FRBSF Weekly Letter

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Forecasting Oil Prices

The sharp decline in oil prices over the last 12 months has greatly reduced the actual rate of inflation in the United States, and served as a renewed reminder of the importance of forecasting the future behavior of oil prices as part of any forecast of the general rate of inflation. The economic theory of futures markets suggests that oil futures prices may provide information useful in forecasting future oil prices.

This *Letter* examines the forecasting ability of futures prices for oil. Specifically, prices on three- and six-month futures contracts for crude oil since August 1983 are compared with the subsequent spot prices — the price of oil for current delivery — three and six months in the future.

Several conclusions emerge from this comparison. First, oil futures prices during the period examined are as likely to underpredict as to overpredict future spot prices. In technical terms, they are unbiased.

Second, futures prices provide relatively inaccurate forecasts of future spot prices even though they are unbiased. Forecast errors may, on average, be equal to zero, but this result tends to reflect large positive and large negative errors that cancel each other out.

Third, futures prices seem to provide somewhat more accurate forecasts than current and past spot prices. Finally, incorporating information on the relationship between current futures prices and the current spot price improves the forecast.

Oil futures prices

Futures markets exist to enable individuals and firms to reduce the risk of future price movements. A firm that knows it will need oil in the future has two choices. It can wait until it needs the oil to purchase it, and then buy at an uncertain future price in the spot market. Or it can contract today at a known price in the futures market for later delivery. For example, if the firm needs oil in three months, it could make the purchase at today's three-month futures price and eliminate uncertainty about the actual cost of the oil in three months time.

The desirability of buying, or selling, oil in the futures market will depend on the futures price relative to the expected future spot price. If the spot price were expected to rise above the current futures price, buyers would have an incentive to buy in the futures market rather than to wait to buy in the spot market. This process would tend to bid the futures price up. Similarly, a futures price higher than the expected future spot price will tend to place downward pressure on the futures price. Futures prices will also be related to the current spot price and the cost of carrying inventories of oil over the relevant time horizon.

This analysis suggests that futures prices should provide forecasts of future spot prices. Economists would describe the futures market for oil as *efficient* if the forecast of future spot prices implicit in futures prices incorporates all currently available relevant information. Futures prices by their very nature are forward-looking. The October three-month futures price for crude oil, for example, should provide a good forecast of the spot price that will prevail in January.

Despite their forward-looking nature, crude oil futures prices vary closely with the *current* spot price. This is illustrated in Chart 1, which plots the spot price of West Texas crude from August 1983 to October 1986, and the three-and six-month futures prices. (All prices are measured as of three business days before the 25th of each month. This corresponds to the settlement date for delivery during the following month since pipeline space must be reserved by the 25th of the month.)

The close relationship between all three price series apparent in Chart 1 might suggest that futures prices would not provide much more information about future spot prices than do current spot prices. Nevertheless, the market would

still be efficient if one generally could not predict changes in the spot price of crude oil at horizons of three and six months. In this case, a rise in the current spot price should lead to an equal upward revision in forecasts of future spot prices and current futures prices since the rise would not be expected to be reversed. If future changes were unpredictable, the spot price in an efficient market could be characterized as following a random walk.

Evaluating forecast accuracy

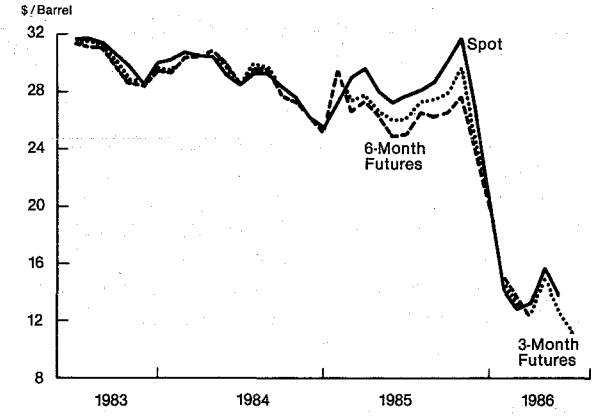
Two basic issues are involved in evaluating the forecast accuracy of futures prices. The first is whether the forecasts are unbiased in the sense that they do not systematically under- or overestimate future spot prices, and the second is the size of the actual forecast errors.

If the forecasts from futures prices were unbiased, the subsequent actual spot prices should be above the current futures prices as often as they are below them. This means that, in a plot of the three-month futures price against the spot price 3 months later, all the points should fall roughly along a 45° line that represents an exact match between the forecast and the actual spot price.

Chart 2A provides such a plot for the three-month futures price; Chart 2B plots the six-month futures price against the actual spot price six months later. In general, the points do seem to fall along the 45° lines, indicating that the forecasts are unbiased. The few points well below the 45° line are associated with the rapid decline in spot prices during 1985 when futures prices consistently indicated less of a decline in future spot prices than subsequently occurred. Statistical tests support the conclusion that, over the sample period, futures prices were unbiased forecasts of future spot prices.

Just because a forecast is right on average does not mean that it is a very accurate forecast. Large positive errors may simply offset large negative errors. Chart 3 shows the errors one would have made using the futures prices as forecasts of future spot prices. The failure of futures prices to predict the full decline during late 1985 and early 1986 is readily apparent. Earlier in 1985, positive errors were common. These forecast errors are large relative to the level of spot prices, which averaged $28 in 1985 and $15 during the first ten months of 1986.

Chart 1
Spot and Futures Oil Prices Vary Closely



More accurate

Even though futures prices and spot prices tend to move together, futures prices may still provide a better forecast of future spot prices. A direct comparison of the predictive accuracy of futures prices with that of forecasts based only on current and lagged spot prices yielded two interesting results. First, futures prices do provide better forecasts, as ranked by a measure of their forecast errors.

Second, based on current and lagged spot prices, forecasts of future spot prices for forecast horizons of three months or more are all equal. Thus, the best forecast of the spot price six months in the future is the same as the best forecast of the spot price three months in the future. The six-month futures price, as a forecast of the spot price in six months, should therefore roughly equal the three-month futures price since the latter is a forecast of spot prices in three months. This helps explain why the three- and six-month futures prices move together so closely, and it supports the hypothesis that the pattern of spot price behavior is close to a random walk at these horizons.

Improving the forecast

Forecasts of future spot prices can be improved by taking the relationship between current spot and futures prices into account. Specifically, the future change in the spot price should be related to the *difference* between the futures price and the current spot price. If spot prices were expected to rise, for example, futures prices should be higher than the current spot price,

Chart 2
Oil Futures Prices are Unbiased Forecasts of Future Spot Oil Prices

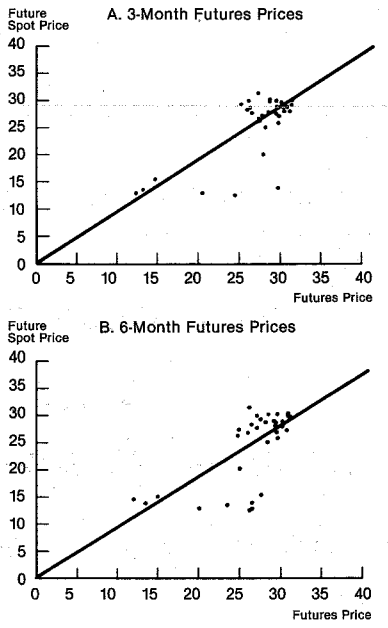
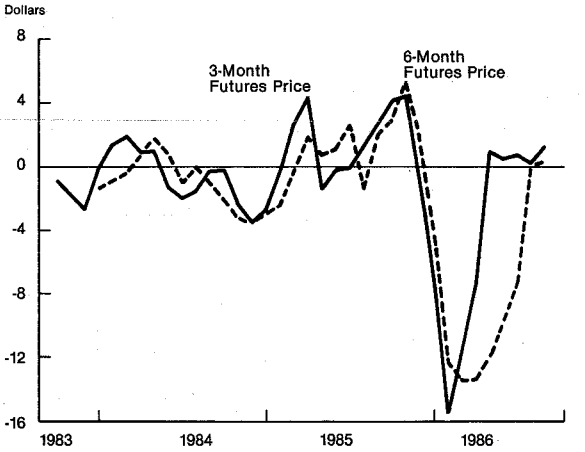


Chart 3
Large Forecast Errors from Oil Futures Prices



although never by more than the cost of carrying inventories over the same horizon. Forecasts derived using this difference between current spot and futures prices have smaller forecast errors than forecasts based just on the futures prices themselves.

Conclusion

On the basis of the estimated relationship between future changes in spot prices and the differences between current spot and futures prices, forecasts of crude oil prices for January 1987 and April 1987 can be calculated from October spot and futures prices. On the 21st of October, the spot price for West Texas crude oil was $14.80. The three- and six-month futures prices were both $15.52.

Based on these data and a relationship between futures and spot prices derived from historical data, the forecast is $15.86 for the January spot price and $15.84 for the April spot price. However, the accuracy of such forecasts is very low and, at best, the historical relationships only allow one to say that, with 95 percent certainty, spot prices next January and April will be somewhere in the $5-$25 range.

These large margins of error in forecasts of future oil prices imply that market participants concerned with the future course of oil prices face a high level of uncertainty. During the past fifteen years, the market for oil has been dominated by political developments. Such influences are inherently difficult to predict, and for that reason, it is perhaps not surprising that oil price forecasts are so inaccurate.

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BANKING DATA—TWELFTH FEDERAL RESERVE DISTRICT

(Dollar amounts in millions)

Selected Assets and Liabilities Large Commercial Banks	Amount Outstanding 11/12/86	Change from 11/5/86	Change from 11/13/85 Dollar	Percent[7]
Loans, Leases and Investments[1 2]	203,358	– 239	5,829	2.9
Loans and Leases[1 6]	182,688	– 519	4,055	2.2
Commercial and Industrial	50,076	– 194	– 1,360	– 2.6
Real estate	67,061	61	1,352	2.0
Loans to Individuals	39,476	– 44	1,633	4.3
Leases	5,590	6	194	3.5
U.S. Treasury and Agency Securities[2]	12,779	259	1,134	9.7
Other Securities[2]	7,891	21	639	8.8
Total Deposits	210,324	2,591	7,208	3.5
Demand Deposits	57,598	2,439	7,162	14.2
Demand Deposits Adjusted[3]	38,015	189	– 8,156	– 17.6
Other Transaction Balances[4]	18,358	– 40	3,814	26.2
Total Non-Transaction Balances[6]	134,368	193	– 3,767	– 2.7
Money Market Deposit Accounts—Total	46,328	– 64	656	1.4
Time Deposits in Amounts of $100,000 or more	32,925	131	– 5,663	– 14.6
Other Liabilities for Borrowed Money[5]	25,504	– 472	1,258	5.1

Two Week Averages of Daily Figures	Period ended 11/3/86	Period ended 10/20/86
Reserve Position, All Reporting Banks		
Excess Reserves (+)/Deficiency (–)	21	59
Borrowings	64	12
Net free reserves (+)/Net borrowed(–)	– 42	48

1 Includes loss reserves, unearned income, excludes interbank loans
2 Excludes trading account securities
3 Excludes U.S. government and depository institution deposits and cash items
4 ATS, NOW, Super NOW and savings accounts with telephone transfers
5 Includes borrowing via FRB, TT&L notes, Fed Funds, RPs and other sources
6 Includes items not shown separately
7 Annualized percent change