Price Effects and Security of Supply during the Russian-Ukrainian Gas Conflict - A Model-based Analysis -

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Introduction

The Russian-Ukrainian Gas Conflict

- Russia is the single largest gas supplier to Europe
- 65 percent of gas volumes transited via Ukraine
- Ukraine itself importer of Russian gas
- “Regular“ disputes regarding
  - gas prices paid by Ukraine
  - transit fees paid by Russia
- January 2009: prolonged interruption (13 days) of all gas transits from Russia to Europe via Ukraine
- Severe shortages in some Eastern European countries
- Much smaller short-term impacts in Western and central Europe
Introduction

Contribution of this paper:

- Application of model for simulation of events in the European gas market during crisis (efficient price signals / disruptions)
- Could a more competitively organised market have dealt better with the crisis?
- What physical bottlenecks existed?
- 2nd simulation: What are the price and supply effects of improved physical market integration?
European Infrastructure Model TIGER

Linear Optimisation

Objective:
Cost-minimal demand satisfaction, restricted by available capacities

daily granularity

Production
- costs and capacities

Gas demand
- by sector, regionalised

Infrastructure
- Capacities (exist. + exp.)

Natural gas flows and usage of infrastructure assets
(Pipelines, Gas Storages, LNG Terminals)

Locational Marginal Cost Price Estimator

Source: Institute of Energy Economics at the University of Cologne (EWI)
Applications:

- Analysis of infrastructure projects in the context of the whole European infrastructure system
- Security of supply considerations
- Estimation of short-run marginal cost prices
- Economic valuation of natural gas transmission capacities / infrastructure bottlenecks

Characteristics

- Maximum forecasting period: 12 to 15 years
- Maximum granularity: daily, specification of temperature levels (based on historic temperatures) possible
- Grid model: nodes connected with edges
TIGER – Infrastructure database

Geocoded Database:

>550 Nodes

>750 Pipelines sections
  • Based on TSO data
  • Capacity / Pressure / Diameter
  • Nearly all Entry-Points
  • Major Exit Points
  • Border point capacities

>200 Storages
  • Type
  • Maximum Injection/ Withdrawal Rates
  • Working Gas Volume

>20 LNG Terminals
  • Max hourly/yearly Cap.
  • Storage Capacity

Source: Institute of Energy Economics at the University of Cologne (EWI)
Analyses

Approach:

- Parameterization of model for January 2009, actual availability of infrastructure, estimated demand / supply situation

- (A) Simulation for January 2009 with assumption of efficient infrastructure utilization (i.e. TSO perform all efficient swaps)

- Comparison: Simulation of “Normal Winter Day“
**January 2009:**

- Supply shortage more than 300 mcm (10,600 mcf) per day
- 92% can be compensated by reducing transit flows, imports from Western Europe and additional storage withdrawals
- Supply Gap persists even in this market simulation presuming efficient TSO operations (in reality larger than the 22.5 mcm /day)
- Model results largely match actual observations

Source: own illustration based on Bettzüge & Lochner (2009)
(A2) Short-run marginal supply costs during disruption

Location-specific SRMC: what are the total system costs of supplying one additional unit of natural gas at the respective node?

January 2009:
- severe supply disruptions in Eastern European countries of Romania, Bulgaria, Hungary
- only slight increases in marginal supply costs in central and Northwestern Europe (as observed at spot markets)
- significant increases in Austria, Slovakia (but no liquid spot markets to compare with)

Source: Bettzüge & Lochner (2009)
Conclusion & Further Analysis

• Model results match market observations -> industry reacted to crisis efficiently
• Supply shortages were consequence of infrastructure limitations, especially in Eastern Europe

Would further physical market interconnection have improved security of supply?

Approach:
• (B) Same simulation assuming changing flow directions on all pipelines is possible -> i.e. least cost scenario for increased physical market integration
(B) Impact of increased market integration

January 2009:

- supply disruptions in Romania, Bulgaria could have been avoided, though not in Hungary
- much smaller price signals to consumers in Austria and Slovakia
- highest increases of short-run supply costs in Eastern European countries which escaped crisis due to alternative routes from Russia, i.e., Greece, Turkey, Poland and Czech Republic
- Western Europe: positive (+) price effect for France, Italy, large parts of Germany; negative (-) for UK
Conclusions

- Detailed infrastructure model allows sophisticated analyses of price effects / natural gas flow scenarios in the European gas market

Crisis:
- Market behaved almost as efficiently as the infrastructure allowed it to during the crisis
- (although adequate price signals in Eastern European Countries would have improved allocative efficiency)
- Slightly improved physical market integration would have reduced supply disruptions in some countries, but not all!
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Appendix: Reference and selected EWI publications


