of large-scale energy projects.

Although Phil Verleger suggested selling options to finance the SPR back in the early 1980s, we are aware of no published work to quantify this suggestion nor do we know of any published work that used option theory to value the SPR amongst the many models used to analyse the SPR Thus, our contribution in this paper is a first attempt to apply option value theory on the U.S. SPR.

## Methods

The US Strategic Petroleum Reserve can be viewed as a large storage facility for crude oil supplies. A standard Net Present Value model can be used to value the Strategic Petroleum Reserve as a simple commercial storage facility—providing the opportunity to cycle the oil reserves in order to take advantage of predictable annual fluctuations in crude oil prices. At the same time, the reserve can be viewed as a call option on crude oil supplies.

This study will utilize a standard Cox-Rubenstein binomial lattice to illustrate the basic value of the US strategic petroleum reserve. Assuming that the price of oil follows a binomial process, let T equal the option’s time to maturity or expiration. The time to maturity is divided into N small intervals of equal duration , so that T = N. The oil price can move in one of two directions, up from S to uS with probability q, or downwards from S to dS, with probability (1-q). The values of q, u and d are functions of the mean, variance and rate of return on the price of oil (asset price) S. Specifically, in a risk neutral world, these values will satisfy the following four relationships:

, , , 

The binomial process for the world oil price for two periods is illustrated in the figure below. The actual value of the oil price **S** is observed at time t. At some point in the future—say  -- the oil price can take on two different values-- Su with probability q, or Sd with probability (1-q). Another time period later, the oil price has three different values: Su2 with probability q2; S with probability q(1-q); or Sd2 with probability (1-q)2.

When a real options approach is utilised, the US Strategic Petroleum Reserve can be seen, and valued, as a call option on crude oil supplies. With a small investment in ‘project logistics,’ which might include writing back to back put and call options, initiating future investments in cavern infrastructure, purchasing or renting property, negotiating a lease with a foreign government, or initiating negotiations with a major oil company. the project operator has a real option to delay incremental investment decisions for a significant time period, while crude oil prices are low. Given current levels of volatility in the crude oil price—and forward curve—and political and legislative uncertainty in the host country, there is a significant probability that the project will come ‘into the money’ at some time in the future. In short, the project operator has an implied call option on a future capital investment. The value of this ‘implied’ call option can be calculated by standard options pricing procedures.

If the world oil price follows a binomial process, the terminal value of a call option on the world oil price at time t+t, which matures at time t with K the exercise or strike price, is:

1. , with probability q, and
2. , with probability (1-q)

The actual value of the call option (CT) at T is the maximum of its intrinsic value or zero: 

In a risk-neutral world, the value of an option is equal to the expected value of that option discounted at a risk free rate of interest for the period under investigation. In the case of an American call option, the project operator can call the option in at anytime between the settlement date and the exercise date, so that the firm does not suffer from losses that may arise from the restriction to call the option at the expiry date. As a result, the price of an American option must be equal too, or greater than, the intrinsic value of the option at any given time. This amounts to another restriction on the options price. The value of an American call option on the world oil price at time t+it, which matures at time it, is given by:



The price of an American call option on the world oil price can be written as an implicit function of the following variables:



As there is no cash dividend involved in the transaction, the expression on the left of the maximum − − will never come into play, and the price of the American call option will always be equal to .

## Results

First, a DNPV approach will be used to value the existing storage capacity. Second, uncertain variables will be identified, modeled and used to run Monte Carlo simulations on the original NPV valuation. Third, the project optionality will be identified and modeled using a combination of Black & Scholes, Monte Carlo simulations and decision trees -- (i) Market maker cycling functions, (ii) Park and loan; (iii) Selling back to back call and put options, (iv) identifying the optional mix of sweet and sour crude, Finally, all of the estimates including sensitivity tests will be compared: (i) Simple NPV: (ii) Simple Call Option, and (iii) DNPV with Monte Carlo and optionality. The first two estimates yield point estimates, and the last ROV will yield a probability distribution of results.

## Conclusions

Using market information, there may be clear economic and financial incentives to determine the real economic value of the U.S. SPR and take the appropriate actions to optimize this precious resource.

## References

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