

Natural Gas Market Integration in Germany

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Agenda

1. Motivation
2. Previous Literature
3. Methodology
4. Data
5. Empirical Results
6. Conclusions

- EU Regulatory Framework
 - Acceleration Directive in 2003
 - Third legislative energy & gas package in 2007
 - ⇒ EU working towards a single market for natural gas
- Regulation in Germany
 - German Energy Law (Energiewirtschaftsgesetz) in 2005
 - Introduction of an Entry-Exit-System in October 2007
 - German energy regulator aims at reducing number of Entry-Exit-Zones (and trading hubs) to one single for high caloric (H-) natural gas and one for low caloric (L-) natural gas

- Development and present situation
 - Number of Entry-Exit Zones reduced from 19 (2007) to 6 (October 2009)
 - Potentially liquid high-caloric natural gas trading hubs
 - ‘Net Connect Germany’ (NCG)
 - Bayernets + E.ON Gastransport
 - since October 1st 2008
 - ‘Gaspool’, until October 1st: ‘GUD’
 - Gasunie Deutschland + Dong + StatoilHydro
 - established August 2006
 - since October 1st 2009: also ONTRAS + WINGAS

- Development and present situation (ctd.)
 - July 1st 2008: Dutch Gasunie acquires BEB Transport and forms GUD
 - July 1st 2007: European Energy Exchange EEX starts trading of NCG and GUD spot markets
 - EEX natural gas wholesale trading
 - Prices for NCG and GUD trading points
 - NCG is more liquid than GUD
 - Churn-Rate: NCG ≈ 1.5 (vs. NBP ≈ 10)
 - Transmission network: hardly any free capacity (“red lights”)

Motivation

Research Question

- Effect of the Entry-Exit-System on the competitiveness of the German natural gas wholesale market
- Measurement of competitiveness: Analysis of price development to identify level of market integration
 - Price cointegration
 - Price convergence
- Comparison of NCG and GUD
 - Price development within Germany
- Dutch hub Title Transfer Facility (TTF) as competitive benchmark
 - Market integration of Germany and the Netherlands

Previous Literature

- USA
 - Walls (1994): Cointegration analysis of natural gas prices at different citygates
 - Ripple (2001): Cointegration analysis of U.S. West Coast and Gulf Coast as well as Asia
 - King/Cuc (1996): Analysis of U.S. spot price applying Kalman Filter
 - Europa
 - Asche et al. (2001): Cointegration analysis of Belgium, France and Germany
 - Neumann et al. (2005): Kalman Filter Analysis of spot market prices at Zeebrügge and NBP, considering natural gas flows in the Interconnector
- ⇒ Increasing market integration over time

- Competitive Benchmark
 - Homogenous goods should have identical prices if markets are efficient (Law of one Price)
 - Price differences should only reflect transportation and transaction costs in the long run
- Markets are economically integrated markets if prices are cointegrated
- Methods
 - Cointegration Analysis following Johansen (1988)
 - Kalman Filter (Kalman, 1960)

- Johansen Test: weaknesses
 - Cointegration vector constant over time
 - Cointegration dynamics not considered
 - Limited explanatory power for
 - Short observation periods
 - Structural or institutional changes
- Application of Kalman Filter
 - Allows for a time-varying integration relation
 - Uncovers price formation dynamics

- Consider a price relationship between two markets X and Y

$$P_{X,t} = \alpha_{XY,t} + \beta_{XY,t} P_{Y,t} + \varepsilon_t$$

- $\alpha_{XY,t}$: transaction and transportation costs between markets X and Y
- $\beta_{XY,t}$: intensity of price relationship across the markets with constant α

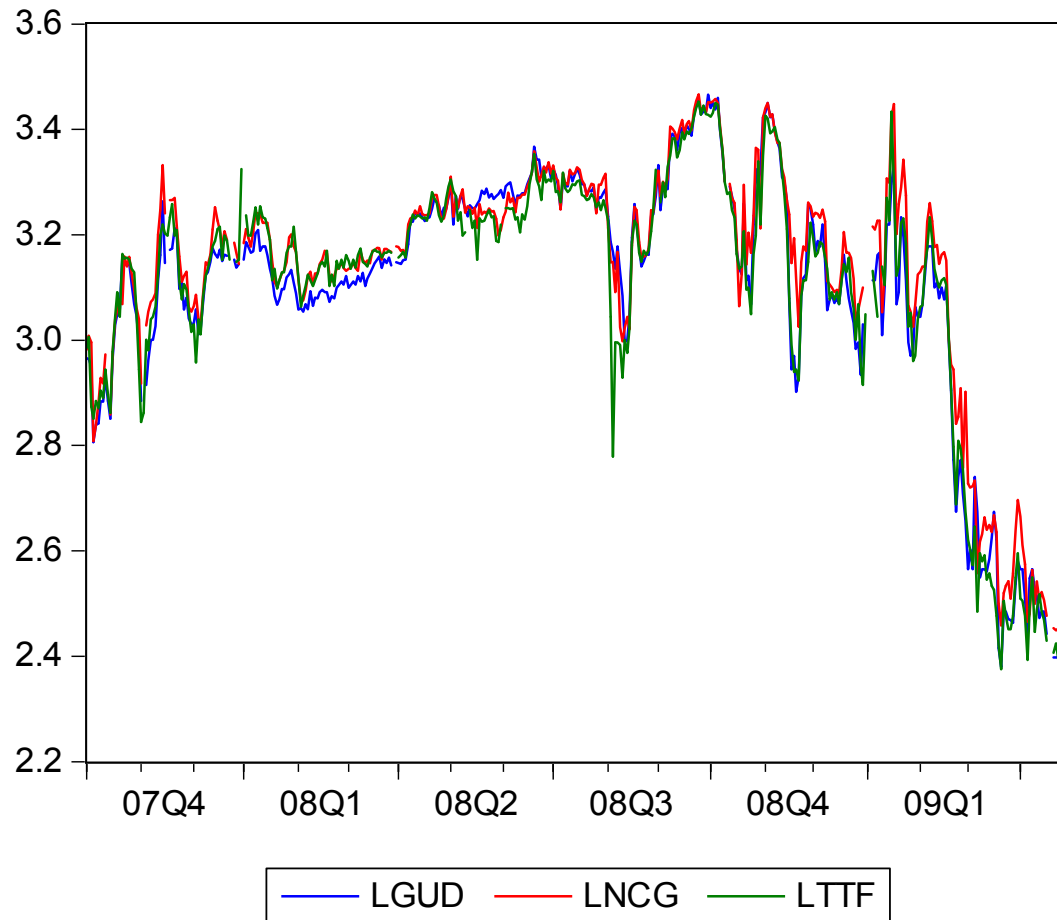
- Recursive estimation of β

$$\beta_{XY,t} = \beta_{XY,t-1} + \theta_t$$

- if markets X and Y are fully integrated, we expect that

- $\left\{ \lim_{t \rightarrow \infty} (P_X - P_Y) \right\} = \alpha_{XY}$
- $\left\{ \lim_{t \rightarrow \infty} \beta_{XY} \right\} = 1$

- Day ahead Preise (logs)
 - Net Connect Germany (NCG): EEX
 - Gasunie Deutschland (GUD): EEX
 - Title Transfer Facility Hub (TTF): energate
- Daily day-ahead prices
- Timeframe
 - October 1st 2007 – April 30th 2009
 - Starting with the introduction of the Entry-Exit System
 - No reliable price information for earlier periods



Empirical Results

Preliminaries

- Unit Root
 - ADF and KPSS
 - Time-series are $I(1)$
- Granger Causality Test
 - GUD granger causes NCG
 - TTF granger causes NCG
 - GUD and TTF granger cause each other
 - results indicate a stronger integration of GUD and TTF than of NCG and TTF

Empirical Results

Cointegration

Johansen-Test

Vari-ables	H ₀	H ₁	Maximum eigenvalue (λ_{\max})	Critical value (5%)	p-value	Trace statistics (λ_{trace})	Critical value (5%)	p-value
GUD TTF	r = 0	r = 1	34.46	14.26	0.000	35.58	15.49	0.000
	r ≤ 1	r = 2	1.13	3.84	0.288	1.13	3.84	0.288
NCG TTF	r = 0	r = 1	41.86	14.26	0.000	42.85	15.49	0.000
	r ≤ 1	r = 2	0.99	3.84	0.319	0.99	3.84	0.319
GUD NCG	r = 0	r = 1	34.56	14.26	0.000	35.29	15.49	0.000
	r ≤ 1	r = 2	0.74	3.84	0.391	0.74	3.84	0.391

- Pairwise cointegration of prices
- Long-run equilibrium with constant price difference
- Differences can be attributed to transaction and transportation costs

Empirical Results

Cointegration

Long-run coefficients

Variables	β
GUD TTF	1.000
NCG TTF	0.957
GUD NCG	0.96

- Full market integration between GUD and TTF
- Strong cointegration also between other prices
- Confirms Granger-Test results

Empirical Results

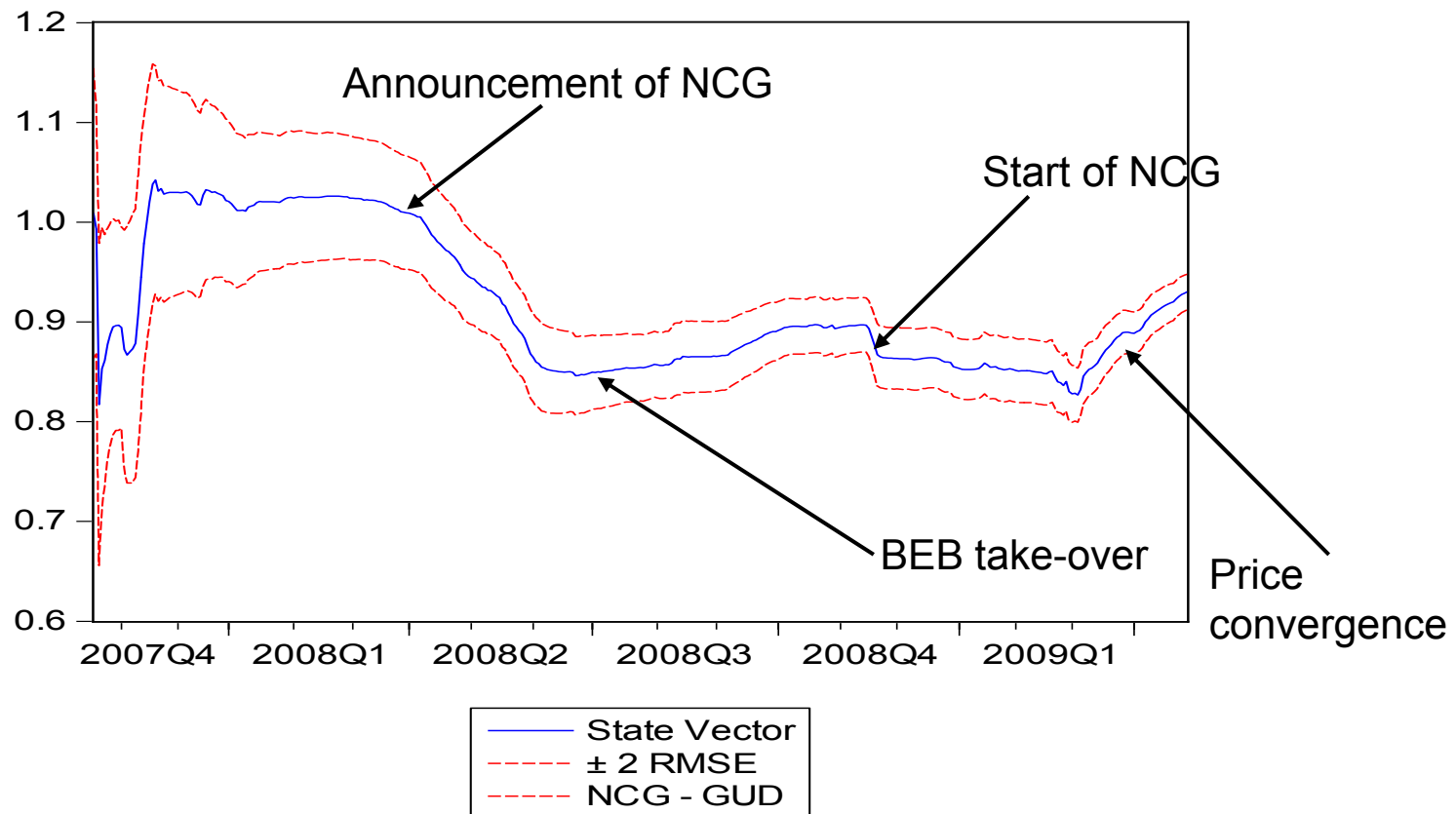
Tests for structural breaks

- Reasons
 - Dynamic regulatory environment
 - Mergers of Entry-Exit Zones
 - ⇒ Hypothesis: β not constant over time
- Cumulative Sum of Squares (CUSUM) Test
 - ⇒ Indicates structural breaks
- Chow-Test: significant structural breaks at
 - July 1st 2008: Take-over of BEB by Gasunie
 - October 1st 2008: Bayernets and E.ON merge to NCG

Empirical Results

Kalman Filter

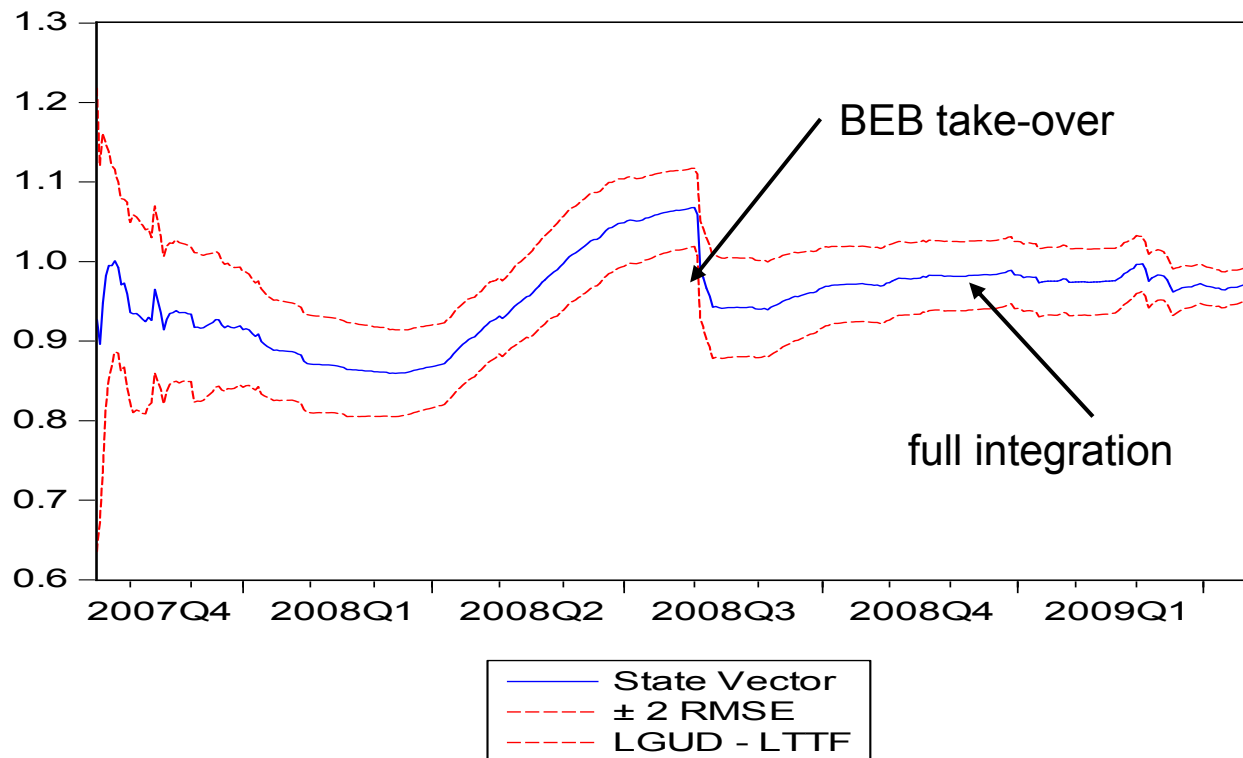
GUD and NCG



Empirical Results

Kalman Filter

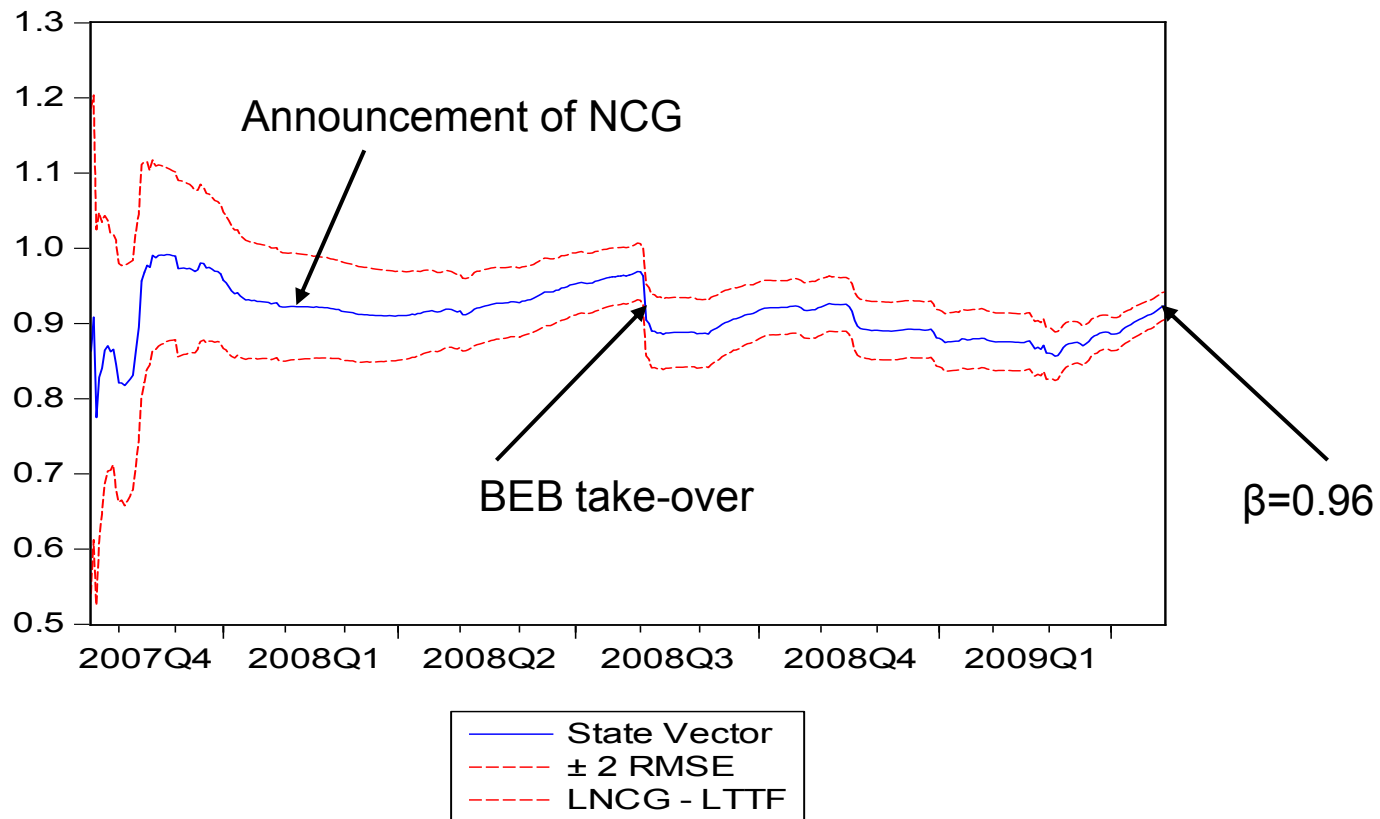
GUD and TTF



Empirical Results

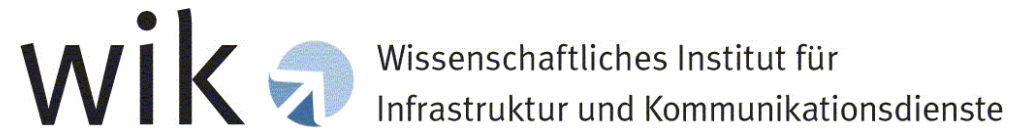
Kalman Filter

NCG and TTF



Conclusions

- Increasing integration of the three natural gas markets Net connect Germany, Gasunie Deutschland und Title Transfer Facility Hub
- GUD and TTF seem to be a single market (with Gasunie being joint owner)
- NCG follows GUD/TTF being fairly integrated
- Structural changes tend to cause short-run desintegration
- German regulatory quest of achieving full market integration seems to be achievable also with two German hubs



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