A strategic perspective on competition in international gas markets

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Competition in natural gas markets

- **Gas markets fundamentally changed over last 10 years**
  - Traditionally pipelines projects backed by long-term contracts
    - High investment costs & high degree of asset specificity
  - Now increasingly trade in seaborne liquefied natural gas (LNG)
    - Greater flexibility to export gas to different regions
- **Gas importing regions: Varying situations & price levels**
  - Asia/Japan: Heavy LNG dependence & high prices (Fukushima)
  - Europe: Broader import mix & mid-level prices (security of supply)
  - US: No significant imports & low gas prices (shale gas)

$\Longrightarrow$ **Which producers have a competitive advantage, and why?**

- How is competition affected by demand & supply shifts?
- What are the implications for consumer welfare?

Overview of the model & results

- **Stylized model of global gas market competition**
  - Two producers & two regions
    - Multi-market firm sells to both regions (Qatar LNG to Europe & Asia)
    - Single-market firm sells only to one (Gazprom piped gas to Europe)
  - Capacity investment followed by quantity competition
- **Main results from the analysis**
  - Single-market producer enjoys a structural competitive advantage
    - Gazprom's focus on European market as a source of *strength*
  - But various market developments likely to erode this advantage
    - {Fukushima accident, US LNG exports, EU energy policy}
      $\rightarrow$ Favour Qatar/LNG & often hurt European gas buyers

Related literature

1. **Models of gas market competition**
   - Golombek-Hoel (1987); Egging-Gabriel-Holz-Zhuang (2008); Holz-von Hirschhausen-Kemfert (2008); Chyong-Hobbs (2014); Ritz (2014)
2. **Multi-market oligopoly & 3^{rd} degree price discrimination**
   - Bulow-Geneakoplos-Klemperer (1985); Cowan (2012); Shelegia (2012)
3. **Cost pass-through as an economic tool**
   - Andersen-Renault (2003); Weyl-Fabinger (2013)
4. **Heterogeneous firms in international trade**
   - Melitz (2003); Mrázová-Neary(2013)

Setup of the model

- **Two producers**:
  - Firm 1 sells both into markets A and B
  - Firm 2 can sell only into market A
- **Demand conditions**:
  - $p^A(q_1^A, q_2^A) = \alpha - \beta(q_1^A + q_2^A)$
  - $p^B(q_1^B)$ with curvature $\xi^B \equiv (-q_1^B p_{qq}^B / p_q^B) < 1$ (log-concave)
- **Two stages**:
  1. Firms invest in production capacities k_1,k_2 (unit cost $r > 0$)
  2. Firms make output decisions (unit costs c_1,c_2)

  - Assume both producers are capacity-constrained
  - Assume no third-party price arbitrage between markets

$\Longrightarrow$ Subgame-perfect Nash equilibrium (interior solution)

Stage 2: Output decisions

- Binding capacity constraints $\Longrightarrow q_1^A + q_1^B = k_1$ and $q_2^A = k_2$
- Producer 1's optimal strategy equalizes (net) marginal revenues

$$MR_1^A(q_1^A, q_2^A) - c_1 = MR_1^B(q_1^B) - c_1 > 0$$

$$\Longrightarrow MR_1^A(q_1^A, k_2) = MR_1^B(k_1 - q_1^A)$$

- Output decisions are affected by capacity investment
  - More own capacity raises own production, $\partial q_1^A / k_1 > 0$
  - **Key point**: Higher capacity by producer 2 induces producer 1 to cut output, $\partial q_1^A / k_2 < 0$ (*but not vice versa*)
- In sum, given $\mathbf{k} = (k_1, k_2)$, output choices $q_1^A(\mathbf{k})$, $q_1^B(\mathbf{k})$, $q_2^A(\mathbf{k}) = k_2$

Stage 1: Capacity decisions

- **Producer** 1**: Capacity choice solves**

$$\max_{k_1 \in \mathbb{R}_+} \left\{ R_1^A(q_1^A(\mathbf{k}), q_2^A(\mathbf{k})) + R_1^B(q_1^B(\mathbf{k})) - rk_1 - c_1(q_1^A(\mathbf{k}) + q_2^A(\mathbf{k})) \right\}$$

  - First-order condition: $0 = MR_1^A \frac{\partial q_1^A}{\partial k_1} + MR_1^B \frac{\partial q_1^B}{\partial k_1} - r - c_1 \left(\frac{\partial q_1^A}{\partial k_1} + \frac{\partial q_1^B}{\partial k_1} \right)$
  - Since $MR_1^A = MR_1^B$ and $\frac{\partial q_1^A}{\partial k_1} + \frac{\partial q_1^B}{\partial k_1} = 1 \Longrightarrow MR_1^A = MR_1^B = r + c_1$

$\Longrightarrow$ Monopoly solution in market B: $\widehat{q}_1^B = q_m^B$ and so $\widehat{q}_1^A = \hat{k}_1 - q_m^B$

- **Producer** 2**: Capacity choice solves**

$$\max_{k_2 \in \mathbb{R}_+} \left\{ R_2^A(q_1^A(\mathbf{k}), q_2^A(\mathbf{k})) - rk_2 - c_2 q_2^A \right\}$$

  - First-order condition: $0 = MR_2^A \frac{\partial q_2^A}{\partial k_2} + \frac{\partial R_2^A}{\partial q_1^A} \frac{\partial q_1^A}{\partial k_2} - r - c_2 \frac{\partial q_2^A}{\partial k_2}$

Strategic effect, cost pass-through & market power

- Strategic effect of producer 2's capacity choice

$$\lambda \equiv -\left(\frac{\partial q_1^A}{\partial k_2}\right) = \frac{\frac{\partial MR_1^A}{\partial k_2} - \frac{\partial MR_1^B}{\partial k_2}}{\frac{\partial MR_1^A}{\partial q_1^A} - \frac{\partial MR_1^B}{\partial q_1^A}} = \frac{\beta}{\left[2\beta + \left(-p_q^B\right)\left(2 - \xi^B\right)\right]} \in \left(0, \tfrac{1}{2}\right)$$

- Firm 2 can induce firm 1 to cut back output in common market A
  - Unless, in the limit, $\beta \to 0$ or $\left(-p_q^B\right)\left(2 - \xi^B\right) \to \infty$

$\Longrightarrow$ Degree of monopoly power in market B key to analysis

- Index of market power $\left(2 - \xi^B\right) = 1/\rho^B$ where $\rho^B \equiv dp_m^B/dc$
  - High market power $\Longleftrightarrow$ low cost pass-through:
    Prices driven by willingness to pay, not costs
    - No necessary relationship with price elasticity of demand

Competitive advantage of "focused" firms

- Measure of competitive advantage in terms of market shares

$$\frac{\widehat{q}_1^A}{\widehat{q}_2^A} = \frac{(2-\lambda)(\alpha - r - c_1) - (\alpha - r - c_2)}{2(\alpha - r - c_2) - (\alpha - r - c_1)}$$

Proposition 1 *Single-market firm* 2 *has a competitive advantage in market A over multi-market firm* 1 *(as long as* $(c_2 - c_1)$ *not too large).*

- Goes against standard result that low costs $\Longleftrightarrow$ high market share
  - Standard result holds in all common (single-market) oligopoly models

$\Longrightarrow$ Focused pipeline-based sellers (Gazprom) enjoy structural advantage over multi-market LNG sellers (Qatar)

Demand shock in market B ("Fukushima")

- Let $p^B(q_1^B, \theta)$ where $p_\theta^B > 0$ and let $\eta_\theta^B \equiv \left| \frac{d \log p_\theta^B}{d \log q_1^B} \right|_{q_1^B = \hat{q}_1^B}$
- How does a demand shock in B affect competition in market A?
  - Only cross-market impact is via strategic effect $\lambda(\theta)$
  - Strategic effect $\lambda'(\theta) < 0 \iff \frac{d}{d\theta}\left[-p_q^B\left(2 - \xi^B\right)\right] > 0$
- Before that, how does a demand shock affect price & output?

Lemma 1 *A small demand shock has the following equilibrium effects*:

$$\frac{d\hat{q}_1^B}{d\theta} > 0 \iff \eta_\theta^B > -1$$

$$\frac{d\hat{p}_1^B}{d\theta} > 0 \iff \eta_\theta^B < 1 - \xi^B$$

$\Longrightarrow$ "Obvious" first-order effects actually require additional structure...

Demand shock in market B ("Fukushima")

- Suppose demand rises from θ' to $\theta'' > \theta'$ (e.g., Fukushima)
- Strategic effect weakens $\lambda(\theta'') < \lambda(\theta') \Longleftrightarrow$ Firm 2's competitive advantage declines $\Longleftrightarrow$ Consumer surplus in market A falls

Proposition 2 *A demand shock leads to $\lambda(\theta'') < \lambda(\theta')$ if:*
(i) Cost pass-through in market B does not increase, $d\rho^B / d\theta \leq 0$
(ii) Impact on consumers' WTP satisfies $\eta_\theta^B < -\xi^B/2$

[Grossly sufficient: $\xi^B < 0 \Leftrightarrow \rho^B < \frac{1}{2}$ and $p_{\theta q}^B \leq 0$]

- Result holds where firm 1 enjoys high market power in market B
  - Gas demand curves commonly assumed to be concave

$\Longrightarrow$ Qatar benefits twice from Fukushima: Direct gains in Asian LNG market plus indirect strengthening of European position

Competitive entry in market B ("US LNG exports")

- Let $p^B(q_1^B, q_f)$ and $s_1^B \equiv q_1^B/(q_1^B + q_f) \in (0,1)$
- Strategic effect now $\lambda = \frac{\beta}{\left[2\beta + \left(-p_q^B\right)\left(2 - \hat{s}_1^B \xi^B\right)\right]} \in (0, \frac{1}{2})$
- How does more entry in B affect competition in market A?

Proposition 3 *Competitive entry in market B leads to* $\lambda(q_f'') < \lambda(q_f')$ *if:*
(i) Demand is concave/pass-through is "low" $\xi^B < 0 \Leftrightarrow \rho^B < \frac{1}{2}$
(ii) Demand curvature is non-increasing, $\xi_q^B \leq 0$

- Condition $\xi_q^B \leq 0$ plays similar role to $d\rho^B/d\theta \leq 0$ before

$\Longrightarrow$ European gas customers lose twice: Directly since US exports go elsewhere, plus indirectly due to softer competition

- US LNG to Asia makes Qatar a stronger competitor in Europe

Demand shock in market A ("EU energy policy")

- EU energy policy can raise demand for natural gas
  - For example, cutbacks in EU renewables subsidies
- To model this, vary demand parameters α and/or β
  - Higher α: Higher WTP of existing gas customers
  - Lower β: Arrival of new gas customers (larger market size)

Proposition 4 *"Higher demand" in market A raises firm 1's market share: (i)* $\partial\left(\widehat{q}_1^A/\widehat{q}_2^A\right)/\partial\alpha > 0 \Longleftrightarrow c_1 > c_2$*, and (ii)* $\partial\left(\widehat{q}_1^A/\widehat{q}_2^A\right)/\partial\beta < 0$.

- Higher α helps higher-cost firm (profit margins expand)
  - Qatar's LNG costs > Russian pipeline costs
- Lower β alleviates multi-market effect (market B matters less)

$\Longrightarrow$ Demand shifts due to EU policy help Qatar & hurt Gazprom

Some observations on Russian gas export strategy

- **Recent export diversification efforts**
  - Traditionally, Russian pipeline exports to European market
  - Some recent efforts to diversify to the East (China pipeline deal)
    - LNG still only small share ($\leq 5\%$) of exports (Shtokman LNG on hold)

$\Longrightarrow$ Such diversification seems puzzling in light of above analysis...

- **Strategic impact of diversification?**
  - **Key point**: Gas pipelines cannot be redirected like LNG tankers
    - Eastern & Western pipelines are different capacities (route-specific)
    - Russian gas/LNG to Asia may hurt Gazprom's position in Europe
  - Whatever its benefits, "flexible" diversification has a strategic cost

Conclusions

- **Gazprom has had a structural advantage over LNG producers**
  - Goes against conventional wisdom:
    Here Gazprom's European focus is a source of strength, not weakness
    - Fairly robust to changes in model specification/functional forms
- **Past/future market developments erode competitive advantage**
  - {Fukushima accident, US LNG exports to Asia, EU energy policy}:
    Favour LNG producers (Qatar) but often hurt European gas buyers
    - Relies on high market power/low cost pass-through in Asian LNG
- **Russian gas export diversification may come at a strategic cost**