



What Drives U.S. Natural Gas Prices?

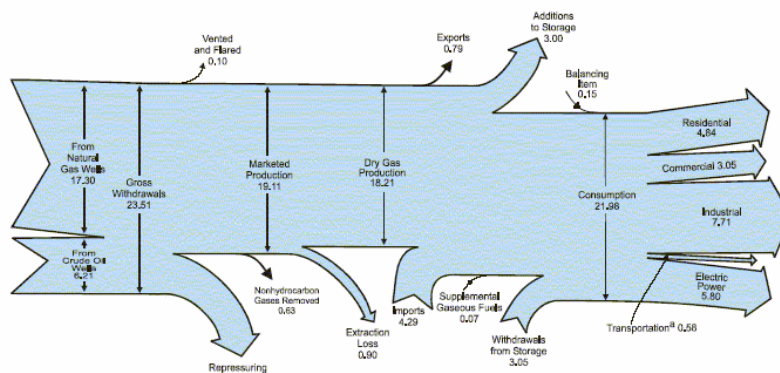
Stephen Brown and Mine Yücel
Federal Reserve Bank of Dallas

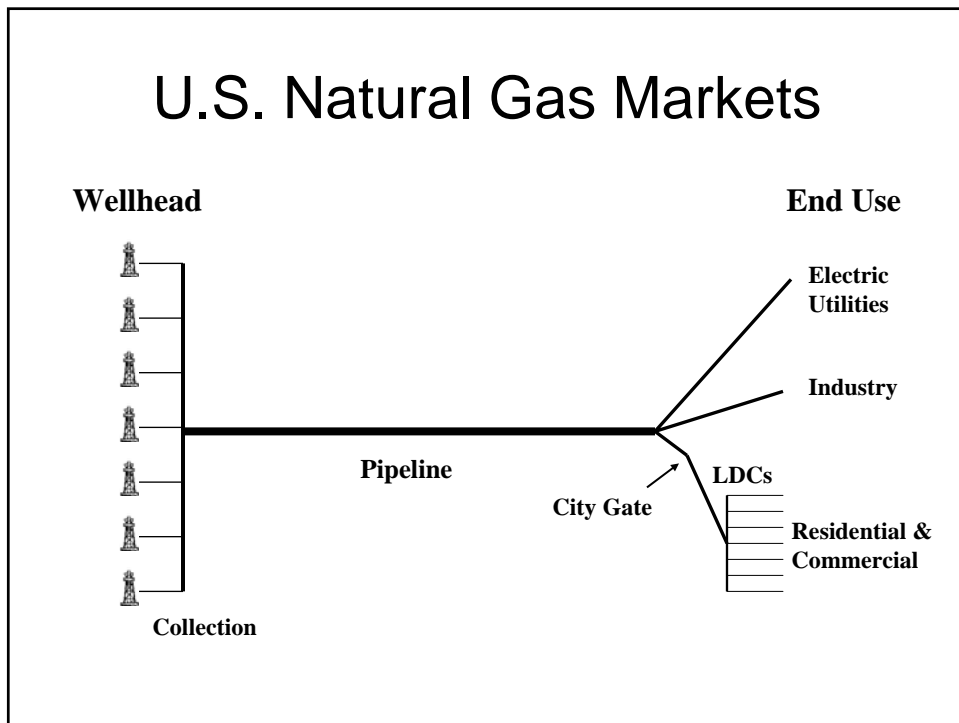
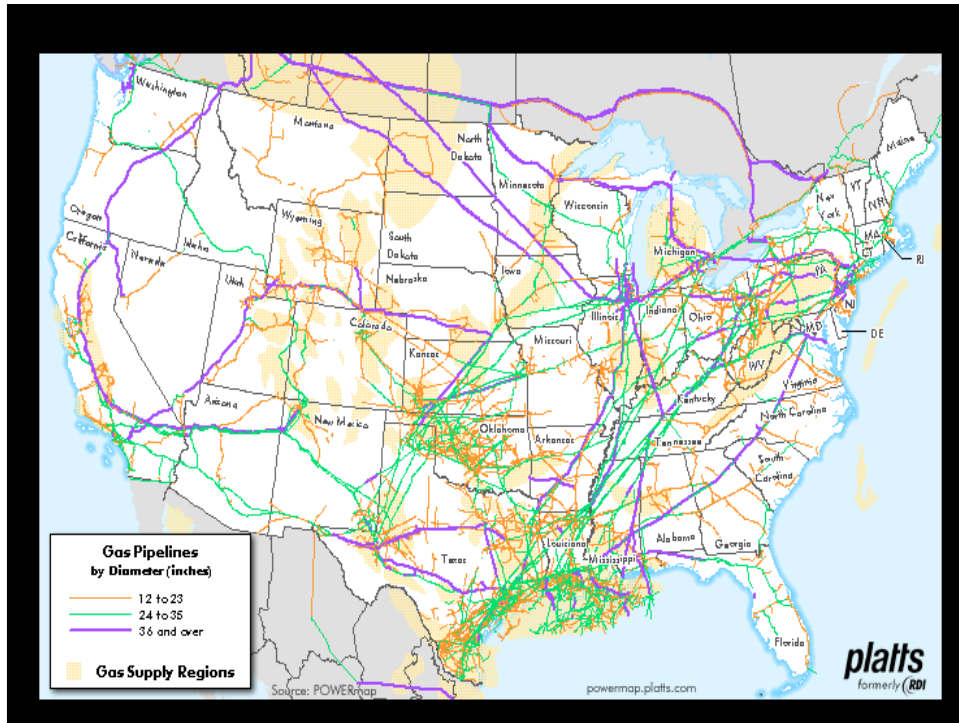
Overview

- Some basics of U.S. natural gas markets
- U.S. natural gas prices: Do oil prices matter?
- Outlook for U.S. natural gas markets

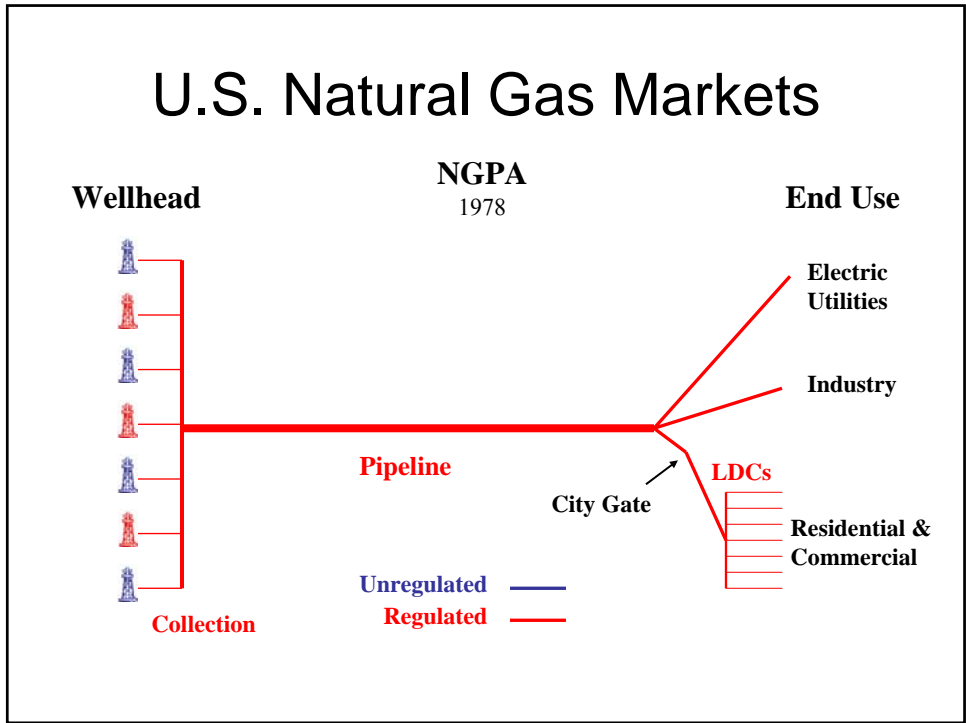
Some Basics of U.S. Natural Gas Markets

U.S. Natural Gas Flow, 2005
Quadrillion Btu

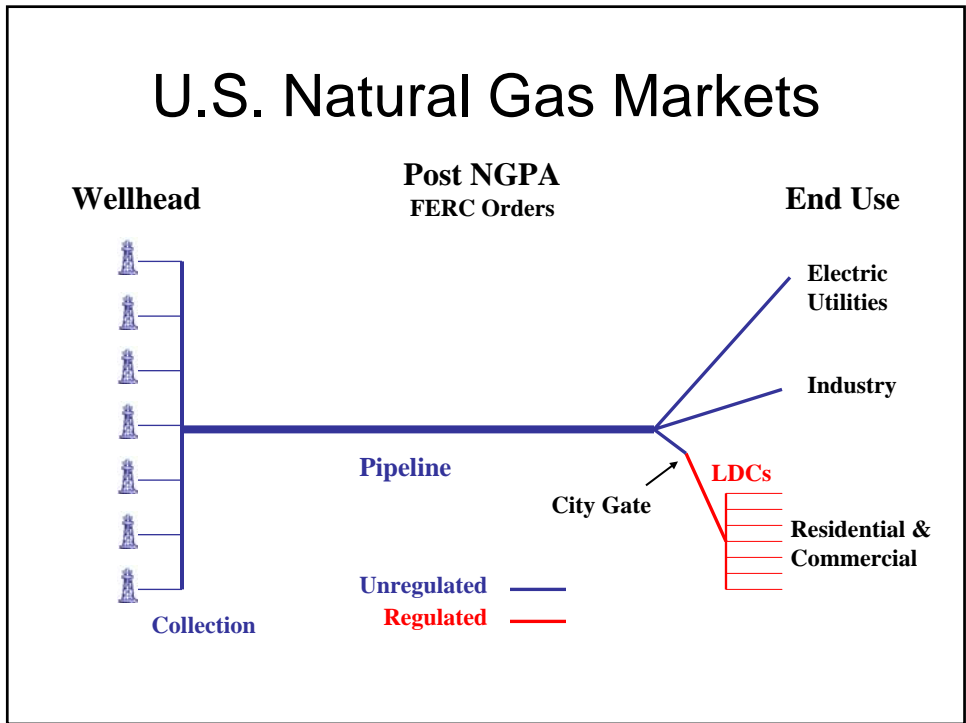




U.S. Natural Gas Markets



U.S. Natural Gas Markets



Post NGPA Environment

- Natural gas price deregulation successful
 - consumer prices for natural gas reduced
 - pipelines no longer earning rents
 - natural gas competitive with oil
- Some deregulation now moving to LDCs
 - state experience mixed

U.S. Natural Gas Prices:
Do Oil Prices Matter?

Natural Gas and Oil Prices



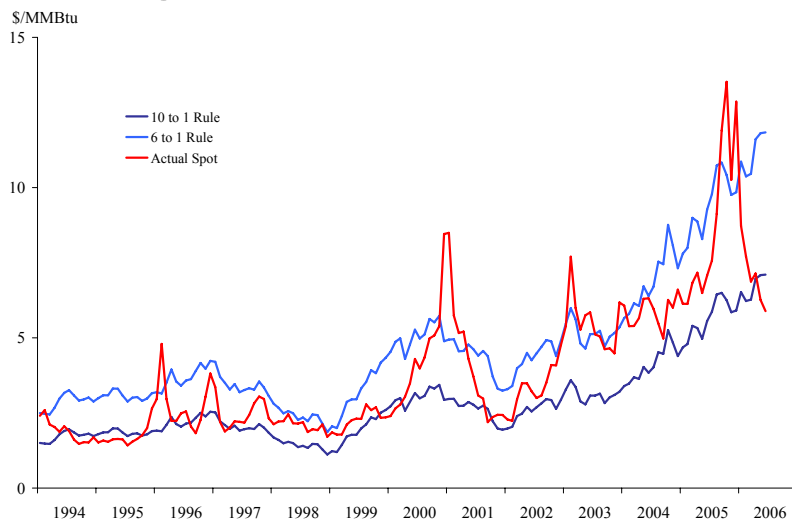
Natural Gas and Oil Prices

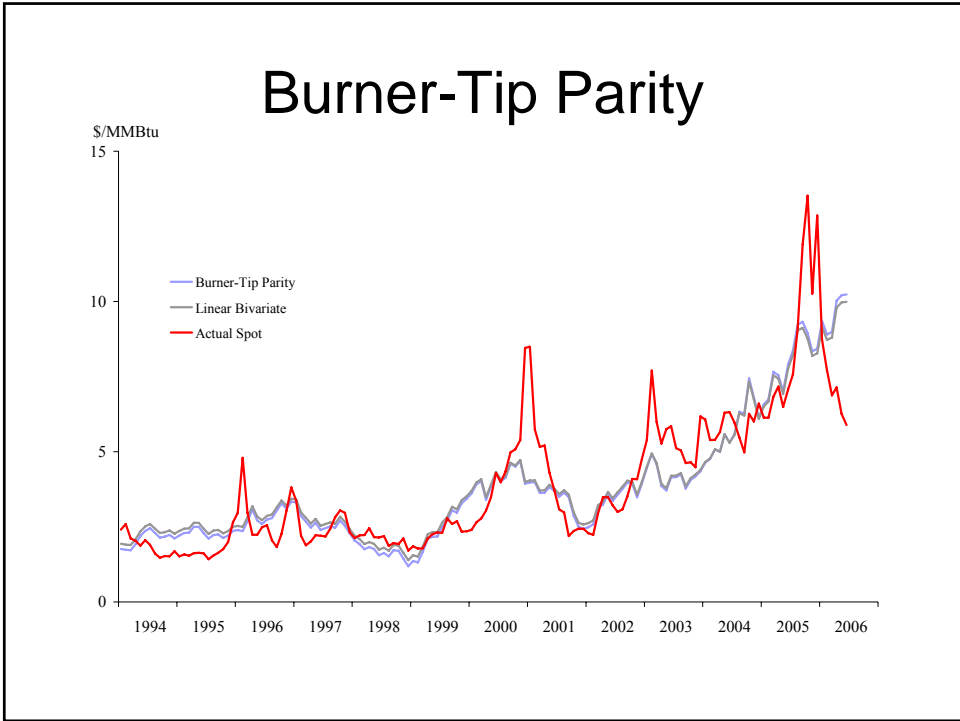


Some Pricing Rules

- 10-to-1: Henry Hub price is $.1 \cdot \text{WTI}$.
- 6-to-1: Henry Hub price is $.1667 \cdot \text{WTI}$.
- Burner-tip parity: Henry Hub price is $-.50 + .1511 \cdot \text{WTI}$.
 - Based on competition with residual fuel oil
- Simple regression: Henry Hub price is $-0.1104 + .1393 \cdot \text{WTI}$.

Old Rules of Thumb



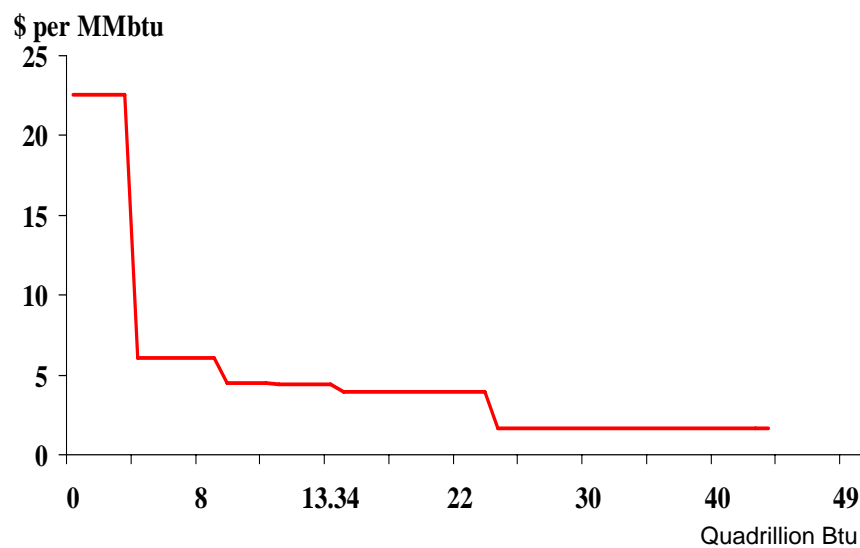


A Closer Look at Burner Tip Parity

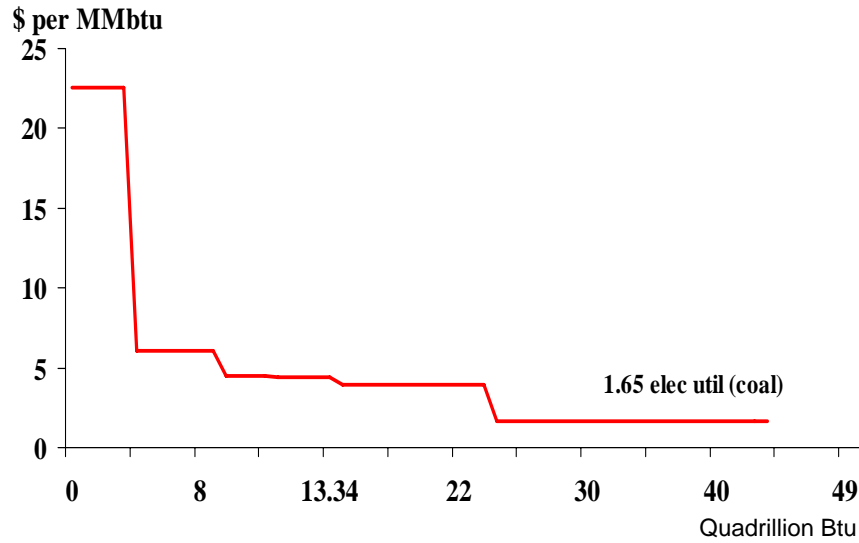
Burner-tip parity: end-use substitution

- electric utility (coal)
- industrial (residual)
- electric utility (residual)
- refinery use (residual)
- residential/commercial (distillate)
- residential/commercial (electricity)

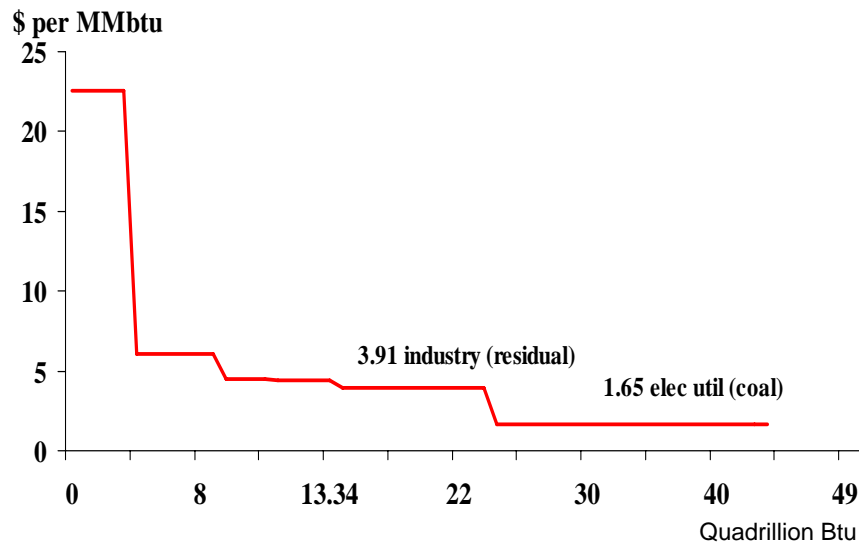
Natural Gas Demand, 2000



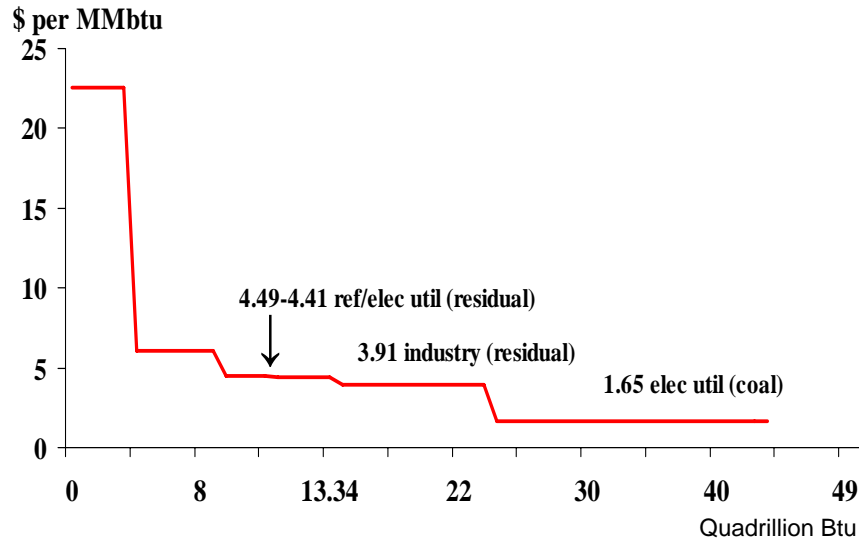
Natural Gas Demand, 2000



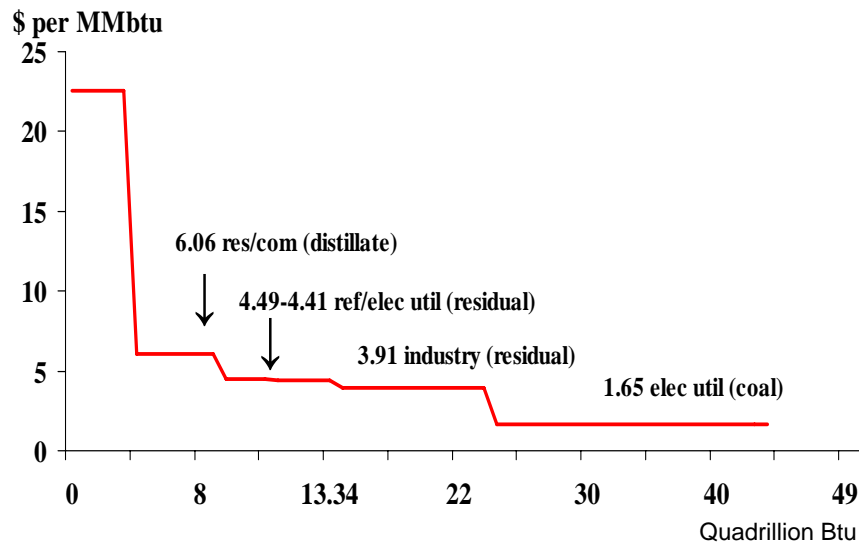
Natural Gas Demand, 2000



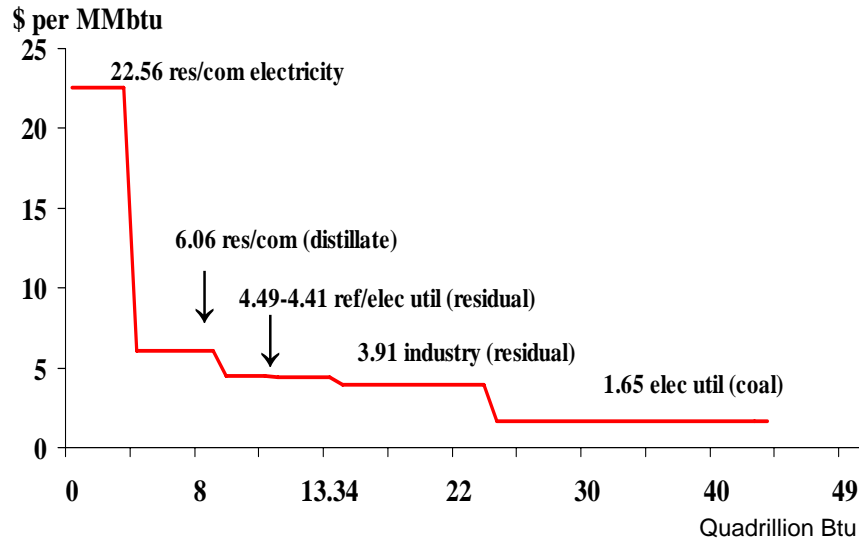
Natural Gas Demand, 2000



Natural Gas Demand, 2000



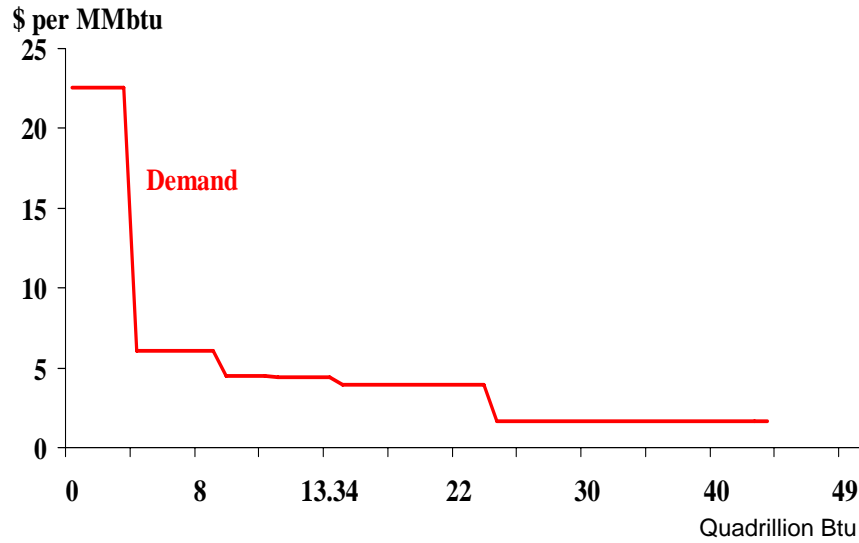
Natural Gas Demand, 2000



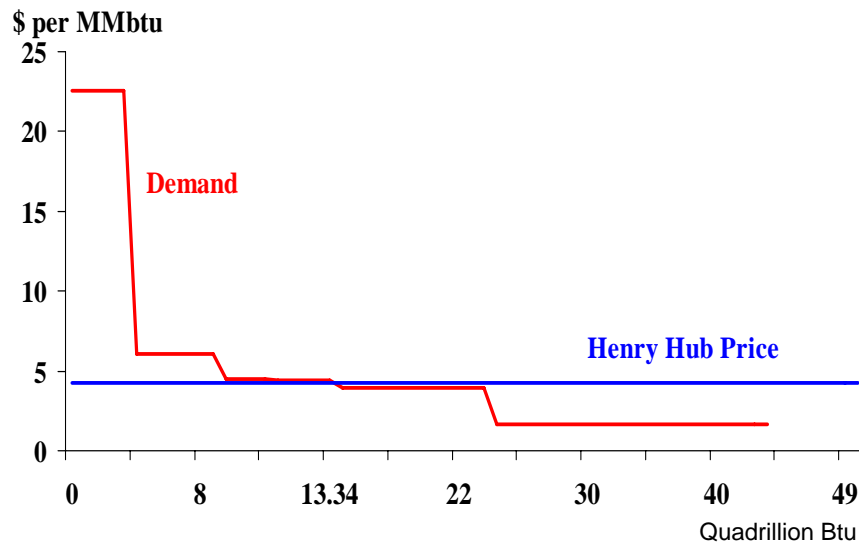
Burner-tip parity: the rules of thumb

- res/com (elec) del electricity price - 0.65 3.50 quads
- res/com (dis) $[(1.2 \cdot \text{WTI})/5.825] - 0.65$ 5.24 quads
- refinery (resid) $[(.95 \cdot \text{WTI})/6.287] - 0.07$ 1.30 quads
- elec util (resid) $[(.95 \cdot \text{WTI})/6.287] - 0.15$ 3.30 quads
- indust (resid) $[(.95 \cdot \text{WTI})/6.287] - 0.65$ 10.31 quads
- elec util (coal) del coal price + .60 - 0.15 -

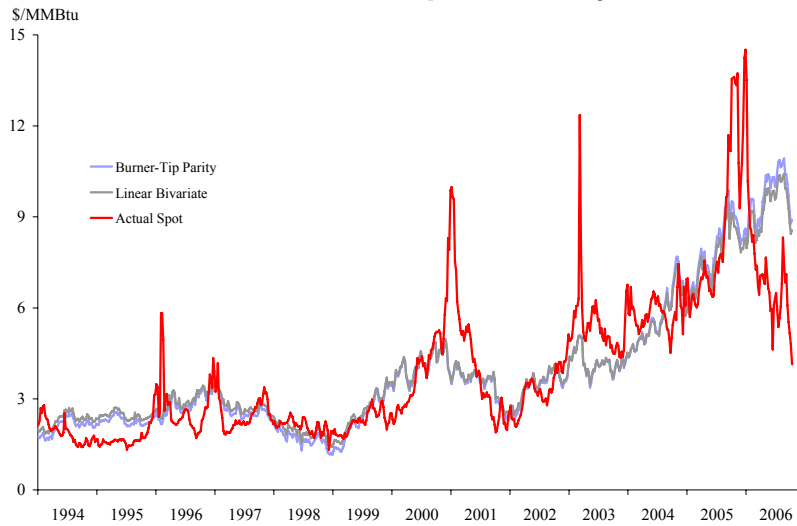
Natural Gas Market, 2000



Natural Gas Market, 2000



Burner-Tip Parity

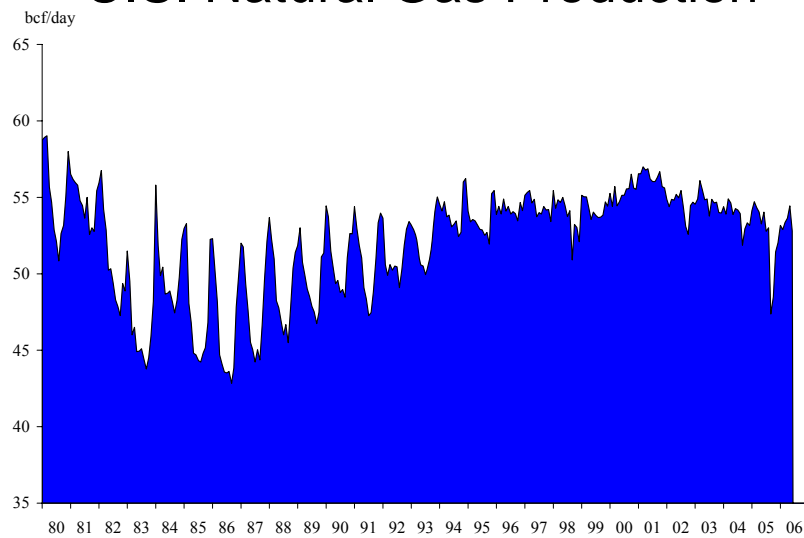


Looking Beyond
Rules of Thumb

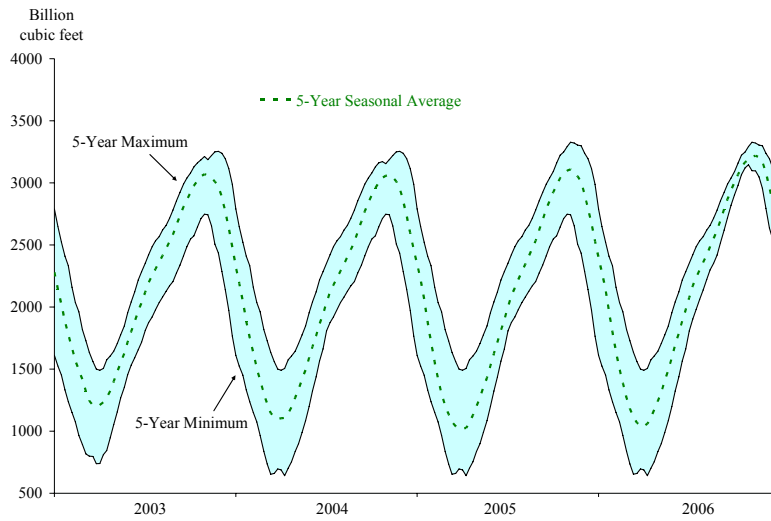
Other Factors Shaping Natural Gas Prices

- Weather
- Seasonality
- Storage
- Hurricane Disruptions

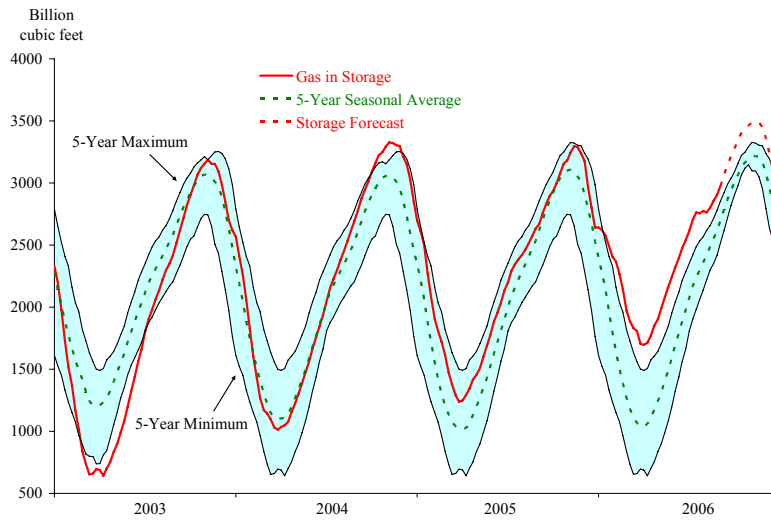
U.S. Natural Gas Production



Natural Gas Storage



Natural Gas Storage



Econometric Modeling of Natural Gas Prices

- Develop an econometric model to investigate the influence of
 - storage
 - seasonality
 - weather
 - production disruptions
 - oil prices

Variables

- PHH I(1)
- PWTI I(1)
- HDD I(0)
- HDDDEV I(0)
- CDD I(0)
- CDDDEV I(0)
- STORAGE DIFF I(0)
- SHUT IN I(0)

Econometric Modeling

- Oil price (WTI) and Henry Hub price of natural gas are difference stationary and cointegrated
- Causality runs from WTI to Henry Hub
- No causality from Henry Hub to WTI
- Natural gas prices adjust to movements in oil prices in an error-correction process
- Other factors are stationary
 - weather, seasonality, storage, supply disruptions

Error-Correction Models of the Change in Natural Gas Price

explanatory variables	Model 1		Model 2	
	coefficients	joint significance	coefficients	joint significance
constant	0.0212 (0.7987)		-0.1019 (-1.0821)	
cointegrating term (t-3)	-0.0855 (-4.3179)**	*	-0.1745 (-6.8281)**	*
QPWTI (t-1)	0.0444 (2.3891)*	/ 0.0000	0.0468 (2.6716)**	/ 0.0000
QPWTI (t-2)	-0.0259 (-1.3790)	*	0.0047 (0.2602)	*
QPHH (t-1)	-0.0765 (-1.6108)	/	-0.2097 (-4.5332)**	/
QPHH (t-2)	-0.0484 (-1.0115)	* 0.1840	-0.1804 (-3.6101)**	/ 0.0000
HDD (t)			0.0019 (3.1909)**	
HDDDEV (t)			0.0069 (5.1086)**	
CDD (t)			0.0009 (0.4914)	
CDDDEV (t)			0.0134 (2.9758)**	
STORAGE DIFF (t)			-0.0005 (-4.3600)**	
SHUT IN (t)			0.0001 (3.7322)**	

adj R² = 0.043

adj R² = 0.165

Values shown in parentheses are t-statistics.

*, * and ** denote significance at better than 0.1, 0.05 and 0.01 percent, respectively.

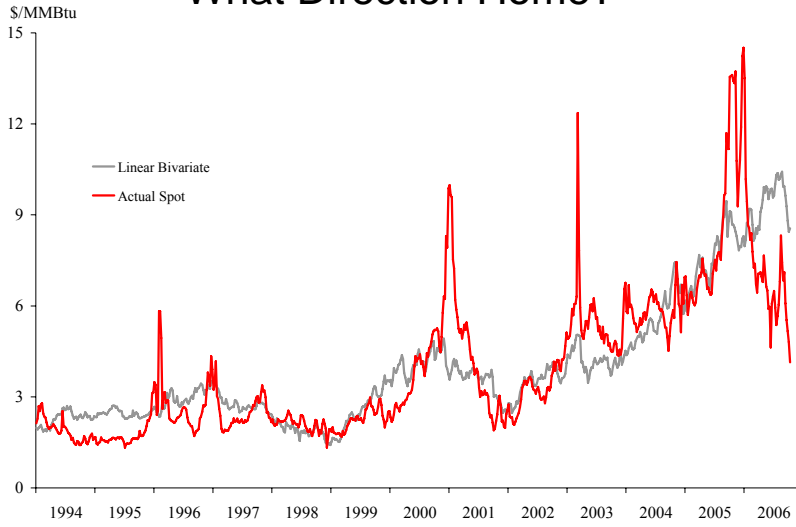
Natural Gas Prices Significant Variables

- Crude Oil (error-correction process)
- Weather
 - Heating degree days (seasonality)
 - Deviations of heating and cooling degree days from normal
- Storage (differential from seasonal norm)
- Hurricane disruptions

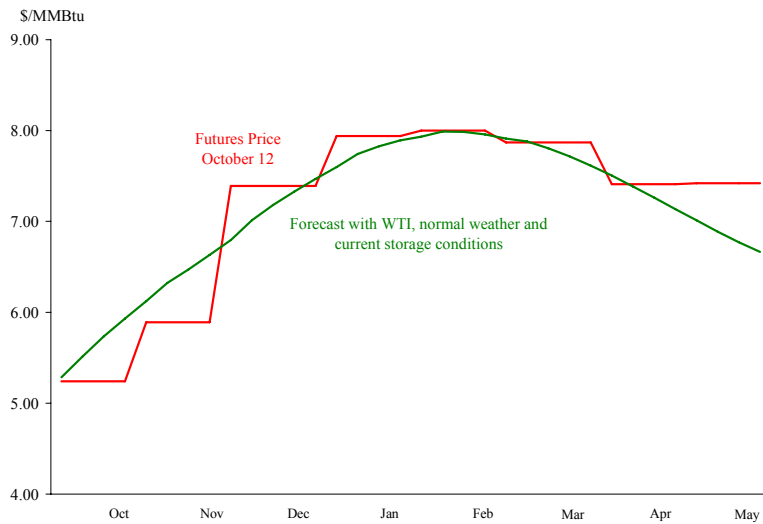
Natural Gas Price Error-Correction Process



Natural Gas Price What Direction Home?



Forecast and Futures Prices

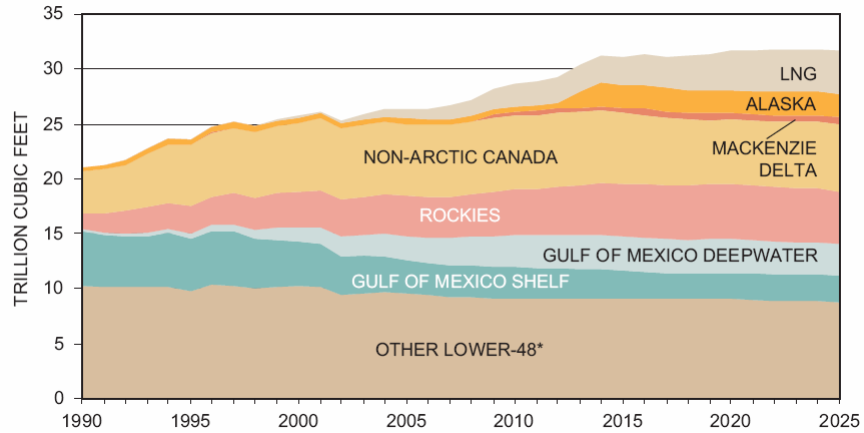


U.S. Natural Gas Prices

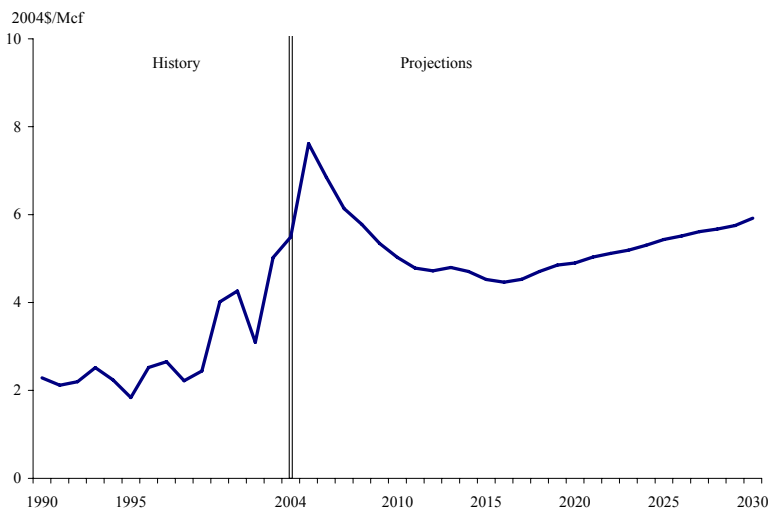
- Driven by crude oil prices in an error-correction process
- and
 - weather, seasonality, storage, hurricane disruptions
- Implies a continuum of substitutability
- Linkage to oil likely to continue?
 - A low natural gas price relative to oil is likely to yield a rapid expansion in natural gas consumption.

Outlook for U.S. Natural Gas Markets

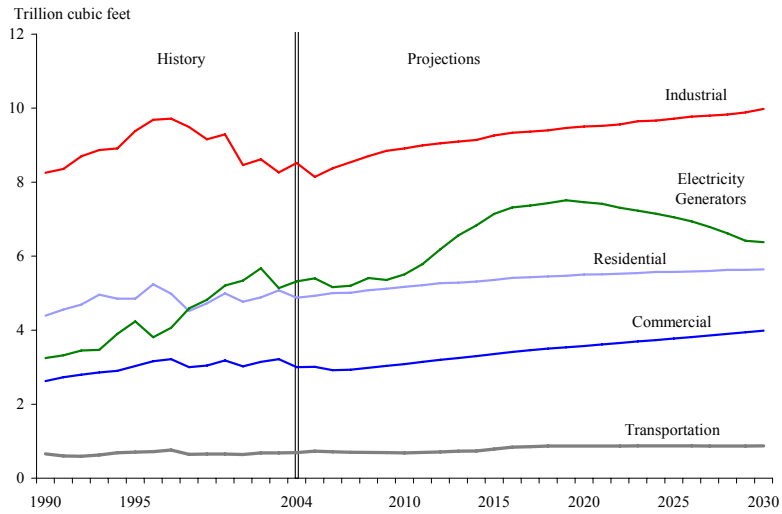
U.S. and Canadian natural gas sources



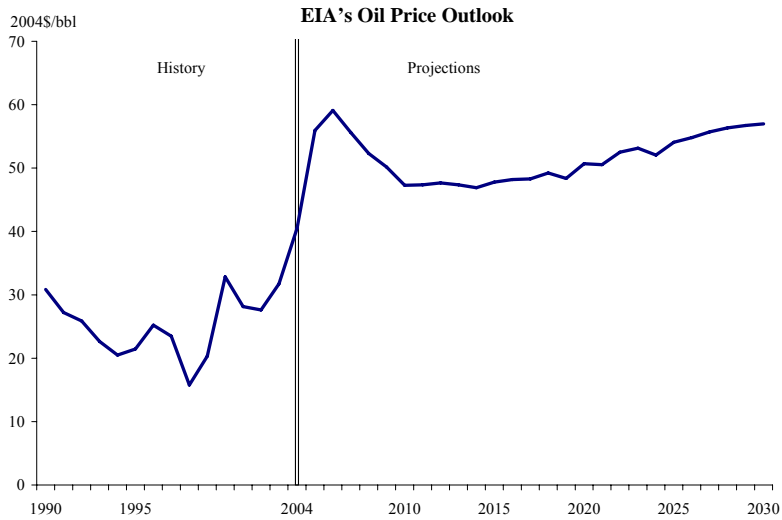
EIA's Natural Gas Price Outlook



EIA's Natural Gas Consumption Outlook



EIA's Oil Price Outlook



U.S. Natural Gas Outlook

- Development of Alaska natural gas
- Increased reliance on imports (LNG)
 - with most new terminals in Gulf of Mexico
- Technical feasibility suggests natural gas prices at \$4.00-5.00 per million Btu
- Moderate growth of natural gas use?
 - depends on relative prices
- More likely is \$6.50+ per million Btu
 - oil prices drive natural gas prices

