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Returns to Storage

Increasing inventories have provided the principal downward pressure experienced by natural gas and petroleum markets this year. The rise in stocks has occurred as new participants in the markets (hedge funds and commodity investors) have provided the financial liquidity required to finance inventory accumulation.

Many have noted the boost in inventories. Many have also noted that inventory data are very imperfect, a problem that has been known for years. This report has offered an alternative now for 20 years: "returns to storage." Returns to storage derive information from the price structure. As such, they indicate the amount of oil in stocks available to the market today and the amount that will be available in the future. If one accepts the principle that prices contain all information, returns tell the analyst everything there is to know about stocks on a contemporaneous basis in every market where trading occurs. Properly studied, these data can give a very clear picture of the global stock position, probably a better one than traditional data.

Today these data point to an inventory glut. Stocks are at 20-year highs on an economic basis. For those who worry that high stocks signal a future price collapse, these data should be positively frightening.

This section explains returns and provides a basis for linking this concept to other, more traditional measures of supply and demand. In the process, current returns are examined for heating oil and Brent crude. The explanation is then followed by a review of current returns to storage data.

The Basics

Returns to storage provide a mechanism for measuring the financial return earned by renting a commodity. Rental rates for commodities are the amount paid by a commercial entity that either lends out or "rents" the commodity. This concept, which had been used by traders in precious metals, was formalized by Jeffrey Williams.[2]

The "rental rate" is simply the amount paid to make use of the commodity for a period. It is, in other words, the profit or loss made by hedging. For example, a refiner holding inventories in effect rents them to a second party when the refiner sells futures against the stocks. If the oil is purchased for $60 per barrel and sold

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[2] Jeffrey C. Williams, *The Economic Function of Futures Markets* (New York: Cambridge University Press, 1986).

forward for delivery in 60 days for $63 per barrel, the firm renting out the crude earns $3 per barrel for its two-month lease of crude.

Returns to storage are designed to provide a mechanism for measuring the financial return on this transaction. Specifically, *returns indicate the financial return that can be realized from a traditional cash-and-carry transaction*. In the example above, the return on the crude sold forward is approximately 34 percent at annual rates. This is calculated by annualizing the 5-percent return earned over six months.[3]

Returns to storage have an obvious implication for any firm in the business of buying and selling commodities. Inventories of a commodity should be acquired when returns are positive and exceed the cost of holding inventories. On the other hand, inventories should be liquidated and the cash generated by their disposal should be invested in other instruments when returns are less than what can be earned from other investing activities.

The actual calculation made by a trader allocating short-term capital between inventories and other investments will be more complicated, of course, than the one described above. At a minimum, the trader will want to examine the costs associated with holding inventories. Thus, the costs of storage, insurance, and shrinkage must be deducted from the imputed rent before returns are calculated. Processors such as refiners or natural gas distribution companies may also want to make adjustments for risks of an unfavorable change in the basis between prices quoted at the delivery location and prices quoted on the futures market.[4]

In the example shown above, the following adjustments might be incorporated into the calculation for a company considering adding incremental stocks to inventories and selling them forward on futures markets (effectively leasing its oil).

- Storage costs — $0.25 per barrel per month
- Insurance — $0.05 per barrel per month
- Basis risk between the NYMEX price and the local point of storage — $0.10 per barrel

Total charges amount to $0.40 per barrel per month. Thus, the net profit (rent) from selling the oil forward is $2.30 per barrel (two months' rent plus basis risk subtracted from the $3 profit). After adjustment, the returns would drop to

[3] The annual return is calculated as 5 percent over 60 days (the $3 profit divided by the $60 base cost). Annualizing this figure (taking 1.05 to the sixth power) yields a return of 34 percent.

[4] A number of natural gas producers experienced losses in 1996 when prices at the Henry Hub rose by larger amounts than prices at delivery locations in Texas because of a lack of pipeline capacity from Texas. Firms hedging jet fuel with distillate futures have experienced similar risks when the basis between distillate and jet fuel prices has changed.

25 percent.[5] For most firms, such a return would provide more than an adequate incentive to build inventories.

In fact, the economic incentives facing every firm will differ because no two will have the same cost of storage, insurance, basis risk, and capital. Some companies will be able to add profitably to inventories when spreads are small. Other companies will face much higher costs and thus will be less able to take advantage of the economic opportunities.

Implications for Market Observers

It is impossible to compute returns to storage for individual companies because of a lack of information on company-specific storage costs, insurance premiums, and basis risk. It is possible, however, to compute simple returns to storage (that is, returns based only on price spreads). In turn, returns computed in this manner ought to indicate the level of inventories—or at least the demand for inventories. If the aggregate costs of storage are roughly constant, the number of companies that can profitably store oil and the amount of oil stored will presumably increase as returns increase. Thus, returns ought to provide a measure of stock levels.

The Petroleum Economics Monthly relies on returns to storage as an indicator of stock levels because we believe that higher returns should be associated with higher stock levels. This belief is based on an assumption that markets are competitive, storage costs for most of the principal market participants are roughly similar, and market participants act in their own self interest. This implies that firms will hold on to product or crude barrels if they calculate it will be more profitable to sell the materials next month than this month—or next year rather than this year. The measure of profitability will be associated with returns to storage: the higher the returns, the higher the profit. This leads to a conclusion that returns should be positively related to inventories.

Returns also provide better and earlier insights into inventory levels than physical measures of stocks because they can be calculated instantaneously. They are also less subject to measurement error, assuming market players make rational trading decisions.

Graphs of returns to storage for two commodities—New York Harbor heating oil and Brent crude—illustrate this point. Returns for heating oil are shown in Figure 21. Returns for Brent are shown in Figure 23. Each graph shows the returns to storage during the current year, as well as returns in a year when inventories were low. Also shown are the historical ranges for returns. The historical range is defined as one standard deviation above and below the average return for the specific week of the year.

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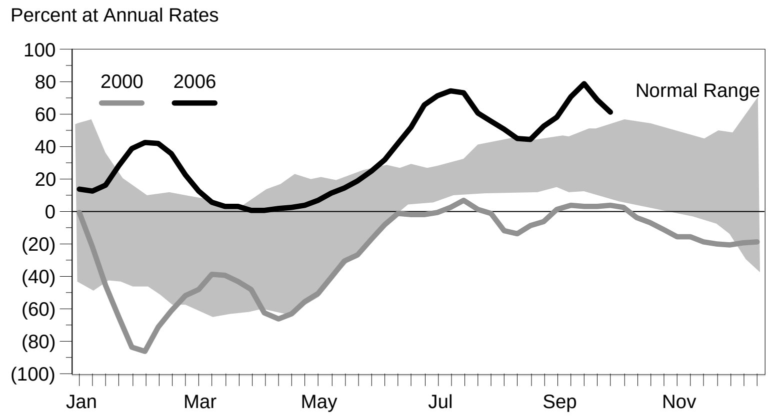
[5] Calculated as 62.3/60, or 1.038, for two months. Over a year, this return is 25 percent.

First examine Figure 21 and note that returns in 2000 were at the bottom of the normal range throughout most of the year. In contrast, returns to storage for heating oil in 2006 have been well above the historical range.

Compare Figure 21 to Figure 22. Figure 22 shows heating oil inventories at the national level. Here we again show the normal range and stocks for the years 2000 and 2006. Notice that inventories in 2000 were at the bottom of the normal range, while stocks in 2006 were at the top.

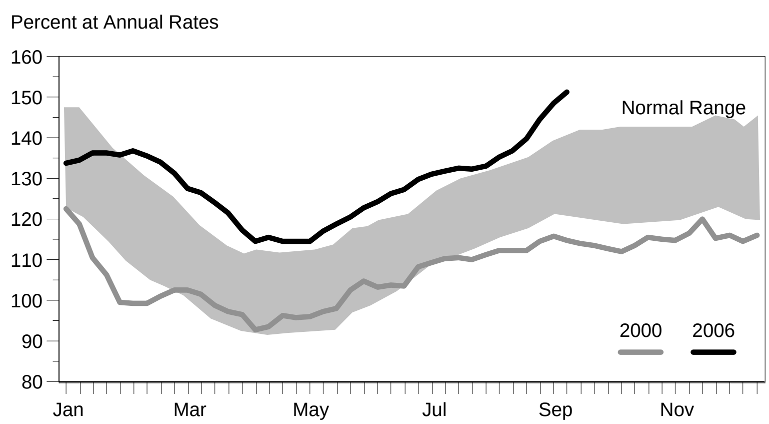
By watching returns closely, analysts could have noted in 2006 that inventories were building to ten-year record levels and could have been warned that prices might drop if the U.S. East did not experience an early cold winter.

Figure 21
Returns to Storage for Heating Oil — 2000, 2006, and Normal Range



Source: PKVerleger LLC.

Figure 22
Commercial Inventories of Distillate Fuel Oil — 2000, 2006, and Normal Range

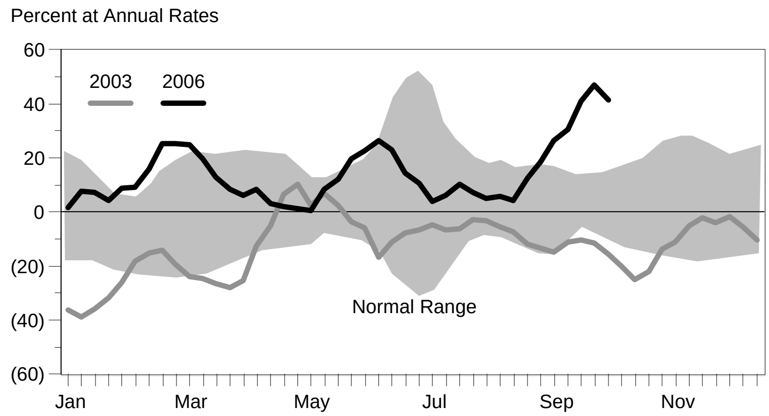


Source: U.S. DOE; PKVerleger LLC.

Further confirmation that supplies were at record levels in 2006 can be found in the matrix of returns to storage. Table 5 shows returns to storage computed as of the end of September for heating oil to be delivered in October through September. Note that the returns for each forward delivery month were much higher in 2006 than in the prior six years.

One additional note. In the example on page 26, returns were computed for 60 days. There is no reason why one could not compute returns for 90 days or for 30 days. In Table 5, returns are shown for product purchased and held for five days (the October return), product purchased and held for 35 days (the November return), product purchased and held for 65 days (the December return), and so on. Each calculation uses a different futures contract, a different number of days to maturity, and a slightly different calculation.

Figure 23
Returns to Storage for Brent — 2003, 2006, and Normal Range



Source: PKVerleger LLC.

Figure 23 shows returns to storage for Brent crude for 2003 and 2006. In 2003, returns fluctuated near the bottom of the historical range for much of the year, reflecting OPEC's aggressive efforts to keep global inventories tight. In 2006, returns have been high as stocks have moved toward record levels.

Table 5. End-September Returns to Storage for Heating Oil – Financial Return Earned on Heating Oil Stored in New York and Delivered to Satisfy Obligations under the NYMEX Contracts (Percent at Annual Rates)

Contract	1999	2000	2001	2002	2003	2004	2005	2006
Nov	14.6	0.7	17.3	23.0	8.9	0.5	41.9	77.4
Dec	13.0	-2.1	16.0	17.0	8.6	0.9	31.6	64.2
Jan	9.3	-4.3	12.8	13.3	8.0	-0.1	23.0	54.9
Feb	3.6	-9.5	8.6	5.5	4.3	-3.8	16.0	45.9
Mar	-4.6	-16.7	1.7	-3.0	-2.9	-10.6	8.6	36.9
Apr	-11.6	-20.5	-2.7	-9.5	-9.2	-16.4	0.5	28.5
May	-15.2	-23.3	-5.4	-14.6	-13.4	-20.2	-4.5	22.4
Jun	-15.6	-23.5	-5.6	-15.9	-14.6	-21.4	-6.9	19.4
Jul	-14.8	-22.5	-4.8	-15.5	-14.3	-20.9	-6.7	18.0
Aug	-13.1	-20.5	-3.8	-14.2	-12.8	-19.1	-5.7	17.3
Sep	-10.8	-18.5	-2.6	-12.6	-11.1	-17.1	-4.4	17.2

Note: Returns exclude storage costs.

Source: PKVerleger LLC.

Again, the difference between 2006 and previous years becomes more apparent when the returns matrix is examined. The returns shown in Table 6 suggest that the Brent market is better supplied today than in recent years.

Returns to storage for Brent cannot be compared to contemporaneous data for global inventories of light crude because data on stocks are not available. In fact, no data on global stocks of light crude are available even with a lag. Thus returns to storage for Brent provide a unique view on the supply situation for light crude oil.

Table 6. End-September Returns to Storage for Brent – Financial Return Earned on Brent Stored in Europe and Delivered to Buyers if Contract is Linked to the IPE Contract (Percent at Annual Rates)

Contract	1999	2000	2001	2002	2003	2004	2005	2006
Nov	13.7	46.8	46.9	-3.4	-11.5	-3.7	25.8	69.3
Dec	-0.7	26.7	28.7	-3.7	-13.1	-8.9	18.9	50.4
Jan	-9.8	16.2	23.6	-5.9	-13.3	-11.0	17.9	39.8
Feb	-16.0	9.3	17.1	-9.1	-13.2	-11.8	15.0	33.1
Mar	-17.6	4.6	12.3	-13.3	-13.0	-12.4	12.9	29.0
Apr	-19.0	1.5	8.9	-15.9	-12.6	-12.5	11.0	25.3
May	-20.0	-0.7	6.7	-17.5	-12.1	-12.6	9.5	22.9
Jun	-21.0	-2.3	5.1	-18.4	-11.7	-12.5	8.2	20.7
Jul	-21.0	-3.4	3.8	-18.3	-11.2	-12.5	7.1	19.1
Aug	-20.5	-4.3	2.8	-18.4	-10.8	-12.4	6.2	17.5
Sep	-20.0	-5.0	2.0	-18.1	-10.3	-12.2	5.5	16.2
Oct	-19.8	-5.3	1.4	-17.7	-9.7	-12.2	4.9	15.0

Note: Returns exclude storage costs.

Source: PKVerleger LLC.

Returns Defined Mathematically

Returns for a commodity are calculated as the *annualized* ratio of the forward price to the spot price. The specific formula used here is written as

$$Return_t = 100*(Exp(Ln(F_{t,T}/S_t)*(365/(T-t)))-1) \quad [3]$$

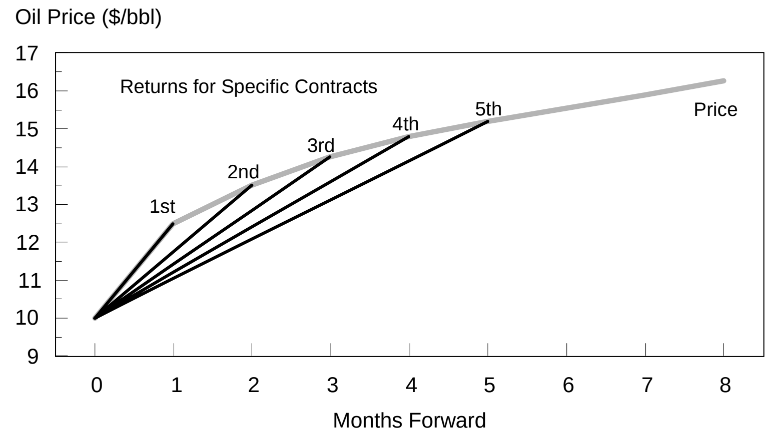
where $Return_t$ is the return to storage at time t, $F_{t,T}$ is the futures price today (represented by t) for a commodity to be delivered at time T (some day in the future), and S_t is the cash price for the commodity today.

Returns can be calculated for any period for which a futures contract is traded or for which some firm makes a market in derivatives. Returns to storage for December 2006 would be based on the December 2006 futures contract and the spot price, while returns to storage for December 2007 would be computed using the December 2007 futures contract and the spot price.

While it is difficult to describe returns graphically, the concept can be shown by the straight lines drawn on the forward price curve in Figure 24. On this graph, the straight lines emanate from the spot price and go to the forward price (first, second, third, fourth, or fifth contracts). In effect, returns to storage measure the slope of that straight line.

It is noted that all returns are measured from the spot price, not from a forward price, because the concept measures the financial return from *buying and holding hedged inventories*.

Figure 24
Graphical Representation of Returns to Storage



Source: PKVerleger LLC.

Several comments need to be made about this basic formula. First, as noted above, no allowance is made for the cost of storage. Second, delivery is assumed to occur in the delivery market. Third, no adjustment is made for the cost of money (interest rates). Fourth, the delivery date is arbitrary. Fifth, it is assumed that futures prices are not affected by the sale of futures. Sixth, *and most important*, the formula is based on spot prices, *not the spot futures contract*.

Allowance for the Cost of Storage

No allowance is made in the formula for the cost of storage because, as noted above, storage costs will vary from firm to firm. A firm with surplus storage capacity will incur essentially no costs. For this firm—and for most other firms in the oil business—the opportunity cost of adding an additional barrel to inventories will generally be zero.

However, this is not always the case. Companies using public storage (GATX facilities, for example) will generally be required to pay a fixed fee to move the product into and out of the tanks, along with a monthly fee for storage. Letting X represent the "in and out charge" and D the daily charge for storage, the formula is modified as follows:

$$Return_t = 100*(Exp(Ln((F_{t,T} - X - (T-t)D)/S_t)*(365/(T-t)))-1) \qquad [4]$$

The introduction of storage costs will reduce returns. However, the reduction will be essentially constant as long as interest rates do not change significantly. Thus, as an indicator of supply-and-demand balances, the failure to include storage costs is not a problem.

The Delivery Market

Returns are also computed under the assumption that the commodity is purchased in the delivery market, stored in the delivery market, and delivered in the delivery market. The computations do not make allowances for transportation costs or basis risk (for example, storing product in Chicago for delivery in Chicago while hedging on the NYMEX).

Of course, it is possible to make an adjustment for locational differences. For example, the formula in Equation 3 can be modified for a case where storage occurs in Texas. Under such circumstances, the denominator in the returns calculation would include both the spot price of the commodity (S_t) and the transportation charge for moving the commodity to the delivery market (C). The formula would appear as follows:

$$Return_t = 100*(Exp(Ln(F_{t,T}/(S_t+C))*(365/(T-t)))-1) \quad [5]$$

Cost of Money

The calculation also makes no adjustment for the cost of money. The explanation for this omission is simple: the computation is designed to give a CFO a measure of return that could be earned from investing in inventories. However, adjustments can be made simply by subtracting the annualized return earned on short-term instruments from the calculated returns to storage.

The Arbitrary Delivery Date

Perhaps the most critical assumption in the calculation is that associated with the delivery date. In the computations, it is assumed that delivery occurs on the first of the month. However, this is not always the case. Deliveries of crude and natural gas can occur ratably over a month, while traders taking delivery of gasoline or heating oil can pick a five-day "delivery window."

The choice of the delivery window for products makes the computation much more difficult. The reason is buyers will tend to delay deliveries to the end of the month when the market is in contango, while taking delivery early in the month when the market is in backwardation. Indeed, an analysis of delivery statistics made in connection with litigation between Apex and DiMauro revealed that deliveries followed a bimodal distribution—occurring at either the beginning or the end of the month. In addition, the research indicated that the distribution of deliveries was closely related to the shape of the price curve.

The imposition of the delivery assumption made in my calculation imparts an upward bias to the calculations. Firms storing products or crude face the risk that buyers will delay delivery to the end of the month and thus cut into the returns.

This effect of delay has a substantial impact on one- or two-month returns but diminishes as the storage period is extended.

The Spot Price

The most critical assumption in the calculation is the use of the spot price for the commodity. In these calculations, prices reported for immediate delivery of heating oil, gasoline, and crude oil as reported by Platts are used.

Current Returns to Storage

Returns to storage for the January 2007 contract of the six key energy commodities followed by PKVerleger LLC are shown in Table 7. Also shown are the previous record high for returns to storage for that contract for mid-October and the record's date. Returns for three of the six contracts are at all-time highs. Returns for WTI have broken a 20-year record, as have returns for gasoline. Returns for natural gas have broken a 15-year record. Returns to storage for heating oil and gasoil are also near all-time highs and last month (September) broke the previous record for mid-September. Returns to storage for Brent also reached record highs before production in Norway was disrupted. These data point to high stocks and planned production everywhere. Tanks are full and more production is coming if facilities can be found to hold it.

This does not imply that stocks are at record levels. Heating oil inventory levels were almost twice as high 30 years ago. However, the industry has become more efficient at inventory management and use has dropped. These data only indicate that inventories and planned product availability are very high relative to market capacity and recent events.

Table 7. Returns to Storage for Principal Petroleum Products, Crude, and Natural Gas for Delivery in January 2007 as of Mid-October 2006 Compared to Record Highs (Percent at Annual Rates)

	Mid-Oct 2006	Previous Record	Year of Previous Record
Light Sweet Crude	**24.5***	13.0	1998
Brent Crude	22.4	32.5	2001
New York Harbor Gasoline	**21.5***	14.9	2001
New York Harbor Heating Oil	37.2	54.9	1986
Gasoil Delivered in Rotterdam	22.5	29.6	1988
U.S. Natural Gas	**357.4***	185.0	2004

* New record

Source: PKVerleger LLC.