Impact of Hinterland Access Conditions on Rivalry between Ports

Anming Zhang

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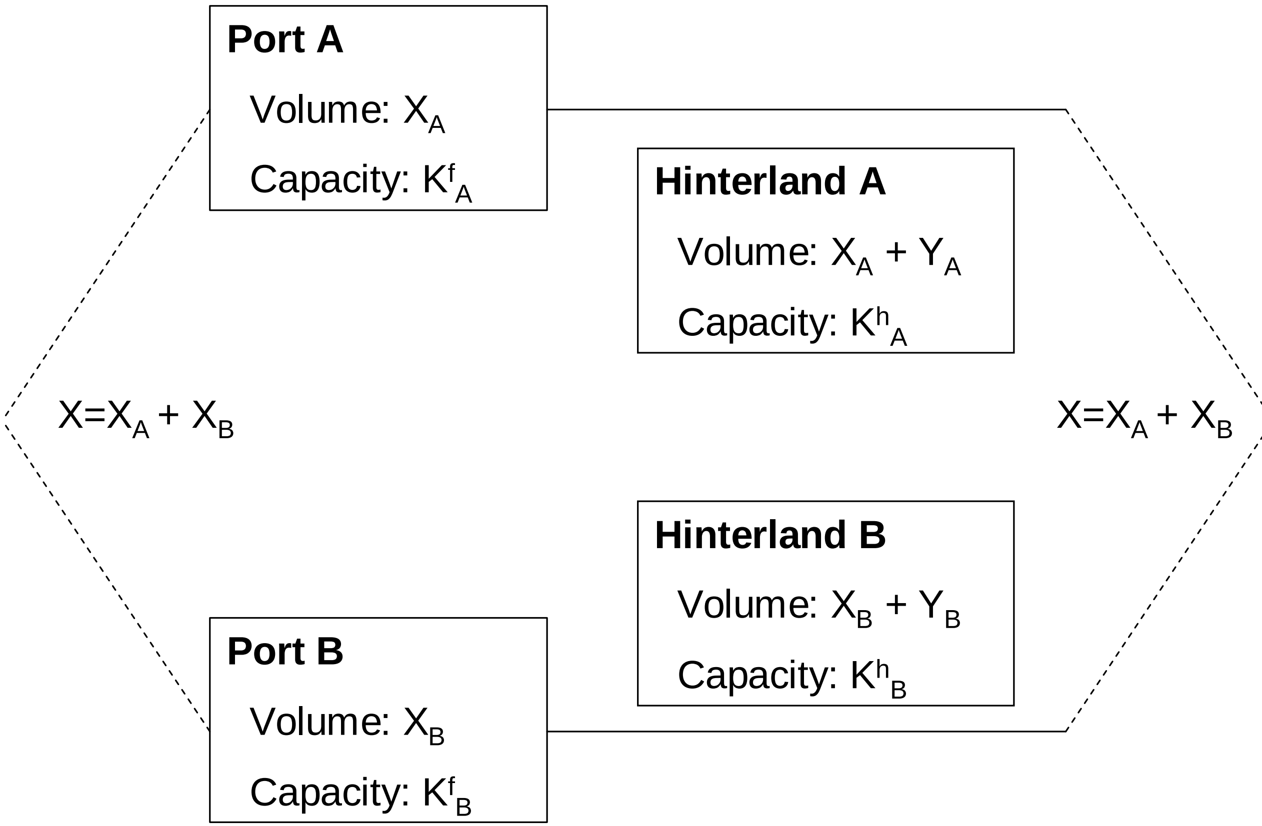
SAUDER School of Business

THE UNIVERSITY OF BRITISH COLUMBIA

De Borger, Proost & Van Dender (2008)



De Borger, Proost & Van Dender: Main results

1. Investment in port capacity reduces prices & congestion at both ports, but increases hinterland congestion in the region where the port investment is made

2. **Investment in a port's hinterland is likely to lead to more port congestion & higher prices for port use, and to less congestion and a lower prices at the competing port**

3. Imposing congestion tolls on the hinterland roads raises port capacity investment

- **The present paper:** Hinterland access conditions → the port and port competition
    - Port congestion & capacity investment abstracted away
    - Bottleneck of the logistics chain shifted to the port/inland interface
        - e.g. hinterland connection; inland transportation

- **2nd objective:** Link port competition with corridor capacity & urban mobility

  - Corridor capacity:
    Rail connection: Inland terminal (e.g. the Alameda corridor)
    Rail competition: Monopoly or oligopoly?
    Barge
    Border crossing

  - Urban mobility: Trucking for final, local delivery
    Road capacity
    Road pricing

Model

- Like De Borger, Proost & Van Dender:

  Two seaports, labeled 1 & 2, share the same overseas customers and have each a downstream, congestible transport network to a common hinterland

- Unlike De Borger, Proost & Van Dender:

  1) Port & its hinterland belong to a single region, ensuring coordination in their decisions

  2) Imperfect substitutes: allow both overlapping and captive hinterlands

Total (generalized) cost faced by users:

$$\rho_i = p_i + D_{Ci}(K_{Ci}) + D_{Li}(V_i, K_{Li}) + t_i, \quad i = 1,2 \qquad (1)$$

- Corridor delay cost falls as the corridor capacity (K_{ci}) increases
- Road used by both cargo shipments X_i and local commuters Y_i, we have $V_i = X_i + Y_i$
- Road delay cost satisfies:

$$\frac{\partial D_{Li}}{\partial V_i} > 0, \quad \frac{\partial D_{Li}}{\partial K_{Li}} < 0, \quad \frac{\partial^2 D_{Li}}{\partial {V_i}^2} \geq 0, \quad \frac{\partial^2 D_{Li}}{\partial V_i \partial K_{Li}} \leq 0 \qquad (2)$$

- Increasing traffic volume (V) raises road congestion while adding capacity (K_{Li}) decreases road congestion, and the effects are more pronounced when there is more congestion

Total cost of local road traffic:

$$\rho_{Li}(Y_i) = t_i + D_{Li}(X_i + Y_i, K_{Li}) \qquad i = 1,2 \qquad (3)$$

(a) an increase in road toll reduces local traffic;

(b) an increase in cargo traffic decreases local traffic;

(c) an increase in road capacity increases local traffic;

(d) an increase in cargo traffic will, while reducing local traffic, increase overall road traffic.

- Each port's demand depends on both its total cost ρ_i and the rival port's total cost ρ_j:

$$X_1 = X_1(\rho_1, \rho_2) \ , \qquad X_2 = X_2(\rho_1, \rho_2) \qquad (5)$$

- Inverting (5) yields:

$$\rho_1 = \rho_1(X_1, X_2) \ , \qquad \rho_2 = \rho_2(X_1, X_2) \qquad (6)$$

- Using (1) and $Y_i = Y_i^*(t_i, X_i, K_{Li})$, equations (6) can be written as, for i=1,2:

$$p_i = \rho_i(X_1, X_2) - D_{Ci}(K_{Ci}) - D_{Li}(V_i, K_{Li}) - t_i \equiv p_i(X_1, X_2; K_{Ci}, K_{Li}, t_i) \qquad (7)$$

- Each port's revenue as:

$$\pi^i = p_i(X_1, X_2; K_{Ci}, K_{Li}, t_i) \cdot X_i = \pi^i(X_1, X_2; K_{Ci}, K_{Li}, t_i) \qquad (8)$$

Main results

- Port competition: Competition between alternate intermodal chains; while hinterland access conditions represented by corridor facilities and by inland roads

- When the ports compete in quantities, an increase in corridor capacity will:
  a) increase own port's output
  b) reduce the rival port's output
  c) increase own port's revenue

Main results (cont.)

- Port competition results in higher level of corridor capacity investment than would be in the absence of competition

- This capacity competition between regions/countries improves social welfare, but the generalized costs are still too high compared to social optimum

- This capacity competition between regions/countries may lead to a Prisoner’s Dilemma

Main results (cont.)

- An increase in road capacity may or may not increase own port’s output and profit, owing to various offsetting effects

- Road pricing may or may not increase own port’s output and profit

- The above over-investment result is weakened if the mode of port competition is <u>in prices</u>

Further research

1. Empirical work:

a) Which model of competition is “correct” for ports?

- Cournot: Firms (here, ports) commit to quantities, and prices then adjust to clear the market implying the industry is flexible in price adjustments, even in short run
- Bertrand: Capacity is unlimited or easily adjusted in the short run.
- Some industries behave like Bertrand and others Cournot; as such, which model of oligopoly is applicable to a particular industry (here, the port industry) is of an empirical question

b) Empirical test of the theoretical predictions:

Hard given lack of data

c) Correlation of annual container throughput growth (market share, respectively) and changes in urban area mobility – LA/Long Beach, 1995-2006

	Total delay (person-hrs)	Delay per peak traveler (person-hrs)	Travel time index	Total congestion cost ($)	Congestion cost per peak traveler ($)
LA+LB container throughput growth	-0.683* (0.029)	-0.649* (0.024)	-0.716* (0.020)	-0.684* (0.029)	-0.642* (0.045)
LA+LB container market share	-0.414 (0.235)	-0.353 (0.318)	-0.301 (0.398)	-0.405 (0.246)	-0.367 (0.297)

Oakland

	Total delay (person-hrs)	Delay per peak traveler (person-hrs)	Travel time index	Total congestion cost ($)	Congestion cost per peak traveler ($)
Throughput growth	0.368 (0.295)	0.426 (0.220)	0.449 (0.193)	0.461 (0.180)	0.478 (0.163)
Market share	0.198 (0.584)	0.243 (0.500)	0.301 (0.398)	0.355 (0.314)	0.401 (0.251)

Portland

	Total delay (person-hrs)	Delay per peak traveler (person-hrs)	Travel time index	Total congestion cost ($)	Congestion cost per peak traveler ($)
Throughput growth	0.164 (0.650)	0.019 (0.959)	0.062 (0.864)	0.039 (0.914)	-0.131 (0.718)
Market share	0.144 (0.692)	0.016 (0.965)	0.103 (0.777)	0.022 (0.951)	-0.154 (0.671)

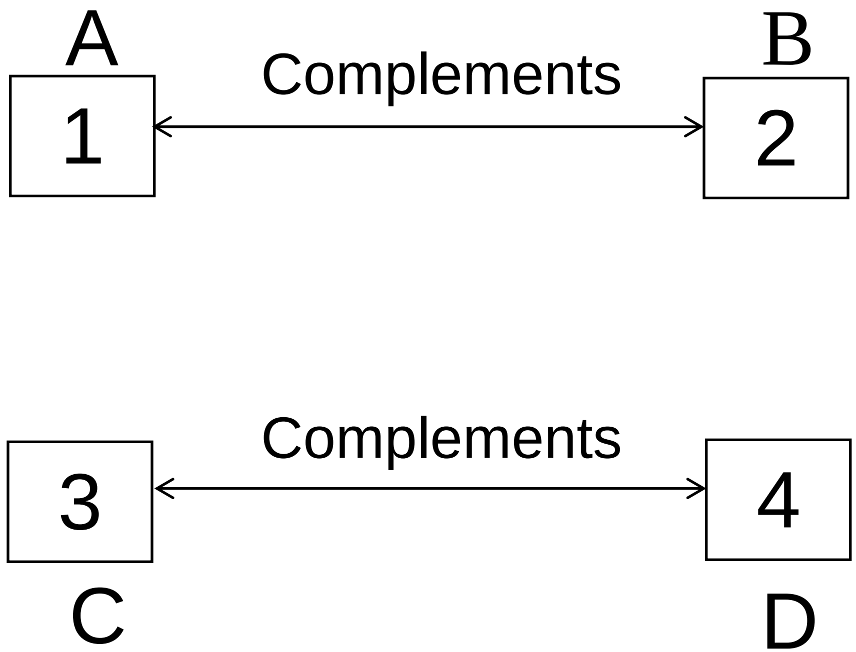
Seattle

	Total delay (person-hrs)	Delay per peak traveler (person-hrs)	Travel time index	Total congestion cost ($)	Congestion cost per peak traveler ($)
Throughput growth	0.201 (0.577)	0.244 (0.498)	-0.103 (0.778)	0.210 (0.561)	0.242 (0.501)
Market share	0.165 (0.648)	0.204 (0.571)	-0.126 (0.729)	0.181 (0.616)	0.216 (0.549)

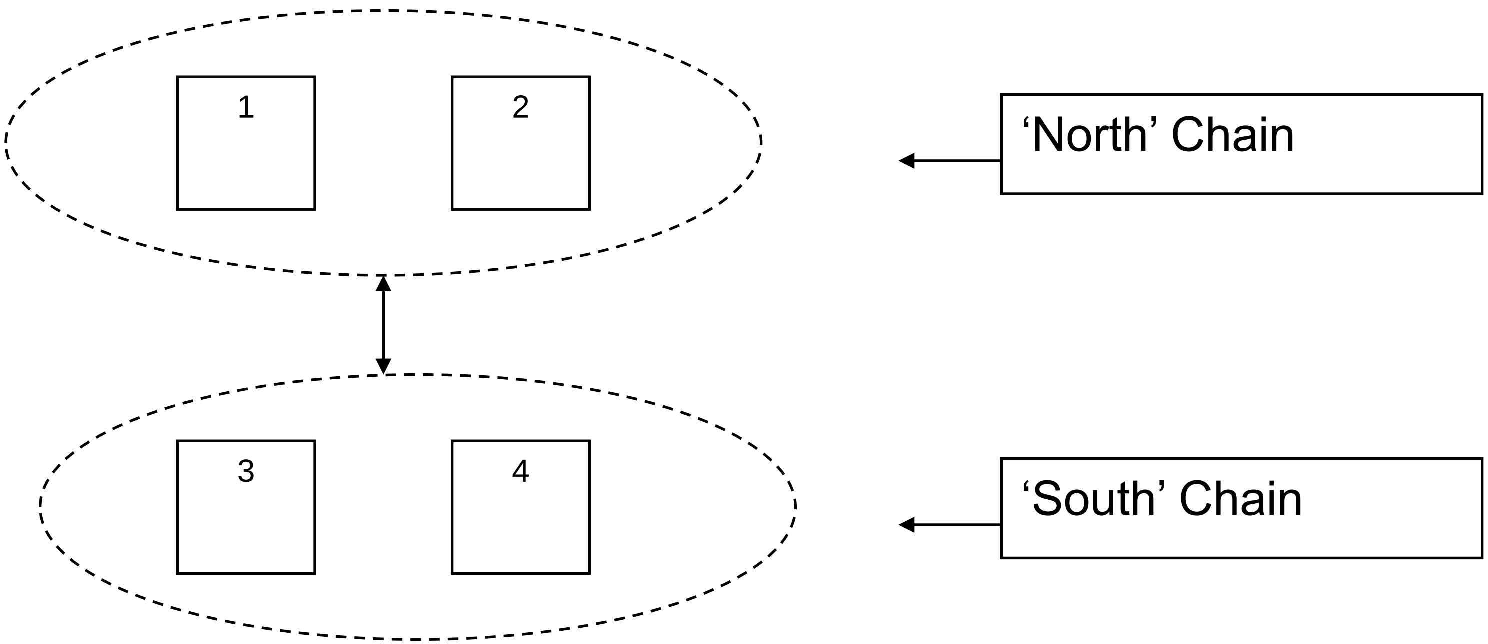
2. Organizational coordination

- For an intermodal chain: port, corridor & road may belong to different, separate organizations

- Each maximizes own interest, which may not be the same as the interest for the entire chain’s


A
B
Complements
1
2
Complements
3
4
C
D

Two (potential) functional <u>integration</u> or <u>alliance</u> chains



3. Overlapping & captive hinterlands

- Although the captive hinterlands do not subject to immediate competition, they play an important role in port competition

- How?
  - If both the overlapping and captive markets are considered, important interactions between the two markets & their impact on port competition need to be analyzed
  - This involves an explicit derivation of demand functions

Modal Structure