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ECONOMIC ANALYSIS OF LINER SHIPPING INTERMODAL SERVICES AND RATESETTING PRACTICES

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1 - Introduction

Recent studies on trade flows have confirmed that the concept of "natural hinterlands" for seaports no longer applies to containerized shipments and that the trend is towards "load centering ports". These findings are directly linked to the technological advances of containerization and intermodalism which have given birth to new patterns and practices in international cargo distribution. One striking result of these developments is the advent of sea-rail intermodal services involving co-ordinated strategies and efforts between ocean and rail carriers in order to enhance their efficiency in container movements and enter into new markets. It is becoming evident, during the past ten years, that some new economic realities in the internatioanl liner shipping industry have been the driving forces behind the growth and innovation in intermodal services.

Shipping companies strive for cost advantages through further economies of scale, leading them to order ever larger fully cellular container ships. A direct side effect of the load capacity of these new container vessels has been the need for a rationalization of the maritime ports of call to ensure high traffic density, which is a vital prerequisite for achieving the economies of scale. However, expected economies in containership operations and the rationalization of ports of call depend upon efficient intermodal access and connections, in order to extend the reach of liner companies into distant inland markets and provide a rapid overland turnaround of containers. Due to these new conditions of efficiency in container movements, liner companies are increasingly playing a greater role in the total distribution of cargo by providing a complete transportation service to shippers, usually under a single rate assessed for the transport of cargo over the entire route.

Relatively little information has been published concerning intermodal ratesetting practices of liner companies and the structure of their intermodal rates. This paper will examine these issues by using the results of an economic analysis of outbound intermodal rates quoted by three major Conferences serving Canadian North Atlantic trades. Two of these Conferences operate from the Canadian east coast ports, while the other operates from the west coast of Canada.

2 - Liner Intermodal Rate Practices

One of the major effects of the integration of intermodalism into liner shipping activities has been a significant reform of the conventional weight or measurement based liner tariffs. The new system has adopted a lump-sum commodity box rate system, itself extended with comprehensive intermodal rates which include conditions for inland transportation.

The conversion to commodity box rates has not resulted in a reduction in the number of commodity classifications. In fact the commodity nomenclature has remained as extensive as it was under the conventional system. However, all intermodal services are rated strictly accordingly to the commodity box rate system and intermodal tariffs apply to unitized cargo in containers provided by the carrier.

As shown in Table 1, there is a diversity of products covered by the outbound intermodal rates quoted in the tariffs by the three major conferences linking Canada with the United Kingdom and Continental Europe. Although individual cargo moving in containers is assessed a freight rate in accordance with the commodity entries, it does not preclude the shipment of a container stuffed with mixed commodities. In such a case, each component cargo will have to be rated on a pro rata basis determinated by the weight of the cargo making up the full container load. Furthermore, as the containers are usually provided by the lines, they are made available to the shippers for container (de-) stuffing and positionning tasks subject to free time conditions. Once the free time period - which varies by container type and the number involved - has expired, demurrage charges will be applied. In order to take into account the various transportation and stuffing requirements related to the movements of cargo in containers and the economics of moving goods intermodally, two sets of service conditions have been implemented by liner companies.

The first set of conditions is the (de-) stuffing terms of any containerized shipments which apply to

TABLE 1

LINER INTERMODAL RATE COMMODITY CHARACTERISTICS*

	COMMODITY GROUP					
	BULK CARGO	CRUDE MATERIALS	FABRICATED MATERIALS	END PRODUCTS	OTHER	TOTAL
NBER OF COMMODITIES	7	18	26	30	7	88
Percentage	(8,0)	(20,5)	(29,5)	(34,1)	(8,0)	(100,0)
NBER OF RATES	83	132	119	87	34	455
Percentage	(18,2)	(29,0)	(26,2)	(19,1)	(7,5)	(100,0)
UNIT VALUE (per kg)						
mean ($)	0,45	2,56	1,78	8,10	°°	3,01
minimum ($)	0,15	0,14	0,10	1,04	°°	0,10
maximum ($)	0,70	5,09	6,53	26,00	°°	26,00

* Effective as of November 1984, outbound intermodal rates between Canada and United Kingdom, and Continental Europe.

°° Not intended to be calculated.

each end of an intermodal service. Two terms, "House"(H) and "Pier"(P), determine whether the shipper or the liner company has to arrange for the proper(un-) packing of the container(s). The term House means that the shipper has to load (or unload) cargo into (out of) the container(s) at his own expense, usually at a facility other than the terminal of the carrier involved, and to present at (or remove from) the terminal designated by the carrier the loaded container(s). The other (de-) stuffing term - Pier- signifies that the carrier arranges at shipper's request, for the container (de-) stuffing but at the carrier's designated location. The assignment of the two terms (H/H, H/P and P/H) defines the conditions applicable to the origin and destination of the shipment.

The second set of conditions refers specifically to the type of intermodal services available to the shipper and to the scope of rates. Four types of intermodal service can be supplied: Door-to-Door (D/D), Door-to-Terminal(D/T), Terminal-to-Door(T/D) and Terminal-to-Terminal(T/T). Various intermodal rates, inclusive of all transportation charges incurred for the movement of the container(s) between two specified locations, can be assessed in accordance with the commodity entries in the tariffs. The "Door" and "Terminal" terms are indicative of the service pattern. The term Door is used to indicate that the inland point explicitly refers to the shipper's designated place of stuffing or destuffing while the term Terminal specifically refers to one of the liner company inland container depots (also referred as container freight stations).

As a typical example, let us take a "Door-to-Terminal" movement from Brampton, Ont. to a U.K. container depot, under "House-to-House" stuffing terms. The intermodal rate quoted by a liner company will include the charges for: (1) truck delivery of empty container for loading and pick-up of loaded container between Brampton, Ont. and the Toronto railway container terminal, (2) the truck-rail container transshipment, (3) the container identification and inter-carriers telex reports on container(s) moved, (4) the transport by rail, (5) the railway and steamship terminal services, (6) the ocean transport and finally, (7) the overseas terminal services where the loaded container is placed at the disposal of the consignee. However, as stuffing terms are governed by "House-to-House" conditions, all expenses incurred for the proper packing and unpacking of the cargo will not be included in the liner intermodal rate, being under shipper's responsibility.

Based on the 1984 liner intermodal rates, Table 2 reveals two leading liner intermodal service practices.

TABLE 2

MAIN CHARACTERISTICS OF LINER INTERMODAL RATES
(EFFECTIVE AS OF NOVEMBER 1984)*

	TERMINAL/ TERMINAL	DOOR/ TERMINAL	TERMINAL/ DOOR	DOOR/ DOOR	TOTAL
HOUSE/HOUSE	94	76	65	155	390
PIER/HOUSE	51	8	-	-	59
HOUSE/PIER	6	-	-	-	6
TOTAL	151	84	65	155	455
	20' CONTAINERS				
MEAN RATES ($)	1,285	2,274	1,395	1,786	
MEDIAN ($)	1,315	1,800	1,330	1,816	
STD. DEV.	167	1,067	218	324	
MIN. RATES ($)	925	1,260	1,130	1,298	
MAX. RATES ($)	1,975	5,750	2,218	2,542	
MEAN INLAND DISTANCE (MILES)	-----	607	162	413	
UNIT VALUE ($/TONNE)	1,128	4,423	1,901	1,869	

* Outbound intermodal rates between Canada and United Kingdom, and Continental Europe.

First, 86 per cent of intermodal rates were quoted on "House-to-House" terms, indicating that the costs incurred for container stuffing were not generally covered by the intermodal rates assessed by liner companies and reflecting, that those latter tend to put the responsibility on shippers to arrange for proper stuffing of their cargo. Second, inland container depots (ICD) seem to play a major role in the patterns of liner intermodal services: one third of their intermodal rates correspond to intermodal service performed between two ICDs and another third to intermodal services either starting from or terminating at an ICD. The identification of ICDs in Canada shows that they are all located either close to or at a railway-head switching yard or a railway-head terminal (i.e. Halifax, N.S., Saint John, N.B., Québec City and Montréal in Qc, Toronto, Hamilton, Sarnia and Windsor in Ont., Winnipeg, Man, Regina and Saskatoon in Sask. Calgary and Edmonton in Alta, and Vancouver in B.C.).

From the latter observations, it is reasonnable to infer that the tendency of liner companies to locate their ICDs close to railway container terminals reflects their drive toward obtaining cost and operational advantages, by developing patterns of intermodal services which generally concentrate on full container loads to be moved on unit trains. In other words, the liner strategies are based on the potential of railways for expanding the hinterland container markets and on opportunities to take advantage of railway time-volume rates for point-to-point services.

Two transportation economic premises support these liner intermodal practices. The first is that greater efficiencies in intermodal operations can be realized when relative long distance line-hauls can be performed, before containers are broken down into their component packages. The second is that railways have economic advantages for long distance and high density volume shipments, where economies of scale can be achieved from block movements of containers on unit trains. Furthermore, there are opportunities for liner companies to take advantage of the concentration of transportation services at most of railway container terminal areas. In addition to available local truck operations for the remaining part of an intermodal transport, cargo consolidation and distribution activities usually already exist around these railway facilities - two key operational aspects which make intermodalism possible.

Table 3, Line (1), attests to the fact that railway time-volume rates may lead to a high discount per container, depending on the shipper's ability and capacity

TABLE 3

COST BREAKDOWN OF A 20' CONTAINER D/T SERVICE FROM KITCHENER (ONT) TO A WESTERN EUROPE BASE PORT (NOVEMBER 1984)

TRANSPORT COST COMPONENTS	$	REGULAR RATE	TIME-VOLUME FREIGHT RATE min. nber of containers			
			2	20 p.w.	50 p.w.	12,000 p.y.
Del. and pick-up of cont.	X	219	145	145	145	145
Container identification	8					
Truck-rail transshipment	69					
(1) Rail freight rate*	X	509	339	263	247	219
Telex reports on cont. (min)	5					
Rail Terminal Service at port	69					
Liner Terminal Service (Canada)	54					
Ocean Freigh rate**	910					
Liner Terminal Service (W.E.)	100					
(2) Total transport cost ($)		1,943	1,699	1,623	1,607	1,579
(3) Liner intermodal rate quoted ($)		1,650	1,650	1,650	1,650	1,650
(4) Difference of (2) - (3) ($)		293	49	(27)	(43)	(71)

* Kitchener has been linked to the Toronto railway container terminal; p.w.=per week, p.y.=per year.

** The commodity involved is "Video monitors and parts".

to commit himself to large volume of containers over a given period of time. Line (2) indicates what might be the total transport cost to the shipper if he elects to arrange his own transportation by comparaison to Line (3), where the liner intermodal rate quoted for this particular "Door-to-Terminal" service is shown. This example, although limited, illustrates how the railway time-volume rates can, to a large extent, allow liner companies to supply intermodal services at a competitive price relative to other transport operators, such as some freight forwarders.

To summarize, in the context of container transport, the operations of larger liner containerships and of railway unit trains entail very similar conditions of efficiency: traffic density and both steady and balanced cargo flows. This situation has led liner companies and rail carriers, on a purely commercial basis, to co-operate and co-ordinate their efforts to improve the efficiency of their container activities. Three main organizational devices of uniting liner and rail activities are:

(1) the synchronization of containership's and unit trains' schedules allowing more efficient and further flows of containers to and from ports, through direct transshipments of boxes from (to) vessels to from) unit train cars,
(2) the provision by liner companies of point-to-point rates and intermodal services, in order to control the costs and quality of services offered to inland shippers and, with the advent of mini and micro land-bridges, to enhance the competitiveness of their maritime services relative to their competitors and finally,
(3) the implementation by railways of flexible high discount time-volume box rates, largely set by competitive forces and negotiations, for both import and export sea-container traffic between specified Canadian ports and major railway container terminals.

3 - Regression Analysis of Liner Intermodal Rates

A recent CTC study, based on 1983 liner conference tariffs, has empirically shown that the commodity box rates system is positively and significantly related to the conventional weight-measurement tariff system. From this result, it is reasonable to expect that the determinants of the intermodal commodity box rates will also include some factors that past studies have identified as influencing the level of port-to-port liner freight rates. Using, as a case study, the 1984 intermodal rates quoted by the Canada-United Kingdom

Freight Conference Canadian - Continental Eastbound Freight Conference and Western Canada - Europe Conference for Canadian exports, this section aims to identify statistically the determinants of the liner intermodal rates.

The analysis which follows is based on the premise that liner intermodal tariffs reflect the cost and value of services provided as well as the market supply conditions on the routes. Accordingly, the intermodal rates are related by multiple regression analysis to cost and value of service factors, where the straight linear estimated form is:

$$CIR = B_0 + B_1\ UVAL + B_2\ Inld + B_3\ TIS = B_4\ COST + B_5\ MSC + u$$

where

CIR = the commodity intermodal rate
Bo = the constant term
UVAL = the unit value of commodity per kg
INLD = the total inland distance in Canada and in Europe
TIS = the type of intermodal service
COST = a group of dummy variables used to represent various cost determinants, which could be
- FEU: 40' container size
- OST: overseas service terminal charges
- STUFF: stuffing conditions
- WC: Vancouver as port of export
- TCC: temperature controlled cargo
- EMR: Special conditions of inland carriage

MSC = a group of variables used to represent various market supply conditions which could be
- TONS: total tonnes of containerized commodity carried by each conference
- COMP: proportion of containerized commodity carried by non-conference lines on the route
- DIVR: commodity rate of diversion through American ports.

The major sources of data include conference tariffs and rules filed with the Canadian Transport Commission, data on cargo shipping records obtained from Statistics Canada, special tabulations on commodity unit value and commodity trade diverted through American ports produced by Statistic Canada and various Canadian and foreigh inland distance matrixes.

The results of the regressions are shown in Table 4. The high coefficients of determination ($\bar{R}^2$)

TABLE 4

REGRESSION ANALYSIS OF LINER INTERMODAL RATES**

VARIABLES	T/T & D/T	T/D & D/D	EAST COAST	ALL RATES
CONSTANT	1 142,5 (13,1)	1 318,2 (19,7)	1 328,2 (16,3)	1 137,9 (18,1)
FEU (d)	728,7 (11,4)	641,1 (10,8)	675,1 (16,6)	695,2 (19,3)
WC (d)	240,0 (1,9)	--	--	292,0 (3,2)
STUFF (d)	-145,3 (2,1)	--	-89,7 (1,7)*	-15,9 (0,3)*
OST (d)	126,7 (1,7)*	--	165,0 (4,0)	144,9 (3,6)
INLD	0,44 (5,9)	0,30 (4,1)	0,58 (9,8)	0,69 (14,3)
UVAL	0,025 (4,5)	0,009 (1,4)*	0,014 (4,2)	0,014 (3,8)
TIS (d)	395,0 (3,9)	726,9 (19,7)	--	--
TCC (d)	1 930,0 (10,9)	--	--	1 870,4 (14,6)
EMR (d)	1 611,8) (11,8)	--	--	1 053,9 (9,6)
COMP	--	-368,7 (6,2)	-238,4 (3,2)	--
TONS	--	--	-0,003 (2,0)	--
DIVR	--	-2,4 (2,1)	--	--
$\bar{R}^2$:	0,85	0,82	0,76	0,85
N :	204	87	188	289

d = Dummy variable * = Insignificant variable at 5% level if T<1,9

** By November 1984, between Canada and the U.K. and the Continental Europe.

indicate that the four regression equations explain a large portion of the variations in intermodal rates. Several important points can be highlighted from the Table 4. Considering determinants linked to demand characteristics, two independant variables have been found significant: the commodity unit value (UVAL) and the commodity-by-commodity tonnage of containerized cargo carried (TONS). The significant positive coefficient of the unit value in three of the four equations suggests that liner companies still practice price discrimination, by setting generally higher rates for high-value commodities than for low-value ones. However, the insignificant UVAL coefficient, observed in the second equation which applies only to the conferences operating from the Canadian east coast ports, might be an indication that the pressure of market competition may negatively affect the traditional approach to tariffs: "the higher the value of an item the better it is able to bear a high cost". Market competition emerges from both other Canadian based liner companies serving the same markets (COMP) and foreign intermodal services offered by American based liner companies (approximated by the commodity rate of diversion DIVR).

The other demand-related variable, TONS, enables us to test the hypothesis that liner companies tend to quote lower rates for commodities moved in large quantities. Due to the unavailability of data on commodities carried intermodally, the containerized tonnage by commodity for each of the two East Coast conferences has been used as a proxy-variable. The significant negative sign of the TONS' coefficients (equation (3)) can be attributed to a possible barginning position of shippers in two ways. First, it may correspond to a partial transfer, from the liner company to the shippers, of lower railway time-volume rates available to liners as a result of their capacity to commit large volumes of traffic to railways. Second, a more global reason, large quantities imply security of revenues and ensure economies of scale in overall liner container operations, benefits which could be reflected in the pricing decisions of some lines.

Seven different cost and value related independant variables have been identified as potential sources of variation in intermodal rates. Two necessary variables taken into account are the specific cost factors associated with inland and maritime distances involved. The inland distance variable (INLD) refers to the total Canadian and European distance overland, considered for each intermodal rate. The longer maritime distance associated to Vancouver relative to Montréal, as port of exit, has been represented by the dummy variable WC. As expected, in all equations (where applicable)

the INLD and WC coefficients were positive and statistically significant.

The five other specific cost factors, represented by dummy variables, refer explicitly to particular service conditions that could be included in some intermodal services offered by liner companies. Two of them, which relate to distinctive cargo characteristics, are the temperature controlled cargo (TCC) and other special requirements for cargo handling or inland carriage (EMR), such as the case of some western grains moved via Vancouver. Both, when applicable, were found positive and significant variables influencing the level of liner intermodal rates. Two other explanatory variables, statistically significant, are the inclusion or exclusion of the overseas terminal service charges in the intermodal rates (OST) and the (de-)stuffing terms linked to each individual intermodal service (STUFF). The expected negative coefficient of the variable STUFF, in equation (1), is consistant with the fact that, under "H-to-H" terms, the liner company is not making any arrangements for container stuffing activities, which is reflected in lower intermodal rates. The last cost factor identified is the 40' versus 20' container size to which rates apply, represented by the dummy variable FEU. In all equations, the coefficient of the FEU variable is significantly positive and always smaller than the constant term. This can be attributed, on the one hand, to the higher handling and transportation cost of a 40' container relative to a 20' container and, on the other hand, the usually lower cost to move a single 40' container rather than two 20' containers.

In addition, the economic premise that a competitive market environment usually leads to lower prices or reduces the sustainability of price discrimination in a given industry has been confirmed. In equation (2), the commodity-by-commodity proportion of containerized cargo tonnage carried by other liner shipping companies serving Canada (COMP) and rate of cargo diversion through American ports (DIVR) are negatively related to the intermodal rates. This may also indicate that, as a result of development of efficient intermodal networks, the competition in the liner market has been enhanced, not only on a national level but also, between liner companies calling at ports located in two adjacent countries (Canada and the U.S.A. in the present case).

Finally, in equations (1) and (2), the significant positive sign of the coefficients of the dummy variable TIS (type of intermodal services) can be interpreted in two ways. In one instance, this gives support to the hypothesis that liner companies would practice

a value-of-service pricing based on the relative overall quality-value that could be associated to each of the four type of intermodal services. In the other instance, this may also indicate the omission of other explanatory variables influencing the level of intermodal rates, either related to the demand side or the supply side, however. This latter would suggest a need for further research.

In conclusion, the results of this regression analysis confirm the hypothesis that some determinants - commodity unit value, the requirement for temperature controlled containers, the maritime distance and the quantity of the commodity moved - already identified in previous studies as factors for variations in the level of ocean freight rates, can also be significant variables to account for intermodal rate variations. However, the most striking result is the importance of COST and MARKET SUPPLY determinants to explain differences between liner intermodal rates. The level of intermodal rates appears to vary more in response to cost characteristics of the services and to liner shipping supply conditions than to demand-related factors.

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Endnote

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