An Empirical Analysis of Market Power in the U.S. Natural Gas Market

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Introduction

- Market efficiency is a key issue in today's natural gas market
  - Deregulation of the gas market increased the dependence on maintaining efficient trading hubs
  - California crisis heightened the interest in the effectiveness of competitive pressures to discipline the regional gas markets
  - The collapse of Enron and related events thinned regional markets

Introduction

- Market power studies were popular for the U.S. power market especially after the California power crisis
- Market concentration measures traditionally used to gauge market power
- Problems associated with the market concentration issues
- Gas market power studies are rare, but important
- Previous studies investigated market integration, not market power issues

Market Efficiency, Rent Seeking and Market Prices

- In perfectly efficient markets, arbitrage ensures the randomness of rent capturing
- Market power leads to rent seeking
  - Buyers with market power will delay price increases as long as possible
  - Sellers with market power will delay price declines as long as possible
- This creates a basis to evaluate the efficiency of the natural gas trading hubs

Empirical Approach

- Systematically asymmetric price adjustments imply market power
  - Prices move down slowly with exogenous influences if there is market power on the seller's side
  - Prices move up slowly with exogenous influences if there is market power on the buyer's side
  - The speed of adjustment in returning to a market equilibrium is an index of the degree of market impediments

Empirical Approach

- Assuming the NYMEX is a competitive market, it is a standard for comparison with the price movements in the physical market
- Comparing the market adjustments at trading hubs to the NYMEX price changes reveals the relative efficiency of the trading hubs and the presence of market power

Empirical Approach

- In a competitive trading hub, we expect the spot prices to respond to exogenous price movements systematically and symmetrically
- Systematic impediments indicate inefficiency – a logical explanation is the existence of a market power
- Spot price responses studied at 19 trading hubs to the shocks that change equilibrium relationship between spot and futures prices

Table 1. Selected Natural Gas Trading Hubs

Ticker	Trading Hub	Region
EPP:	El Paso, Permian Basin	Permian Basin Area
WAHA:	Waha	Permian Basin Area
MRTM:	MRT, Mainline	East Texas-North Louisiana
SHIP:	Houston Ship Channel	East-Houston-Katy
KATY:	Katy	East-Houston-Katy
AGUA:	Agua Dulce Hub	South-Corpus Christi
FGTZ3:	Florida Gas, Zone 3	Louisiana-Onshore South
HH:	Henry Hub	Louisiana-Onshore South
TGTSL:	Texas Gas, Zone SL	Louisiana-Onshore South
RMID:	Reliant East	Oklahoma
OGT:	Oneok, OK	Oklahoma
EPB:	El Paso, Bondad	New Mexico-San Juan Basin
QUEST:	Questar, Rocky Mountains	Rockies
COLAP:	Columbia Gas, Appalachia	Appalachia
NGPLA:	NGPL, Amarillo Receipt	Others
CHI:	Chicago City-gate	Citigates
TRNY:	Transco Zone 6 N.Y.	Citigates
TRS85:	Transco, Zeon 4	Mississippi-Alabama
MALIN:	PG&E, Malin	Others

Empirical Approach

- The empirical model of spot and futures prices – An Engle-Granger procedure

$$\log(S_t) = \alpha_0 + \alpha_1 \log(F_t) + \varepsilon_t$$

$$\Delta \log S_t = \beta_{10} + \beta_{11}\varepsilon_{t-1} + \beta_{12}\varepsilon_{t-1}D_{t-1} + \sum_{i>2} \beta_{1i}\Delta \log S_{t-i} + \sum_{j>i} \beta_{1j}\Delta \log F_{t-j} + \mu_{1t}$$

$$\Delta \log F_t = \beta_{20} + \beta_{21}\varepsilon_t + \beta_{21}\varepsilon_{t-1}D_{t-1} + \sum_{i>2} \beta_{2i}\Delta \log S_{t-i} + \sum_{j>i} \beta_{2j}\Delta \log F_{t-j} + \mu_{2t}$$

Empirical Approach

- The parameter a_1 indicates the long run equilibrium relationship between the NYMEX market and a particular trading hub
- D_t is the dummy variable taking the value of 1 when the disequilibrium term is positive, zero when the disequilibrium term is negative
- $\beta_{11}+\beta_{12}$ measures how fast the spot prices adjust to the disequilibrium when the spot prices lie above the equilibrium between the spot and futures prices
- β_{11} measures how fast the spot prices adjust to the disequilibrium when the spot prices lie below the equilibrium between the spot and futures prices

Empirical Findings

- Daily data from 2001:1:2 to 2003:12:31 are used in empirical analysis
- MA corrections are used to correct for correlated error terms
- Figure 1
- Table 2
- The spot and NYMEX prices are cointegrated by formal test.
- The speed of adjustment parameter for the futures equation is not significant.

Figure 1: Selected Spot Prices and Futures Prices

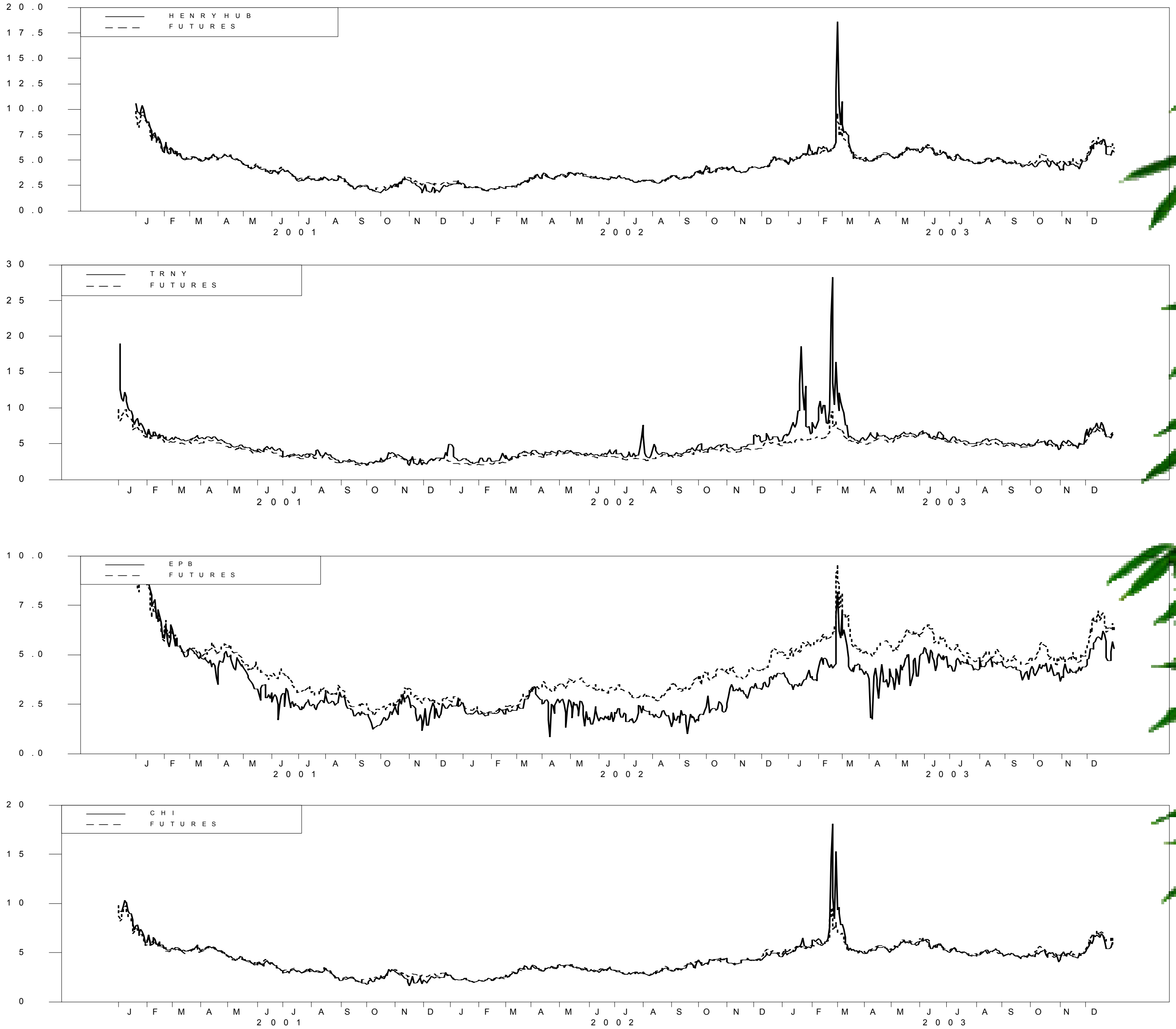

Table 2. Equilibrium Relationship between Spot and Futures Prices

The following equations are estimated:

$\log(S_t) = \alpha_0 + \alpha_1 \log(F_t) + \varepsilon_t$.

t-statistics are in parentheses. * indicates statistical significance at a 5% level.

Hub	α_0	α_1	F-Test (α_1 = 1.0)	Phillip-Perron Unit Root Test (ε_t)
EPP	-.127* (-5.15)	1.02* (61.65)	3.31	-28.43*
WAHA	-0.101* (-4.02)	1.023* (59.98)	1.89	-28.47*
MRTM	-0.040 (-1.878)	1.017* (69.39)	1.375	-28.76*
SHIP	-0.0169 (-0.753)	0.996* (65.15)	0..059	-28.82*
KATY	-0.051* (-2.276)	1.013* (66.29)	0.716	-28.63*
AGUA	-0.102* (-4.69)	1.035* (70.15)	5.819*	-28.45*
FGTZ3	-0.018* (-2.113)	1.0026* (71.51)	0.0341	-28.69*
HH	-0.041* (-2.113)	1.017* (77.28)	1.7942	-28.86*
TGTSL	-0.057* (-2.79)	1.024* (73.49)	2.993	-28.84*
RMID	-0.076* (-3.40)	1.019* (67.08)	1.628	-28.66*
OGT	-0.098* (-4.21)	1.019* (64.17)	1.538	-28.69

Table 2 Continued.

Hub	α_0	α_1	F-Test (α_1 = 1.0)	Phillip-Perron Unit Root Test (ε_t)
EPB	-0.302* (-5.62)	1.039* (28.27)	1.124	-27.47*
QUEST	-0.595* (-7.26)	1.143* (20.497)	6.612*	-25.91*
COLAP	0.0563* (2.427)	0.982* (61.98)	1.226	-28.26*
NPGLA	-0.089* (-4.002)	1.0199* (67.42)	1.745	-28.42*
CHI	-0.066* (-3.206)	1.04* (74.32)	8.181*	-28.40*
TRNY	0.091 (1.82)	1.033* (30.44)	0.956	-29.26*
TRS85	0.0014 (0.066)	0.997* (69.23)	0.0389	-28.73
MALIN	-0.109* (-2.105)	1.039* (29.69)	1.256	-27.63

Table 3. Speed of Adjustment of Spot Prices to Disequilibrium

The following equations are estimated:

$$\Delta \log S_t = \beta_{10} + \beta_{11}\varepsilon_{t-1} + \beta_{12}\varepsilon_{t-1}D_{t-1} + \sum_{i>2} \beta_{1i}\Delta \log S_{t-i} + \sum_{j>i} \beta_{1j}\Delta \log F_{t-j} + \mu_{1t}$$

$$\Delta \log F_t = \beta_{20} + \beta_{21}\varepsilon_t + \beta_{21}\varepsilon_{t-1}D_{t-1} + \sum_{i>2} \beta_{2i}\Delta \log S_{t-i} + \sum_{j>i} \beta_{2j}\Delta \log F_{t-j} + \mu_{2t}$$

t-statistics are in parentheses. Half life for the prices to return to equilibrium has been calculated as ln(0.5)/ln(1+(β_{11} + β_{12})).

Hub	β_{11}	β_{12}	Half Life (Days) Spot Above Equil.	Half Life (Days) Spot Below Equil.
EPP	-0.361 (-4.53)	-0.134 (-1.034)	1.015	1.548
WAHA	-0.39 (-4.72)	-0.123 (-1.46)	0.963	1.402
MRTM	-0.304 (-3.485)	-0.263 (-2.914)	0.828	1.913
SHIP	-0.318 (-3.713)	-0.307 (-3.714)	0.709	1.818
KATY	-0.219 (-2.76)	-0.468 (-5.88)	0.579	2.804
AGUA	-0.3378 (-4.14)	-0.163 (-2.10)	0.928	1.680
FGTZ3	-0.215 (-2.777)	-0.365 (-4.209)	1.060	2.863
HH	-0.219 (-2.86)	-0.384 (-4.56)	0.750	2.804
TGTSL	-0.269 (-3.40)	-0.313 (-3.589)	0.795	2.212
RMID	-0.3315 (-4.161)	-0.2117 (-2.435)	0.885	1.721
OGT	-0.417 (-4.97)	-0.084 (-0.934)	0.997	1.285

Table 3 Continued.

EPB	-0.242 (-3.59)	0.202 (2.049)	16.98	2.502
QUEST	-0.216 (-4.069)	0.116 (1.22)	6.579	2.848
COLAP	-0.234 (-3.05)	-0.418 (-4.93)	0.654	2.600
NPGLA	-0.268 (-3.08)	-0.544 (-5.75)	0.415	2.222
CHI	-0.302 (-3.506)	-0.278 (-3.113)	0.799	1.928
TRNY	-0.883 (-7.222)	0.416 (4.081)	1.102	0.323
TRS85	-0.24 (-3.182)	-0.303 (-3.518)	0.885	2.526
MALIN	-0.353 (-5.002)	0.274 (3.503)	8.423	1.592

Empirical Results

- Spot prices adjust to disequilibria in the gas market – the NYMEX drives the spot market
- Most markets eliminate disequilibria fairly quickly, e.g., it takes about 1.5 days for the spot prices to return to the equilibrium relationship at Henry Hub.
- Prices at some hubs adjust to disequilibria much more slowly, e.g., EPB, QUEST, MALIN and TRNY.
- The asymmetric speeds of adjustment imply market power.

Conclusions

- The U.S. gas market is generally integrated
- Evidence is consistent with the presence of market power at some regional gas trading hubs
- Market power may be on either the buyer’s or seller’s side
- At any trading hub, the presence of market power may be temporary