

An Assessment of Prices of Natural Gas Futures Contracts As A Predictor of Realized Spot Prices at the Henry Hub

This article compares realized Henry Hub spot market prices for natural gas during the three most recent winters with futures prices as they evolve from April through the following February, when trading for the March contract ends. Questions or comments should be directed to Lejla Alic at lejla.alic@eia.doe.gov or (202) 586-0858.

Introduction

A futures contract is a binding, legal agreement between a buyer and a seller for delivery of a particular quantity of a commodity at a specified time, place, and price. These contracts are traded on regulated exchanges and are settled daily based on their current value in the marketplace.

Most natural gas futures contracts traded on the New York Mercantile Exchange (NYMEX) end without actual physical delivery of the commodity. Futures contracts most often are liquidated or cancelled out by purchasing a covering position prior to the delivery date and are generally used as a financial risk management and investment tool rather than for supply purposes. Futures contracts are most widely used for hedging. Hedging allows someone to offset the risk of fluctuating prices when he buys or sells physical supplies of a commodity. However, as an indication of market expectations concerning prices in the future, some industry and market participants tend to use the prices for futures contracts as predictions of commodity prices that will be realized in subsequent months, although NYMEX itself does not explicitly encourage this view.

An examination of price data for recent years shows that futures prices are relatively poor predictors of the Henry Hub spot price that is realized during the corresponding delivery or target month, and even the final futures price for a given contract often does not anticipate correctly the realized average spot price. Futures prices vary substantially over time and apparently reflect current market conditions as well as future expectations. The purpose of this analysis is to review the recent performance of futures contracts prices as predictors of the realized spot price. It does not examine the merits of futures trading for hedging or of particular hedging strategies.

The following analysis examines futures contract prices for heating season months (November through March) during three consecutive years (2002-03, 2003-04, and 2004-05) and compares them with average monthly spot prices at the Henry Hub (see Box for a description of the data used in this analysis). The period of analysis for each heating season is the 12 months from April (the start of

the refill season) through March (the end of the heating season). Comparing monthly futures and spot market prices allows an examination of the influence of current market conditions on price expectations and provides a basis to assess the performance of futures prices as a predictor of spot prices.

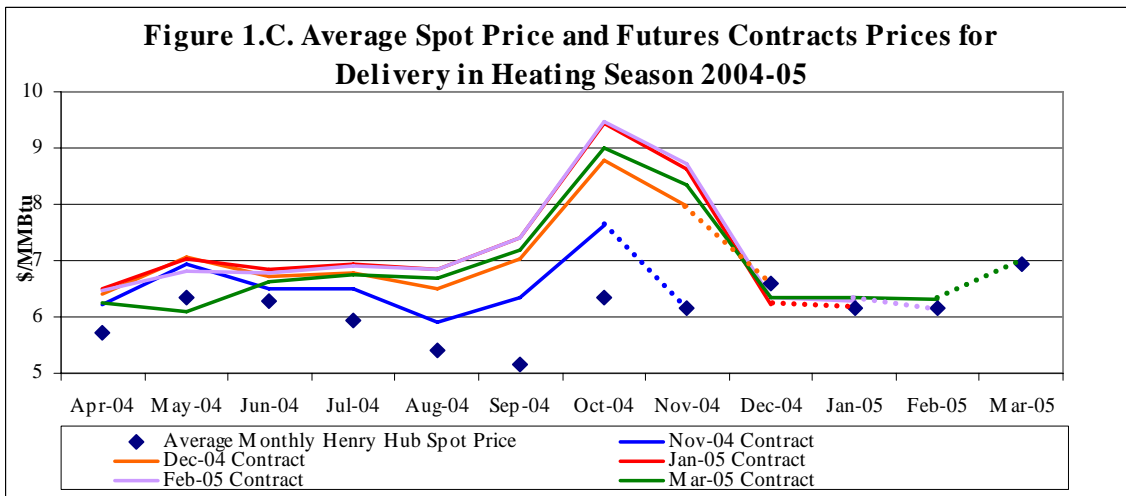
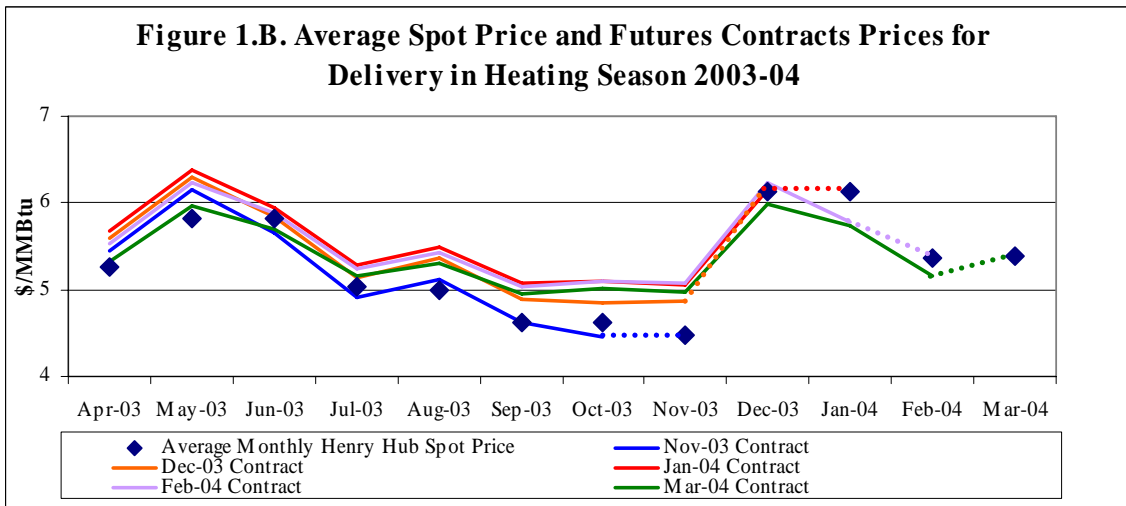
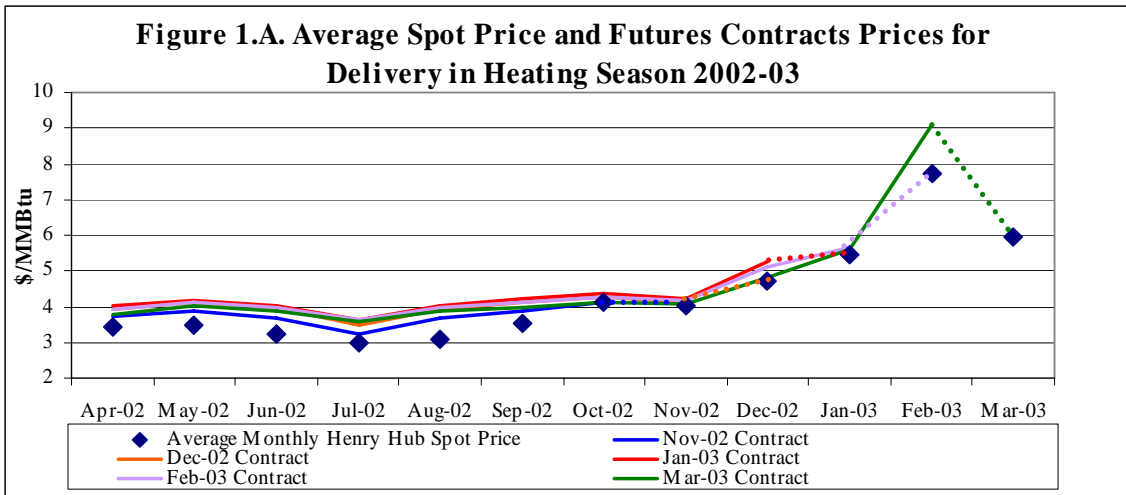
Analysis

The heating season futures and spot price data for the three-year period, April 2002 through March 2005, are displayed in three graphs. The graph lines in Figures 1.A, 1.B, and 1.C depict the futures settlement prices recorded each month on the final day of trading for the near-month future delivery contract. The diamond-shaped points on these graphs represent the average monthly spot prices at the Henry Hub. Because trading on each futures contract expires in the month prior to the delivery month, the futures price series end in the month preceding the delivery month. The final futures price is connected to the realized spot price by dashed lines. The steeper the slope of the dashed line - up or down, then the greater the difference between the expiration price and the subsequent Henry Hub spot price in the delivery month.

Futures Contract Prices and the Henry Hub Spot Price Data

The futures contract prices used in this analysis are prices as reported on the final trading day of each near-month NYMEX contract. Because each futures contract has its final trading day in the month prior to the delivery month, the prices of any given contract do not continue into the actual delivery month. The spot prices are the arithmetic average of the Henry Hub spot prices for the month. The analysis is based on the selected futures contracts for delivery in the three heating seasons (November-March) 2002-2003, 2003-2004, and 2004-2005. The data used in the analysis were derived by the Natural Gas Division based on data published in the *NGI's Daily Gas Price Index* (<http://intelligencepress.com>). A copy of the data is available in pdf format at http://www.eia.doe.gov/oil_gas/fwd/futures.html.

AVERAGE MONTHLY HENRY HUB SPOT PRICE AND FUTURES CONTRACT PRICES ON THE FINAL TRADING DAY OF THE NEAR-MONTH CONTRACT, APRIL-MARCH



- The data curves in the above figures represent the futures prices as reported on the final trading day of each near-month contract. Because each futures contract has its final trading day in the month prior to the delivery month, the prices do not continue into the actual delivery month.
- The diamond-shaped points represent the average monthly spot prices at the Henry Hub.
- The dashed line is provided for reference to show the change from final settlement price for each futures contract to the corresponding average Henry Hub spot price.

An examination of the prices for the November 2002 futures contract during the trading months from April through October 2002 serves as an example of the analysis of the various price series to assess the relationship between the futures contract prices and the eventual average spot price. The November 2002 contract prices in this period differ by as much as 81 cents per million British Thermal Units (MMBtu) or 20 percent from the realized November average Henry Hub spot price of \$4.042 (Figure 1.A). The November contract price was below the realized price in all months prior to October. The closing price for the November contract was established in October. It was \$4.126 per MMBtu, which was 8 cents, or about 2 percent, higher than the realized average Henry Hub spot price in November. Thus, except for the final settlement price, the November contract prices could not be used as a reasonably accurate predictor of the realized average commodity spot price in November.

As a futures contract gets closer to its delivery month, it is expected that futures and spot prices will tend to converge so that the final settlement price of the contract at expiration will be quite similar to the spot market price.¹ However, conformity between final settlement prices and the realized spot price is not assured in all cases. For example, the February 2003 contract, after ranging as low as \$3.610 per MMBtu, closed at \$5.660 which was \$2.073 or about 27 percent lower than the average February Henry Hub spot price of \$7.733 per MMBtu.

Analysis of the November 2002 contract prices and Henry Hub spot prices illustrates that futures prices may be influenced by current market conditions even though delivery is not obligated until some time thereafter when the market likely will have changed. The price change patterns of the November contract prices and the concurrent spot prices were quite similar. In April 2002, the November futures contract was priced at \$3.707 per MMBtu. After increasing by 16 cents per MMBtu in May, the November contract fell by 64 cents, to \$3.230 per MMBtu between May and July 2002. The net change of 48 cents per MMBtu for the price of the November contract in these 3 months is very similar to the net change of 44 cents for the average Henry Hub spot price. In the subsequent, and last, 3 months of trading for the November contract, both prices again exhibited a similar overall change. The futures contract price increased by roughly 90 cents per MMBtu in those 3 months, which was almost 79 percent of the \$1.14 increase in the monthly spot price.

¹ See, for example, Energy Information Administration, "The Developing Natural Gas Futures Market and Its Potential Impact on Domestic Natural Gas Markets," *Natural Gas Monthly* (March 1990), p. 13.

The prices for the set of futures contracts for delivery during the 2002-03 (Figure 1.A) and 2003-04 (Figure 1.B) heating seasons (November – March) generally tracked the monthly Henry Hub spot price during the period from April through the following March. The correlation coefficients for the pairings of monthly Henry Hub spot prices and the prices for each futures contract for delivery in the 2002-03 heating season during trading in April 2002 to February 2003 are high, ranging between 0.78 and 0.89. The correlation coefficients for the 2003-04 heating season are even higher, with all close to 0.95. However, the monthly spot price varied by more than \$1 in the months preceding each winter. Although the futures prices correlate well with concurrent spot prices in those years, the resulting wide variation in the futures prices caused at least some large differences between futures contract prices and realized spot prices. Consequently, the futures prices were relatively poor predictors of the Henry Hub spot price during the winters of 2002-03 and 2003-04.

The similarity in patterns of the futures prices and of the Henry Hub spot prices in 2002-03 and 2003-04 is indicative of the strong influence of current market conditions on the market expectations for future spot prices in those years. Unusually low inventories of working gas in storage in February and March 2003 led to much higher Henry Hub spot prices and the futures prices at the time. This condition apparently also affected the futures contract prices for delivery in the next (2003-04) heating season during early trading in the following heating season.

The price movement patterns for the 2004-05 heating season contracts (Figure 1.C) differ from those for the 2002-03 (Figure 1.A) and 2003-04 (Figure 1.B) heating season contracts, as the futures prices diverged from the Henry Hub spot price (e.g., September 2004). This is further evidenced by the lower correlation coefficients ranging from 0.19 to 0.73 for spot and concurrent futures contracts prices for the 2004-05 heating season.

In September and October 2004, the Category-4 Hurricane Ivan caused a significant reduction in natural gas and crude oil production in the Gulf of Mexico. The production shut-ins were as high as 6.5 billion cubic feet (Bcf) per day of natural gas and 1.3 million barrels per day of oil, which is about 53 percent and 77 percent of the total daily production of natural gas and oil in the Federal Gulf of Mexico, respectively. The loss of production contributed to futures price increases at that time of 20 to 28 percent for the set of futures contracts for delivery during the following heating season, while the Henry Hub spot price increased by more than 23 percent. Another factor behind the upward natural gas price trend was the

rising price of crude oil, which increased by 16 percent during the same period.

The large differences between the futures contract prices and the realized spot prices are readily apparent in Figures 2.A, 2.B, and 2.C, which display the difference between the price of a futures contract for a particular heating season delivery month and the average monthly Henry Hub spot price that is realized in the corresponding delivery month for each of the three heating seasons. When the differentials are close to zero, the futures prices are approximately equal to the corresponding average spot price. For the 2002-03 winter delivery contracts, the prices for all contracts in July 2002 were at least \$0.82 per MMBtu below the corresponding realized spot prices, with the futures price for February delivery more than \$4 per MMBtu below the realized February 2003 average spot price.

Futures prices tend to fluctuate over a wide range. In each of the three years of analysis, futures prices for all contracts for delivery in the heating season months varied by close to \$1 per MMBtu or more. The price differential graphs for the three heating seasons show that:

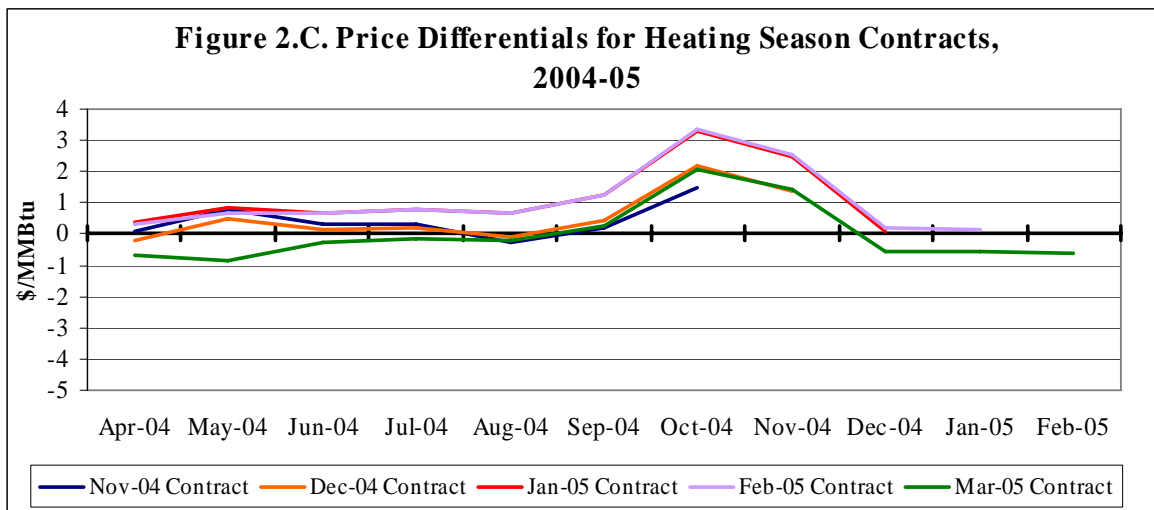
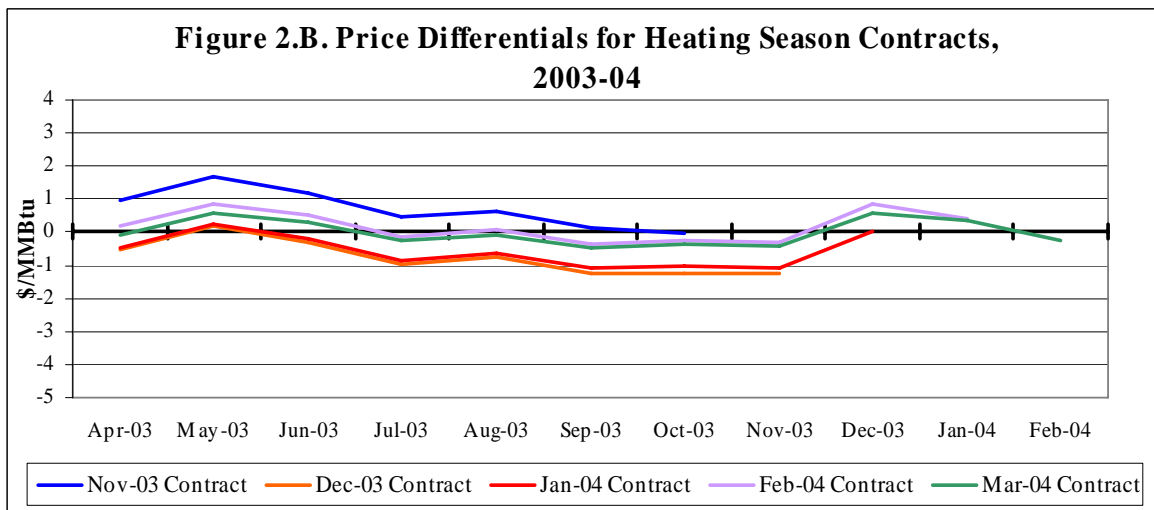
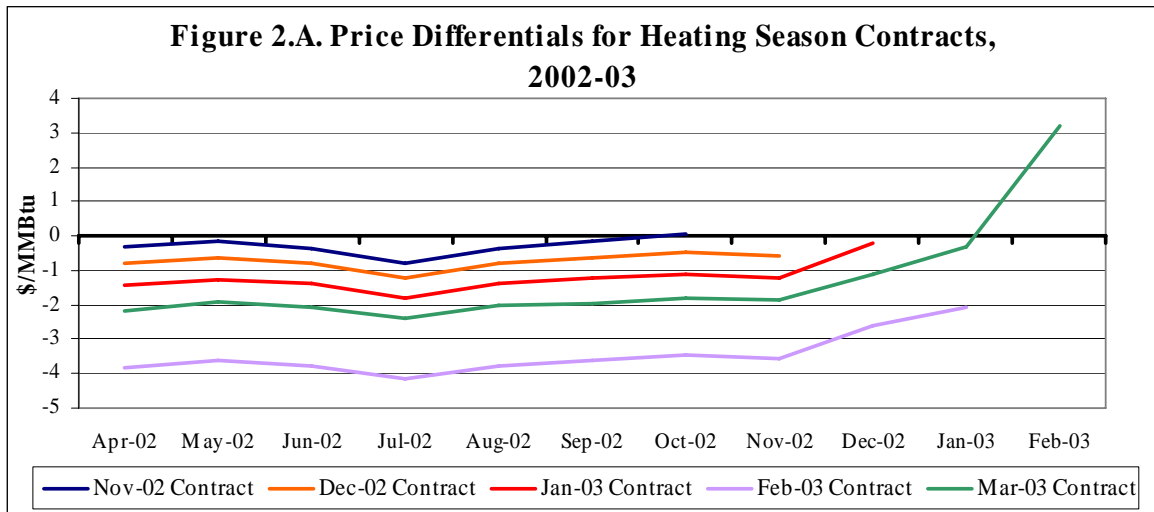
- In the 2002-03 heating season (Figure 2.A), the realized Henry Hub spot prices were below the corresponding futures contract prices in virtually all months in the analysis period. The largest differences were those of the February 2003 contract price, which underestimated the Henry Hub spot price by as much as \$4 per MMBtu in July 2002 and failed to converge by final settlement. The final price for the February 2003 delivery contract was \$2.073 MMBtu, or about 27 percent, below the realized February price. The price for the March 2003 contract had an even larger difference with a final settlement price that was more than \$3 per MMBtu above the average March spot price.
- The 2003-04 futures prices exceeded the corresponding target Henry Hub spot prices early in the analysis period (Figure 2.B). In successive months, however, the futures prices generally declined until by the start of the heating season all but the November 2003 contract price were below the ultimate spot prices. The February and March 2004 futures contracts were overestimated in December 2003 and January 2004 by as much as 87 cents, or more than 16 percent per MMBtu. The final prices for these contracts were closer to the realized spot prices, with differences of only \$0.40 and \$0.24 per MMBtu, respectively.
- Differences between the 2004-05 futures prices and the realized spot prices were lowest in the early months, as the price differentials averaged less than \$1 per MMBtu, or about 7 percent, in April through September. However, the futures prices' performance as a predictor of the Henry Hub spot price worsened after Hurricane Ivan. In October 2004, price differentials for winter delivery contracts exceeded the corresponding realized spot prices by more than \$1 per MMBtu and as much as \$3.329 (Figure 2.C).

An examination of the data for each of the three 12-month periods provides a number of observations. First, while the prices for futures contracts may be close in value to the realized future average Henry Hub spot price at times, there are frequently sizeable differences. Second, even the final settlement prices differ from the realized average spot price in the following month a number of times each winter. Lastly, the futures contract prices often exhibit price change patterns similar to that of the concurrent average monthly spot prices, although some significant exceptions are evident.

Findings

- **The prices for futures contracts for delivery in a given future month can vary greatly over time.** Owing to the large price changes, it is evident that even if the futures price correctly anticipates the target spot price periodically, continued price changes inevitably lead to differences from the future realized price.
- **The differences between futures prices and the corresponding realized spot prices do not necessarily diminish over time.** While the prices of some futures contracts performed adequately as predictors of the Henry Hub spot price in the last month of trading, settling within 4 percent of the realized Henry Hub spot price, the prices for these contracts and those for delivery in other months generally failed to perform very well as predictors during the course of trading.
- **Although prices for futures contracts in any given heating season may exhibit a systematic bias (e.g., consistently underestimating prices for the 2002-2003 heating season), the patterns do not evolve in a predictable way between seasons.** This would impede attempts to use futures prices to predict actual heating season prices based on previous patterns in the data.

PRICE DIFFERENTIALS BETWEEN FUTURES CONTRACTS PRICES ON THE FINAL TRADING DAY OF THE NEAR-MONTH CONTRACT AND THE AVERAGE REALIZED SPOT PRICE



The price differential is calculated as the difference between the price of a futures contract for a particular delivery month on the final trading day of each near-month contract (in successive months) and the average Henry Hub spot price that is realized in the corresponding delivery month.

Prices of natural gas futures contracts expiring during the past three heating seasons (2002-03, 2003-04, and 2004-05) generally did not perform well as a predictor of realized spot prices at the Henry Hub. However, trading in futures contracts provides benefits to market participants by providing some degree of price certainty, market transparency, and liquidity. In addition, trading in

futures contracts is an important tool in an array of options for gas managers to consider in establishing their supply transaction portfolios. The availability of futures market allows each gas manager to optimize his portfolio relative to his situation. As such, trading in futures contracts is expected to remain an important tool for managing price risk.