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Storage pricing strategies for import container terminals under stochastic conditions

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ABSTRACT

This paper presents a model for determining the optimal storage pricing schedule for import containers. A generic schedule which is characterized by a flat rate and a storage time charge is adopted. The model considers analytically the stochastic behavior of the storage yard, as input/output flows are random variables, and includes the migration to an off-dock warehouse. Two objective functions are proposed: maximizing terminal operator profits and minimizing total integrated cost of the system. Some numerical experiments are provided and a sensitivity analysis is performed to investigate the effect of main variables and approaches on the optimal solution.

1. Introduction

The process of containerization and its continuous development involve various technological innovations in relation to the size of container ships and maritime container terminals. Over the last two decades, container traffic has grown at an average annual rate of 10%. This steady growth is explained by several factors, such as reduced transit time, reduced shipping costs, increased reliability and security, and multi-modality. However, the global financial crisis and subsequent economic recession halted the spectacular growth in 2009, although international seaborne trade is expected to recover and grow within a few years and to exceed 371 million twenty-foot equivalent units (TEU) in 2020 (UNCTAD, 2008, 2012). Even without this expansion, many terminals are currently operating at or close to capacity due to the continuous increase in container trade. Thus, handling processes at the terminal are likely to be subject to delay, reducing productivity and increasing operating costs because the time required for handling a single container will be higher.

In addition, because of the importance of economies of scale in container shipping, the size of container vessels has been increasing constantly and measures to improve efficiency have been introduced. The total container carrying capacity of the world's container ships is more than 14 million TEUs and the largest container ship, operated by the Maersk Line, has an overall capacity of 18,000 TEUs (UNCTAD, 2012). Considering the trend towards large container ships, the need for efficient terminal operations is more important than ever as a result of difficulties in enhancing physical capacity due to a lack of space and budget constraints.

In this context, improving port efficiency and the productivity of terminal facilities appears to be the only viable solution, helping to make the best use of the port infrastructure and resources (Frankel, 1987). According to Huynh (2008), the

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terminal throughput (volume of TEUs handled per year) can be increased by including new technologies and improving those that are already in use (mechanization in cargo handling, information exchange), increasing the storage density (using efficient storage strategies), blocking containers, and extending gate hours.

Congestion in storage yards can also be a consequence of the longer periods containers remain there. The average dwell time, which is the length of time that a container spends at the terminal, in Europe's main ports ranges between four and eight days. In the ports of Hamburg, Bremen, Rotterdam, and Antwerp, it is approximately 6.4 days for imports and 4.6 days for export cargo. In the Italian ports of La Spezia and Gioia Tauro, it is higher than for Northern European counterparts, averaging 7.4 days for vessel to truck cargo and 5.6 days for truck to vessel cargo (Dekker, 2005). The overall dwell time in the Port of Los Angeles is approximately four days for loaded containers, and in Asian ports, such as Singapore and Hong Kong, it is approximately two to three days.

The duration of stay of a container at a terminal before shipping (exports) or leaving by rail/road transport (imports) is an indicator of terminal efficiency: the higher the dwell time, the lower terminal efficiency (Choo Chung, 1993). In the case of imports, there is an additional problem as the departure time is unpredictable and long stays are regularly registered. To reduce the dwell time for imports, terminal operators try to persuade the shippers, carriers and owners to pick up their containers promptly.

One measure aimed at achieving timely collection is to introduce a storage charge that is proportional to the length of stay. A pricing storage schedule can adopt different formulations, such as a linear charge for storage after an initial period free of charge. A storage charge proportional to the time at the terminal is applied by most container terminals around the world. The main difference in price schedules is the duration of the free period. It is customarily accepted as three to five days (Goss and Stevens, 2001; Heggie, 1974), but even among the most important ports (Table 1), it varies from three to ten days—the longest duration being in Egyptian ports.

Table 1 shows little consistency in storage pricing policies, showing that terminals often do not price according to their costs; commercial policies or indirect charges apply instead. In general terms, terminal operators do not derive large profits from storage charges because their main activity is container transshipment between different modes of transport, but they would like to satisfy certain targets by introducing storage pricing, namely the following:

1) To avoid customers storing containers at the storage yard for long periods.
2) To guarantee the efficiency of terminal performance and greater profitability of storage space.
3) To provide an additional service to customers (i.e., storage), which is currently in high demand, especially for those users that do not have warehouse facilities.

Table 1
Import Storage charges and free time at major container terminals (charge per TEU) (CMA-CGM, 2012).

	Terminal	Free time	Thereafter	Cost per TEU day
EUROPE	Southampton (UK)	6 days	7–13 days	20.00 GBP
			14 onwards	45.00 GBP
	Rotterdam (ECT)	9 days	10–16 days	€4.83
			17–23 days	€10.35
			24 onwards	€12.78
	Hamburg (HHLA, Eurogate)	3 days	4 onwards	N.A.
			6–10 days	€7.50
	Antwerp (Dry)		11–20 days	€10.00
			21 onwards	€15.00
	Barcelona (TCB)	5 days	6–7 days	€2.00
			8–14 days	€5.00
			15–21 days	€10.00
			22–28 days	€15.00
			29–42 days	€20.00
			43 onwards	€40.00
Asia	Singapore (PSA)	3 days	0–7 days	SGD 12.00
			8–28 days	SGD 13.00
			29 onwards	SGD 34.00
	Hong Kong	5 days	6 onwards	HKD 277.00
	Colombo-Sri Lanka	3 days	0–3 days	USD 8.00
	(Jaya Container Terminal)		3–8 days	USD 15.00
			9 onwards	USD 23.00
USA	Long Beach	4 working days	5–9 days	USD 21.83
			10 onwards	USD 43.60
			5–8 days	USD 98.00
			9–12 days	USD 145.00
			13 onwards	USD 295.00
MIDDLE EAST	Egypt (All ports)	10 days	11 onwards	USD 12.00