Strategic Eurasian Natural Gas Market Model for Energy Security and Policy Analysis
Application to South Stream investment and Ukraine’s gas diversification policy

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• The model
• Results – South Stream
• Results – Ukraine’s gas diversification policy
• Conclusions
Motivation

• Energy security high on energy policy agenda:
  – 2006, 2009 Russia-Ukraine gas disputes
  – Security crisis in the east of Ukraine ➞ threats to EU gas supply
  – Gas security crises happened at the same time as wider geopolitical crises in Europe
• 2004 Orange revolution
• Russian 2008 invasion of Georgia, 2014 annexation of Crimea ➞ fears in Europe (esp. Baltics and Central Europe) that Russia is using energy as a political weapon
• Thus, energy security used to justify policies in other areas
  – shale gas in Poland,
  – LNG terminals in the Baltics
  – gas diversification policy in Ukraine
• Some of these policies and projects, including South Stream, would not go ahead without 'security' justification
Gas supplies as proportion of total energy use

Source: Eurogas

NY Times, 10/31/2014
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NY Times, 10/31/2014
Model Description

- Model foundations:
  - Microeconomics
  - Game Theory

- Purpose:
  - Analyse energy policy questions such as economic justification for energy security projects

- Features:
  - Each player: MAX profit s.t. constraints
  - Includes gaming in the upstream gas market by large producers, or perfect competition
  - Flexible and generalizable under various market assumptions and data inputs

- Details are in Chyong and Hobbs, *Energy Economics*, (2014)
Model Description

- Capture the full gas value chain:
  - Producers
  - Traders
  - Pipeline transmission operators
  - LNG terminal operators
  - LNG shipping
  - Storage operators
  - Final markets
Model Description
Representing market power in the gas supply chain

- Producers anticipate traders’ reaction (Asymmetric/Leader-Follower game)

- Traders and Producers: Cournot Game (i.e., game in quantities) → each player believes that if it changes gas sales, competitors maintain sales by cutting or raising their prices

- Consumers are represented by aggregate inverse demand functions in each market

- These are standard in other equilibrium models, such as: WGM (Gabriel et al.), DIW Gas Market Model (Holz et al.), GASTALE (Boots, Rijkers, Hobbs), EWI COLUMBUS Global Gas Model etc.
- New: Market power of large gas transporters
- Transit market power represented by the conjectured transit demand curve. Large transit countries (e.g., Ukraine, Belarus) believe that they face a declining effective demand curve for their services with an assumed slope $M$ (exogenous parameter):

  $$(x - x^*) - M(tf - tf^*) = 0, \quad M < 0$$

where $(x-x^*)$ is change in demand for transit that the transit country conjectures will happen if it changes its transit fee by $(tf-tf^*)$
Model Outputs

- Consumer P’s, Q’s
- P’s for gas transmission services, LNG services
- Gas trade Q between contracted parties
- Production Q at each production field
- Storage withdrawal/injection Q
- Gas flows for both LNG and pipelines
- Investment in gas infrastructure facilities (production, pipeline, LNG, storage)
## Data Input

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<thead>
<tr>
<th>INFORMATION</th>
<th>AVAILABILITY</th>
<th>SOURCE</th>
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<td>IEA Natural Gas Information 2013</td>
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<tr>
<td>Pipeline transport capacities</td>
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<td>IEA, EIA, and various other sources</td>
</tr>
<tr>
<td>LNG regasification capacity</td>
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<td>IEA Natural Gas Information 2013</td>
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<tr>
<td>Liquefaction and shipping capacities</td>
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<td>IEA Natural Gas Information 2013; Bloomberg</td>
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<td>Storage withdrawal capacity</td>
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<td>Injection capacity</td>
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NY Times, 10/31/2014
South Stream economics

- South stream is not a profitable project under ‘normal’ circumstances, in absence of Ukraine transit market power.
South Stream economics

- Nor is South Stream profitable project under gas transit disruptions through Ukraine as well, unless project developers (Gazprom) are very risk averse.

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<td>High Demand Case</td>
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South Stream economics

- South Stream profitable only if Ukraine increases transport cost; i.e., exerts its transit market power

<table>
<thead>
<tr>
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<th>Low Demand Case</th>
<th>Base Case</th>
<th>High Demand Case</th>
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<td>Scenario</td>
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www.eprg.group.cam.ac.uk
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“Diversification” the buzzword of the month in EU energy policies

Ukraine’s gas diversification strategy:

- interconnection Central Europe (“Reverse flow”)
- LNG project in southern Ukraine
- Equity participation in LNG projects in Poland and Croatia
- Develop indigenous gas production, including shale
Potential non-Russian supply options for Ukraine – Fixed cost

Existing reverse flow from Poland & Hungary

New reverse flow from Slovakia

Unconventional gas

Conventional gas

Adria LNG (Croatia)

Current gas imports from Russia

Current gas imports from Russia
Potential non-Russian supply options for Ukraine

- How much diversification does Ukraine need?
  - How much gas would Ukraine receive from Europe?
  - At what P?

This depends on international gas markets

![Graph showing netback import price for Ukraine from Western Europe.

25 mmtpa of LNG from NA & high energy demand from Asia.

120 mmtpa of LNG from NA & low energy demand from Asia.](https://www.eprg.group.cam.ac.uk)
Variable costs for non-Russian supply options

- Reverse flow options from Europe
- Conventional gas
- Unconventional gas

LNG market is tight

New range of import price from Russia

So the obvious & cheap solutions that are discussed may turn out to be not so cheap
Conclusions

• Equilibrium models useful to support rational, rigorous analysis of investment (South Stream) & policy

• Increasing energy costs & their effects on EU competitiveness
  → we need better models for rigorous analysis of economic impact of energy security policies and regulations on EU energy markets & economies

• EPECs needed to evaluate security of supply regulations
  – Where regulators are Stackelberg leaders who set rules which must be followed by all market participants
  – Two-stage games result in EPECs
Thank you for your attention

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