Gateways and intermodal pricing

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International conference on gateways and corridors
May 2-4, 2007, Pan Pacific Vancouver
Agenda

• Introduction
• Overview over the study
• The basic model for integrated firms
• Numerical example
• The adjusted model for disintegrated firms
• Conclusions
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Characteristics of the gateways and corridors initiative:

• Different transport modes are involved: sea, road, rail, air

• Transport modes are complementary or substitutable in nature
  - Complementary: Sea and road or rail
  - Substitutable: Sea and air, road and rail,...

• Focus is on the integration of transport systems, on specific ports, and on specific parts of the road/rail network

• Integration is considered to generate productivity gains (economies of scale)
This study addresses the following questions:

• What is the effect of gateways on competition, prices, capacities and revenues?

• What are the incentives to create gateways?

• In other words, when should private firms invest in gateways?
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Overview over the study

- Two transport modes are considered: road and sea

- Analysis focuses on

  1. Two integrated firms that provide road and sea transportation services *(basic model)*

  2. Disintegrated firms that provide either road or sea transportation services *(adjusted model)*

     a) 2 road firms and 2 sea firms

     b) 2 road firms and 1 sea firm
**Individuals:**

- Set of individuals with mass 2
- Individuals are uniformly distributed over the [0,2]-interval
- Each individual wishes to send 1 good from its location to an overseas destination ⇒ *door-to-door services are considered!*
- Willingness to pay is constant and equal to 1
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Demand:

- Two firms charge price $p_i \geq 0$ ($i \in \{1, 2\}$) for door-to-door services
- Capacities are $k_i \in [0, 2]$
- Demand is

$$D_i(p_1, p_2) = \begin{cases} 
2 & \text{for } p_i < p_j \\
\max\{1, 2 - k_j\} & \text{for } p_i = p_j \\
\max\{0, 2 - k_j\} & \text{for } p_i > p_j
\end{cases}$$

with $j \neq i.$
The basic model for integrated firms

Ports:
- Three ports exist that charge zero-prices (for simplicity).
- Two are located at the borders of the [0,2]-interval. The third is located in the middle:
Three-stage game:

• Stage 1: Firms **cooperatively** choose locations
  - Firms locate at ports 1 and 3 (*border case referred by index M1*)
  - Both firms locate at port 2 (*gateway case referred by index G1*)

• Stage 2:
  - **Border case M1:** Firms choose capacities
  - **Gateway case G1:** Firms cooperatively choose total capacity $k$ and share it evenly, i.e. $k_1 = k_2 = k/2$

• Stage 3: Firms **non-cooperatively** choose prices
The basic model for integrated firms

Border case M1:

Firm 1

Road

Firm 2

Sea

Destination

Pacific

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The basic model for integrated firms

Gateway case G1:

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Variable road transportation costs (sea transportation costs = 0, no capacity limits there):

- Transportation costs per marginal distance unit are 1
- Denote \( q_i \equiv \min\{k_i, D_i(p_1, p_2)\} \)
- Transportation costs \( C_i \) depend on the firm’s location

- Border case M1:
  \[ C_{i}^{M1}(q_i) \equiv \frac{q_i^2}{2} \]

- Gateway case G1:
  \[ C_{i}^{G1}(q_1, q_2) \equiv \begin{cases} 
  \frac{q_i^2}{4} & \text{for } p_i < p_j \\
  \frac{q_i (q_1 + q_2)}{4} & \text{for } p_i = p_j \\
  \frac{(q_1 + q_2)^2 - q_j^2}{4} & \text{for } p_i > p_j 
  \end{cases} \]
The basic model for integrated firms

Capacity costs:

\[
\frac{k^\beta}{\alpha^{1-\beta}}
\]

- \( \beta \geq 0 \) determines the **constant elasticity of capacity costs**
- Increasing economies of scale for \( \beta < 1 \) (in this case integration (/concentration) can lead to productivity gains)
- \( \alpha \) is used to adjust the cost function such that average capacity costs are decreasing in \( \beta \)
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Numerical example

\[ \alpha = 4 \]

\[ \text{Profit G1} \]

\[ \text{Profit M1} \]

\[ \text{Borders} \]

\[ \text{Gateway} \]

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The adjusted model for disintegrated firms

2 road firms and 2 sea firms:

Price competition between seaside firms

⇒ 0-prices in both cases (border and gateway case)

⇒ For road firms the situation is similar to the model with 2 integrated firms

⇒ Above results can be applied to this situation!
The adjusted model for disintegrated firms

2 road firms and 1 sea firm:

Border case (referred by index M2):

• Sum of prices is 1
• Total price is shared such that profits net of capacity costs are equal

Gateway case (referred by index G2):

• Sum of prices is 1
• Liners are Stackelberg-leaders in prices
The adjusted model for disintegrated firms

\[ \alpha = 4 \]

\[ \hat{\beta} < \bar{\beta} \]

Borders

Gateway

Sea firm profit M2

Sea firm profit G2

\[ \hat{\beta} \]

\[ \beta \]

\[ 0.1 \quad 0.2 \]

\[ 0.4 \quad 0.5 \quad 0.6 \quad 0.7 \]
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Conclusions

1. Gateways are chosen when economies of scale are low or, respectively, capacity costs are high.
2. Integrated firms tend to favor gateways compared to disintegrated firms.
3. Incentives to invest in gateways strongly depend on the market structure.
Thank you!