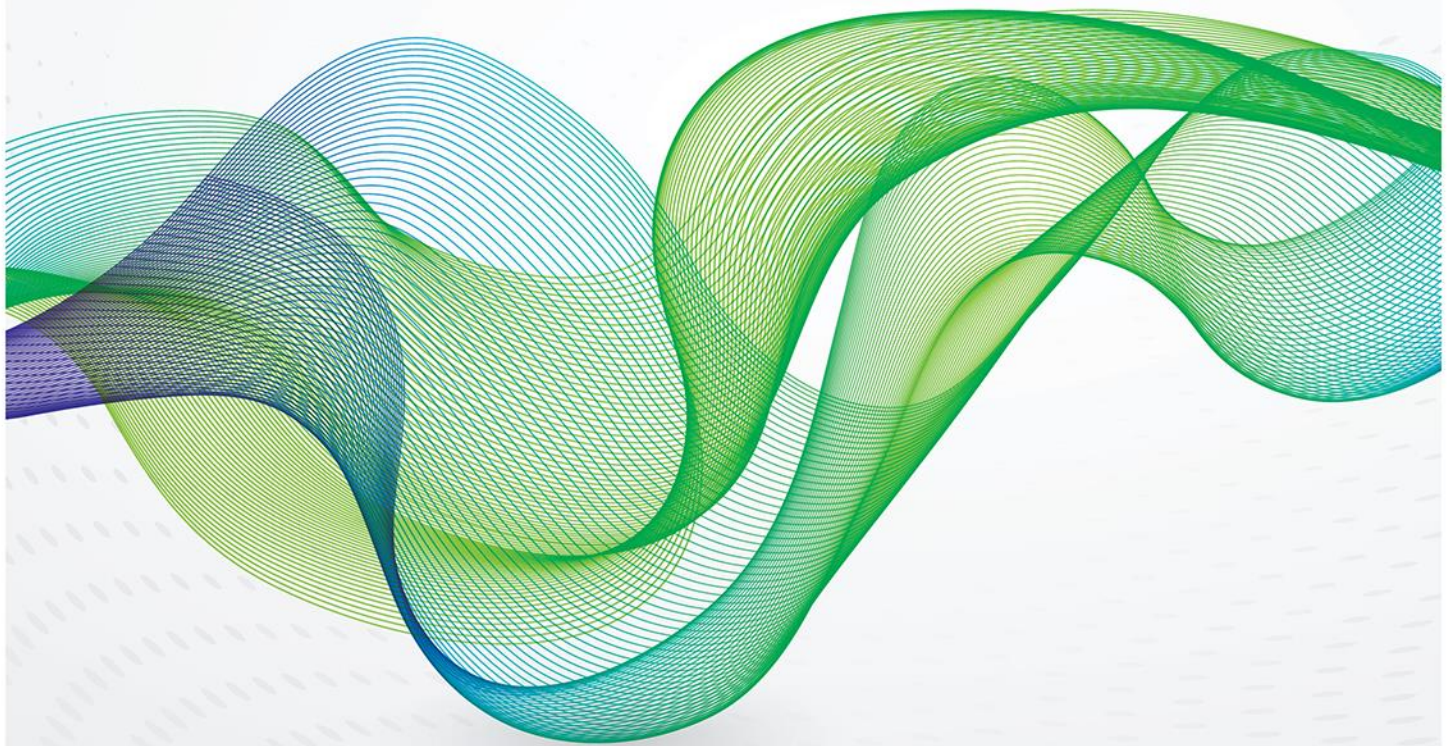




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The Strategic Petroleum Reserve Strategies: Risk-Free Return or Return-Free Risk?



OXFORD ENERGY COMMENT

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Background

The U.S. Strategic Petroleum Reserve (SPR) is the world's largest supply of emergency crude oil. The SPR was established in 1975 by the Energy Policy and Conservation Act (EPCA) following the Oil Embargo of 1973-1974 by the Organization of Arab Petroleum Exporting Countries (OAPEC). The mission of the SPR is to store petroleum to diminish the impact of disruptions on petroleum supplies and to carry out U.S. obligations under the International Energy Program.¹ The federally-owned crude oil stocks are stored in four underground salt caverns located in Texas and Louisiana. Current authorized storage capacity is 714 million barrels. The SPR was filled to its maximum capacity in December 2009 which was 727 million barrels at that time.²

Oil stocks can be released from the SPR either via competitive sales, or as exchanges. The U.S. President can authorize the sale in the case of 'severe energy supply interruption' which means a national energy supply shortage of an emergency nature that may cause major adverse impact on the national economy. A severe energy supply interruption is deemed to exist if the President determines an emergency situation with significant reduction in supply or severe increase in the price of petroleum products that resulted from such emergency situation.³

In addition, the President can direct the U.S. Secretary of Energy to exchange oil from the SPR for the purpose of acquiring additional stockpile. In other words, oil can be released to the market by means of loans. If the oil market is in backwardation, i.e., the situation when the spot price exceeds forward prices, then oil borrowers must return more barrels to the SPR than the quantity that was originally received. The government collects interest on the oil loan in the form of additional barrels similar to an interest on financial loans.

Oil loans have no explicit costs to the SPR, as all operational costs are used to reduce the interest on the loan. Lending oil is effectively an arbitrage strategy that allows the storage owner to monetize an optionality embedded in the physical asset. In contrast, the net cost of outright sales and subsequent repurchase of the SPR barrels is highly uncertain, as it depends on future market prices. This article looks at two alternative strategies of emergency sales and oil loans from the perspective of the commercial storage manager.

Recent developments

Prior to 2022, the emergency SPR releases occurred three times, at the beginning of the Gulf War in 1991, in the aftermath of hurricane Katrina in 2005, and during supply disruptions in Libya in 2011. The magnitude of the authorized 2022 emergency SPR drawdowns, however, is three times larger than all previous emergency sales combined. On several other occasions, sales from the SPR were also mandated by the Congress to reduce the budget deficit and finance some other projects. SPR exchanges, or loans, have been used more frequently but for smaller quantities, typically in response to short-term supply disruptions, such as the ones caused by hurricanes (see **Figure 1**).

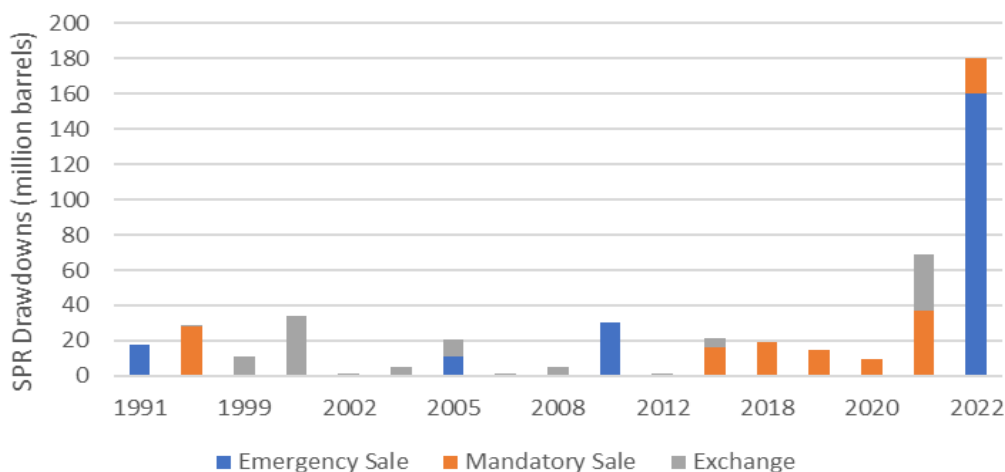
As the result of recent emergency drawdowns, as of June 2022 SPR stocks fell below 500mb, the lowest level since 1986. SPR stocks are expected to decline further, as previously authorized withdrawals continue to take place (see **Figure 2**). Despite the large size of the SPR stock release, WTI prices continued to rise.

¹ <https://www.energy.gov/fecm/strategic-petroleum-reserve>. International Energy Agency (IEA) requires all of its member countries to hold strategic stocks equal to no less than 90 days of petroleum imports based on the previous year net imports.

² <https://www.energy.gov/fecm/strategic-petroleum-reserve-9>

³ <https://www.energy.gov/fecm/strategic-petroleum-reserve-2>

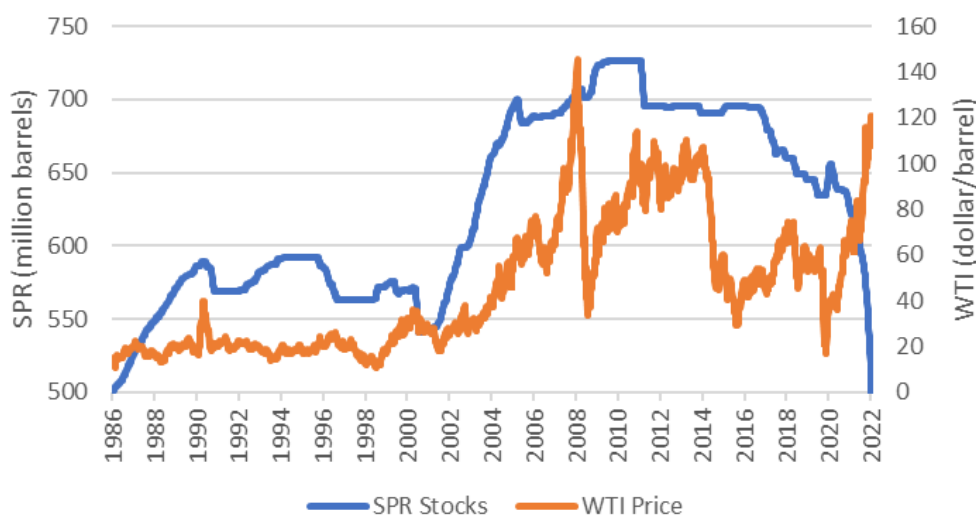
Figure 1: The history of SPR sales and exchanges (loans)



Source: U.S. Department of Energy

SPR stocks include light-sweet and medium-sour grades of crude oil. Sour crude trades at a discount to sweet crude due to its lower quality, but it is better suited for the configuration of U.S. Gulf Coast refineries. The stocks that were released in 2022 were predominantly sour, which makes the pace of the SPR drawdown of the most important crude oil grade for U.S. refineries even more extreme.⁴

Figure 2: Crude oil stocks in the SPR and WTI price



Source: U.S. EIA

At the time of writing this article, four competitive SPR auctions have so far been announced in 2022. The details of these auctions are summarized in **Table 1**. Additional sales are expected in the fall of 2022. The average prices received by the SPR on the first three sales were \$95.80, \$105.67, and \$108.64 per barrel.⁵ For these transactions to be profitable, SPR barrels must be repurchased in the future at prices lower than the price of the sale.

⁴ See J. Blas (2022), "The US is depleting its Strategic Petroleum Reserve faster than it looks", June 17, <https://www.bloomberg.com/opinion/articles/2022-06-17>.

⁵ Average sale prices were calculated by the author using individual transaction data, as reported in <https://www.spr.doe.gov/doesec/OilSaleArchivalReports/OilSaleArchive.htm>



Table 1: Emergency SPR sales in 2022

2022 SPR Sales	Notice Date	Volume (mb)	Sour (mb)	Sweet (mb)	Average Price
Emergency Sale 1	3/2/2022	30	20	10	95.80
Emergency Sale 2.A	4/1/2022	30	26.5	3.5	105.67
Emergency Sale 2.B	5/24/2022	40.1	39	1.1	108.64
Emergency Sale 3.A	6/14/2022	45	15.5	29.5	N/A

Source: U.S. Department of Energy, author's price calculations

To compare the strategy of emergency sales to exchanges, consider the latest SPR loan which was announced in November 2021 and implemented in early 2022. Borrowers were given several choices for barrels return periods. As the oil curve was backwardated, longer duration loans imply lower forward prices. Therefore, larger quantity of barrels must be returned to the SPR by longer-term borrowers resulting in the higher cumulative rate of return for the lender. **Table 2** provides details, including rates of return, for various loan tenors.

Table 2: SPR loans in 2021-2022

SPR Site	Volume (mb)	Return Period 1	Rate	Return Period 2	Rate	Return Period 3	Rate
Bryan Mound	10	Jan-Feb 2023	3.9%	Jun-Sep 2023	5.3%	Jun-Sep 2024	8.6%
Big Hill	10	July-Sep 2022	2.3%	Jan-Feb 2023	3.9%	Aug-Sep 2024	9.1%
West Hackberry	7	July-Aug 2022	2.3%	Jul-Sep 2023	5.6%	Jun-Sep 2024	8.6%
Bayou Choctaw	5	Sep 2023	6.1%	Jun-Sep 2024	8.6%	N/A	N/A

Source: U.S. Department of Energy, author's price calculations

Even though the return on the oil loan is guaranteed and effectively riskless, the latest emergency drawdowns were implemented as outright sales. In response to an earlier story published by Reuters that questioned this choice, an official from the Biden administration commented that “it is much more efficient to do the sale than to seek to arrange company-by-company contracts (as required by a swap or exchange)”.⁶ In this article, we provide further challenge to this decision based on theoretical grounds of the theory of storage and from the market perspective.

Learnings from the Theory of Storage

Commodity storage represents an option on time. It allows to shift limited supply from the times of plenty to the times of relative scarcity. The economic theory of storage has a long history starting with the pioneering work of Gustafson in 1950s.⁷ Its primary motive was to help governments to manage price volatility of agricultural commodities using state-owned reserves held in storage. The problem of optimal resource allocations in the presence of uncertain supply is rather complicated. It is the problem of stochastic dynamic programming with several monographs and numerous papers written on the subject.⁸

The basic idea of the optimal storage management hinges on the inverse relationship between inventories and the price of the commodity. When the demand for commodity exceeds the supply, leading to lower inventories and rising prices, then releasing stocks from storage helps to restore immediate fundamental balances. However, it also reduces forward supply of storage, as storage simply buys time for supply and demand to adjust. This theory can work in practice only if the price of the commodity reacts quickly to any changes in supply and demand. Unfortunately, the conventional argument does not apply well to the oil market due to extremely low-price elasticity of oil supply and

⁶ T. Gardner, J. Payne, and A. Ghaddar (2022). “Analysis: U.S. strategic oil sale speeds fuel-price fix, but at what cost?” April 11, <https://www.reuters.com/business/energy/us-strategic-oil-sale-speeds-fuel-price-fix-what-cost-2022-04-11>

⁷ R. L. Gustafson (1958), “Carryover Level for Grains”, U.S. Department of Agriculture, Technical Bulletin No. 1178.

⁸ See J. Williams and B. Wright (1991), “Storage and Commodity Markets”, Cambridge University Press, and C. Pirrong (2012), “Commodity Price Dynamics: A Structural Approach”, Cambridge University Press, and references therein.

demand and as a result an alternative market-based approach to the problem has been recently proposed.⁹

The spot oil price can be thought of having two components. One component represents the long-term oil price which is driven by the combination of the marginal cost of production and the net hedging pressure from the derivatives market. The second component is a time spread between the spot oil price with immediate delivery and the long-term price. In other words, the short-term oil price is the sum of the long-term oil price and the time spread. The sensitivity of the long-term price to immediate changes in supply and demand is nearly zero. In contrast, the correlation between time spreads and inventories is highly negative.

Any storage management strategy prescribed by the traditional storage theory that attempts to influence the price by releasing inventories is highly questionable and extremely risky. In fact, it can even lead to a perverse effect of higher forward prices, as derivatives traders buy long-term futures knowing that the buffer provided by storage becomes smaller in the future. While storage management cannot easily influence the price level, it can have a pronounced effect on time spreads.

Commercial inventory traders view storage facility as a real option, specifically, as a put option on the spread between spot and futures prices. Alternatively, one can view it as a call option on the spread between futures and spot prices with the strike price determined by the cost of storage. If the futures-spot spread exceeds the cost of storage, then the storage operator buys the physical barrel of oil and sells futures to lock in riskless profits. If the futures-spot spread does not cover the cost of storage, then the operator empties the storage by selling barrels in the physical market.

In practice, storage decisions are not binary. Optimal storage management depends on the volatility of time spreads. It is rarely optimal to fill up storage to its maximum capacity, as by doing it, the operator gives up a potential for larger profits if contango increases further. Likewise, traders do not like keeping stocks near minimum operational capacity of the storage tank, as empty storage removes them from the valuable chain of information about ongoing physical flows. Storage traders tend to be scale-in buyers of time spreads when spreads move into steeper contango, and scale-up sellers of time spreads when the market moves into backwardation. Option traders refer to such strategy as delta hedging of the real spread option embedded in the physical asset.

Two strategies available to SPR managers effectively correspond to two alternative approaches to the theory of storage. One that sells oil with the hope to impact the price of oil has its roots in the conventional approach to the theory of storage. The other one that lends oil represents the market-based approach of trading time spreads similar to the one widely used by professional oil traders. From the trading perspective, the former is akin to speculation, often dubbed by traders, as legging the spread. The latter, on the other hand, is the prudent arbitrage strategy that monetizes optionality embedded in the physical asset.

Mark-to-Market of the SPR strategies

The recent performance of two alternative SPR strategies is illustrated with a simple example. One strategy sells oil with an intent to buy it back in one year at a cheaper price. The second strategy is an arbitrage strategy of lending oil for one year. To keep the output of this case study more transparent, we use WTI futures instead of prices for medium-sour oil. Since our focus is on relative performance of two strategies, we can ignore the basis risk between sour crude and WTI and the impact of operational and interest rate costs, which should be similar for both strategies.

We assume that both strategies are executed on April 1, 2022, i.e., the day after the announcement by U.S. President to sell one million barrel per day of the SPR stocks for the following six months. The price of the spot May 2022 WTI contract on that day was \$99.27 per barrel, and the price of one-year

⁹ I. Bouchouev (2020), "A Stylized Model of the Oil Squeeze", SSRN, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3781158

May 2023 futures was \$87.52 per barrel. If one lends one hundred barrels from the SPR at \$99.27, then in one year the same amount of money, ignoring, for simplicity an interest rate, would buy $\frac{100 \times 99.27}{87.52} = 113.4$ barrels. Therefore, the loan generates 13.4% investment return to the lender if the return is measured directly in oil barrels. In his seminal book on employment, money and interest, John Maynard Keynes aptly labelled such return, as a commodity own rate of interest.¹⁰

The loan return is fixed, which is shown as a horizontal line in **Figure 3**, to highlight that there is no market risk in this arbitrage strategy. In contrast, the expected return on the oil sale fluctuates daily along with forward prices. If the forward price increases, then the expected return decreases, and vice versa. The graph shows daily mark-to-market for this sell strategy with an expectation to buy barrels back in one year. By June 8, 2022, this strategy not only gave up all potential gains from the market backwardation, but even turned into a loss. This occurred when the price for May 2023 futures contract increased above \$100 per barrel, therefore, exceeding the original sale price of spot barrels on April 1, 2022. With the recent downward correction in oil prices, the sell strategy was able to recover a portion of its mark-to-market losses.

Figure 3: Expected investment return on loan versus sales



Source: U.S. EIA for prices, author's calculations

From an investment perspective, the choice between two strategies is straightforward. One strategy generates a guaranteed attractive return with no market risk. The other strategy has plenty of risk with no guaranteed return, which could even turn into a negative return if forward prices continue to rise. By selling oil in the spot market and committing to buy it back in the future, the seller effectively has a short forward position in the market. It is a well-known fact that, historically, selling forward in a backwardated market would have been a big loser. In fact, the opposite strategy of buying futures in the backwardated market would have generated an outstanding 17% annualized return over the last thirty years.¹¹ To say it differently, an expected outcome of the short forward position established at the price below the spot price is a loss because the best guess of the expected future oil price is today's spot price, and not the price of the futures contract.¹²

¹⁰ J. M. Keynes (1936), "The General Theory of Employment, Interest and Money", Macmillan. A similar concept has been previously used by I. Fisher (1996), "Appreciation and Interest", Publications of the American Economic Association, 11 (4), pp. 331-442, and by P. Sraffa (1932), "Dr. Hayek on Money and Capital", The Economic Journal, 42 (165), pp. 42-53. For simplicity, we omitted the risk-free interest rate in the original definition of the commodity own rate of interest.

¹¹ See I. Bouchouev, and L. Zuo, (2020), "Oil Risk Premia under Changing Regimes", Global Commodities Applied Research Digest, 5(2), Winter, pp. 49-59.

¹² See, for example, R. Alquist, L. Kilian, and R. Vigfusson, (2011), "Forecasting the Price of Oil", Board of Governors of the Federal Reserve System, International Finance Discussion Papers, 1022.

Conclusion

Like any other storage asset, the SPR represents an option on time. It allows inventories to be shifted forward, providing short-term relief to the market when the demand for a commodity exceeds its supply. The inventory replenishment at a later time implies carrying a short position in the forward market. In the case of the SPR, the management of this short position critically depends on whether inventories are released in the form of a loan or as an emergency sale. In the SPR loan, the short forward position is covered contractually when borrowers return the barrels. If the market is in backwardation, then more barrels must be returned to the SPR than the quantity that was borrowed, and the loan generates a guaranteed positive return to the lender.

In contrast, the SPR sale is a bet that barrels can be repurchased at the price lower than the price of the sale. Historically, carrying short forward positions in a backwardated market would have generated large losses, as lower forward prices tend to roll up towards the higher spot price. Not only the strategy of selling oil with a hope to buy it back at a cheaper price takes an enormous amount of risk compared to the strategy of lending oil, but the odds of it generating any positive return to the storage owner are highly unfavorable.