**ROTARY RIG PARITY: THE DRILLING RATE AUGMENTED RELATIONSHIP BETWEEN OIL AND GAS PRICES**

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**Overview**
Demand-side substitution possibilities between crude oil and natural gas have diminished since the turn of the century. Such substitution possibilities formed the basis for the so-called “burner-tip parity” rule, which represented the theoretical foundation for direct cointegration between crude oil prices and natural gas prices. Oil and gas markets continue to be connected on the supply-side, however. Associated gas is usually produced from crude oil wells, while associated liquids are often produced from natural gas wells. Using a model that accounts for supply side connections, and based on the assumption that marginal profits should be equal across oil and gas wells in a competitive market, we derive a theoretical long run equilibrium relationship between crude oil prices and natural gas prices that depends on associated commodity flows and drilling costs. If marginal drilling costs and additions to associated commodity flows increase linearly with increases in drilling rates, then a long run relationship should exist between oil prices, gas prices, oil drilling rates, and gas drilling rates. In order to test our theoretical long run relationship, we use the Johansen procedure to test for the existence of a cointegrating vector between oil and gas prices with and without oil and gas drilling rate variables using a times series from January 1994 to February 2019. Zero cointegrating vectors are identified when only oil and gas prices are used in the analysis; but one unique cointegrating vector is identified when oil and gas drilling rates are added. The signs of the coefficients in this unique cointegrating vector are consistent with expectations from the theoretical model.

**Methods**
Dynamic optimization; cointegration analysis.

**Results**
(1) A dynamic optimization model of the drilling rig allocation decisions of a representative oil and gas producing firm predicts the existence of a long run relationship between oil prices, gas prices, oil drilling rates, and gas drilling rates.

(2) Oil prices and gas prices are not found to be cointegrated between January 1994 and February 2019.

(3) Oil prices, gas prices, oil drilling rate, and gas drilling rate are cointegrated between January 1994 and February 2019. The signs of the coefficients in the cointegrating vector are consistent with the theoretical model.

(4) The role of supply side links between oil and gas markets became stronger as more “wet” natural gas wells (natural gas wells with more liquids) were targeted.

**Conclusions**
We reaffirm previous results that oil and gas prices are no longer directly cointegrated. However, we show that a unique cointegrating vector between oil prices, gas prices, oil drilling rate, and gas drilling rate does exist. This unique cointegrating vector is consistent with a model of the rig allocation decisions of a profit-maximizing rig-allocating firm. These results can inform policymakers or analysts interested in petroleum markets, and especially in the changing nature of the relationship between crude oil and natural gas markets.
References


