Port Performance and Gateway Logistics

Tae Oum, University of British Columbia, Canada
Jose Tongzon, Australian Maritime College, University of Tasmania, Australia
Paper presented at the International Conference on Gateways and Corridors, 2-4 May 2007, Pan Pacific Hotel, Vancouver, Canada

Outline

Introduction

1. Requirements for gateways to function effectively
2. The critical role of seaports in gateways and key port performance measures
3. Linkages of port performance and gateway logistics based on empirical studies
4. Results of container ports efficiency ranking study: empirical Stochastic Frontier methods with Bayesian simulation estimator

Conclusion

1. Requirements for gateways to function

- Free flow of goods, people and information
  - Absence of trading barriers between networks or regions
- Sea-land, air and communications modes
  - Well connected and linked by any of the modes of transport
- Port, airport and teleport nodes
  - World-class infrastructure
  - Efficient and cost-effective
- Strength of the networks
  - Integration of the networks

2. Ports as a critical node in gateways

- Since the bulk of international trade is carried out by sea, ports play a critical role in the facilitation of international trade and economic development
  - Over 90% of trade volumes are carried by sea
  - Maritime transport provides low-cost and efficient transportation
- Port performance has significant implications for gateway performance
  - By impacting on the physical distribution channel in terms of cost, quality of service, timeliness and risk
  - By providing an efficient, safe and effective transshipment service
    - Increasing globalization and internationalization of production and distribution has led to longer and more complex supply chains spanning continents and various regions
  - By linking sea transport and land transport
    - Growing importance of inter-modal and door-to-door logistics

Key Determinants of Gateway Ports

- Strategic location
  - Centrality or proximity to growth centers
  - Proximity to major transport lanes
- Efficiency
  - Speed and reliability
  - Low degree of risk
- Connectivity
  - Linkage with other overseas ports
  - Access to regular and frequent transport services
    - Number of ships and shipping frequency
- Adequate infrastructure
  - Sufficient equipment and berthing space
  - Quality of the infrastructure
  - Adequate and well motivated workforce

Gateway port choice factors: Southeast Asia as a case study

- A survey conducted among a sample of freight forwarders based in Singapore, Malaysia and Thailand
- To identify the major factors they consider as important in the choice of gateway ports
- The results have confirmed previous studies on the critical importance of port efficiency (e.g. Tongzon and Heng, 2005; Tongzon, J., 1995, 2002)

Ranking of Gateway Port Choice Factors: Shippers' Perspective

Ranks	Mean	Standard Deviation
1. Efficiency	3.2	1.83
2. Shipping frequency	4.2	2.01
3. Adequate infrastructure	4.4	2.02
4. Location	4.6	2.09
5. Port charges	5.2	2.06
6. Quick response to port users' needs	5.4	2.24
7. Reputation for cargo damage	7.1	2.34
N = 47		

Note: Ranking ranges from 1 (most important) to 7 (least important)

3. Linkage: Port Performance and Gateway Logistics

- Port efficiency, connectivity, infrastructure and transportation
  - An efficient port facilitates the efficient transportation of goods and thus lowers the cost of transportation and improves the quality of customer service
  - Port connectivity lowers transportation costs by allowing more competition among carriers and attracts more users by providing them with more choices
  - Better port infrastructure reduces maritime transport costs
  - Studies by Wilmsmeier, et al. (2006); Martinez-Zarzoso et al. (2003); Sanchez et al. (2003); Sayareh and Lewarn (2006) have shown empirically these linkages.
- Port efficiency and international trade
  - An efficient port raises the productivity of the factors of production and profitability of producing units and thus a nation's international competitiveness
  - Wilson et al. (2003); Sanchez et al. (2003); Tally (1988)
- Port orientation and globalized supply chain
  - Given the increasingly competitive environment and globalization, port supply chain orientation plays a critical role in logistics performancve
  - Panayides (2006b); Bichou and Gray (2004); Notteboom and Rodriguez (2005)

Dependent variable: maritime transport costs per tonne of containerizable cargo

Variable	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13
Observations	N = 75 928	N = 75 928	N = 75 928	N = 75 928	N = 75 928	N = 35 438	N = 73 818
$TONS_k$	-0.0863 (-57.65)	-0.0863 (-57.67)	-0.0869 (-58.11)	-0.0846 (-56.51)	-0.0874 (-58.85)	-0.0632 (-29.15)	-0.0857 (-57.00)
$VALUEPERTON_k$	0.3422 (128.74)	0.3416 (128.82)	0.3416 (128.94)	0.3408 (128.38)	0.3374 (127.73)	0.4665 (113.19)	0.3447 (129.16)
$DISTANCE_{ij}$	0.3716 (95.80)	0.3698 (97.26)	0.3542 (90.31)	0.3716 (92.47)	0.3890 (96.81)	0.3380 (55.36)	0.1769 (30.28)
$BILATERALVOLUME_{ij}$	-0.0100 (-4.46)	-0.0109 (-5.53)	-0.0161 (-7.97)	-0.0075 (-3.31)	-0.0322 (-13.70)	-0.0794 (-23.74)	0.0256 (10.91)
$BALANCEROUTE_{ij}$	0.00020 (1.73)	0.00027 (2.40)	0.00047 (4.25)	0.00051 (4.31)	0.00022 (-1.80)	0.00082 (5.06)	0.00228 (14.31)
$PORTEFIC_{ij}$			-0.3835 (-17.65)				

Better (perceived) port efficiency reduces maritime transport costs

Dependent variable: maritime transport costs per tonne of containerizable cargo

Variable	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13
Observations	N = 75 928	N = 75 928	N = 75 928	N = 75 928	N = 75 928	N = 35 438	N = 73 818
$TONS_k$	-0.0863 (-57.65)	-0.0863 (-57.67)	-0.0869 (-58.11)	-0.0846 (-56.51)	-0.0874 (-58.85)	-0.0632 (-29.15)	-0.0857 (-57.00)
$VALUEPERTON_k$	0.3422 (128.74)	0.3416 (128.82)	0.3416 (128.94)	0.3408 (128.38)	0.3374 (127.73)	0.4665 (113.19)	0.3447 (129.16)
$DISTANCE_{ij}$	0.3716 (95.80)	0.3698 (97.26)	0.3542 (90.31)	0.3716 (92.47)	0.3890 (96.81)	0.3380 (55.36)	0.1769 (30.28)
$BILATERALVOLUME_{ij}$	-0.0100 (-4.46)	-0.0109 (-5.53)	-0.0161 (-7.97)	-0.0075 (-3.31)	-0.0322 (-13.70)	-0.0794 (-23.74)	0.0256 (10.91)
$BALANCEROUTE_{ij}$	0.00020 (1.73)	0.00027 (2.40)	0.00047 (4.25)	0.00051 (4.31)	0.00022 (-1.80)	0.00082 (5.06)	0.00228 (14.31)
$LINERSERVICES_{ij}$							-0.1129 (-32.60)

Better connectivity between ports/ more competition among carriers reduces maritime transport costs

Dependent variable:
maritime transport costs per tonne of containerizable cargo

Variable	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13
Observations	N = 75 928	N = 75 928	N = 75 928	N = 75 928	N = 75 928	N = 35 438	N = 73 818
$TONS_k$	-0.0863	-0.0863	-0.0869	-0.0846	-0.0874	-0.0632	-0.0857
	(-57.65)	(-57.67)	(-58.11)	(-56.51)	(-58.85)	(-29.15)	(-57.00)
$VALUEPERTON_k$	0.3422	0.3416	0.3416	0.3408	0.3374	0.4665	0.3447
	(128.74)	(128.82)	(128.94)	(128.38)	(127.73)	(113.19)	(129.16)
$DISTANCE_{ij}$	0.3716	0.3698	0.3542	0.3716	0.3890	0.3380	0.1769
	(95.80)	(97.26)	(90.31)	(92.47)	(96.81)	(55.36)	(30.28)
$BILATERALVOLUME_{ij}$	-0.0100	-0.0109	-0.0161	-0.0075	-0.0322	-0.0794	0.0256
	(-4.46)	(-5.53)	(-7.97)	(-3.31)	(-13.70)	(-23.74)	(10.91)
$BALANCEROUTE_{ij}$	0.00020	0.00027	0.00047	0.00051	0.00022	0.00082	0.00228
	(1.73)	(2.40)	(4.25)	(4.31)	(-1.80)	(5.06)	(14.31)
$PORTINFRA_i$	-0.0333						
	(-9.92)						
$PORTINFRA_j$	-0.0497						
	(-10.76)						
$PORTINFRA_{ij}$		-0.2444					
		(-13.51)					

Better port infrastructure
reduces maritime transport costs

The role of ports in global SC

- Ports may need to be oriented towards supply chains to meet the changing needs of their customers (shipping lines) and fulfill their new role in the supply chain management era
- The relevance of port supply chain orientation has been well established (e.g. Bichou and Gray, 2004; Notteboom and Rodriguez, 2005)
- However, only very limited empirical work has been done to establish the significance of port supply chain orientation to port competitiveness

Supply chain orientation and gateway port performance

- Orientation towards supply chain management has positive effects on the competitiveness of gateway ports
- Gateway ports may be able to customize services and provide value-added services at higher prices
- There are substantial gains to be made from technology investment and from implementing programs on customer and stakeholder relationships and from introducing value-added services
- More must be done to implement programs for port integration in the supply chain
- Ensure that investments in technology are manifested in cost savings to clients
- More flexibility and responsiveness to the preferences of shipping lines vis-à-vis their competitors

4. Container Terminal Efficiency Benchmarking

Task Force Members:
John Liu and Jia Yan, Principal Investigators, Hong Kong Polytechnic University
Tae H. Oum, University of British Columbia, Canada
Theodore Noteboom, University of Antwerp, Belgium
Steimtz Seiji, California State University at Long Beach
Dong-Wook Song, University of Hong Kong
Jose Tongzon, National University of Singapore
Wesley Wilson, University of Oregon
Advisory Council Members: **Trevor Heaver, Mike Bell, Wayne Talley, Janice Tse**

Outline

- Data: Sample container terminals
- Methodology of efficiency measurement
- Preliminary results

Data Overview

- The basic unit is *operator.*
- Time period: 1997-2004 (unbalanced panel data)
- The data includes 302 observations and covers 42 of top 50 ports from 21 countries:

North America:	13 ports 24 operators
Europe:	14 ports 26 operators
Asia:	15 ports 30 operators

Data Required for Efficiency Measurement

Traditional Productivity Measurement requires:

- Output measures
- Shares of revenues generated from various sources
- Input measures
- Input cost shares

Control variables:

characteristics of ports

Inputs used in Empirical Specification

Inputs	Symbols
Cargo handling equipments at quay side = the sum of (1) Quay Cranes (2) Ship shore Container Gantries	K1
Cargo handling equipments at the yard = the sum of (1) Gantry Cranes (2)Yard Cranes (3)Yard Gantries (4)Reachstackers (5)Yard Tracktors (6)Yard chassis trailers (7)Forklifts (8)Straddle carriers (9)Container Lifters (10)Mobile Cranes	K2
Number of berths	K3
Length of quay lines(m)	K4
Terminal area (sqm)	K5
Storage Capacity of Port(TEUs)	K6
Reefer points (electric) of port	K7

Port characteristics used

(1) Depth of water (m) z_1

(2) Number of ship calls z_2

(3) NA dummy z_3

(4) EU dummy z_4

Part 2: **Methodology**

We estimate a **stochastic production frontier via Bayesian simulation estimator**

Main reasons:

1. **Data availability** – **financial data** is generally unavailable; can not estimate neoclassical cost function
2. To seek for **more robust results** – need to account for data measurement error – assuming certain distribution (compared with DEA analysis)
3. To study **policy implications** (compared with DEA analysis)

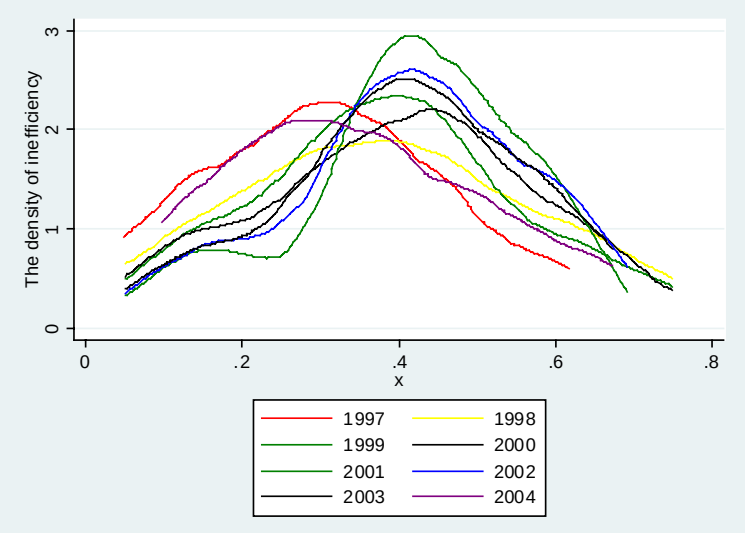
Our methodology

Empirical stochastic frontier estimated via Bayesian simulation estimator is also different from normal Stochastic Frontier method (e.g., Tim Coelli's work) in that

- It allows us to establish unique efficiency frontier for each container terminal,
- to measures each container terminal's actual efficiency performance against its own frontier, and
- is econometrically more efficient estimator

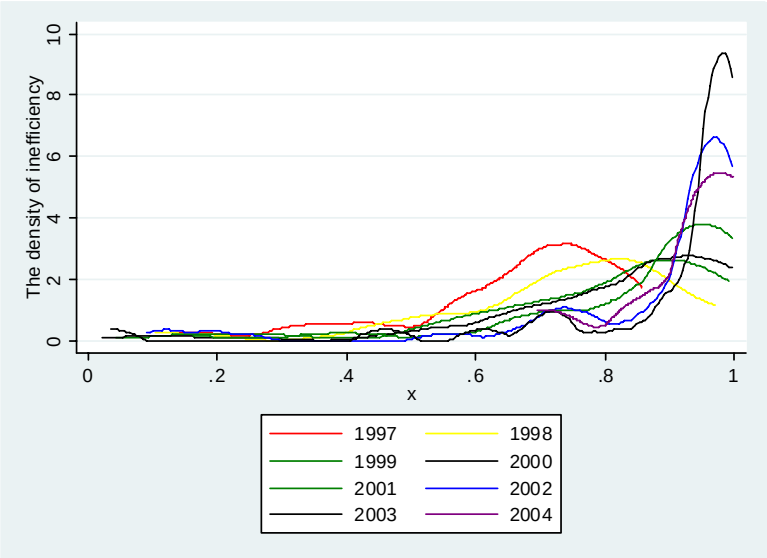
Measured Efficiency Distribution

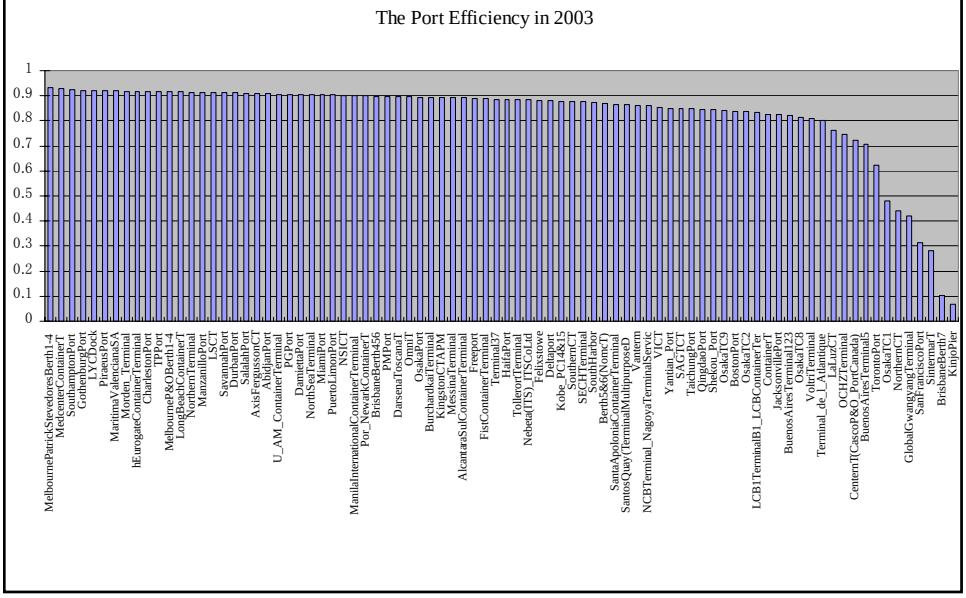
(when using common frontier for all terminals)

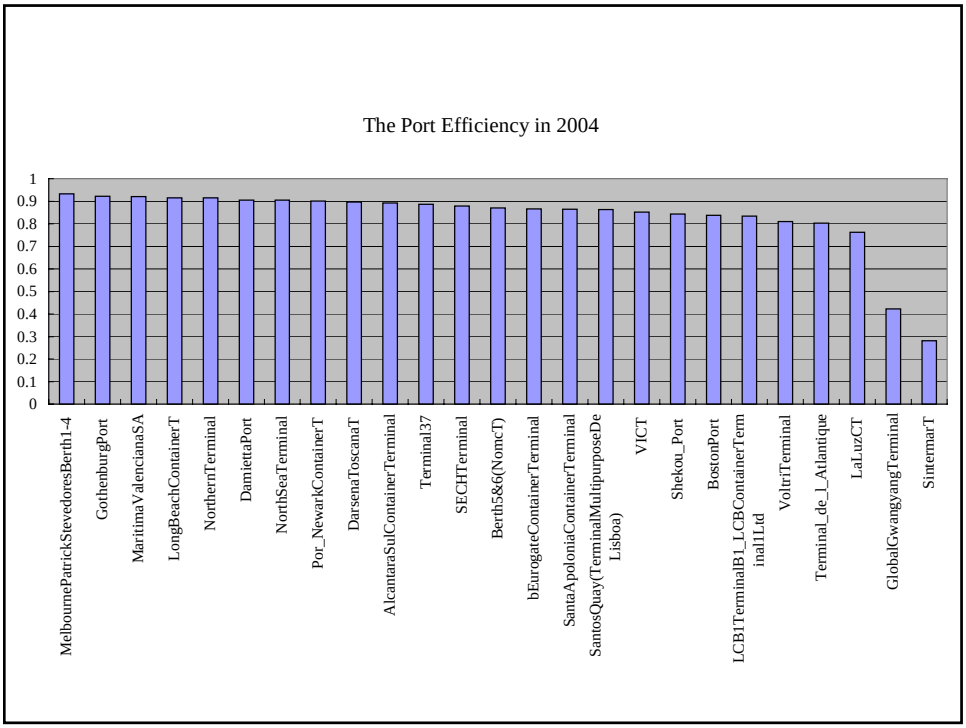


Measured efficiency distribution

(when using unique frontiers for each terminal)







Summary of our First Year Efforts

- Our first year effort is for setting up the system for annual performance measurement and benchmarking:
- Modeling and specification
- Data collection framework:

  Outputs, Inputs, Costs: Real data vs. Proxy measures
- Establishing linkage between our task force and container operators
- Our results are still preliminary

Conclusion from this paper

- Port performance is critical to the success of gateways
- The key aspects to port performance in the context of gateways are efficiency, connectivity, adequate infrastructure and supply chain orientation
- Port efficiency is also considered the most important determinant of gateway port performance by impacting gateway logistics via
  - reducing maritime transport costs ,and
  - improving customer service

Thank You for Listening