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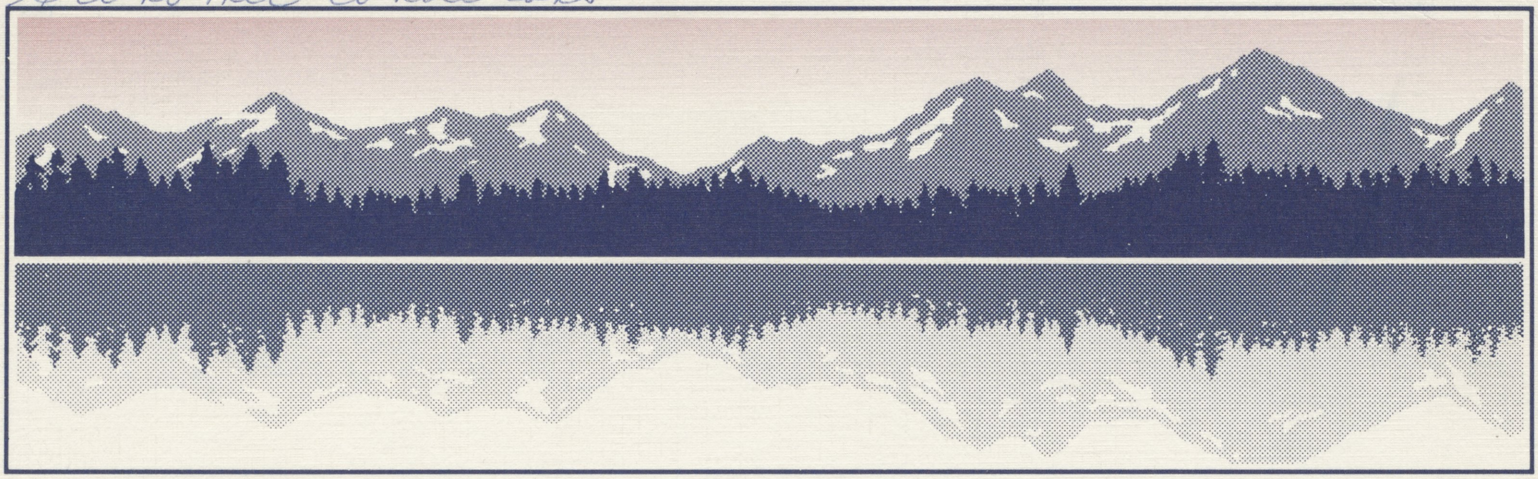

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THE DYNAMICS OF COST-BASED COMPETITION IN TRANSPORTATION: THE CASE OF THE PACIFIC NORTHWEST FRUIT AND VEGETABLE INDUSTRY

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INTRODUCTION

Transportation is the dynamic link between production areas and consumers. United States regulatory changes affecting all transportation modes have changed the competitive environment within which modal choices must be made by shippers and receivers. Transportation costs are changing as transport firms reorganize in response to the new freedoms granted under deregulation. The complete deregulation of rail intermodal traffic in 1982 and the Maritime Act of 1984, which allowed maritime companies to make cross modal investments, are bringing major changes to intermodal competition. Doublestack trains now criss-cross the U.S. and, while original traffic was dependent upon containerized international freight, the impact of doublestack trains has been dramatic upon all competing modal choices in their corridors of service moving domestic as well as international cargoes (11; 12). Railroads have streamlined existing intermodal operations by eliminating ramps, initiating dedicated intermodal trains, and through train service between carriers in an attempt to compete with the service characteristics of trucks. Even as shippers now perceive truck transport to have higher service attributes, they continue to search for a better price/product combination in their transport alternatives. These technologies, soon potentially available to perishables movements as well, are affecting the competition among modes.

The overall goal of this paper is to compare the future competitive cost relationship of trucks, piggyback, and refrigerated boxcars, the primary transportation modes used for the movement of fresh fruits and vegetables between selected U.S. cities. The specific objectives are to: (1) develop truck and rail costs for shipment of selected fresh fruits and vegetables between selected origin and destination pairs; and (2) use sensitivity analysis to test the effects of differing equipment utilization rates on shipment costs and therefore on the future competitive position of the alternative modes.

ANALYTICAL STRUCTURE

Fully allocated truck and rail movement costs were developed for the shipment of truckload movements of apples from Central Washington to four major US markets.

Truck Costs

Economic engineering, an accepted technique for estimating truck costs and reliable cost functions, was chosen to estimate the truck costs in this paper (See 2; 6; and 14). The components of the cost function for a typical Pacific Northwest FFV trucking firm were identified through a 1983 survey of perishables trucking firms (5). Cost coefficients for this study were updated to 1987 cost levels using national price indexes, 1987 equipment prices, and operating experiences with 1987 equipment (11).

Long run average truck costs were developed by modeling a representative Pacific Northwest FFV trucking firm (See 11 for specifics). The average PNW FFV trucking firm operated 20 trucks and was 100 percent self owned. The owner usually drove one of the trucks as well as managing the fleet. The primary investment was in the trucks. Most firms operated out of the home of the owner and had minimal investment in shops or terminals. Average annual mileage per truck was 130,000 miles. Seven percent of those miles were empty.

Long run average costs were modeled and were broken into short-run fixed and variable cost components. Short-run fixed costs include: depreciation on capital investment; interest charges on debt or return on investment; license fees and taxes; insurance; and management, overhead, or housing expenses. Combining the various short run fixed cost categories results in the total annual fixed cost of $56,548. By dividing the annual short run fixed costs by 130,000 annual miles, per mile fixed costs of $.435 were estimated.

Variable costs are the costs directly related to output, in this case, mileage. They are the costs the firm must recover if it is to stay in operation in the short run. Included in variable costs are: tires; fuel; maintenance and repairs; and driving labor. The summation of per mile tire cost, per mile fuel cost, per mile maintenance and repair cost, and per mile driving labor cost results in total per mile variable cost of $.538 per mile. By adding the short run fixed costs per mile to the variable costs per mile, Washington FFV truck transportation costs in 1987 were estimated to be $.973 per mile at an average annual mileage per truck of 130,000 miles.

The truckload costs of shipping apples, the major perishable commodity shipped from Washington, to the selected destination cities are reported in Table 1. The truck load cost for a load of apples to a destination city, the fifth column in Table 1, is the fully allocated front haul truck costs. These costs are the per mile truck costs of the front haul with refrigeration fuel costs, plus the costs associated with the expected empty miles travelled during the round trip.

TABLE 1. Truck Transportation Costs of a Representative Pacific Northwest Fresh Fruit and Vegetable Trucking Firm for a 44,000 lb. Load of Apples from Yakima to Selected Cities, 1987

Destination City	Fronthaul Miles	Truck Costs[a]	Refrigeration Fuel Costs	Costs Per Truckload
Los Angeles	1,103	$1,224	$29.61	$1,254
Chicago	2,018	$2,238	$47.12	$2,285
New York	2,807	$3,114	$62.21	$3,178
Atlanta	2,591	$2,874	$58.08	$2,932

SOURCE: Newkirk, Jonathan R. and Kenneth Casavant. *An Evaluation of the Competitive Position of Transportation Modes Moving Washington Fresh Fruits and Vegetables.* Manuscript under review as an Agricultural Research Center Research Bulletin, College of Agriculture, Washington State University, Pullman, WA. 1989.

[a] $\text{Cost per mile} * \text{Fronthaul miles} * 1 + \frac{\text{Empty Miles}}{\text{Fronthaul Miles}}$

Rail Costs

The U.S. Interstate Commerce Commission developed Rail Form A (RFA), a general purpose rail costing method, to determine reliable and comparable costs for their rate making regulatory responsibilities. Modifications to RFA were developed at the Great Plains Transportation Institute, Fargo, North Dakota by Denver Tolliver and the modified RFA was used to estimate rail costs in this study. The modified RFA uses rail line specific operating factors, car-specific operating and adjustment factors, and other movement specific factors to synthesize costs specific to a particular car type and railroad.[1]

Rail Form A uses variable unit costs and fixed cost factors to derive the costs associated with a particular rail movement. The variable and constant portions are based on the results of ICC statistical regression studies of railroad expenses and outputs (9). RFA developed costs are improved by replacing broad average cost categories with more specific information. RFA averages all cars in a railroad's fleet to calculate a single average car day cost and an average car mile cost for a particular railroad. Costs specific to a particular car type, i.e. boxcar or flatcar, are substituted for the above overall average to improve the accuracy of costs associated with a particular shipment. Knowledge of specific train operations can also be used to add specificity to RFA calculations. Dedicated intermodal trains have significantly reduced switching operations when compared to general merchandise trains. These and other specific operating characteristics were utilized in the modified RFA costing used in this paper to develop the rail costs.

The addition of specific non-railroad intermodal shipment costs such as the costs of loading and unloading the trailers is added to the rail costs. These were developed from 1987 annual reports of the railroads in question. Drayage costs for the trailers were calculated outside of RFA and were adapted from the truck cost study with

1. See 13. The information presented in that document was developed by Denver Tolliver of the UGPTI, Fargo, ND. Unless otherwise specified, the discussion on RFA and the modifications to RFA used in this study are based on 13.

verification of those costs by industry representatives. Special drayage charges for the interchange of intermodal trailers in Chicago that are headed for New York were received from BN personnel in Ft. Worth, TX via telephone (3).

Once variable movement costs have been calculated, the total or fully allocated costs are calculated by adding the constant costs to the variable costs. RFA assigns constant costs, the medium to long-run costs that are incurred on behalf of the entire railroad operation and cannot be traced to particular units of output, on the basis of a unit cost per shipment ton mile (distance related) and a unit cost per shipment ton (weight related) (8).

Piggyback trailer ownership costs and loss and damage costs are the final costs to be added. Trailer ownership costs, maintenance, return on investment, and depreciation, were adapted from the truck costing model.

Shipment characteristics for typical reefer boxcar and piggyback movements (e.g. switch numbers and type of switches, time in transit, short line miles), were developed from interviews with railroad personnel and perishable shippers and incorporated in the RFA costing (see 11 for specifics). There are several differences between rail intermodal operations and reefer boxcars operations. The number of intra-train and inter-train switches are reduced with intermodal operations. Piggyback rail movements travel primarily via dedicated intermodal trains operating between intermodal terminals (15). Assembly of trailers from packinghouse to intermodal terminals is done by truck. Reefer boxcars are loaded directly at packinghouse sidings and are moved to the originating classification yard (most intermodal terminals are located near classification yards) via switch engines or way trains or regional/short line railroads. There they are switched into general merchandise trains for the line-haul portion of the trip with some changing of trains at other classification yards enroute. At the terminating classification yard the reefer boxcars will be switched out of the line-haul train and moved to the receiving warehouse siding via switch engine or way train.

The piggyback movement cost for a typical load of apples (44,000 lb) to Los Angeles was $3.59 per cwt, to Chicago $3.89 per cwt, to New York $6.32 per cwt, and to Atlanta $5.12 per cwt (Table 2). Apple reefer boxcar movement costs to Los Angeles were $2.63 per cwt (96,000 lb)., to Chicago were $2.55, to New York were $4.14 per cwt, and to Atlanta were $3.50 per cwt (Table 3).

Comparisons of the different modal costs are available in Table 4. Refrigerated boxcar costs (all cost comparisons will be in dollars per hundred-weight) are the least cost transportation mode to all

TABLE 2. Apple Piggyback Shipment Costs, 44,000 LB. Load, Yakima, Washington to Selected U.S. Cities, 1987

Destination City	Train Miles	Variable[a] Costs	Fully Allocated Costs	Fully Allocated Costs
		(------------ per trailer	-------------)	(- per cwt -)
Los Angeles	1371	$1,363.54	$1,579.28	$3.59
Chicago	1989	$1,513.27	$1,712.53	$3.89
New York	2892	$2,445.24	$2,780.09	$6.32
Atlanta	2527	$2,012.75	$2,254.55	$5.12

SOURCE: Newkirk, Jonathan R. and Kenneth Casavant. *An Evaluation of the Competitive Position of Transportation Modes Moving Washington Fresh Fruits and Vegetables.* Manuscript under review as an Agricultural Research Center Research Bulletin, College of Agriculture, Washington State University, Pullman, WA. 1989.

[a] Variable costs includes variable carload costs, variable car mile costs, variable gross ton mile costs, variable locomotive unit mile costs, variable train mile costs, variable switch engine minute costs, variable freight car costs, TCU load and unload costs, TCU costs, and drayage costs.

TABLE 3. Refrigerated Boxcar Shipment Costs for Washington Apples to Selected U.S. Cities

Destination City	Shortline Miles	Variable Costs	Fully Allocated Costs
		(-------------- per cwt	-------------)
Los Angeles	1,312	$1.70	$2.63
Chicago	2,082	$1.63	$2.55
New York	2,985	$2.63	$4.14
Atlanta	2,787	$2.79	$3.50

SOURCE: Newkirk, Jonathan R. and Kenneth Casavant. *An Evaluation of the Competitive Position of Transportation Modes Moving Washington Fresh Fruits and Vegetables.* Manuscript under review as an Agricultural Research Center Research Bulletin, College of Agriculture, Washington State University, Pullman, WA. 1989.

NOTE: Shipment size of 96,000 lbs. per car and a Yakima,WA origin.

TABLE 4. Apple Transportation Costs Via Truck, Piggyback and Refrigerated Boxcar From Central Washington to Selected U.S. Cities

Destination City	Truck	Piggyback	Reefer
	(--------------------------------	dollars per cwt	--------------------------------)
Los Angeles	2.85	3.59	2.63
Chicago	5.19	3.89	2.55
New YorK	7.22	6.32	4.14
Atlanta	6.66	5.12	3.50

SOURCE: Newkirk, Jonathan R. and Kenneth Casavant. *An Evaluation of the Competitive Position of Transportation Modes Moving Washington Fresh Fruits and Vegetables.* Manuscript under review as an Agricultural Research Center Research Bulletin, College of Agriculture, Washington State University, Pullman, WA. 1989.

destinations for apples, although the cost difference to Los Angeles is significantly smaller than to the other more distant destinations. This is consistent with the findings of other researchers, that as distances increase past some break-even point, rail costs are less than truck and the spread should increase as distances are increased (1).

Truck movement costs were the highest to all destinations, with the exception of Los Angeles, where piggyback costs were highest (Table 4). Most researchers have found that piggyback costs usually go below truck costs in the 800 to 1,000 mile range (1). Even though shipment distance is over 1,000 miles to Los Angeles, the linehaul savings of the railroad over trucks is offset by distance differences and switching costs.

The cost difference between reefer boxcar costs and piggyback or truck costs would be somewhat less if final distribution costs from destination warehouse or rail siding were included in the boxcar costs. Although some truck and piggyback movements are also off loaded at warehouses or distribution centers and reloaded on other trucks for delivery to retail outlets, most truck and piggyback movements move directly from a warehouse to retail store in trailer load units as well.

Effects of Backhaul Changes

The ability of perishables shippers to secure backhauls has been directly affected by the adoption of the doublestack train. Doublestack train operators have at different times deeply discounted westbound rates in an effort to reposition containers back at west coast ports for return to Pacific Rim countries (12). This has increased the competition for non-refrigerated freight, the staple of backhaul loads for perishable haulers. In order to test the impact of changing success rate in securing backhauls, a sensitivity analysis was performed on the truck and piggyback costs. Analysis was not run on reefers because their success rate for backhauls is already low (45 percent of miles are empty) and railroad management expected little change (4).

Equipment utilization rates were varied in the sensitivity analysis to reflect cost changes that would occur if back-haul success rates (percent empty miles) changed or annual mileage were reduced as a result of lost backhaul opportunities. Truck backhaul rates were varied by altering the empty mileage from 7 to 20 percent and annual mileage was varied from 100,000 to 130,000 miles per year. Piggyback trailer empty mileage percentage was varied from 20 to 40 percent.

Comparisons were made on movements of apples to Chicago and New York, two major doublestack destination points. Truck costs to Chicago increased 22 percent from the baseline $5.19 per cwt, estimated with seven percent annual empty mileage, to $6.35 per cwt at 20 percent annual empty mileage. Truck costs to New York also increased 22 percent from $7.22 per cwt to $8.83 for the same change in empty mileage (Table 5).

TABLE 5. Truck Transportation Costs at Various Empty to Loaded Ratios for a 44,000 Lb Trailer Load of Apples Shipped from Yakima, Washington to Chicago and New York City

	Percent Empty Miles			
Destination	7[a]	10	15	20
	(----------	per cwt	----------	----------)
Chicago	$5.19	$5.46	$5.91	$6.35
New York	$7.22	$7.59	$8.21	$8.83

SOURCE: Newkirk, Jonathan R. and Kenneth Casavant. *An Evaluation of the Competitive Position of Transportation Modes Moving Washington Fresh Fruits and Vegetables.* Manuscript under review as an Agricultural Research Center Research Bulletin, College of Agriculture, Washington State University, Pullman, WA. 1989.

[a] Seven percent used in model to develop baseline costs.

Annual mileage variation resulted in similar changes. Movement costs from Yakima to Chicago and New York, increased 3.7 and 3.6 percent respectively when annual mileage dropped from 130,000 miles to 120,000 miles while holding empty mileage to seven percent. Costs increased 13.3 and 13.2 percent to Chicago and New York when annual mileage fell to 100,000 miles (11).

Equipment utilization rates vary between modes. The piggyback trailer back-haul success rate is worse than trucks (seven percent empty mileage) and was determined to be near 20 percent empty mileage. Both the utilization of the trailer and the rail flatcar carrying the trailer affect movement costs. Present utilization rates on TOFC flatcars are very high, as almost 97 percent of total TOFC flat mileage is loaded mileage (4). Piggyback movement costs to Chicago and New York, even under a worst case scenario where piggyback trailer empty mileage would rise to 40 percent and TOFC flat empty mileage to 10 percent, remain lower than baseline truck costs (Table 6). Considering the situation where the TOFC flat empty to loaded ratio is stable and trailer utilization varies, piggyback costs to Chicago ranges from $3.78 per cwt at 15 percent empty trailer mileage (an improvement over the 20 percent baseline percentage), to $4.34 per cwt at 40 percent empty mileage, an increase of 12 percent over baseline costs of $3.89 per cwt (11).

If piggyback equipment utilization improved from 20 percent empty mileage to 15 percent empty mileage, boxcar costs at $2.55 per cwt would still remain lower than piggyback costs to Chicago at $3.78 per cwt (Table 6). Boxcar rates remain the least cost to New York under similar circumstances of improved piggyback trailer utilization.

TABLE 6. Comparative Sensitivity Analysis, Apple Trip Costs, Yakima, Washington to Chicago

Mode	Base Case Scenario	Medium[a] Scenario	Worst Case[b] Scenario
	(-------	per cwt	-------)
Truck	$5.19	$5.91	$6.35
Piggyback	$3.89	$4.12	$4.55
Reefer	$2.55	$2.55	$2.55

SOURCE: Newkirk, Jonathan R. and Kenneth Casavant. *An Evaluation of the Competitive Position of Transportation Modes Moving Washington Fresh Fruits and Vegetables.* Manuscript under review as an Agricultural Research Center Research Bulletin, College of Agriculture, Washington State University, Pullman, WA. 1989.

[a] Truck empty mileage 15 percent of total mileage; piggyback trailer empty mileage 30 percent of total mileage and TOFC flat 3.15 percent empty mileage; reefer boxcar empty mileage 45 percent of total reefer boxcar mileage.

[b] Truck empty mileage, 20 percent of total mileage; piggyback trailer empty mileage 40 percent of total and TOFC flat empty mileage 9.1 percent of total mileage; reefer boxcar empty mileage, 45 percent of total reefer boxcar mileage.

CONCLUSIONS

Rail movement costs, whether piggyback or reefer, of Washington FFV are significantly lower to the three most distant destinations tested, Chicago, New York, and Atlanta, and reefer boxcar shipment costs are the lowest of the three modes to all destinations. Reefer movement costs to Chicago were less than 50 percent of truck movement costs. In spite of truck being the most costly transportation mode for shipment, trucks remain the dominant mode of choice for FFV shippers. This finding lends support to other study findings, such as those by Miklius and Casavant (10) and Beilock and Casavant (1), that factors other than transportation costs play a key role in the modal choice decision. Service factors were not considered directly in this study and future research should measure the service differences of the three modes and attempt to assign costs to those differences.

Reefer boxcar movement costs will remain the least cost alternative for Washington FFV. If truck and piggyback costs increase due to the increased competition for back-hauls, their costs will increase relative to boxcar costs as boxcar costs will be the least affected by the backhaul problem. The widening spread between reefer boxcar costs, and the movement costs of the other two alternatives, may provide opportunities for increased usage of boxcars in spite of the lower service quality and operational inflexibility associated with their use.

Since back-haul is being affected, FFV marketers should be sensitive to fronthaul possibilities and changes brought about by regulatory reform in the transportation industry. The economic and technical feasibility of container movement of refrigerated products via doublestack trains needs research. Most doublestack cars have insufficient capacity to carry two refrigerated containers with their higher tare weight without decreasing the load to be carried in the containers. Recent rail industry reports identify that doublestack cars with increased lading capacity are being placed in service (BN and American President Lines) and doublestack train operators are actively pursuing domestic containerized freight for their trains.

Another new technology potentially applicable to perishables is the Roadrailer, a trailer that has a set of rubber wheels for highway travel and a set of rail wheels for rail travel. It has been used predominantly by the auto industry for their just in time delivery program for auto parts. Recent developments increase the lading weight of the trailer by making the steel rail wheels removable, which may make refrigerated roadrailer trailers feasible.

The changes happening in the transportation industry, while affecting the cost to shippers, have not changed the relative position of the three modes. FFV shippers using truck or piggyback will face increased costs and a possible deterioration of service. Pressure will be placed upon shippers to decide how much they can afford to pay for the service characteristics associated with the higher cost modes, trucks and piggyback. Transportation costs may become a more important part of the modal decision.

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