IMPACTS OF FUEL COSTS, DISTANCE-TO-MARKET, AND EQUIPMENT UTILIZATION ON RELATIVE COSTS OF TRAILER-ON-FLATCAR AND TRUCK TRANSPORTATION FOR FRESH FRUITS AND VEGETABLES IN THE SOUTH

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Throughout the principal fresh fruit and vegetable (FFV) growing areas in southeastern and southwestern states, trucking is the dominant mode for transporting fresh produce to the northeast and upper Midwest. The dramatic shift to trucks in the last 30 years has virtually displaced the railroads from FFV transportation. In 1950, 63 percent of all interstate FFV surface traffic was by truck. By 1980, the trucking industry's share had increased to 90 percent (USDA, 1950, 1980), and in some regions, such as Texas and Florida, trucking accounts for more than 98 percent of the FFV traffic (Table 1). However, energy savings, or efficiency and fuel cost concerns, as well as a growing apprehension among producers and shippers that there are dangers associated with almost total dependence on one mode of agricultural transportation, emphasize the need for analyses of alternative perishable produce delivery systems.

The feasibility of employing intermodal transportation of FFV, specifically trailer-on-flatcars (TOFC) or piggyback shipments, to alleviate the transportation concerns of southern producers and shippers is examined. TOFC costs and trucking costs are generated over a spectrum of fuel prices and TOFC equipment utilization levels, including backhauls, to determine the combinations of these prices and usage levels necessary to make TOFC competitive with trucking for transporting fresh fruits and vegetables from the Southwest and the Southeast.

Two major simplifications are made in the analysis. First, the costs associated with transportation service quality (speed, reliability, etc.) are not estimated and are given only cursory treatment. Johnson, Kolsen, and others have correctly pointed out that rational modal choice decisions involve consideration of the full or effective costs of transportation alternatives, which includes both direct and service quality costs. There are three reasons for the tangential treatment of service costs. First, service quality costs are likely to be highly commodity specific. For example, shippers of perishable and fragile commodities would be expected to be more sensitive to differences in transit times and handling practices than would shippers of longer-lived and more durable produce (Miklius et al.). Second, recent technical, managerial, and regulatory developments lead to the expectation that service quality differences between trucking and TOFC will narrow. Among these developments are new intermodal vehicle and handling techniques, par-

TABLE 1. Domestic Fruit and Vegetable Shipments by Mode and Percentage of FFV Volume, 1980[1]

	Florida		Texas		Arizona		California		Total U.S.	
Mode	1,000 cwt.	%	1,000 cwt.	%	1,000 cwt.	%	1,000 cwt.	%	1,000 cwt.	%
Truck	71,684	100	23,269	99	16,512	93	143,585	85	410,672	90
Rail	3	0	19	<1	1,210	7	20,572	12	39,186	9
TOFC	689	<1	0	0	43	<1	5,047	3	6,391	1
TOTAL	72,376	100	23,288	100	17,765	100	169,204	100	456,249	100

[1] No shipment information by mode for Mexican imports of FFV, but the 41 city unload data indicates 6,000 cwt. rail and 10,628,000 cwt. truck.
Source: USDA, *Fruit and Vegetable Shipments* (1980).

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tial deregulation of the railroads under the Staggers Rail Act of 1980 and the ICC deregulation of TOFC in Ex Parte 230 Sub 5 and Sub 6,[1] mergers such as that of the Family Lines and the Chessie System to form CSX, and growing interest on the part of railroad managements to recapture FFV traffic. A study to assess the impacts of rail exemption of FFV movements indicates that the service characteristics of both straight rail and TOFC have improved (ICC, 1980, p. 3). The final reason is that it was felt that estimation of service costs were beyond both the resources of the study and were not central to the problems which the study was intended to address.

The second simplification in the analysis is that truck utilization rates were held constant. This strategy was adopted to provide a standard for comparison for TOFC.[2] The approach may be justified by the fact that the market shares of FFV transportation currently held by TOFC in most regions are minimal, generally from 0 to 5 percent (USDA, 1980). Therefore, large increases in TOFC traffic would likely have to occur before trucking operations are affected.

THE COSTING ROUTINE

Truck and TOFC cost estimates are generated by the use of modified versions of two existing models. For trucking, the model developed by Boles is employed. Several of the specific cost elements have been slightly adjusted to reflect changes in the price level and/or alternative estimates of the authors.[3] Costs for the rail portion of the TOFC movements are calculated with methodology developed by the ICC which employs Rail Form A. The principal modifications were made to account for nonrailroad ownership of the TOFC trailer unit by costing out the unit in a manner similar to that employed in the trucking portion of the routine.[4] Drayage costs for TOFC shipments are calculated in the same manner as for trucking. It should be stressed that these costs are estimates of average truck and TOFC costs. Actual trip costs would differ depending upon such factors as commodity mix, train length, road conditions, and so on. Moreover, especially with respect to rail costing, there are problems associated with allocation of fixed costs.[5]

This focus market or destination for all shipments is New York City, as this is the largest single market for FFV. For both modes, 42,000-pound loads are assumed. Two pickups and two deliveries are assumed for each load, regardless of mode or if it is a fronthaul or a backhaul. Trucks are assumed to make 45, 30, 25, and 22 round trips per year for Florida, Texas, Arizona, and California, respectively, with 75-percent-loaded backhauls. The number of round trips varies with the origin so as to maintain an annual average mileage per truck of 100–120 thousand miles to be consistent with the average annual mileage estimated for refrigerated tractor-trailers by Knorr. The percent loaded backhaul estimate corresponds to the percentage of empty refrigerated trucks reported in ICC (1977). Similar estimates have been reported in other studies (Batts; Knorr; Pavlovic et al.). The number of trips and the backhaul percentages for TOFC are varied from 10 to 30 and from 0 to 100, respectively. In practice, full backhaul rates vary considerably for TOFC. In one study of two routes, only a 28-percent full return rate for TOFC was found (Manalytics, Vol. 5, p. 25). On the other hand, the well-coordinated "Sprint" TOFC demonstration service between Chicago and Minneapolis realized 90 percent of full capacity during its six-week evaluation period (Association of American Railroads). For both modes,

[1] Intermodal developments include advances in flatcar loading equipment, more reliable refrigeration units, and improved car designs (such as Itel Rail's "Impact" flatcar with articulated couplings to reduce jostling at starting and stopping.

Ex Parte 230 Sub 6 is pending at the time of this writing.

[2] In essence, this is comparable to the approach employed by Klindworth and Brooks. In their study, TOFC backhaul rates were varied and the costs compared to unchanging truck freight rates.

[3] The straight truck and drayage portions of the costing routine employ Boles. Adjustments in Boles's estimates (other than those in Table 1) are as follows:

Cost Item	Boles	Author's Estimate
Interest rate	13.5%	19%
Annual management expenses	$ 2,995	$ 3,260
Insurance on trailer and tractor	$ 6,860	$ 7,450
Licenses and permits	$ 1,990	$ 2,220
Per diem	$ 15	$ 18
Motel	$ 25	$ 30
Unloading costs	$ 88	$ 90
Tractor cost	$63,000	$74,500
Trailer cost	$27,000	$28,000

[4] The rail portion of TOFC costs are based upon the ICC costing and methodology based on Rail Form A and described in pages 147–53, ICC (1978b). Update ratios for January 1981 are employed. The use of these ratios is described in ICC (1978a). The fuel component of a rail movement is difficult to identify in the ICC procedures. Therefore, fuel costs for a rail movement (FRC) were calculated separately (text and Table 2). These were then subtracted from the ICC rail cost estimates (RC) to determine non-fuel rail costs (NFRC): RC = NFRC + FRC. To investigate the effects of changes in fuel costs in the analysis, NFRC was assumed to remain constant, while FRC was varied.

TOFC trailer ownership costs are calculated as are truck ownership costs in the trucking portion of the routine. This was done as it appears that Plan III or shipper-controlled trailer movements of FFV are the most common (Klindworth and Brooks). The value of a trailer unit is assumed to be $28,000, which is Klindworth's estimate.

[5] In the ICC rail costing methodology, 50 percent of the before-tax capital costs associated with roadbed property and 100 percent for equipment are assumed to be variable costs and are assigned trip-specific usage. The remainder of rents, capital costs, and non-federal tax expenses are identified as constant or fixed costs. These costs are distributed based upon tonnage (terminal costs) and ton-miles (fixed line-haul costs) without regard to equipment used. This method is based upon a study, conducted over several years, by the ICC's Section of Cost and Valuation (ICC, 1978b, pp. 3, 4, 185).

The ICC methodology has represented the state of the art for several years. Nevertheless, there are problems related to this machine-like assigning of fixed and "variable" capital and equipment costs. While this is recognized, it was clearly beyond the means of the researchers to develop an alternative technique. Moreover, it did not seem likely that these problems would seriously affect the results of the study.

half of the loaded backhauls and all of the fronthauls require refrigeration. Fuel costs are varied from a price level of \$1.30 to \$2.60 per gallon. Fuel consumption rates in miles per gallon and refrigeration unit fuel usage rates in gallons per hour are stipulated (see Table 2). They were derived from Boles's estimates and from conversations with truck and rail representatives. Total costs are calculated employing estimates of the actual distances traveled by each mode from each origin to each destination (Table 2).

The same number of revenue miles, equal to the one-way trucking distance, are assumed to be generated by each loaded one-way haul from a given origin to a given destination, regardless of mode. Total costs (again, based on actual mileage) are divided by total revenue miles for each mode so as to arrive at that mode's cost per revenue mile.[6] This procedure avoids favoring a more circuitous mode with higher total trip costs but lower per mile costs.[7]

The model generates cost estimates that are comparable to actual rates charged for FFV shipping. For example, given fuel costs of \$1.30 per gallon, the Florida to New York, Texas to New York, and California to New York one-way over-the-road hauls cost \$1,474, \$2,468, and \$3,213, respectively. These estimates generally fall within the range of fees charged for similar over-the-road transportation of fresh produce, as published weekly in the "Fruit and Vegetable Truck Rate Report" (USDA-AMS, 1981).[8]

TABLE 2. Basic Assumptions of Model

ITEM		ASSUMPTIONS			
Focus Market (Destination):		New York City			
		FL (Orlando)	TX (Laredo)	AZ (Nogales)	CA (Barstow)
Distance (miles):	Truck[1]	= 1100	1900	2500	2700
	TOFC[1]	= 1137	2070	2780	2900
Revenue Miles, if Full		= 1100	1990	2500	2700
	Between pickup or delivery points = 25				
	Origin Drayage[2] = 25				
	Destination Drayage[3] = 40				
Pickups:	Origin[2]	= 2			
Destination (if backhaul)[2]		= 2			
Delivery Stops[2]		= 2 per load			
		FL	TX	AZ	CA
Trips per year:[4]	Truck	= 45	30	25	22
	TOFC	= variable			
Percentage loaded backhauls:[5]		Truck = 75			
		TOFC = variable			
Percentage loaded backhauls requiring refrigeration[3] = 50					
Fuel Consumption:	Truck, loaded[6]		= 4.5 mpg.		
	Truck, unloaded[6]		= 5.2 mpg.		
	TOFC, loaded[7]		= 9.0 mpg.		
	TOFC, unloaded[7]		= 10.0 mpg.		
	Refrigeration, precool[8]		= 1 gal/hr (4 hrs.)		
	Refrigeration, normal[8] running		= .5 gal/hr		
Fuel Prices:	Diesel (gal.)		= \$1.30 to \$2.60		

[1] Road distances estimated from the "Highway Atlas of the United States" and Railroad distances by "Handy Road Atlas", both by Rand McNally, 1980 and 1978 respectively. For costing the rail portion of a TOFC move, an additional 12 percent is added to account for roundabout routings.

[2] Boles (1980).

[3] Author's estimate.

[4] Chosen so as to maintain between 100,000 and 120,000 per year, per truck. This range was considered to represent a reasonable average, and corresponds closely to previous estimates such as those of Knorr (1979).

[5] Estimate based on ICC (1977).

[6] Averaging of estimates made by Boles (1980) and Batts (1981).

[7] Averaging of the estimates made by various sources, including conversations with railroad officials, Paxson (1980), and Reebie (1981).

[8] Corresponds to estimates of Klindworth (1981) and Knorr (1979).

The Impact of Fuel Prices, TOFC Utilization Levels, and Distances-to-Market Expectations

Since trucking is relatively fuel intensive, (Table 2), trucking costs should be more sensitive to fuel price changes than are rail costs. Consequently, fuel price increases would be expected to have favorable effects on the competitiveness of TOFC service relative to trucking. Increases in TOFC equipment utilization levels should also have an impact in favor of TOFC, because this spreads fixed costs over a larger number of revenue miles. Increases in the percentage of loaded TOFC backhauls registers favorably by lowering the ratio of empty to total miles traveled. Finally, increased distance to market should favor TOFC, because the longer the haul, the more significant is the advantage of lower per-mile running costs associated with rail transport.

[6] An implicit assumption of this methodology is that costs are allocated equally among revenue miles regardless of whether the revenue miles were generated over the fronthaul or the backhaul. As backhauls and fronthauls are complements in production, this may be a somewhat arbitrary allocation of fixed costs. Moreover, considering the sequential nature of the movements, once the fronthaul has been made, if the vehicle must return to the starting point, then the fuel, tire wear, labor, and other costs associated with returning empty become, effectively, fixed costs. Conceivably, backhaul rates could be bid down to the marginal costs—the costs of pickup and delivery and the additional running costs associated with running full rather than empty (reduced miles per gallon, load checks, refrigeration costs, etc.).

The justification for the equal spreading out of costs across all revenue miles is based on two agreements. First, the direction of the backhaul is not obvious. If vehicles repeatedly shuttle between two regions delivering chilled meat one way and fresh vegetables the other way, neither direction is clearly the backhaul. If the driver or firm is based at one of the points, movements away from that point might arbitrarily be considered the fronthaul. What if, however, the base is at some interim point? Second, unless the shipper can identify backhaulers and has some special market power over them, there is no reason to expect that backhaulers would receive lower rates than fronthaulers. These rates will depend in part upon the overall balance of commodity flows between the two points, but not upon which direction is considered to be the fronthaul for an individual vehicle.

Nevertheless, it should be recognized that the importance of generating revenue miles in a given direction depends upon the costs and compensation from that traffic. If backhaul loads receive lower returns, then the advantages of maintaining high equipment utilization in that direction are lessened. This would tend to favor modes with lower backhaul capacity utilization performance, as the costs of foregone backhaul traffic would be less.

[7] The crucial assumption here is that the total costs of a round trip may be assigned to loads based upon the proportion of revenue miles that the load travels. That is, if no backhauls are assumed, the full costs of the trip are assigned to the fronthaul load; if half the time a backhaul is secured, then on the average trip, two-thirds of the trip costs are assigned to the fronthaul load; half of those costs, if backhauls are always secured, etc.

The use of over-the-road distances as the divisor to arrive at per-revenue-mile costs is arbitrary but not critical to the analysis. TOFC mileage or any other constant could have been employed without altering the results.

[8] In May, 1981, FFV truck rates to New York as reported by USDA (1981) were: Florida, \$1,350–\$2,400 (most \$1,400–\$1,600); Texas, \$1,800–\$2,500 (most \$2,000–\$2,300); and California, \$2,400–\$3,200 (most \$2,900–\$3,100).

Results

Selected combinations of loaded backhaul percentages and fuel costs necessary to make the per-revenue-miles costs for TOFC competitive with trucking are presented in Table 3. It should be borne in mind that these estimates do not include costs related to service quality. Higher fuel prices and increased distances to market favor TOFC in all instances. However, the effect of fuel costs is surprisingly small. For Texas, a 10-percent rise in fuel costs translates as between a half cent and a two cent per-revenue-mile advantage for TOFC, depending upon the number of roundtrips and the percent full backhauls which are assumed. For Florida, the impact is somewhat smaller. Depending upon the point of origin and the annual number of TOFC roundtrips, 100-percent increase in fuel costs from $1.30 to $2.60 per gallon reduces the loaded backhauls necessary for TOFC to be competitive or break even with trucks by only 5 to 20 percent of the total number of trips (Table 3). For an unknown number of trips per year from any point of origin, is TOFC competitive without some backhauls, even assuming a 100-percent increase in fuel prices (Figure 1)? Assuming a constant proportion of loaded backhauls, but increasing fuel costs 60 to 70 percent above the $1.30-per-gallon price level, 18 TOFC round trips would be needed to break even.

Distance also acts to the advantage of TOFC, as indicated in Table 3. Assuming 18 TOFC round trips and $1.30-per-gallon fuel costs, Florida must realize 52-percent-loaded backhauls for TOFC to be competitive with trucking, as compared to 26 percent for Texas and 18 percent for California.

Increases in TOFC equipment utilization levels have an accentuated impact on relative transportation costs, particularly in regard to increases in the proportion of loaded backhauls. For example, assuming 19-percent loaded backhauls for Texas and a 44-percent increase in TOFC round trips—from 18 to 26 trips (an increase in revenue mileage from 46,626 to 61,571 miles)—lowers the level of fuel costs needed to break even with per-revenue-mile trucking costs by 41 percent, from $2.21 to $1.30 per gallon. The same reduction in the break-even fuel costs can be realized for Texas by increasing the total loaded backhauls from 19 to 40 percent, and by

TABLE 3. Selected Truck and TOFC Per Revenue Mile Cost Breakeven Combination of Fuel Prices and TOFC Equipment Utilization for Selected TOFC Round Trips[1]

	TOFC Roundtrips Per Year											
	Florida[2] (1100)[2]			Texas[2] (1990)[2]			Arizona (2500)[2]			California (2700)[2]		
Fuel Prices	10	18	26	10	18	26	10	18	26	10	18	26
$/gal.	% Loaded Backhaul											
1.30	79	52	42	40	26	19	30	19	15	29	18	13
1.43	75	49	39	39	24	18	29	18	14	28	17	12
1.56	73	48	37	37	23	17	28	18	14	28	16	12
1.69	71	46	36	36	22	17	28	17	13	26	16	11
1.82	69	44	35	35	21	16	27	17	13	25	15	11
1.95	67	43	34	34	21	16	26	16	12	24	14	11
2.08	65	42	33	33	20	15	25	16	12	23	14	10
2.21	64	41	32	32	19	14	24	15	12	23	13	10
2.34	62	40	31	31	18	14	24	15	11	22	13	9
2.47	61	39	31	30	18	13	23	14	11	21	12	9
2.60	59	38	30	29	17	13	23	14	10	20	12	8

[1] See Table 2 for underlying assumptions. In all cases higher fuel prices and/or higher proportions of full backhauls result in relatively lower TOFC costs.

[2] Trucking distance to New York City (Table 2).

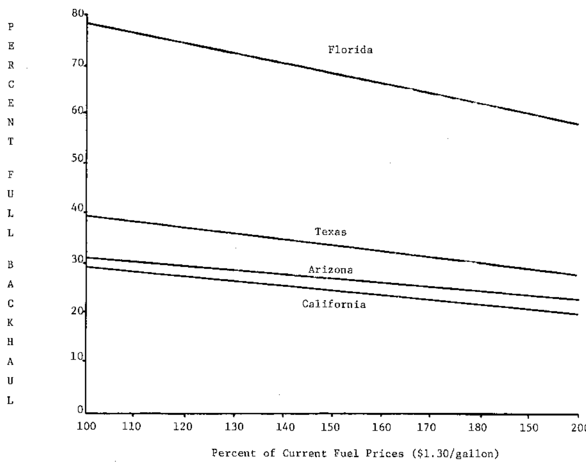

FIGURE 1. Fuel Price and Full Backhaul Breakeven Combinations for Truck and TOFC Costs Per Revenue Mile, Assuming 10 TOFC Round Trips Per Year

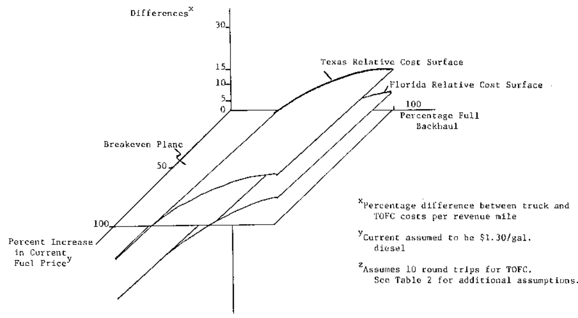

FIGURE 2. Percentage Differences in Cost Per Revenue Mile for Truck and TOFC for Texas and Florida

reducing the number of round trips from 18 to 10, a 35-percent decrease in the number of revenue miles and a 44-percent decrease in total miles. Similarly, for Florida, an increase in loaded TOFC backhauls from 43 to 67 percent, with fuel price steady at $1.95 per gallon, decreases the break-even number of revenue miles per Florida trailer by 35 percent, from 28,314 to 18,370 miles and round trips from 18 to 10 (Table 3).

In Figure 2, the percentage differences between the costs per revenue mile for trucks and TOFC for Texas and Florida are presented to dramatize three dimensionally the results of the preceding discussion. Ten round trips for TOFC are assumed. The vertical span between the Florida and Texas relative cost surfaces results from the effect of distance to market. Regardless of the fuel cost-percentage, full-return combination selected, TOFC has a comparative advantage in Texas over Florida. (If the California surface were also represented, it would be above and to the left of the Texas cost surface, indicating the relative advantage in TOFC shipments that California appears to be already experiencing). The slowness with which the break-even lines—represented by the intersections of the relative cost surfaces with the break-even plane—approach the fuel cost axis reflects the insensitivity of the relative costs of the modes to changes in fuel costs.[9] However, the relatively steep slopes of the surfaces from right to left reveal the powerful impact of the percentage of loaded backhauls.

SUMMARY AND IMPLICATIONS

Assuming approximate equality with respect to transportation services for fruits and vegetables, the effects of distance to market, changing fuel prices, and varying TOFC equipment utilization levels on the relative costs of trucks and TOFC were examined. The results suggest that increased distance to market; higher TOFC equipment utilization levels, particularly with respect to the attained percentage of loaded backhauls; and, to a lesser extent, higher fuel costs lower the per-revenue-mile costs of TOFC relative to trucking.

Three major implications can be drawn from the study. First, the more distant from a market is the producing region, *ceteris paribus,* the more likely that intermodal transportation, such as trailers-on-flatcar, or some other rail option will be used. Reflecting this, the reemergence of rail usage, especially TOFC, for fresh fruits and vegetables is occurring most rapidly in the Far West, as California and Washington are best able to capitalize on the advantages of lower per-ton-mile fuel consumption associated with rail transport.[10]

Second, fuel prices would have to rise several-fold before the economic viability of trucking using refrigerated trailers for hauling FFV would be seriously threatened in most areas. Moreover, as Arizona, Texas, and Florida shippers are located successively closer to the major fresh produce market, these states require higher fuel costs, relatively, to justify switching from trucks to TOFC, *ceteris paribus.* Increases in fuel prices shrink threshold distances at which TOFC is competitive with trucking; consequently, Arizona, then Texas, and finally Florida should successively turn to some rail option to

[9] The lines formed by the intersection of the relative cost surfaces on the "floor" or break-even plane of Figure 2 are the same as the Texas and Florida break-even lines in Figure 1. In other words, Figure 1 presents the break-even plane of Figure 2.

[10] In fact, California and Washington are the only states in which TOFC FFV shipments increased appreciably between 1978 and 1980. In California and Washington, TOFC shipments increased from 1,644,000 hundredweight in 1978 to 5,574,000 hundredweight in 1980. In Florida, TOFC usage actually decreased from 878,000 hundredweight in 1978 to 689,000 hundredweight in 1980 (USDA, 1978 & 1980).

service the northeastern and midwestern markets.

The expansion eastward of TOFC service for FFV will likely be slower than the fairly rapid adoption in California and Arizona over the last few years might at first suggest. As western shippers turn to TOFC or to some other rail option, over-the-road refrigerated capacity will be released. Some of this equipment will migrate eastward, thereby bidding down the value of over-the-road rigs and, in turn, lowering rates. Until this excess capacity is fully depreciated, the resulting depressed truck rates will inhibit penetration by rail options. In addition, there are structural and organizational problems that impede south-to-north FFV rail service. The Baltimore tunnel and the Hudson River crossings south of Albany, as examples, are too low for conventional TOFC. TOFC service out of the Southeast to Boston often stops at Alexandria, Virginia, to be drayed the remainder of the distance. In addition, there are sometimes problems with interlining onto Conrail: the continued financial uncertainty of Conrail clouds prospects for a rapid resolution of this problem.

Third, the ability to attain adequate TOFC equipment utilization levels, particularly the ability to attract backhauls, will be the major factor that determines the feasibility of TOFC for a particular region. This implies that growers and shippers must be willing to organize and to cooperate with shippers in consuming centers in order to ensure adequate usage of the trailers, and that railroads must consistently provide and maintain adequate performance levels. Moreover, the staggered seasonal shipping patterns of the various stages suggest a potential for sharing or cooperative lease arrangements of the refrigerated trailers between regions to increase trailer utilization, decrease grower investment in trailers only used for seasonal shipping demand, and improve the availability of trailers. In Florida and Texas, possibilities for using California TOFC units during the state's off-peak months are being explored and, in at least one case, implemented.

Assuming that railroads can provide adequate transport service levels, the ability of growers, shippers, carriers, and receivers to develop a system that can fully employ TOFC equipment will be the most important single determinant for making TOFC competitive with trucking in any area. This is especially true for the Southeast, where the advantages of lower-than-truck per-mile fuel consumption associated with TOFC is muted by the relatively close proximity of the eastern markets. It should not be assumed that the TOFC equipment utilization problem can be easily overcome in all cases. Nor should fuel cost increases be relied upon to erase the utilization problem.

REFERENCES

Association of American Railroads. *Intermodal Freight Program Phase II. Demonstration Management.* Report prepared for Federal Railroad Administration, Washington, D.C., 1980.

Batts, Lana. "Truck/Rail Relative Energy Efficiency - Revisited." *Transportation Research Forum Proceedings* (1981); pp. 149–55.

Beilock, R. "Toward a Balanced Delivery System for Fresh Fruits and Vegetables." Manuscript, submitted to *Transportation Journal* 1981.

Boles, P. *Owner-Operator Costs of Hauling Fresh Fruits and Vegetables in Refrigerated Trucks.* USDA, ESCS Report No. 82, 1980.

Bressler, R. and R. King. *Markets, Prices, and Interregional Trade.* Wiley and Sons, New York, 1970.

Interstate Commerce Commission. *Empty/Loaded Truck Miles on Interstate Highways During 1976.* Bureau of Economics, 1977.

Interstate Commerce Commission. *Exempt Rail Transportation of Fresh Fruits and Vegetables Initial Impacts.* ICC Office of Policy and Analysis, 1980.

Interstate Commerce Commission. *Explanation of Rail Cost Update Procedures.* ICC Bureau of Accounts, 1978a.

Interstate Commerce Commission. *Rail Carload Cost Scales, 1977.* ICC Bureau of Accounts, 1978b.

Johnson, M. "Estimating the Influence of Service Quality on Transportation Demand." *Amer. J. Agr. Econ.* 58(1976):496–503.

Klindworth, K. and E. Brooks. *Shipping Alternatives for Moving Florida Fruits and Vegetables to Eastern and Midwestern Markets.* USDA Office of Transportation, 1981 (awaiting publication).

Knorr, R. "A Projection and Analysis of Refrigerated Truck Stock and Energy Consumption to the Year 2,000." U.S. Dept. of Energy, Transportation System Report, 1979.

Kolsen, H. *The Economics and Control of Road-Rail Competition.* Sydney: Sydney University Press, 1968.

Manalytics. *A Long Term Study of Produce Transportation.* Department of Transportation, Federal Rail Administration, Volume 5, 1977.

Miklius, W., K. Casavant, and P. Garrod, "Estimation of Demand for Agricultural Commodities," *Amer. J. Agr. Econ.* 58(1976):217–23.

Pavlovic, et. al. "Domestic Transportation for Florida Perishable Produce." Transportation Research Center, University of Florida, 1980.

Paxson, D. "The Energy Crisis and Intermodal Competition." Presented at Transportation Research Board Annual Meeting, 1980.

Reebie, R. "Comparison of Intermodal Equipment." Presented at Transportation Research Board Annual Meeting, 1981.

U.S. Department of Agriculture. *Fresh Fruit and Vegetable Shipments: By Commodities, States, and Months.* USDA Agricultural Marketing Service, 1950, 1980.

U.S. Department of Agriculture. *Fresh Fruit and Vegetables Unload Totals: For 41 Cities.* USDA Agricultural Marketing Service, 1981.

U.S. Department of Agriculture. "Fruit and Vegetable Truck Rate Report." USDA Agricultural Marketing Service 1980–81 (weekly).