Imperfect Models of Imperfect Competition in EU Gas Markets: *Great Potential, Great Shortcomings*

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Outline

- Questions
- Structure (ECN's GASTALE)
- Example: Economics of Nord Stream under Oligopoly
- Unscientific poll:
  1. How has gas modeling been successful?
  2. How has it not?
  3. What should be done next?

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Market Power in the Gas Supply Chain

- *Where?*
  - *Gas producers* emphasized by modelers
  - *Gas transporters & retailers* emphasized by EU Directives
- *Questions that modelers address:*
  - How might prices be manipulated?
  - How does industrial structure & market rules affect that manipulation?
  - What are benefits of policy & infrastructure changes?
    - Economic
    - Supply security
    - Sustainability
  - Who benefits (and thus could pay)?

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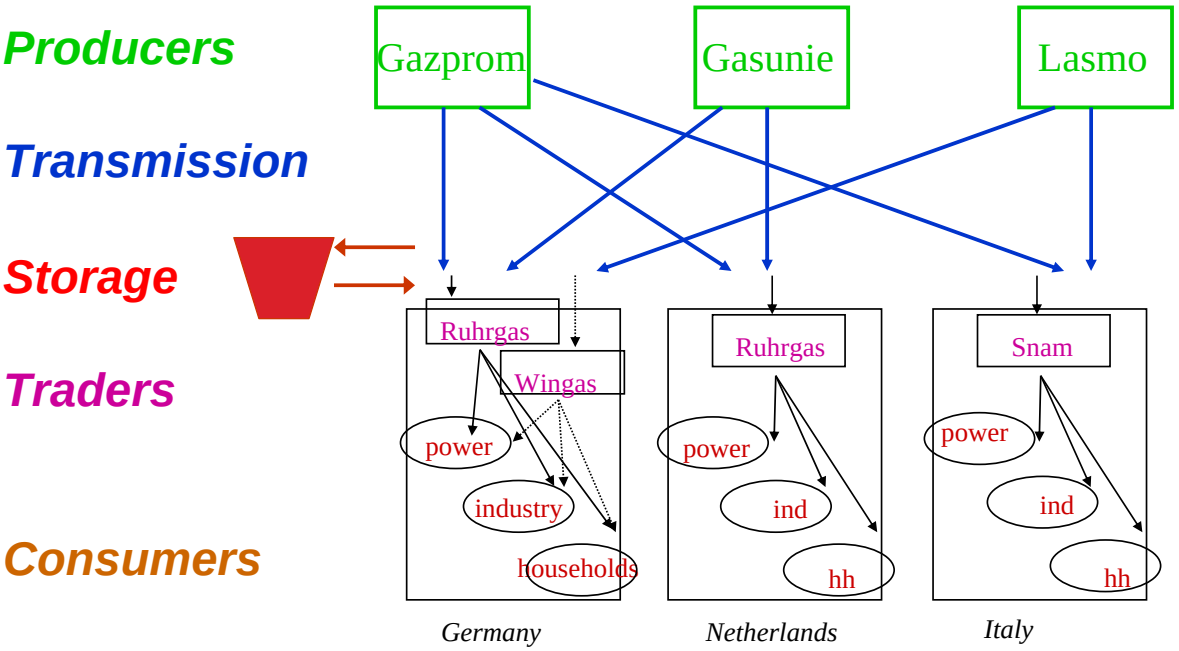
Modelling market structure (e.g., ECN's GASTALE)



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Market Power in the Gas Supply Chain (ECN's GASTALE "3")

- Producers and traders maximize profits
  - Static costs
- Producers oligopolistic (*a la* Cournot)
  - "Quantity" strategies (against Trader derived demand)
- Transmission/Storage:
  - Competitive (Tariff + "Congestion Price")
  - Invest based on most recent prices
- Traders: two options for behaviour
  - Oligopoly → Cournot game (against Consumer demand)
  - Perfect competition
- Consumers' price elasticities → gas use

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Economics of Nord Stream: Effect of Competitive Assumptions

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Our research questions

- Do perfect and imperfect competition models differ in their evaluation of pipelines that improve security of supply?
  - Perfect competition vs.
  - Producer oligopoly vs.
  - Successive (producer, marketer) oligopoly
- Can we explain the differences in their results?

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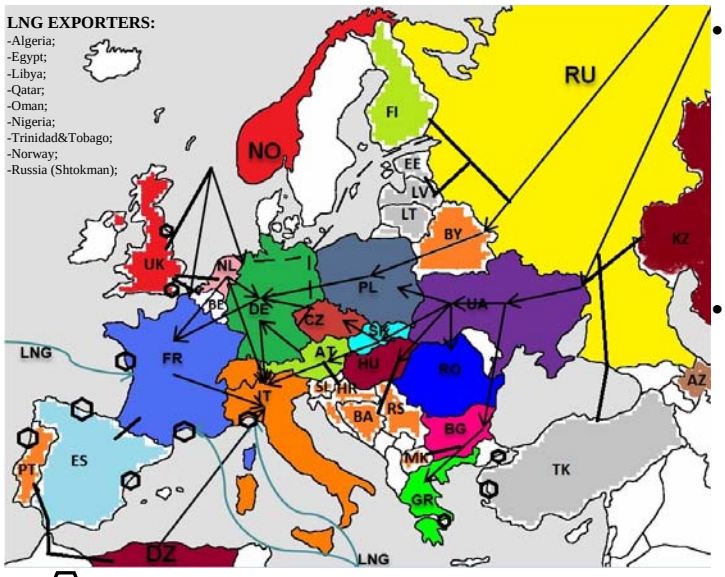
EGASM Model Description



- Regasification Terminals

- *Strategic Eurasian Gas Model*
  - Two-Stage, static equilibrium model of successive oligopolies;
    - Producers 'clever' and know how traders will behave
  - Endogenous Transit Response: 'Conjectured Transit Function' applied to Ukraine.
- *Assumptions for reference case up to 2040:*
  - IEA's Oil Price forecast;
  - Forecast of demand, production and liquefaction capacity from IEA's WEO2009;
  - Costs assumptions: OME2001,2004; IEA2003,2009

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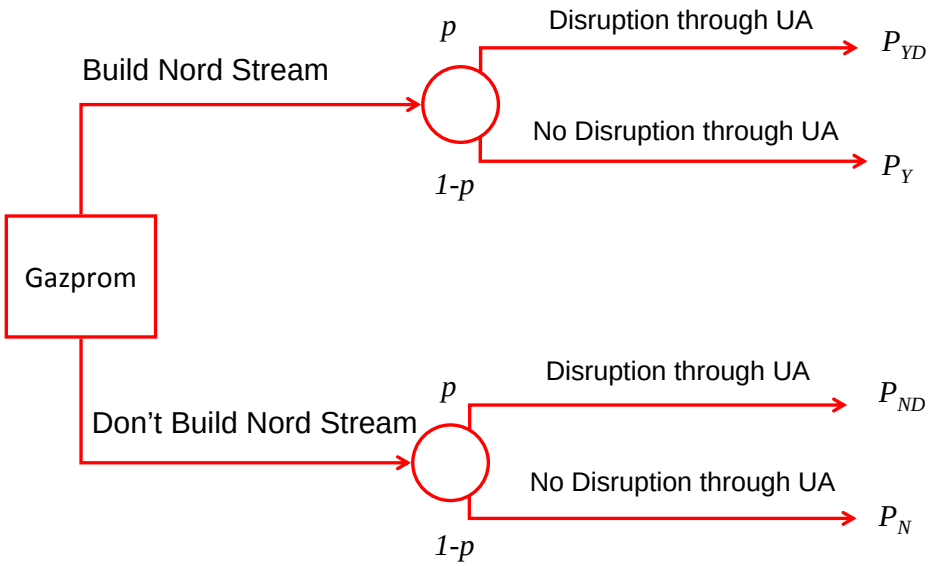
The Case of Nord Stream Pipeline

Expected Value of Nord Stream under transit disruption risks



$$\text{Net Benefits of Nord Stream} = p\cdot(P_{YD}-P_{ND})+(1-p)\cdot(P_Y-P_N)$$

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How can models of perfect and imperfect competition evaluate pipelines that improve security of supply?

Nord Stream is Not Built	Nord Stream is Built
Run Market Simulation Scenarios up to 2040	Run Market Simulation Scenarios up to 2040
Record Gazprom's Profit (P_N) and gas quantity shipped through Ukraine	Record Gazprom's Profit (P_Y) and gas quantity shipped through Ukraine
Disrupt transit flow through Ukraine and record Gazprom's profit (P_{ND}) under different scenarios: Three and six weeks of disruption every 6 and 3 years over next 30 years respectively;	Disrupt transit flow through Ukraine and record Gazprom's profit (P_{YD}) under different scenarios: Three and six weeks of disruption every 6 and 3 years over next 30 years respectively;

Market Scenarios:

1. *Double Marginalization*
2. *Upstream Oligopoly*
3. *Perfect Competition*

Cournot Producers?	Cournot Traders?
√	√
√	

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Results

Net Project Profit (Present Worth 2010, M$US)

Disruption Scenarios	Double Marginalisation	Upstream Oligopoly	Perfect Competition
No Disruption	-10,597	3,962	5,175
3 weeks every 6 years	-10,477	3,998	4,213
6 weeks every 3 years	-10,118	4,568	3,136

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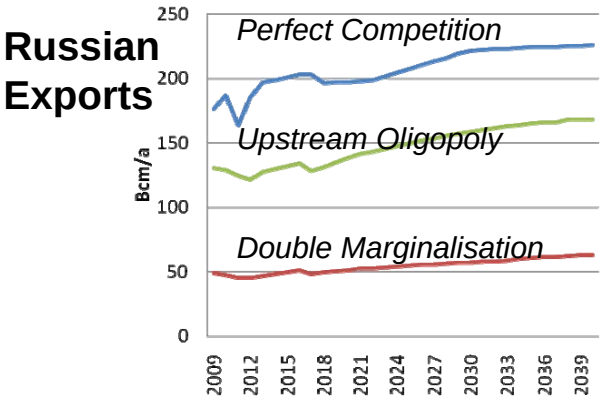
Model Results vs. Real Data



Russian exports to Europe*		
	Model Results, bcm/a	Real Data**, Bcm/a
Double Marginalisation	44	
Upstream oligopoly	115	
Perfect Competition	160	**163**

* Including Turkey
** Real data for 2009 (Preliminary, Gazprom, 2010)
*** Real data for 2008

Russian gas exports: Selected Markets						
	Model Results			Real Data***		
	Germany	France	Italy	Germany	France	Italy
Double Marginalisation	19.5	0.5	3.4	**38**	**10.9**	**22.4**
Upstream oligopoly	34.1	11.4	20.5			
Perfect Competition	69.8	0	34.7			

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A Thoroughly Unscientific Poll of Natural Gas Modelers

*(1) What are the biggest successes of gas market modeling?**

(a) "Models like GASTALE, GASMOD & WGM quantitatively support decisions about market design, infrastructure development, & business opportunities"

- "How does new infrastructure affect market prices? (Balgzand-Bacton pipeline; new LNG import terminals; new Dutch storage) (Egging Gabriel 2006, Lise, Hobbs 2009)
- "What parts of Europe are hurt most by supply disruptions? What counter-measures could dilute the effects? (Lise, Hobbs, Oostvoorn 2007, ENGAGED project, EC 5TH framework programme)
- "How would GASPEC & unconventional US gas production affect Norway's position in the natural gas market? (U.Md./Stat Norway 2010)
- "How would proposed rate decreases for the Dutch network affect congestion and flows at the Dutch-German Border? (Lise et al. 2005, Druk in de gasleiding)"

(Egging, Gabriel, Smeers)

All quotes are paraphrases; I am solely responsible for misinterpretations--BH

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(1) Biggest Successes, Continued

(b) "Oligopolistic models of producer market power are quite useful."

- "They capture the fundamental and observable market power of the producers
  - "They also model relevant transmission & retail markets (as perfect competition models)
- "They are more robust and transparent than models that try to capture both the upstream and downstream parts
  - "They just go one step beyond perfect competition models
- Have shown how disruption scenarios impact the EU
- "Last they pose (and help solve?) the problem of financing a project by identifying those who gain from it"

(Smeers)

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(1) Biggest Successes, Continued

(c) Methodological Successes:

- "The step from optimization to large-scale equilibrium models
  …which better represent market power and the impact of cartels
- "Approaches for solving large-scale stochastic market models
  … can now solve BIG problems (decomposition, scenario reduction)
- "Detail and richness in data, e.g., for pipelines and LNG (capacities, costs, contracted volumes) that allows study of specific topics
- "Better understanding of the role of individual actors, be it with market power or with more technical or political characteristics.
  - E.g., WGM (an equilibrium model), agent-based models (e.g. in theses by S. Tchung-Ming (IFP) or M. van Benthem (TNO))
- "Energy Modeling Forum 23. An extensive attempt to compare and evaluate outlooks using a wide variety of gas market models"

(Egging, Gabriel, Holz, von Hirschhausen)

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(2) What do you think has been the biggest frustration, challenge, failure?

(a) Frustrations:

- Data for prices, volumes, costs, capacities, price-elasticities:
  - unavailable at all;
  - not available at the desired aggregation level; or
  - or undocumented and not reliable.
- Absence of robustness testing
  - Equilibrium models are not forecasting models, but what-if analysis tools. "*Relative to some carefully designed baseline reference scenario, what would be the impact of …*"
  - When presenting the outcomes, the impact of assumptions and data should be addressed extensively

(Eggings)

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(2) Frustration/Challenges/Failures, Continued

(b) Failure of the deterministic market paradigm:

- World LNG trade patterns don't minimize cost; more consistent with portfolio diversification
- Risk averse actors with different future beliefs
  - They behave differently than price taking, risk neutral actors with perfect foresight
- Even existing stochastic models don't allow agents to have different information sets

(David Nissen of Columbia University, Gabriel)

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(2) Frustration/Challenges/Failures, Continued

(c) Failure to capture other important market features:

- "Contracts are crucial in pipeline and LNG markets.
  - "But no trace of them in our models, or they are imposed exogenously
- "Considering detailed engineering equations/relationships can change results
- "Interaction with other markets simplified
  - "The times of partial sectoral models is over; 98% coverage & 75 countries is nice, but we don't have the slightest interrelation with electricity, let alone coal (our direct competitor)
  - "We know little about demand; we know less about how electric renewable obligations and the EU-ETS modify it
- Models often use static production costs
  - Ignore or do a poor job of production and investment decisions over time
- "Failure to realistically capture market power at transmission, storage, & retail levels"

(Eggings, Gabriel, Holz, Smeers, von Hirschausen)

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(2) Frustration/Challenges/Failures, Continued

(d) "Failure to capture market power at multiple levels in the supply chain" (Cont.)

- Successive oligopoly models obviously wrong
- Models assume linear pricing, vs. reality of nonlinear pricing (take or pay)
- "Models assume unconstrained access to transport & storage at competitive prices
  - "They are unsuited to analyse the impact of the organizational barriers identified by the Commission on their use
  - "No model can account for the practice of withdrawing transmission and storage capacities that the Sector Inquiry attributes to insufficient unbundling of supply and infrastructure. One can't select among models on the basis of existing data and theory."
- Models focus on small subset of problems of concern:
  - "EU law addresses 4 problems: agreements between undertakings (Art. 81); State Aid (Art. 87 to 89), abuse (Art. 82) and reinforcement of dominant position (Reg. 139/2004).
  - "Gas models concentrate on just one (excessive prices resulting from dominant positions). Even there, they don't consider exclusionary prices."

(Smeers)

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(3) What Ought to be Developed Next?

(a) Improve representation of private decisions

- "We develop & solve stochastic models. Why do we still analyze deterministic scenarios instead of considering them all at once?
  - Risk aversion and differing perspectives
- Endogenous investment in production
  - Intertemporal production tradeoffs
- "Endogenous long-term contracts
  - "Economists admit that long terms contracts limit the incentive to raise prices on spot markets.
  - "Competition authorities have an altogether different view, arguing that long terms contracts foreclose the market "
- "Better models of transport & storage technology, & market power"

(Eggings, Smeers)

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(3) What Ought to be Developed Next?

(b) Expand scope of models

- Extend partial market models to non-gas energy sectors and environmental issues
  - "Include sustainability
  - "Market power in a larger energy system framework
  - "Endogenously account for substitution effects
- Transmission planning method that accounts for market power mitigation benefits
- "There's abundant talk about security of supply, but recommended actions are unclear. The question seems totally under-researched by modellers .
  - "Can we introduce N-1 constraints in equilibrium models?
  - "Can we make investments endogenous when there is market power? Where would the incentive to build redundant gas transmission and storage infrastructure come from?
- "Multilevel/Stackelberg (MPEC/EPEC) formulation and application:
  - "Monopoly pipeline allocating & expanding capacity subject to oligopolistic gas market.
  - Regulator sets optimal (2nd best) rules to incent investment (e.g., H. Weigt, Dresden)
    - "The absence of any modelling of regulation, and of balkanized regulation for the matter, is a serious drawback. One must get a clean description of the regulations, and then model them."

. (Egging, Gabriel Holz, Smeers, von Hirschhausen)

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(3) What Ought to be Developed Next?

(c) Beyond computation

- Recent changes in EU gas market mean there is little data for building statistical models for projecting market power
  - But statistical analysis can still help validate simulation models.
- The experimental economic approach (live subjects), can identify likely modes of behavior because it allows behavior and rules that are difficult to model:
  - learning and suboptimal decision making
  - complex regulations.

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Conclusions

- *Great Potential*
  - How infrastructure & policy change affects security of supply & exercise of market power
  - Who wins & who loses → who might pay?
- *Great Shortcomings*
  - Oversimplify transmission
  - Absence of theory for endogenous contracts, investment
- *There's lot to do, but models can't do it all*

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