The Relationship between Crude Oil and Natural Gas Prices:

The Role of the Exchange Rate

Peter R. Hartley and Kenneth B. Medlock III

Economics Department and James A. Baker III Institute for Public Policy, Rice University

To the extent that energy sources can be substituted in end-uses, one might expect the prices of different fuels to be linked. High prices for one fuel will create incentives to substitute toward other fuels that are relatively less expensive. Consistent with this basic economic prediction, many authors have documented a tendency for the natural logarithm of prices of different energy commodities to be cointegrated.

Focusing on the ratio of U.S. natural gas price to crude oil price, a number of authors have presented evidence of that the two prices are cointegrated, consistent with economic theory suggests regarding competing fuels. However, several other studies have also documented evidence that the relative price of natural gas to crude oil drifts over time. This has been particularly true in the last few years as the price of natural gas relative to crude oil has deviated dramatically from its recent historical norms.

For the same reason that we expect the prices of energy commodities to be linked over time, deviations in such relative prices have important economic consequences. They can indicate potentially profitable investment strategies for firms. For example, if the relative price of natural gas to crude oil is low, it may signal valuable investment opportunities to move natural gas into the an oil-dominated transportation sector through the development of gas-to-liquids production facilities or compressed natural gas distribution facilities. Deviations in the relative price of energy commodities may also indicate profitable arbitrage opportunities. For example, a low relative price of natural gas to crude oil may increase the incentive to export liquefied natural gas (LNG) to consumers facing oil-indexed prices.

Permanent changes in the pricing relationship between fuels can also be important to policy makers. For example, they can assist or frustrate attempts to promote the use of one fuel over another, especially when, for example, one of the fuels is associated with higher environmental externalities than the other. One explanation for permanent changes in the relative price of different energy commodities that has previously been provided in the literature is technological change. In particular, any change in the relationship between fuel use and the useful energy services it facilitates will tend to alter the relative prices for that fuel.

We present a simple trade model to provide an additional explanation of what drives drift in the relationship between crude oil and natural gas prices. Oil is an internationally traded good with a very large global tanker capacity and well-arbitraged

markets. By contrast, the high costs of liquefaction, transportation and regasification make natural gas a much more expensive waterborne venture. An implication is that natural gas markets tend to be less integrated than crude oil markets and, therefore, natural gas prices are less well arbitraged. In particular, for all practical purposes, North American natural gas has been a non-traded good. The small volumes of imports of LNG are restricted to a few regional markets that are generally difficult to serve due to pipeline capacity constraints. A consequence of the differential in trade of crude oil and natural gas is that the foreign exchange value of the US dollar affects the relative price of the two commodities. Using a simple model, we show that the sign of the effect is unambiguous if own-price elasticities dominate cross-price elasticities in the home and foreign oil market and the ability to switch fuels in the domestic market is constrained. The latter situation applies to the United States where fuel oil use for power generation has become almost entirely restricted to diesel and residual fuel oil peaking plants. Hence, substitution between crude oil and natural gas has virtually disappeared.

Using monthly data from January 1995 through December 2011, we show that the natural logarithms of the prices of Henry Hub natural gas and Brent crude oil are cointegrated once we allow technological change and the exchange rate to affect the relative price. We then estimate a model of the dynamic adjustment process. Following previous papers in the literature, we show that deviations from the estimated long run relationship react to changes in storage levels and unexpected weather shocks that affect the demand or supply (via hurricanes in the Gulf of Mexico). In contrast to previous studies, we split the former effect into anticipated versus unanticipated changes in gas in

storage. We find that, in the preferred specification, unanticipated shocks have a much larger effect on price changes. We also find that the speed of adjustment of natural gas prices to weather and storage changes is on the order of one month, while adjustments to deviations of the relative price from its long run relationship take longer than a year. This result can explain the relatively high volatility of natural gas price as well as why deviations from the long-run relative price relationship can persist for some time.