University College of Southeast Norway

Comparing the productivity of Norwegian and some Nordic and UK container ports

Halvor Schøyen, University College of Southeast Norway, Campus Vestfold

AGENDA

- Background and motivation
- Method and data collection
- Findings
- Conclusions
- Further research

What is produced in a container port?

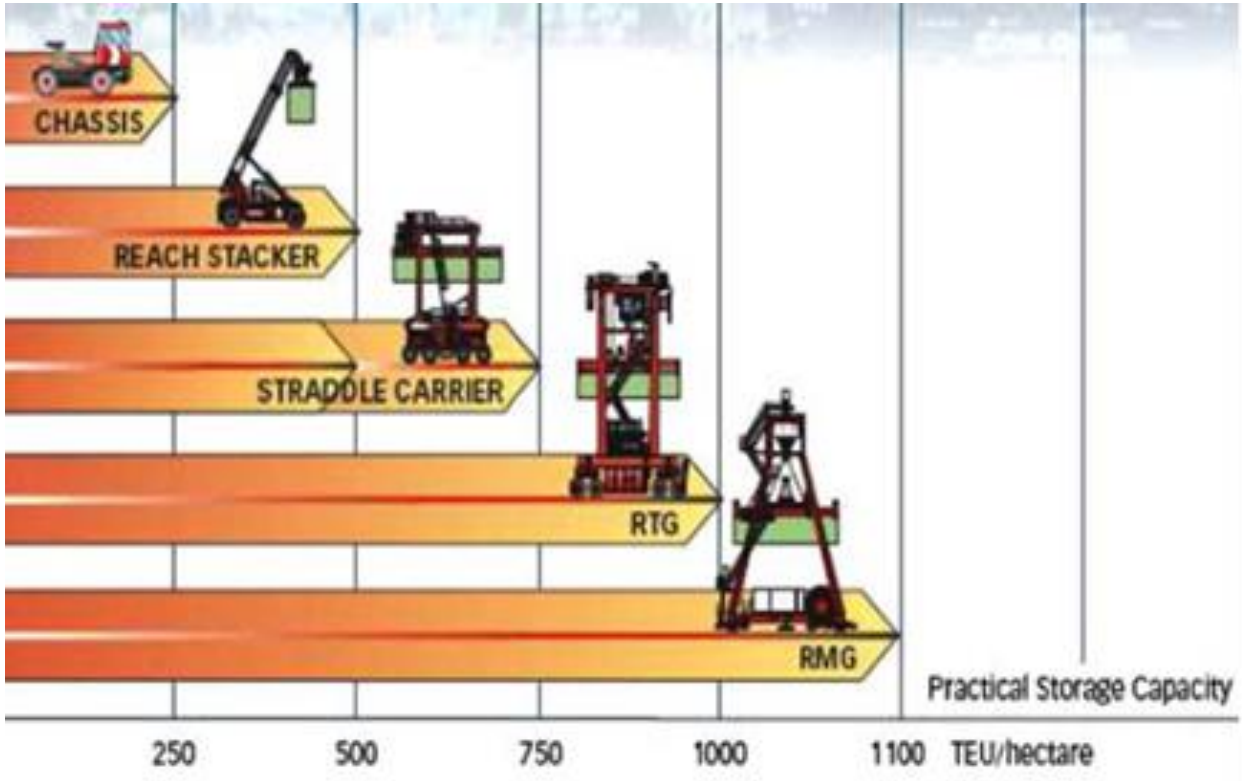
Photo: Halvor Schøyen

Container port productivity development

- Container ports are a capital-intensive industry: Quays, Areas, Container handling equipment

- "Soft" resources:
  (i) Human resources
  (ii) other, e.g. Information Systems

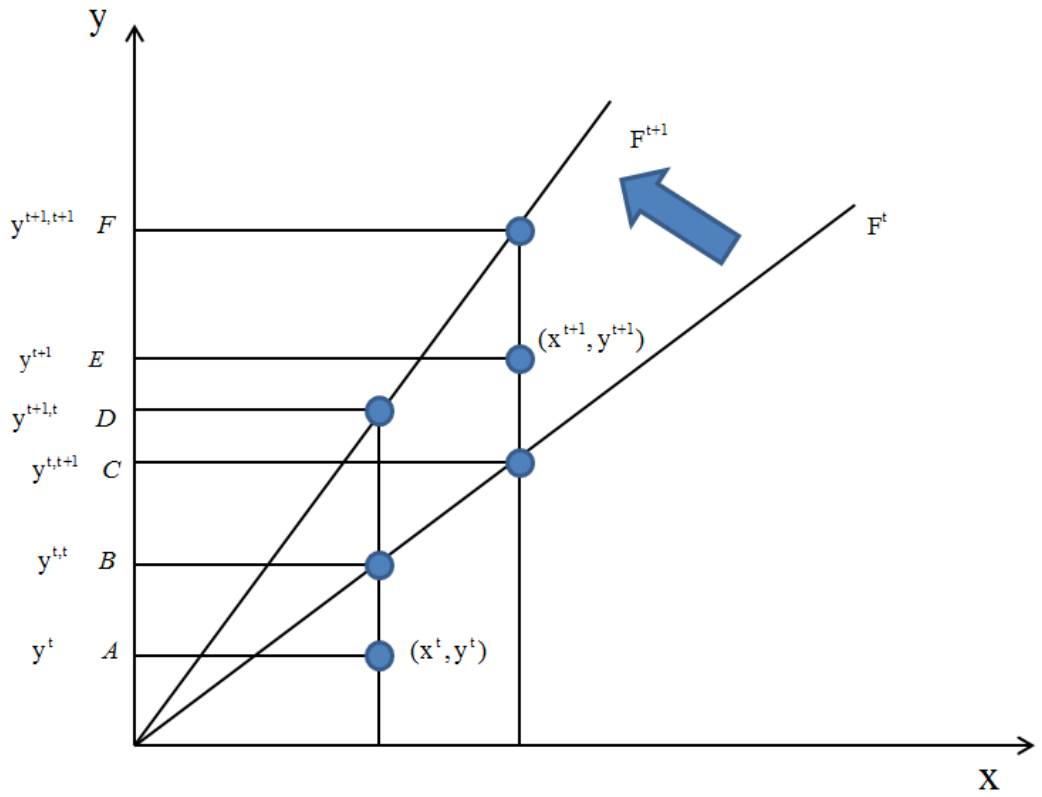
Frontier studies to evaluate the productivity developments of container ports, e.g:
Estache et al. (2004)
Guerrero and Riva (2009)
Liu et al. (2008)
Cheon et al. (2009, 2010)
Song and Cui (2014)



Norwegian container ports' productivity developments over time

- Time span: 2009-2014
- Measure the productivity change by applying a DEA-based Malmquist productivity index (MPI) and decompositions.
- What MPI productivity components explain the derived productivity change? **Technological Change versus Efficiency Change**
- Schøyen, H. & Odeck, J. (2017) Comparing the productivity of Norwegian and some Nordic and UK container ports – An application of Malmquist Productivity Index. *International Journal of Shipping and Transport Logistics,* 9 (2).

How MPI works



$$MPI\ (x^{t+1}, y^{t+1}, x^t, y^t) = \underbrace{\frac{d_v^{t+1}(x^{t+1}, y^{t+1})}{d_v^t(x^t, y^t)}}_{EC} \times \underbrace{\left[\frac{d_v^t(x^t, y^t)}{d_v^{t+1}(x^{t+1}, y^{t+1})} \times \frac{d_c^{t+1}(x^{t+1}, y^{t+1})}{d_c^t(x^t, y^t)}\right]}_{SEC} \times \underbrace{\left[\frac{d_c^t(x^t, y^t)}{d_c^{t+1}(x^t, y^t)} \times \frac{d_c^t(x^{t+1}, y^{t+1})}{d_c^{t+1}(x^{t+1}, y^{t+1})}\right]}_{TC}$$

$$\underbrace{\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad}_{TEC}$$

Selected input and output measures

Output

- Container throughput [TEU/year]

Inputs

- Berth length [m]
- Terminal area [m^2]
- Container handling equipment:
    - Yard gantry cranes [no of units]
    - Straddle carriers [no of units]
    - Container handling trucks [no of units]

20 container ports are measured

6 Norwegian: Oslo, Borg, Moss, Larvik, Ålesund and Kristiansand

3 Swedish: Gothenburg, Stockholm and Helsingborg

3 Danish: Aarhus, Aalborg and Fredricia

4 Finnish: Helsinki, Turku, Rauma and HaminaKotka

1 Icelandic: Reykjavik

3 in the UK: Southampton, Immingham and Grangemouth

14 ports from other Nordic countries and the UK are included:

(1) To increases the discrimination power of the analysis; leads to more reliable results

(2) Statistical test can be conducted to learn how Norwegian container ports perform relative to the foreign ones

Panel data for years 2009 – 2014

Data from Containerisation International Yearbooks were presented to each of the 20 port authorities for verification

	Inputs					Output
Variable name	Berth length	Terminal area	Yard gantry cranes	Straddle carriers	Container handling trucks	Container throughput
Unit of measurement	m	m^2	Number	Number	Number	TEU/year
Average	920	277509	0.6	11.6	9.4	276860
Max	2792	1000717	4.0	90.0	27.0	1830792
Min	140	15000	0.0	0.0	3.0	1884
S.D.	673	292894	1.2	21.3	5.6	362582

Examples of container ports considered

Larvik (2014):
64 948 TEU
50 000 m^2 yard area
5 reach stackers

Moss (2014):
61 090 TEU
80 000 m^2 yard area
4 reach stackers

Photos: H. Schøyen, 2010

Results. Average, annual productivity changes

2009 - 2014		Technical Change	Rank	Efficiency Change	Rank	Tecnical Efficency Change	Rank	Scale Efficiency Change	Rank	Malmquist Index	Rank
No.	Container port	TC (1)		EC (2)=(3)x(4)		TEC (3)		SEC (4)		MPI (5)=(1)x(2)	
1	Oslo	1.026	14	1.021	2	1.019	2	1.002	9	1.047	7
2	Borg	1.043	11	0.983	15	1.013	3	0.970	18	1.025	14
3	Moss	1.061	5	1.006	6	1.000	6	1.006	7	1.067	2
4	Larvik	0.950	20	1.000	13	1.000	6	1.000	15	0.950	18
5	Ålesund	1.047	8	1.002	7	1.000	6	1.002	8	1.049	6
6	Kristiansand	1.065	2	1.000	8	1.000	6	1.000	10	1.065	3
	Geo.mean (Norway)	**1.031**		**1.002**		**1.005**		**0.996**		**1.033**	
7	Gothenburg	1.031	13	0.974	17	0.961	17	1.013	5	1.004	16
8	Stockholm	1.025	15	1.106	1	1.007	4	1.098	1	1.134	1
9	Helsingborg	1.014	16	1.007	4	0.961	18	1.048	2	1.021	15
	Geo.mean (Sweden)	**1.023**		**1.027**		**0.976**		**1.053**		**1.051**	
10	Aarhus	0.978	18	0.944	19	0.945	20	1.000	16	0.924	19
11	Aalborg	1.046	9	0.991	14	0.999	16	0.992	17	1.037	10
12	Fredericia	1.040	12	1.006	5	1.000	6	1.006	6	1.047	8
	Geo.mean (Denmark)	**1.021**		**0.980**		**0.981**		**0.999**		**1.001**	
13	Helsinki	1.051	7	0.976	16	0.958	19	1.019	3	1.026	13
14	Turku	1.054	6	0.613	20	1.048	1	0.585	20	0.646	20
15	Rauma	1.064	3	1.000	8	1.000	6	1.000	10	1.064	4
16	HaminaKotka	1.011	17	1.019	3	1.002	5	1.017	4	1.031	11
	Geo.mean (Finland)	**1.045**		**0.884**		**1.002**		**0.882**		**0.923**	
17	Iceland - Reykjavik	1.062	4	1.000	8	1.000	6	1.000	10	1.062	5
18	Southampton	1.044	10	1.000	8	1.000	6	1.000	10	1.044	9
19	Immingham	0.956	19	1.000	8	1.000	6	1.000	10	0.956	17
20	Grangemouth	1.067	1	0.965	18	0.999	15	0.966	19	1.029	12
	Geo.mean (UK)	**1.021**		**0.988**		**1.000**		**0.988**		**1.009**	
	Grand Geo.mean	1.031		0.975		0.995		0.980		1.006	

There is no statistical evidence that there are differences in productivity between Norwegian ports and the other ports.

Conclusions

(1) Among the Norwegian ports, there has been an annual productivity increase of approximately **3.3%**. The Norwegian average productivity growth is dominated by technical gains (investing in new technology and systems) over technical efficiency change (catching-up), which was also slightly progressing.

(2) Overall, and for the average port considered, there has been an annual productivity increase of approximately **0.6%**.

(3) Five Norwegian container ports progressed in productivity, and one regressed. Oslo, being ranked as number 7 in the sample, showed an above average productivity improvement compared to both the other Norwegian port and the foreign ones.

(4) A probable explanation for the productivity growth is the pressure that has been exerted on ports to improve their performance due to increased container traffic for most of the ports in the sample in the observed period.

Further research

- The presented efficiency and productivity indices should not be interpreted uncritically, as there is bound to be noise in the data and there may be external factors that were not included in the analysis.

- One future area of potential studies is to detect qualitative internal factors, and to identify possible external factors that may impact productivity.

- To study interaction between adjacent ports and terminals.

- Private costs and social costs (EXPORT).