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Price Convergence and Information Efficiency in German Natural Gas Markets

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Agenda

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

Motivation

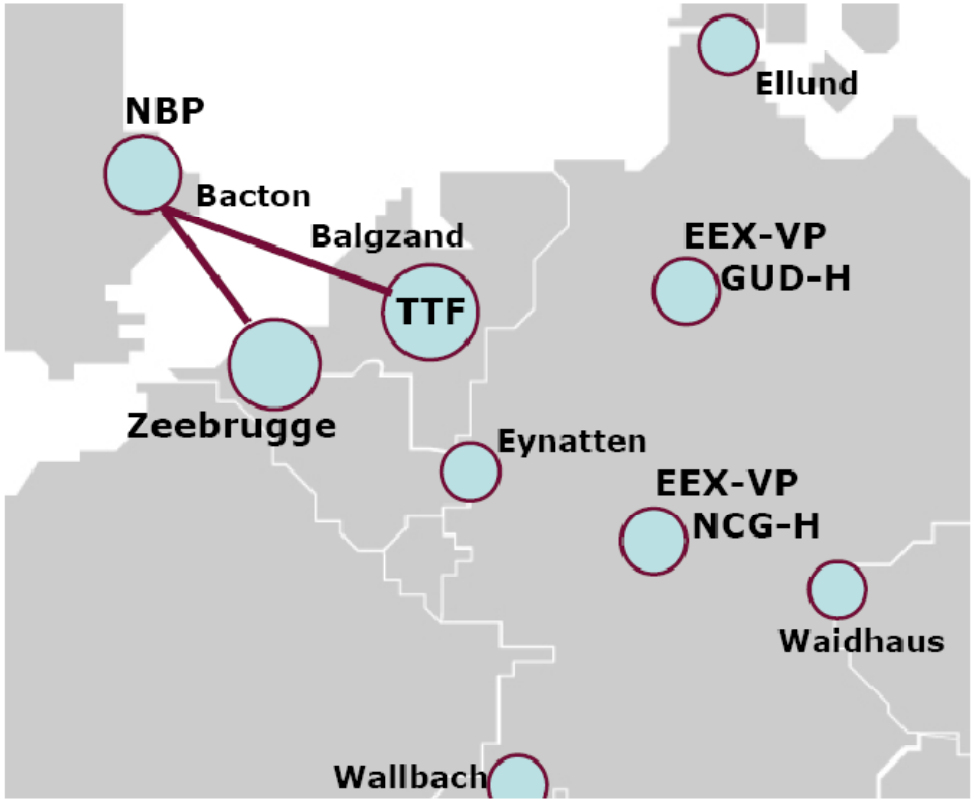
- EU Regulatory Framework
  - Acceleration Directive Gas in 2003
  - Third legislative energy package entering into force 2011
  - ⇨ EU working towards a single market for natural gas
- Regulation in Germany
  - German Energy Law (Energiewirtschaftsgesetz) in 2005
  - Introduction of an Entry-Exit-System 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

Motivation

- 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 2008
      - ENI + GRT + GVS since October 2009
    - ‘Gaspool’ (GPL)
      - BEB + Dong + StatoilHydro established in August 2006
      - Take-over of BEB by Gasunie in July 2008
      - Merger with ONTRAS + WINGAS in October 2009

Motivation

- European wholesale market by the end of 2009



- TTF/ NDL
  - Pipelines from GER, BEL and UK
  - Trading system
  - Connection to NBP via Interconnector
  - Churn rate ca. 3.2
- EEX/ GER
  - Virtual trading points NCG and GPL
  - Churn rate NCG increased from 1.6 to 2.7
  - Capacity shortages

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 convergence / market integration
  - Information efficiency
- Comparison of NCG and GPL
  - Price development within Germany
- Dutch Title Transfer Facility (TTF) hub as competitive benchmark
  - Market integration of Germany and the Netherlands
- Accounting for transmission charges

Previous Literature

- U.S. gas market
  - Walls (1994), De Vany and Walls (1993, 1996) as well as Serletis (1997) study the effect of market opening using cointegration analysis finding increasing market integration over time
  - King and Cuc (1996) confirm these results applying a time-varying coefficient approach (Kalman Filter)
  - Cuddington and Wang (2006) find regional differences regarding market integration by means of an error correction model
- European gas markets
  - Asche et al. (2001) detect integrated markets of Belgium, France and Germany
  - Siliverstovs et al. (2005) study the development of convergence of spot prices at Zeebrugge and NBP

Methodology

- Competitive Benchmark
  - On efficient markets homogenous goods should have identical prices at different locations (Law of one price)
  - Price differences should only reflect transportation and transaction costs
  - New information (innovations) are immediately absorbed by the market

⇨ Markets are economically integrated if time series of prices at different trading points are cointegrated

⇨ Markets are efficient if information processing is fast

Methodology

- Cointegration according to Johansen (1988, 1991)
  - Identification of a long run equilibrium
  - Identification of short run dynamics via error correction model
  - Fixed relations over time
  - Limited explanatory power for
    - Short time periods
    - Structural or institutional changes
- Time-varying coefficient model (Kalman Filter, Kalman, 1960)
  - time-varying relation of market integration / price convergence
  - Error correction model: Time-varying short run dynamics indicating information efficiency

Methodology

- Price relation between two market zones *i* and *j*:

$$p_{i,t}^{net} = c_{ij} + \beta_t p_{j,t}^{net} + \varepsilon_t$$

  - c_{ij} : Transaction costs beyond transmission charges
  - β_t : Degree of market integration

- Kalman Filter: recursive determination of β:

$$\beta_t = \beta_{t-1} + \upsilon_t$$

- Kalman Filter as error correction model:

$$\Delta p_{i,t}^{net} = c_{ij} + \alpha_t (p_{i,t-1}^{net} - p_{j,t-1}^{net}) + \varepsilon_t$$

$$\alpha_t = \alpha_{t-1} + \upsilon_t$$

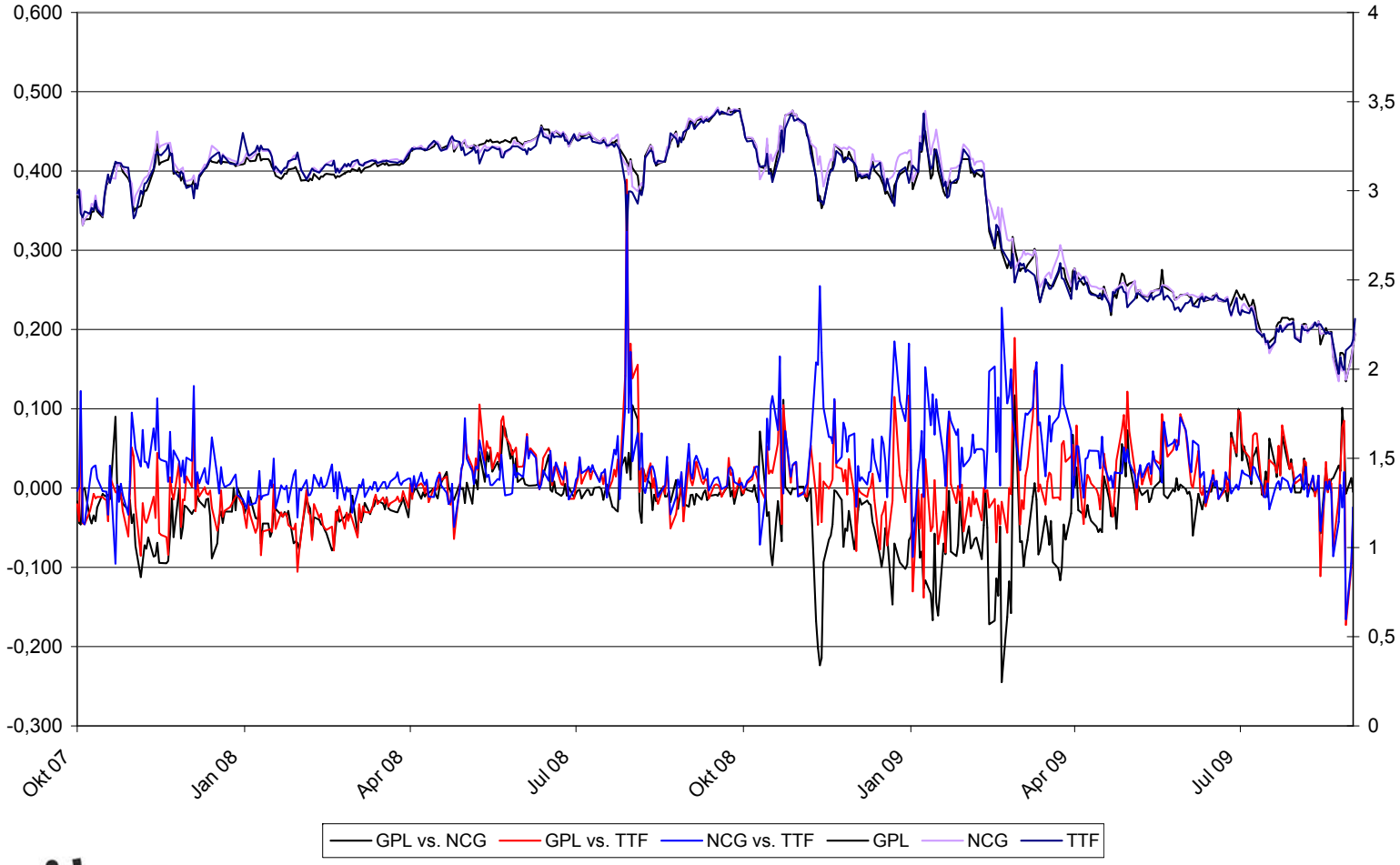
  - α_t : speed of price adjustment

Data

- Daily day ahead prices (logs)
  - Net Connect Germany (NCG): EEX
  - Gaspool (GPL): EEX
  - Title Transfer Facility Hub (TTF): energate
- Prices adjusted for transmission charges
- Timeframe
  - October 1st 2007 – September 30th 2009
  - Starting with the introduction of the Entry-Exit System
  - No reliable price information for earlier periods

Data

- Day ahead prices (logs) and price differentials



Empirical Results

- Long run cointegrating equations and error correction

Region	Cointegrating Equation			
				Constant
GPL-NCG	0.983*** (0.010)	GPL	-0.155** (0.076)	-0.038 (0.028)
		NCG	0.158** (0.073)	
GPL-TTF	0.997*** (0.007)	GPL	-0.332*** (0.064)	-0.014 (0.021)
		TTF	0.188*** (0.064)	
NCG-TTF	1.011*** (0.010)	NCG	-0.342*** (0.076)	0.0166 (0.030)
		TTF	0.025 (0.076)	

Prices are cointegrated ⇒ strong market integration

Empirical Results

- Accounting for structural or institutional changes over time
  - Dynamic regulatory environment
  - Mergers of market zones

⇒ Time-varying coefficient model (Kalman Filter)

  - Development of price convergence
  - ⇨ Hypothesis: β increasing over time
  - Development of market efficiency (information processing)
  - ⇨ Hypothesis: α increasing over time (in absolute terms)

Empirical Results

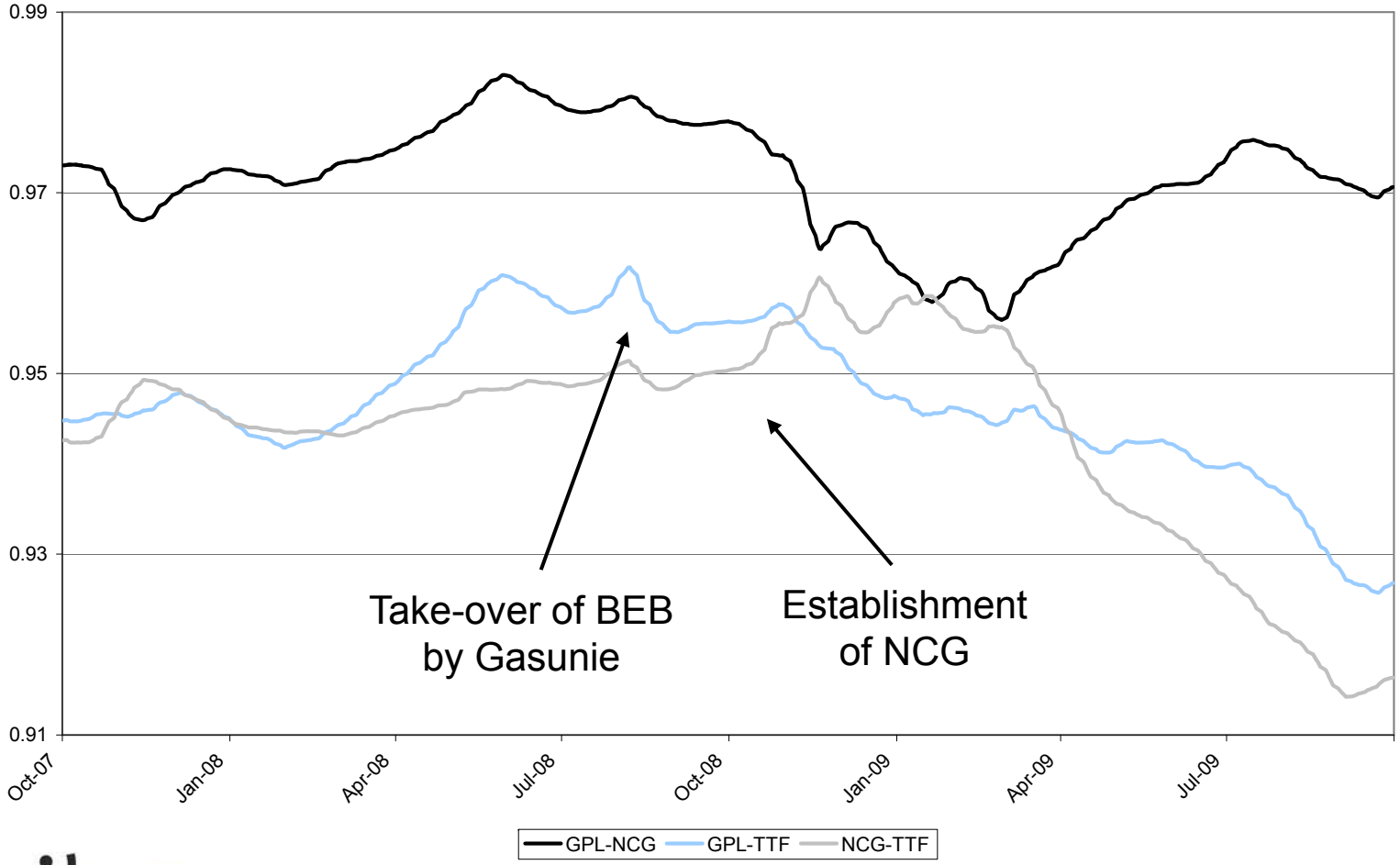
- Time-varying coefficient model (final state)

Region	Price Convergence		Information Efficiency	
	β	Constant	α	Constant
GPL-NCG	0.971*** (0.003)	0.068** (0.027)	-0.684** (0.291)	-0.002 (0.003)
GPL-TTF	0.923*** (0.003)	0.155*** (0.028)	-0.878*** (0.244)	-0.000 (0.002)
NCG-TTF	0.916*** (0.004)	0.178*** (0.026)	-0.653** (0.296)	0.006** (0.003)

- Highest degree of market integration for intra-German trades
- Significant transaction costs (beyond transmission charges)
- Highest information efficiency between GPL and TTF

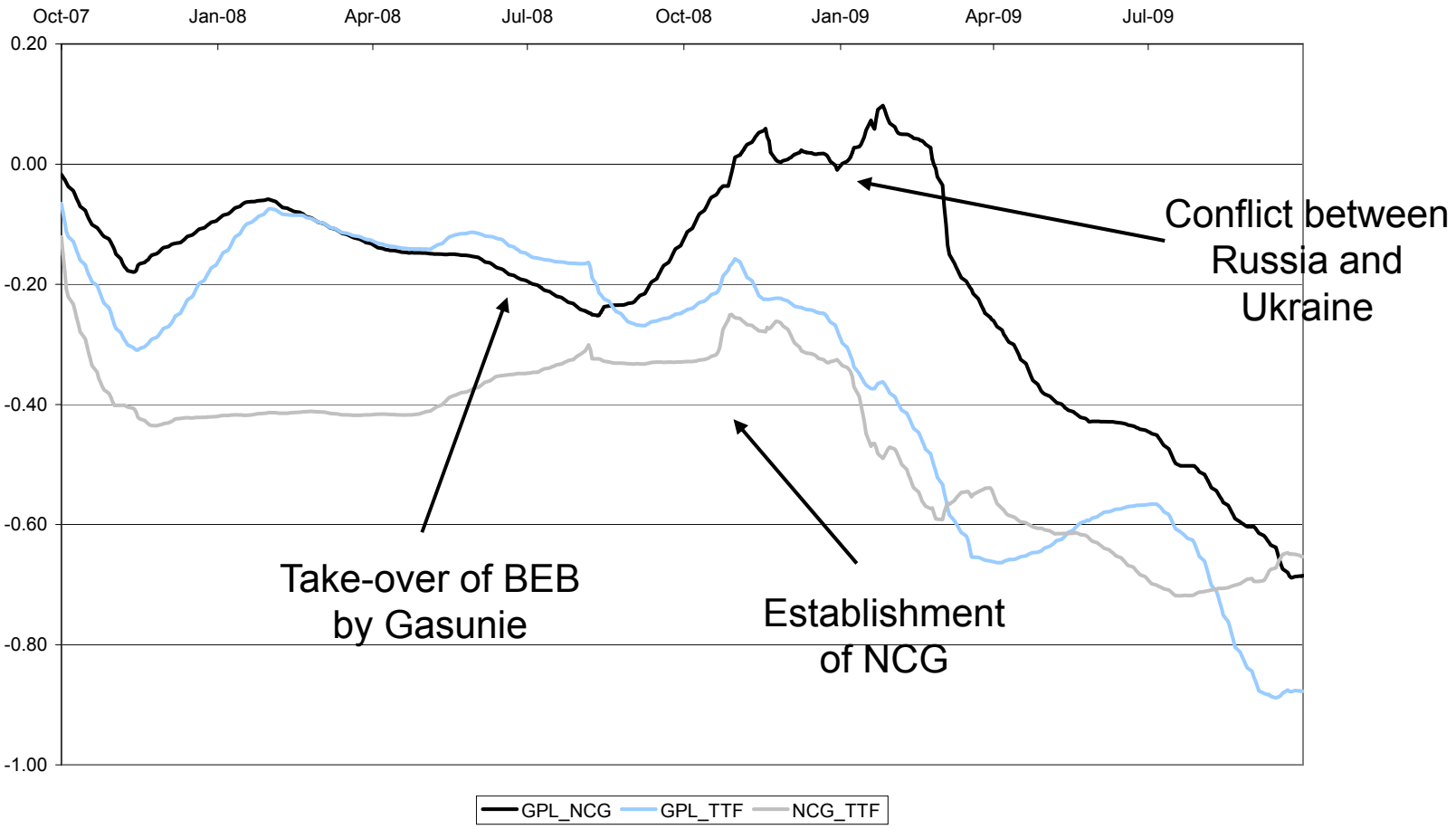
Empirical Results

- Price convergence (β)



Empirical Results

- Information efficiency: Error correction (time-varying α)



Conclusions

- Johansen approach
  - TTF as the leading market for the two German markets
  - Fails to account for changes in market environment
  - Seems to overestimate price convergence due to fixed price relations
- Time-varying coefficient model
  - Wholesale markets sufficiently integrated
  - Considerable increase in market efficiency since mandatory introduction of the Entry-Exit-System
  - Especially after establishment of NCG
  - Still significant price differentials between markets indicating capacity constraints
- Further market investigation suggested

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Methodology

- Accounting for transmission charges
  - Law of one price holds if spatial price differential ≤ transmission charges

$$P_{j,t} - P_{i,t} \leq TC_{i \to j,t}$$

  - In case of asymmetric network charges

$$P_{i,t} + d_{i \to j,t} \cdot TC_{i \to j,t} = P_{j,t} + d_{j \to i,t} \cdot TC_{j \to i,t}$$

with

$d_{i \to j,t} = 1$ if $P_{i,t} + TC_{i \to j,t} \leq P_{j,t}$, otherwise $d_{i \to j,t} = 0$

and

$d_{j \to i,t} = 1$ if $P_{j,t} + TC_{j \to i,t} \leq P_{i,t}$, otherwise $d_{j \to i,t} = 0$

Methodology

- Accounting for transmission charges (cont.)
  - Adjusted spot price net off transmission charges

$$P_{i,t}^{net} = P_{i,t} + d_{i \to j,t} \cdot TC_{i \to j,t}$$

  - Equilibrium condition using log prices

$$p_{i,t}^{net} = p_{j,t}^{net}$$

i,j = GPL, NCG, TTF

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