INLAND/OCEAN WATERBORNE TRANSPORTATION
INNOVATIONS AND PORT CHARGES*

by

Gary L. Belcher
James R. Jones
Karl H. Lindeborg

Research Paper No. 7912

*Presented at Southern Agricultural Economics Association Contributed Papers Session February 3-6, 1980 in Hot Springs, Arkansas.

ABSTRACT

Recent innovations in the area of agricultural commodity transportation have greatly affected the impact of port charges upon the total transportation bill. Container-on-barge and barge-carrying vessel technologies are new applications of intermodal transportation to agricultural commodity transportation which lessen or eliminate the rehandling of goods at the ocean port of embarcation. This study had two objectives: 1) to identify transportation modes and analyze the economics of transportation of bagged farm exports, and 2) to present a comparative analysis of port charges for different modal interfaces at river and seaports. Although a specific commodity and region were dealt with here, the analysis should have applications to similarly shipped commodities in similar shipping environments. The findings indicate that the container-on-barge concept should work well for bagged farm commodity shipping within regions with inland waterways. The barge-carrying vessel concept is less competitive for bagged shipments given the high loading costs at the inland port and limited service and schedules.

INLAND/OCEAN WATERBORNE TRANSPORTATION INNOVATIONS AND PORT CHARGES 1/

Containerization of transoceanic general cargo shipments was pioneered in 1966 when Sea-Land Service, Inc. initiated a containership service from the U.S. East Coast to Europe. Shipping of cargo in uniform sized sealed containers of truck-trailer size has revolutionized the marine transportation industry. The intermodal container enables the shipper to pack his cargo at his own premises and deliver the cargo to a port to be transferred to an ocean vessel and delivered overseas to the foreign consignee, without the contents of the cargo being handled at each stage of the journey. Initially, the container was moved to an ocean port by rail or truck, but recently this leg of the movement has been adapted to inland river movements via the container-on-barge concept. Another recent innovation in intermodal waterborne transportation is the shipborne barge and barge-carrying vessel (BCV).[2/] Specially designed shallow draft barges are directly loaded and discharged on an ocean-going mothership specifically equipped for this purpose.

These technological innovations have brought a new dimension to the potential role of inland river navigation systems in the U.S. agricultural export distribution system. Traditionally, cargo river movements have consisted of low value bulk commodities such as grains, ores, gravels, logs, chips, and petroleum products. The above two innovations allow the possibility of shipping commodities in smaller consignments classified as general cargo, where bags or other separate units are concerned, or in certain cases as mini/bulk.

This paper reports on the results of a transshipment linear programming analysis of the above modes applied to the dry pea transportation system and focusing upon export shipments via the Columbia/Snake navigation system in the Pacific Northwest (PNW). The analysis identified least cost modes and alternative routes under several alternative transportation conditions. It also identified inland origins of shipments and optimal port transshipment points.

While this study was directed to a particular commodity and a particular region, it is reported for its possible implication for these inland/ocean transportation technologies being applied to export shipments of other goods of a similar nature, and where other inland navigation systems are available. For example, rice on the Mississippi and Sacramento waterways also can be shipped under similar circumstances. In addition, the study may have methodological merit for other transportation and trade researchers in that it incorporates all the various transportation and handling charges of a cargo from the time it leaves the inland shipper through all the transshipment points to the overseas port of destination. In particular, identification of interfacing port charges in the detail encompassed in this study has, to the authors' knowledge, never been attempted in other transportation studies of export movements. Most such studies have terminated tracing movements at the ocean port, or begun at that point, without including the various charges incurred at the port interfacing these two movements.

METHODOLOGY

In the transshipment linear programming model [2, 3], the dry pea transportation system was represented by six production origins, seven transshipment points (including two upriver ports), six overseas destinations, and ten transportation methods.[3/] Seven types of inland shipping modes were identified--break-bulk truck, container-on-truck, break-bulk rail, container-on-rail, container-on-barge, shipborne barge, and mini-bridge.[4/]

Three types of ocean transportation were identified for dry pea exports--break-bulk vessel, container vessel, and barge-carrying vessel. Each type can call on all suitable U.S. and foreign ocean ports, although BCV is uniquely suited for ports situated along navigable rivers. Break-bulk and container vessel rates were taken from steamship conference tariffs. BCV vessel rates were estimated by a steamship company official.

Major foreign market areas for dry peas were represented by six destinations: two each in South America, Asia and Europe. Seven intermediate transshipment points were selected--Seattle, Portland, Oakland, New Orleans, and Baltimore as ocean ports, and Lewiston, Idaho and Pasco, Washington as river ports. Port charges for bagged dry pea shipments were identified for these seven ports.

The incorporation of port charges into transportation models has been neglected in past studies. One possible reason is that port handling and shipping terminology and costing is complicated. However, port charges can be significant in terms of overall transportation costs. For example, rail charges to Portland from Lewiston, Idaho are 54¢/cwt. while handling charges involved in transferring the commodity to a containership at Portland total \$1.32/cwt. The cost of barging containers to Portland was estimated to be 36¢/cwt., the river terminal charges were 9¢/cwt. and Portland's handling charges were 33¢. No studies which included an analysis of port charges were found in the literature search. This dearth of information has also been cited by Admunsen who recently conducted a port pricing study for the U.S. Maritime Administration [1]. The discussion of port charges in this study is based on interviews with port officials and a review of published port tariffs.

Port charges were included in the total freight bill according to the steamship conferences' pricing of port services rather than port pricing of port services. The two pricing systems are highly dissimilar but interdependent. Further, each steamship conference may differ in its pricing method and each port may differ similarly. Unfortunately (for research purposes), there is no neat juxtaposition of conference pricing and port pricing of port services.

Generally, the operating port, or private terminal firms at non-operating ports, bill the steamship line who, in turn, bill the account of cargo. An operating port is one which performs many of the physical port services while a non-operating port leases property to private terminal operators who provide port services. An operating port publishes a port tariff which covers all services which are offered and the rates thereof. Private terminal operators will establish competitive rates for services. Regional marine terminal conferences exist which tend to equalize port charges but certain costs can still differ widely. Also, Admunsen shows that costs may not be the most important determinant in choosing a port for export shipments. Other factors such as steamship scheduling, sufficient facilities, or service reputation may be as important but are assumed to be constant in this study.

Table 1 depicts the port pricing of port services. The cost for each service is expressed on a hundredweight basis. The type of inland rate and ocean rate delimit the extent of port charges in each cell listing. Nine types of port interfaces were identified for bagged dry pea shipments. The first type of interface, "break bulk by truck to loose stow on ship," is available at each of the five selected ports. Seattle and Portland, who are in a common terminal conference, denote the costs for the requisite port services as a "break bulk assessment" and a "service and facilities" charge. The former charge includes the movement from where the cargo is first removed from the truck (the "first point of rest") and the wharfage charge. The latter charge is a general fee for using the port facilities and includes such services as receipt, delivery, checking, care, custody, and control of cargo moving through the port. In Oakland, New Orleans, and Baltimore, each has a truck unloading charge and wharfage charge. Oakland's break-bulk charge and New Orlean's terminal charge are similar to the break-bulk assessment described above. It was not found whether such a charge exists in Baltimore or how it would function. In addition, for all interfaces a shiploading cost was involved and is absorbed into the ocean freight rate. Rail unloading was the only additional port cost factor for the second type of interface, "break-bulk by rail to loose stow on ship."

Rail and truck unloading charges are usually paid by the shipper. Port charges after the first point of rest are billed by the port or private marine terminal to the steamship line. The steamship line presents the actual bill for port services to the shipper or the consignee (i.e., the "account of cargo") depending on the terms of sale. For example, most dry pea exports are sold "F.O.B.-dock" which obliges the shipper to deliver to the first point of rest at the U.S. port of discharge. The consignee pays port charges (as billed by the steamship line) and ocean freight. The billing of port charges by different steamship lines and conferences varies in terminology and accounting. To different degrees, port charges may be billed separately and/or "absorbed" into the ocean freight rate. Pacific Northwest steamship conferences use both methods. Port officials stated that the steamship conferences' "handling" and "wharfage" charges are billed independently of the ocean freight bill, but that some of the costs for port services are absorbed into the freight rate. The other ports had terminal and wharfage charges for the bagged cargo. Some port charges, such as dockage, apply only to services required by the vessel aside from the cargo. Such charges are incorporated into the ocean freight rate.

All of the other types of interfacings involve container movements and have mostly common charges among the interfacings. Four of the interfacing types are not applicable to Oakland, New Orleans, or Baltimore. Depending on the type of container interfacing and port, there are truck or rail unloading charges and private or port stuffing charges. Wharfage is a common charge to all container interfacings and ports.

The movements of the container from first point of rest to shipside is counted as a "container throughput" charge at Seattle, Portland, and Oakland. In Oakland, a non-operating port, private terminals also include container stuffing into this cost item. A specific cost item for container movements from first point of rest to shipside was not determined for Baltimore and is probably incorporated into the ocean rate. Steamship lines bill and/or absorb these charges.

Table 1: Port pricing of port services.

	Port									
	Seattle		Portland		Oakland		New Orleans		Baltimore	
break-bulk by truck to loose-stow on ship	truck rate break-bulk assessment $6.50 MT service and facilities $3.16 ST ocean rate	$/cwt .295 .180 .475	truck rate break-bulk assessment $6.50 MT service and facilities $3.16 ST ocean rate	$/cwt .295 .180 .475	truck rate truck unloading $0.72 ST break-bulk charge $19.33 ST wharfage $2.60 ST ocean rate	$/cwt .036 .967 .130 1.133	truck rate truck unloading $4.73 ST wharfage $0.90 ST terminal charge $4.00 LT ocean rate	$/cwt .237 .045 .180 .462	truck rate truck unloading $5.95 ST wharfage $1.00 ST ocean rate	$/cwt .298 .050 .348
break-bulk by rail to loose-stow on ship	rail rate rail unloading $9.88 ST break-bulk assessment $6.50 MT service and facilities $3.16 ST ocean rate	$/cwt .494 .295 .180 .969	rail rate rail unloading $9.88 ST break-bulk assessment $6.50 MT service and facilities $3.16 ST ocean rate	$/cwt .494 .295 .180 .969	rail rate rail unloading $12.25 ST wharfage $2.00 ST break-bulk charge $19.33 ST ocean rate	$/cwt .613 .130 .967 1.710	rail rate rail unloading $4.73 ST wharfage $0.90 ST terminal charge $4.00 LT ocean rate	$/cwt .237 .045 .180 .462	rail rate rail unloading $3.80 ST wharfage $1.00 ST ocean rate	$/cwt .190 .050 .240
break-bulk by truck to privately stuffed container to container ship	truck rate private container stuffing $0.28/cwt throughput $58.25/c wharfage $2.60 ST service and facilities $37.25/c ocean rate	$/cwt .280 .150 .130 .096 .656	truck rate private container stuffing $0.25/cwt throughput $78.00c wharfage $2.60 ST ocean rate	$/cwt .250 .202 .300 .582	truck rate truck unloading $0.72 ST private terminal throughput $125/c (stuffing $82/c) (stevedoring $43/c) wharfage $2.00 ST ocean rate	$/cwt .036 .325 .130 .491	truck rate private container stuffing $10.00 LT terminal charge $4.00 LT wharfage $0.90 ST ocean rate	$/cwt .447 .180 .045 .672	truck rate truck unloading $5.95 ST private container stuffing and handling $175.00/c wharfage $1.00 ST ocean rate	$/cwt .298 .455 .050 .803
break-bulk by truck to port-stuffed container to container ship	truck rate port container stuffing $6.16 ST throughput $58.25/c wharfage $2.60 ST service and facilities $37.25/c ocean rate	$/cwt .308 .150 .130 .096 .684	truck rate port container stuffing $9.77 ST throughput $78.00/c wharfage $2.60 ST ocean rate	$/cwt .489 .202 .130 .821	N.A.		N.A.		N.A.	
break-bulk by rail to privately stuffed container to container ship	rail rate rail unloading and private container stuffing $0.31/cwt throughput $58.25/c wharfage $2.60 ST service and facilities $37.25/c ocean rate	$/cwt .310 .150 .130 .096 .686	rail rate rail unloading and private container stuffing $0.31/cwt throughput $78.00/c wharfage $2.60 ST ocean rate	$/cwt .310 .202 .130 .642	rail rate rail unloading $12.25 ST private terminal throughput $125.00/c (stuffing $82/c) (stevedoring $43/c) wharfage $2.60 ST ocean rate	$/cwt .613 .325 .130 1.068	rail rate private container stuffing $10.00 LT terminal charge $4.00 LT wharfage $0.90 ST ocean rate	$/cwt .447 .180 .045 .672	rail rate rail unloading $3.80 ST private container stuffing and handling $175.00/c wharfage $1.00 ST ocean rate	$/cwt .190 .455 .050 .695
break-bulk by rail to port-stuffed container to ship container	rail rate rail unloading $9.88 ST port container stuffing $6.16 ST throughput $58.25/c wharfage $2.60 ST service and facilities $37.25/c ocean rate	$/cwt .494 .308 .150 .130 .096 1.178	rail rate rail unloading $9.88 ST port container stuffing $9.77 ST throughput $78.00/c wharfage $2.60 ST ocean rate	$/cwt .494 .489 .202 .130 1.315	N.A.		N.A.		N.A.	
all container by truck to container ship	truck container rate throughput $58.25/c wharfage $2.60 ST service and facilities $37.25/c ocean rate	$/cwt .150 .130 .096 .376	truck container rate throughput $78.00/c wharfage $2.60 ST ocean rate	$/cwt .202 .130 .332	N.A.		N.A.		N.A.	
all container by rail to container ship	truck container rate throughput $58.25/c wharfage $2.60 ST service and facilities $37.25/c ocean rate	$/cwt .150 .130 .096 .376	truck container rate throughput $78.00/c wharfage $2.60 ST ocean rate	$/cwt .202 .130 .332	N.A.		N.A.		N.A.	
all container by barge to container ship[a]	N.A.		barge rate throughput $78.00/c wharfage $2.60 ST ocean rate	$/cwt .202 .130 .332	N.A.		N.A.		N.A.	

[a]Charges prior to barge rate not specified here.

The port charges at the representative upriver ports are for container interfacings between truck and barge. There are three inland charges incurred: the round trip container on barge movement, a terminal ("throughput") charge, and the trucking charge for the delivery of the empty container and return of the "stuffed" container from the inland source.

Shipborne barge costs at upriver ports would probably include unloading the bags from the truck, palletizing, and loading into the barge. Since shipborne barges are directly loaded onto the ocean vessel, ocean ports are bypassed.

TRANSPORTATION SETTINGS AND RESULTS

Four transportation settings analyzed with the transshipment model are reported in this paper. The linear programming results are presented in Table 2.

The transportation setting first analyzed represents dry pea shipping conditions prior to and following the introduction of container on barge shipping. This setting includes all modes except BCV. On a least-cost basis, container on barge captured 25% of the total shipments, while the share of the break-bulk truck mode fell from 67% to 42%. Mini-bridge container movements remained at a 33% share. Among the ocean modes, mini-bridge handled 33%, container ships took 25% and break-bulk ships handled 42%.

The second setting introduced a waterway user's fee into the model [4, 6]. The imposition of a waterway user's fee was considered as a separate setting due to its potential implication for the use of barge transportation. A parametric programming procedure brought in a range of a 0-42¢ per gallon fuel tax user fee which represented a range up to 4.41¢ added cost per

TABLE 2. LINEAR PROGRAMMING SOLUTIONS: MODAL SHARES OF PACIFIC NORTHWEST DRY PEA EXPORTS

	INLAND TRANSIT TO OCEAN PORT[a]								OCEAN TRANSIT				
	Break Bulk Truck quantity[b] (%)	Break Bulk Rail quantity (%)	Container on Truck quantity (%)	Container on Rail quantity (%)	Container on Barge-Pasco quantity (%)	Container on Barge-Lewiston quantity (%)	BCV Barge Via Lewiston quantity (%)	Total quantity (%)	Mini Bridge quantity (%)	Vessel quantity (%)	Break Bulk Ship quantity (%)	Container Ship (excluding Mini-Bridge quantity (%)	Total quantity (%)
1. Dry pea shipping without container on barge	1,105,840 (67%)	----	555,070 (33%)	----	N.A.	N.A.	N.A.	1,660,910 (100%)	555,070 (33%)	N.A.	1,105,840 (67%)	----	1,660,910 (100%)
Dry pea shipping with container on barge (BASE MODEL)	704,958 (42%)	----	555,070 (33%)	----	----	400,882 (25%)	N.A.	1,660,910 (100%)	555,070 (33%)	N.A.	704,958 (42%)	400,882 (25%)	1,660,910 (100%)
2. Base Model with 30% increase in container handling charge at Portland	1,105,840 (67%)	----	555,070 (33%)	----	----	----	N.A.	1,660,910 (100%)	555,070 (33%)	N.A.	1,105,840 (67%)	----	1,660,910 (100%)
3. Base Model with 12¢/g. user fee and 30% increase at Portland	1,105,840 (67%)	----	555,070 (33%)	----	----	----	N.A.	1,660,910 (100%)	555,070 (33%)	N.A.	1,105,840 (67%)	----	1,660,910 (100%)
4. Base Model with BCV, including loading and palletization costs at Lewiston	704,958 (42%)	----	555,070 (33%)	----	----	400,882 (25%)	----	1,660,910 (100%)	555,070 (33%)	----	704,958 (42%)	400,882 (25%)	1,660,910 (100%)
Base Model with BCV, with loading but without palletization costs at Lewiston	514,040 (31%)	----	539,088 (32%)	----	----	15,981 (1%)	591,800 (36%)	1,660,910 (100%)	539,088 (32%)	591,800 (36%)	514,040 (31%)	15,982 (1%)	1,660,910 (100%)
Base Model with BCV, not including loading or palletization costs at Lewiston	----	----	146,990 (9%)	----	----	----	1,513,920 (91%)	1,660,910 (100%)	146,990 (9%)	1,513,920 (91%)	----	----	1,660,910 (100%)

[a]The barge modes also require truck transportation from the shipper to the river.

[b]Quantity is in terms of hundredweight bags.

[c]N.A.: not applicable.

hundredweight. The user fee had an initial effect at 27.6¢ per gallon, causing container on barge a reduction of 12%. Since the recently enacted user fee reaches a maximum of 10¢ per gallon by 1985, user fees are estimated to have no impact.

The third transportation setting incorporates a 30% increase in the ocean conference container handling charge at Portland which reportedly was being considered at the time the study was conducted. Although conference port charges are approximately equalized at U.S. West Coast ports, this setting presents, hypothetically, a projection of changes in modal shares if indeed such an increase in port charges were to occur. According to the linear programming results, the container-on-barge mode is eliminated. This indicates that port charges can have significant implications for the most feasible method of shipment.

The final setting analyzed the use of shipborne barge/barge-carrying vessel movements. The BCV system was projected to have a significant impact on dry pea movements if three problems are resolved: 1) that service is offered to appropriate markets; 2) that loading and palletization costs are somehow lowered or absorbed into the barge or ocean vessel freight charge; and 3) that large enough consignments of dry peas occur to comprise full barge loads. The near term solution of these problems is not imminent on the Snake/Columbia navigation system.

CONCLUSIONS

Container-on-barge shipment of bagged dry peas was determined to be competitive with land modes in terms of the freight rate structure incorporated into the transshipment model. However, two qualifications bear consideration.

The model did not explicitly incorporate other considerations such as transit time that also may influence the selection of modes and routes. Moreover, the rates used were those actual rates prevailing around January, 1978, in the study region. Whether these rates reflect long-run costs of each mode is, of course, subject to question. Market imperfections (rates distorted by monopoly or non-economically regulated rates, imperfect information regarding actual costs, etc.) are often the rule, rather than the exception, where transportation rates are concerned so that long-run equilibrium costs can be quite different from actual rates at a point in time. Whether carriers are quoting container-on-barge rates that will be fully compensatory is particularly uncertain given the relatively brief experience that they have had with this mode.

The BCV system is not presently suited to the shipment of dry peas since consignments are usually less than barge load, service currently is too restricted, and loading costs at the inland port are presently prohibitive unless they are absorbed by the river or ocean carrier. However, this service also may in time prove to be viable.[5/]

Variations in port charges can potentially affect routing, and even selection of modes, as they are at times a significant portion of the total costs of moving goods to overseas destinations.

Waterway user fees, as currently legislated, were found to be inconsequential in the competitive position of barge in the study.

FOOTNOTES

1/ This study reported here is one of a series of studies at the University of Idaho analyzing the role of intermodal general cargo commerce on the Columbia/Snake navigation system. The project is supported by funds from Competitive Grant No. 616-15-85 provided by the Cooperative State Research Service of the U.S. Department of Agriculture, Grant Project Nos. R/UI-2 and R/UI-4 from the Oregon State University Sea Grant College Program in cooperation with the National Oceanic and Atmospheric Administration, U.S. Department of Commerce; and other funds provided by the Cooperative State Research Service and the University of Idaho Agricultural Experiment Station. Gary L. Belcher is a Research Associate, James R. Jones is an Associate Professor, and Karl H. Lindeborg is a Professor at the Department of Agricultural Economics, University of Idaho.

2/ To date the two major design concepts of BCV that have been employed are LASH (lighter aboard ship) and SEABEE. This study employs dimensions of shipments at rates applicable to the LASH version.

3/ A standard transshipment linear programming model was used to minimize total transportation cost and identify least cost modes and routes under several simulated transportation settings. There were 410 to 450 activities in the transshipment model, the number depending on the particular transportation setting being analyzed. It was assumed that no short-run anomalies, such as heavy seasonal demand for transportation of other commodities, were occuring at that time which might distort the rates gathered for this study.

4/ Minibridge refers to a service which combines a transcontinental and ocean container movement under one rate.

5/ See [5].

REFERENCES

[1] Admunsen, Paul A. Current Trends in Port Pricing. U.S. Department of Commerce. Maritime Administration. August, 1978.

[2] Belcher, Gary. Inland Waterway/Ocean Movement of Pacific Northwest Dried Pea and Lentil Exports: A Transshipment Linear Programming Analysis. M.S. Thesis, University of Idaho, Moscow. 1978.

[3] ________________, James R. Jones, and Karl H. Lindeborg. Pacific Northwest Dry Pea and Lentil Shipments: Alternatives and Potential. University of Idaho Research Bulletin No. 108 (June, 1979).

[4] Henion, Lloyd, and Fred Hirach. Relationship of Possible Waterway Users Charges to Costs of the Columbia-Snake Inland Waterway Systems. Economic Services Unit. Oregon Department of Transportation. 1978.

[5] Jones, James R. The Columbia/Snake Navigation System's Role in Intermodal Ocean Transportation. University of Idaho Experiment Station Miscellaneous Series (in press).

[6] Thayer, Robert D. Impact of Lower Granite Dam and Waterway Users Charges on Pacific Northwest Wheat Movements. M.S. Thesis, Washington State University, Pullman. 1976.