DRILL-BIT PARITY:

SUPPLY-SIDE LINKS IN OIL & GAS MARKETS

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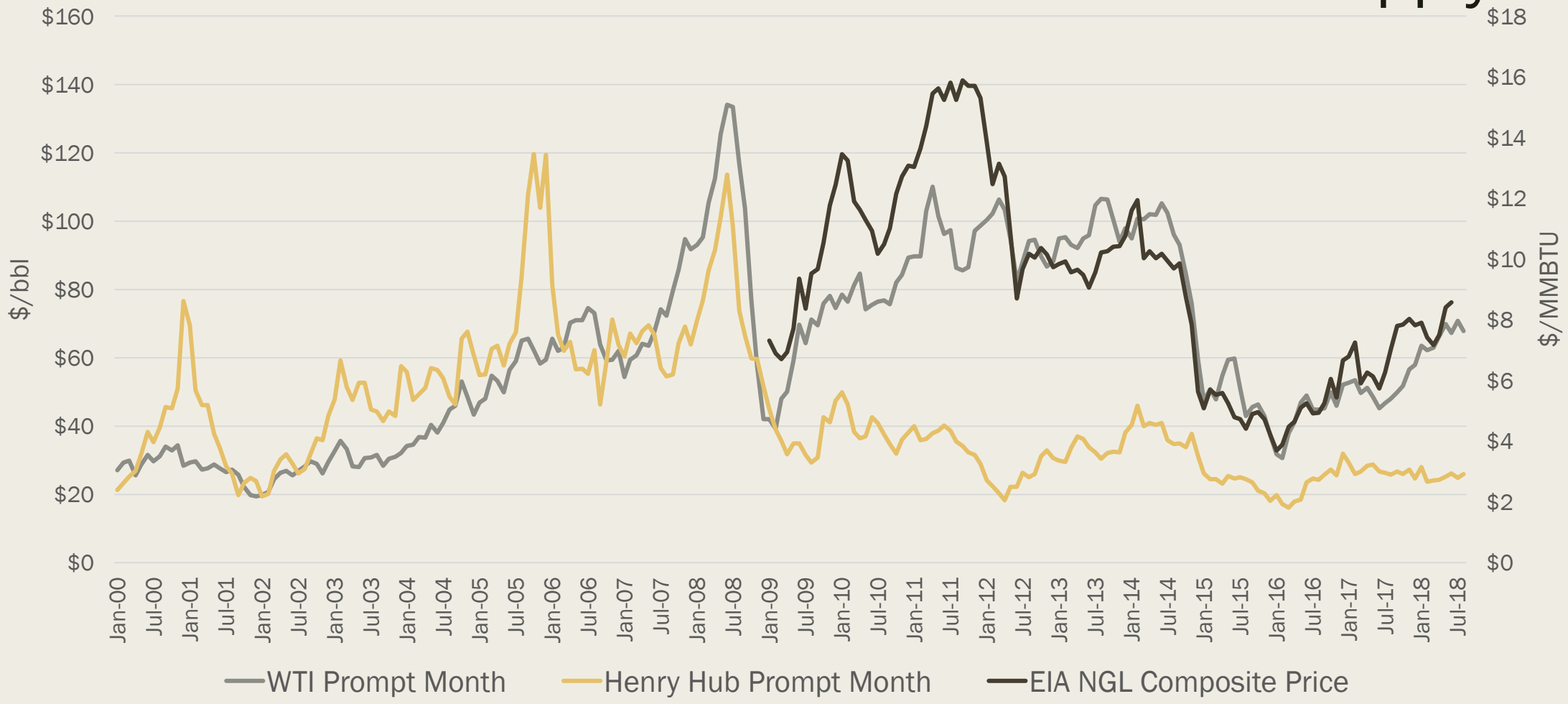
Motivation: A Regime Change

Demand to Supply



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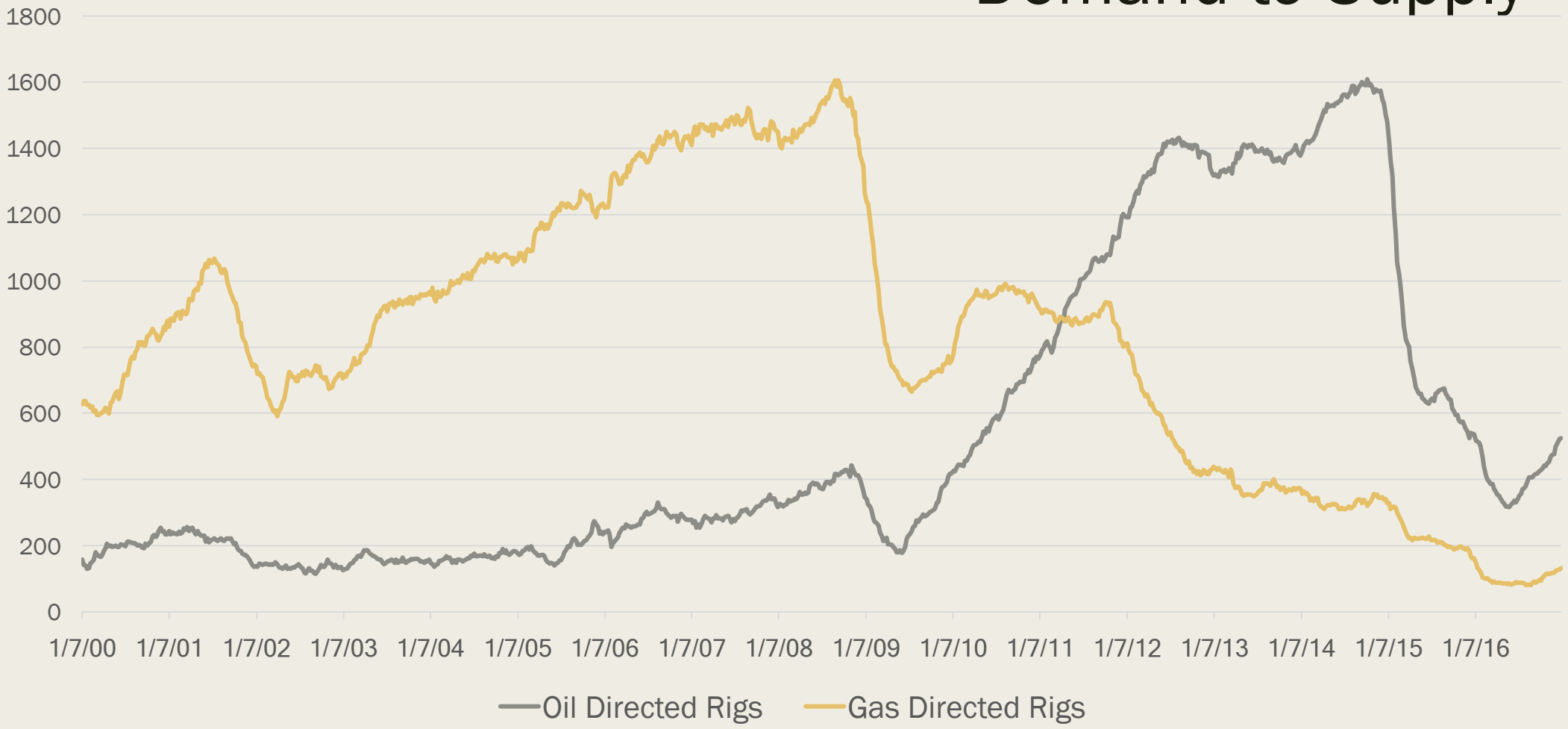

Oil & Gas Market Integration

- Traditional focus on demand-side
  - Marginal benefit
  - Burner-tip parity

$$P_{HH,t} = T + \frac{P_{BT,t}}{P_{WTI,t}} \frac{1}{E_{BT}} P_{WTI,t}$$

- We focus on two potential supply-side connections
  - Competition for inputs
    - Drilling rigs, specialized labor
  - Associated-commodity flows
    - Gas from oil wells, oil & oil substitutes from gas wells

Theoretical Model

- Representative firm allocates rigs towards natural gas wells or crude oil wells to maximize profits
  - Associated commodity parameters
  - Cost spillovers

$$Profit_t = P_{o,t}f_{o,t} + P_{g,t}f_{g,t} - C\left(d_{o,t} + d_{g,t}, d_{o,t}, d_{g,t}, a_o d_g, a_g d_o\right)$$

$$\frac{\partial f_{g,t}}{\partial t} = d_{g,t} - r_g f_{g,t} + a_g d_{o,t}$$

Theoretical Results

- Interested in cross-commodity price shocks
  - e.g., How does oil-price shock affect gas drilling, gas flow (supply), and prices?
- Analyze supply-side links separately
  - If input-competition (cost-spillover) is only link:
    - Oil-price shock leads to: less gas drilling, less gas supply, higher gas price
    - Converging prices
  - If associated-commodity is only link:
    - Oil price shock leads to: ambiguous gas drilling effect, increases gas supply, and decreases gas price
    - Ambiguity in drilling results from two effects
      - Lower gas price due to associated gas
      - Higher value of associated oil from oil wells
    - Possibly diverging prices

Empirical Strategy

- Isolate supply-side links by looking at drilling in five basins with oil and gas production
  - Anadarko (OK and TX), Chautauqua Platform (OK), East Texas Basin (TX), Fort Worth Basin (TX), Permian Basin (TX)
- Estimate own-price and cross-price elasticities using three-stage least squares
- Price instruments: Lagged Brent oil price, lagged HDDs and CDDs, lagged cumulative HDDs and CDDs
- Gas price instrument included in oil price first stage and vice versa to control for potential of demand-side links
- Monthly drilling and production from 2005 to 2016

Empirical Results

Basin	Total Wells	% Gas	% Oil	Gas Decline	Oil Decline	Assoc Gas	Assoc Oil	Gas Gather	Gas on Oil	Oil on Gas
Anadarko	24257	59.6	40.4	0.018	0.022	0.86	0.17	0.76	-0.48 ***	0.44 ***
Chautauqua Platform	7238	47.0	53.0	0.015	0.013	0.52	0.046	0.63	-0.17 *	0.29
East Texas	14478	90.6	9.4	0.020	0.018	0.36	0.025	0.63	-0.10	0.14
Fort Worth	21225	84.6	15.4	0.017	0.022	0.75	0.042	0.57	-0.13 **	0.31 **
Permian	36002	26.8	73.2	0.014	0.015	0.45	0.16	0.86	-0.28 ***	-0.25 **

Empirical Results Summary

- Positive gas price shocks lead to less oil drilling
  - i.e., Negative gas price shocks generally lead to more oil drilling
  - Consistent with input competition (cost spillovers)
  - And/or associated oil with an inelastic oil demand curve and/or costly associated gas
- Positive oil price shocks lead to more gas drilling in most basins
  - Consistent with high value associated oil and/or elastic natural gas demand curve and/or low cost associated oil
- Positive oil price shock leads to less gas drilling in Permian basin

Conclusion

- We provide a theoretical model that highlights the roles of two supply-side links in oil and gas markets
  - Input competition
  - Associated commodity flows
- These supply-side links help explain changes in oil and gas market integration that have occurred since the onsets of the unconventional gas and oil “revolutions”
- Our empirical estimates indicate that these supply-side links are economically significant, and should be accounted for by analysts and policymakers