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THE ADEQUACY OF TRUCKING SERVICE SUPPLIES FOR PRODUCE: TRENDS IN THE 1980S

Richard Beilock, William Dunton, and Paul Kepler

Abstract

Over 90 percent of interstate produce movements are by truck. In recent years, concerns have been raised regarding the adequacy of motor carrier services. Reasons for these concerns include the possibility of increased costs or service erosions resulting from relaxed economic regulations, an eroding road infrastructure, increasing congestion, more stringent safety regulations, demographic trends suggesting the onset of an increasingly severe driver shortage, and declines in rail capacity devoted to produce haulage. In this study, trends in the adequacy of trucking services for trucking during the 1980s was examined employing data sets developed by the USDA regarding haulage from five growing areas to six metropolitan areas across the United States, and a case study based on over 9,000 interviews with drivers hauling Florida produce, conducted between 1982 and 1989. The results of the study suggest that there have been no erosions in service adequacies.

Keywords: fruits and vegetables, produce, transportation, trucking

Fresh fruit and vegetable production in the United States is concentrated into specialized growing areas, primarily along the country's southern and western boundaries. For example, two states (California and Florida) account for over half of all production, and 90 percent of all fresh fruits and vegetables are produced in 10 states (Beilock et al.). This concentration is possible because of the existence of a high-quality, responsive transportation system. Trucking is the backbone of that system. In 1990, 91 percent of interstate produce movements in the United States were by truck (USDA 1991).

Concerns have been raised in recent years, regarding the adequacy of motor carrier service supplies, both in general and, in particular, for hauling produce. "Adequacy" is here defined in terms of the relative positions of market supply and demand schedules. An improvement (erosion) in adequacy occurs when market supply and demand move relative to one another such that there is negative (positive) pressure on prices. Reasons for concerns about trucking supply adequacies include the possibility of increased costs resulting from: relaxed economic regulations (Breimeyer; Bernhagen and Nelson), an eroding road infrastructure and increasing congestion (Office of Technology Assessment 1990), more stringent safety regulations (Office of Technology Assessment 1988; Glaskowsky), demographic trends and other indications of an increasingly severe driver shortage (Casey), and declines in rail capacity devoted to produce haulage (*The Packer*).

The overall goal of this study was to determine if there have been changes in truck supply adequacies during the 1980s as exhibited by changes in real freight rates. To create real freight rates, nominal rates are deflated by an index of costs for produce haulers. The rationale for using this cost index is presented in the DATA section which reports, in effect, two complementary studies drawing from entirely different data sources: an analysis of freight rates for produce shipments between five production areas and six metropolitan areas throughout the United States, and an analysis of freight rates received for produce hauls and complementary hauls (i.e., those in the opposite direction) by motor carriers serving the Florida produce industry. The former will be referred to as the National Study and the latter as the Florida Case Study.

METHODOLOGICAL APPROACH

National Study

To analyze trends in freight rates, a reduced form-model is estimated via regression analysis. Freight rates (RATES) are assumed to be a function of origin- and destination-specific market conditions (MARKET), commodity characteristics (COMMODITY), seasonal and abnormal variations in shipping patterns (SHIP), and trip distances (DISTANCE). Changes over time in freight rates may be

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captured by binary variables for years and months (TIME):

(1) RATES = F(MARKET, COMMODITY, SHIP, DISTANCE, TIME)

To account for the pooling of observations across cross-sections (i.e., routes) and time, a covariance model approach is employed. It is assumed that each time-origin-destination combination is associated with its own special intercept. The empirical model is presented in Equation 2, the variables are defined in Table 1, and the rationales for their inclusion are discussed below:

(2) RATES = b_0 + b_1MONTH + b_2APERANS + b_3DPERANS + b_4ORIGIN + b_5 DESTINATION + b_6PERISH + b_7DIST + b_8DIST2 + b_9YEAR + e

Notes: b_0 ... b_9 indicate unknown parameter values. Some of the variables in Equation 2 represent sets of binary variables. For each binary variable and individual parameter would be estimated.
e denotes the unexplained residual.

Production and shipment volumes from any region can, and typically do, vary markedly across the year. In addition to normal seasonal variations, there may be more transitory aberrations due to natural causes such as freezes, infestations, and rainfall. Seasonality is controlled for by the average percent of annual shipments (over the 10 year sample period) in each month (APERANS). The monthly binary variables, however, are also likely to capture some seasonality effects. Transitory changes in shipment volumes are defined as deviations from the 10-year average percent of shipments (DPERANS). It is anticipated that higher real freight rates would be positively associated with both APERANS and DPERANS.

Cross-commodity differences are captured by differences in their perishability (PERISH). It is common for freight rates to increase with distance, but at a decreasing rate (known as a declining rate-distance gradient). The principle economic rationale for this phenomena is that costs unrelated to distance (such as those associated with pickups, drops, and load search) can be spread over more miles. To capture such effects, both distance (DIST) and distance squared (DIST2) are used. To capture market-specific demand and supply conditions, binary variables are employed to indicate origin and destination points.

The parameter estimates of particular interest are those associated with the annual binary variables. If they become progressively higher (lower) and are significantly different from zero, it would suggest that external factors, such as earned economic regulations, raised the cost (reduced the cost) of providing services and shifted the supply curve accordingly. Also of interest, will be the parameter estimates associated with the average percent of all produce shipped in each month (APERANS) and the actual deviation from that average (DPERANS). Due to the large number of observations, only parameter estimates significantly different from zero at the .01 level of probability will be considered to be significantly different from zero.

Florida Case Study

As will be detailed in the next section, data were gathered, via interviews with truck drivers, regarding the outbound (from Florida) and inbound (to Florida) movements of motor carriers serving the Florida produce industry for the years 1982/83

Table 1. Variable Definition

Variable	Definitions
RATES	Real truckload freight rate (see Data Section)
MONTH	Eleven binary variables indicating the month of the observation. DECEMBER is the omitted category.
APERANS	Ten year average (1980-1989) of the origin-specific percent of shipments in that month.
DPERANS	Current month's deviation from APERANS.
ORIGIN	Four binary variables indicating the origin of the load. They are MEXICO, PACIFIC NW. FLORIDA, and TEXAS. The omitted category is CALIFORNIA.
DESTINATION	Five binary variables indicating the destination of the load. They are ATLANTA, CHICAGO, DALLAS, DENVER, and LOS ANGELES. The omitted category is NEW YORK.
PERISH	The inverse of the number of days of commercial storage possible for the commodity.
DIST	The one-way distance in miles.
DIST2	DIST squared.
YEAR	Nine binary variables indicating the year (e.g. YR = 1985). The omitted category is YR = 1980.

through 1988/89. Trends in average per-mile real freight rates are examined, both for the produce movement and for roundtrips.

DATA

National Study

The Agricultural Marketing Service (AMS) publishes data regarding interstate produce shipment volumes, freight rates, and truck operating costs. In this study, data were used for the years 1980 through 1989 (USDA 1981-90 a,b,& c). The total number of observations was 6,795.

The very large numbers of carriers and shipper/receivers and the absence of evidence of collusion among either group suggest that produce trucking approximates a competitive market (see, for example, Beilock, MacDonald, and Powers), and market prices should tend toward average total costs. As there is essentially free entry and exit, this tendency of rates toward average total costs should hold regardless of shifts in demands. This does not mean, however, that average total costs may not vary from year to year.

For the years 1980 through 1989, AMS truck cost data were collected for the first full week of every month. To obtain real freight rates, an index of these costs (Jan 1980=100) was employed to deflate freight rates. The AMS truck cost estimates take into account items such as the costs of equipment, fuel, and labor. (A complete explanation of the methodology employed to develop these costs is presented in Buxton). However, they do NOT account for costs imposed by the more external factors, which are of particular concern to those believing that truck supplies eroded during the 1980s. For example, while the AMS cost estimates include maintenance, maintenance frequencies are assumed to be constant from year to year. Therefore, additional costs resulting from increased maintenance frequencies due to eroding roadways would not be captured. Likewise, increased costs due to stricter safety regulations and enhanced enforcement, increased opportunity costs of hauling exempt produce due to enhanced opportunities to haul other commodities resulting from relaxed economic regulations, and costs due to more congestion would not be accounted for. If the costs imposed by such external factors increase (decrease), it would be expected that real freight rates, as just-defined, would increase (decrease).

Florida Case Study

From 1982/83 through 1988/89, interviews were conducted with drivers hauling produce as they exited the Florida Peninsula. The sites for the surveys were the Florida Agricultural Inspection Stations located on Interstates I-95, I-75, and I-10. These routes account for between 85 and 90 percent of all produce traffic out of the Peninsula. Florida Agricultural Inspection Stations are located along all possible exits from the Peninsula, are open at all times, and all trucks are required to stop. As coverage is complete, there is no incentive to avoid the major routes for the purpose of evading inspection. In each crop year, interviews were conducted during four two-day survey sessions, in November, January, March, and either late May or early June. Interview times were from 6:00 PM to 1:00 AM, which coincide with the highest outbound commercial traffic periods. The numbers of completed interviews in each year are presented below.

Crop year	Number interviewed
1982/83	658
1983/84	1,345
1984/85	1,955
1985/86	1,941
1986/87	1,515
1988/89	1,780
TOTAL	9,194

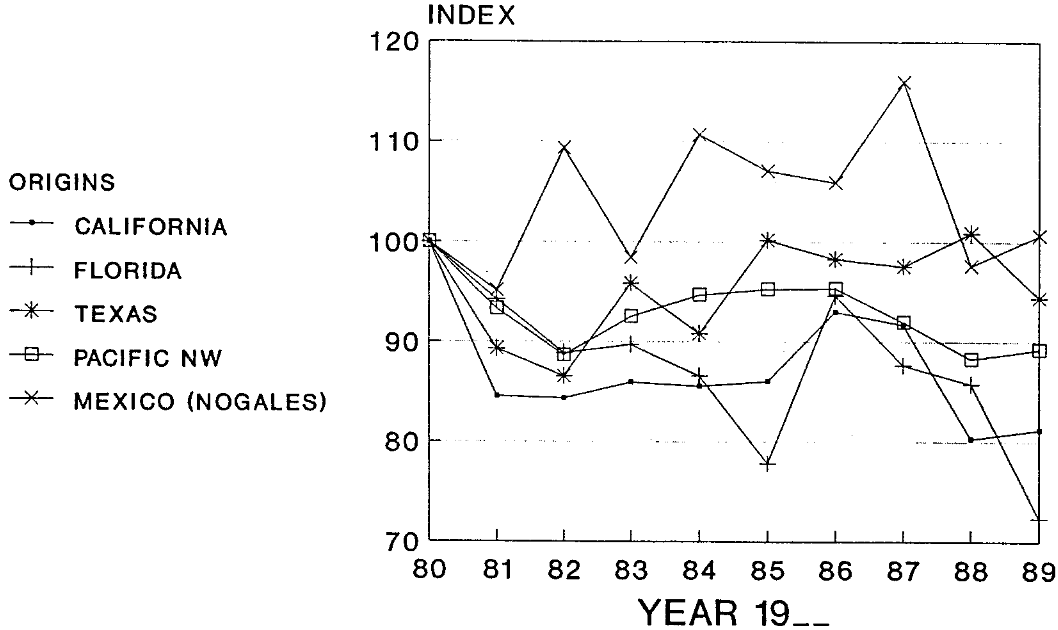
Driver cooperation was excellent. The refusal rate at the survey sites normally ranged from 5 to 15 percent.

RESULTS

National Study

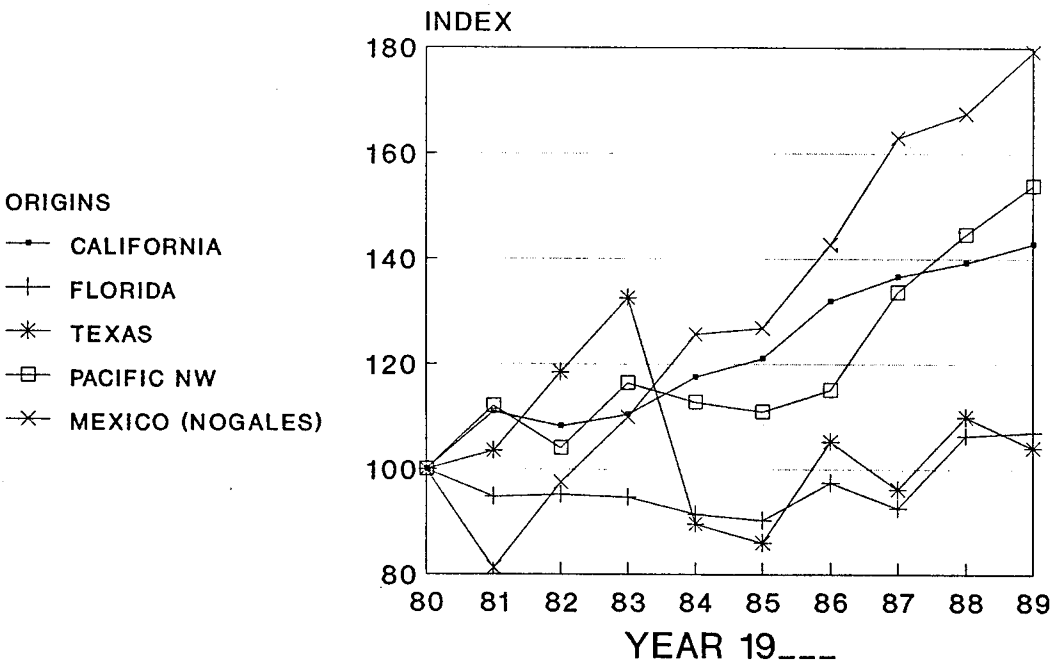
Average real freight rates (reported by the USDA) during the 1980s did not show any tendency to increase. Indeed, average real freight rates for produce shipped from California and Florida tended to decrease, while the freight rates for produce from Texas, Mexico (Nogales), and the Pacific Northwest held fairly steady. These trends are illustrated in Figure 1 with indices of the annual average rates in each year (1980=100) for all produce shipped to New York City. The trends are essentially the same for individual produce types and for comparisons of averages for individual months (e.g., comparisons of averages for January 1980, January 1981, etc.).

There was marked variation in the trends in shipment volumes across the regions (Figure 2). Florida shipment levels remained fairly constant throughout the decade. For Texas, there was a rise in the early 1980s, followed by a sharp decline (due to a severe freeze), and stability in the last half of the decade. For California, Mexico, and the Pacific Northwest, shipment volumes steadily increased. The absence of any evident relationship between average annual



1980=100. Deflated by USDA produce truck cost estimates.
Source: USDA (1980-90C).

Figure 1. Freight Rates Index: for Produce to New York City



1980=100.
Source: USDA (1980-90A)

Figure 2. Shipment Volume Index: for Produce from Selected Regions

freight rates and annual shipment volumes suggests, albeit weakly, that annual supplies of transportation services are sufficiently elastic to adjust to demand changes without large movements in freight rates.

Table 2. Produce Freight[a] Rate Estimation: All Origin Regions

Independent Variable	Parameter Estimate	Standard Error
INTERCEPT	472	(31.3)*
APERANS	2.32	(.105)*
DPERANS	1.03	(.243)*
MEXICO	-243	(17.6)*
PACIFIC NW	147	(8.33)*
FLORIDA	-185	(15.3)*
TEXAS	-127	(12.2)*
ATLANTA	-421	(10.0)*
CHICAGO	-464	(10.2)*
DALLAS	-467	(13.3)*
DENVER	-512	(16.1)*
LOS ANGELES	-418	(16.5)*
PERISH	1253	(107.)*
DIST	.801	(.0298)*
DIST2	-.0000487	(.0000101)*
JAN	53.5	(14.6)*
FEB	72.3	(14.7)*
MAR	51.6	(14.6)*
APR	71.6	(14.4)*
MAY	75.3	(14.7)*
JUN	271	(14.7)*
JUL	510	(15.6)*
AUG	238	(15.7)*
SET	155	(15.6)*
OCT	81.3	(14.9)*
NOV	48.5	(14.5)*
YR81	-120	(14.3)*
YR82	-158	(13.9)*
YR83	-140	(14.0)*
YR84	-112	(14.3)*
YR85	-95.0	(16.2)*
YR86	-25.4	(14.5)
YR87	-92.4	(13.9)*
YR88	-165	(15.5)*
YR89	-198	(15.5)*
EQUATION STASTISTICS:		
F VALUE	1003.*	
R^2	.835	
# OBSERVATIONS	6794.	

[a]Dependent variable is real freight rates per truckload.
*Indicates significantly different from zero at the .01 level of probability.

Multivariate Analysis

In Table 2, the results of the regression analysis of freight rates across the five origin regions are presented. Individual origin region estimates were also made. The parameter estimates associated with the annual binary variables, APERANS, DPERANS, and the equation statistics for the individual origin region estimates are presented in Table 3. As the results for the individual origin regions were largely consistent with those for the cross-region model, only the cross-region model is discussed, unless otherwise noted. The results of the estimation process were quite satisfactory. The estimated equation was highly significant and explained 83 percent of the variation in freight rates. Moreover, the signs and magnitudes of the parameter estimates were consistent with expectations.

Trends in Real Freight Rates

All of the parameter estimates associated with the binary variables for the years 1981 through 1989 are negative and, with the exception of 1986, significantly different from zero at the .01 level of significance. Therefore, controlling for origin, destination, commodity, month, and shipment volumes, there is no evidence that real freight rates for produce rose over the 1980s. Indeed, a modest decline in rate levels appears to have occurred. This constitutes strong evidence that there was no erosion in the overall adequacy of truck supplies for produce in the U.S. during the 1980s.

The model presented in Table 2 does not allow for origin region-specific parameter estimates associated with the binary variables for the years. Rather, the parameter estimates are a composite or average of all regions. It is possible that one or more origin regions experienced escalating real freight rates during the 1980s. However, examination of equation estimates for the individual origin regions indicates that real freight rates tended to decline or, at worst, remained stable in all origin regions (see Table 3).

Intra-Annual Shipment Volume Variations

As would be expected, freight rates are positively related to seasonal swings in shipment volumes and to deviations from seasonal trends. The parameter estimates associated with the average percent of total annual volume shipped each month (APERANS) and the actual deviations from this norm (DPERANS) are positive and significantly different from zero. However, the absolute values of the estimates are small (2.32 and 1.03, respectively). For example,

Table 3. Produce Freight Rate Estimation by Individual Origin Regions, Partial Results[a]

Independent Variable	CALIFORNIA		MEXICO (NOGALES)		PACIFIC NW		FLORIDA		TEXAS	
APERANS	6.09	(1.44)*	-1.18	(0.449)	13.5	(4.09)*	.0809	(0.361)	36.5	(18.0)
DPERANS	5.13	(0.608)*	1.55	(0.634)*	.622	(0.765)	.652	(0.345)	.666	(0.212)
YR81	-215	(18.5)*	-86.1	(62.5)	-86.8	(24.6)*	-26.4	(22.3)	-135	(20.6)*
TR82	-228	(17.5)*	-24.3	(61.9)	-122	(24.8)*	-118	(22.1)*	-185	(19.3)*
YR83	-215	(17.9)*	-72.5	(56.7)	-109	(25.0)*	-104	(23.4)*	-114	(19.5)*
YR84	-196	(17.5)*	29.7	(62.7)	-52.8	(24.7)	-153	(24.8)*	-102	(24.4)*
YR85	-154	(20.8)*	33.4	(63.4)	38.1	(26.3)	-239	(27.6)*	-45.1	(27.2)
YR86	-80.6	(17.3)*	14.1	(63.0)	62.3	(25.1)*	-96.1	(28.2)*	-48.3	(29.4)
YR87	-138	(17.1)*	-9.78	(58.4)	-33.7	(24.2)	-152	(24.4)*	-66.9	(21.9)*
YR88	-284	(19.9)*	-232	(66.6)*	-27.8	(25.5)	-144	(25.6)*	-97.7	(24.9)*
YR89	-313	(20.0)*	-209	(63.3)*	-24.8	(25.6)	-238	(25.7)*	-109	(25.6)*
Equation Statistics:										
F Value	1,102*		105*		304*		290*		265*	
R^2	.914		.889		.809		.880		.900	
# Observations	2,816		322		1,971		892		789	

[a] Complete results are available on demand from the author.
* Indicates significantly different from zero at the .01 level of probability. Standard errors in parentheses.

if a production region ships 15 percent of its annual production in a month in which it normally ships 10 percent, DPERANS would equal 5 and the freight rate would be $11.60 ($2.32 * 5) higher than normal. The small size of the parameter estimate associated with APERANS may, in part, be explained by the binary variables for the months. These binary variables were intended, primarily, to capture within-year differences in overall transportation market conditions. However, they may also capture seasonal differences in shipment volumes. This effect is likely to be particularly strong for the individual origin estimates because there is no mixing of production regions producing high and low percentages of their annual volumes in any month. There is no such problem with regard to the parameter estimate for DPERANS. Its small size suggests that, on average, transportation markets adjust to deviations from normal seasonal shipment patterns without large movements in freight rates. This, in turn, suggests that the monthly supply of transportation capacity for produce is fairly elastic.

Other Explanatory Variables

The remaining explanatory variables are not of central interest in the current study and will be only briefly discussed. The parameter estimates associated with the origins and destinations indicate site-specific rate differences. Reasons for differences include the variations across routings in availability of complementary haulage (i.e., 'backhauls'), congestion, and loading/unloading fees. Similarly, the parameter estimates associated with the binary variables for the months capture season-related freight rate differentials. As noted above, there is likely to be some confounding between these variables and APERANS.

The positive and significant parameter estimate for perishability (PERISH) indicates, as expected, that higher freight rates are associated with commodities which may require more expedited service and/or be more liable to result in freight claims, *ceteris paribus*. The large absolute size of the parameter estimate (1,253) seems to suggest that freight rates are sensitive to perishability. However, the range of this variable is quite small (.0027 to .167) and the associated elasticity, estimated at mean values, is only .025.

For virtually all modes, it is common for freight rates to increase with distance, but at a decreasing rate (known as a declining rate-distance gradient). To capture this effect, both distance and its square were included as explanatory variables. Indicative of a declining rate-distance gradient, the associated parameter estimates were, respectively, positive (.801) and negative (-.0000487). The relative magnitudes of these parameters are such that the nonsensical result of declining absolute rate levels with increased distance occurs well beyond the range of distances in the data.

Florida Case Study

Between 1982/83 and 1988/89, the average freight rates for produce outbound from Florida, reported by the carriers, did not rise and, in fact, exhibited a slight downward drift (see below and Figure 3).

	Outbound Produce Haulage: Average per mile freight rate	
Crop Year	Nominal	Real*
1982/83	$1.59	$1.59
1983/84	$1.64	$1.63
1984/85	$1.56	$1.55
1985/86	$1.56	$1.55
1986/87	$1.41	$1.41
1987/88	$1.47	$1.43
1988/89	$1.57	$1.48

*1982/83 dollars

These results suggest that truck supplies, relative to demands, during the 1980s were stable or slightly increasing, a result consistent with results from the National Study.

The downward drift of the freight rates for produce may raise concerns regarding the longer- run viability of the carriers. It might be argued that declining real rates reflect 'ruinous competition,' leading eventually to widespread carrier bankruptcies and reduced supplies of trucking services. A more complete analysis of the evidence, however, does not support this view.

During its crop year, most produce haulers serving Florida repeatedly shuttle into and out of the State. (Drivers were asked how often they made trips to Florida during the produce shipping season. In each year, the large majority of the respondents indicated they travelled to Florida three or more times per month.) Therefore, a better picture of the profitability of their operations may be obtained by examining roundtrip revenues. Between 1982/83 and 1988/89, per mile roundtrip revenues rose by 25 percent nominally and 18 percent in real terms (see below and Figure 3).

	Roundtrip Revenues: Average per mile freight rate	
Crop Year	Nominal	Real*
1982/83	$1.14	$1.14
1983/84	$1.19	$1.18
1984/85	$1.21	$1.20
1985/86	$1.30	$1.29
1986/87	$1.23	$1.23
1987/88	$1.24	$1.20
1988/89	$1.42	$1.34

*1982/83 dollars

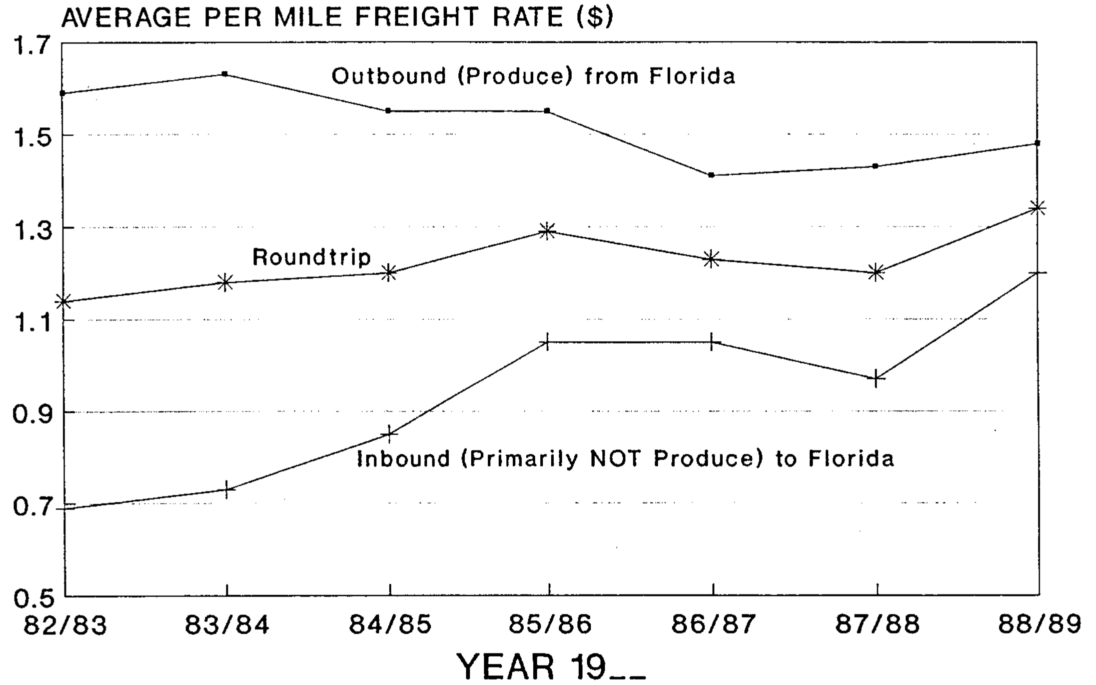
It should be noted that average per-mile freight rates rose sharply in 1988/89. Without 1988/89, the improvement in roundtrip revenues is modest.

The reason for improved roundtrip revenues was improved average earnings on trips inbound to Florida. Only 12 percent of the loads hauled into Florida by these carriers are produce. Rather, the large majority (79 percent) of the loads are regulated freight. Over the 7-year study period, the share of roundtrip revenues accounted for by these inbound movements rose from 34 to 45 percent. This does not mean, however, that inbound freight rates rose. With the exception of the final year of the study (1988/89), the rise in average per-mile freight rates received was entirely due to reductions in empty inbound movements. In other words, it was not that freight rates on these hauls rose, but that outbound produce haulers were acquiring inbound loads more frequently. At the beginning of the study period, a third of those hauling produce from Florida entered the state without a load. By the end of the study period, the empty movement rate was around 10 percent (see Figure 4).

While economic regulation of motor carriers was loosened by administrative means throughout the late 1970s, the Motor Carrier Act of 1980 is widely regarded as the beginning of the era of reduced regulatory controls over entry and freight rates. The study period (1982 through 1989), coincides with the early years of this era. The increasing frequency with which the haulers in the study secured inbound, largely regulated loads constitutes strong circumstantial evidence of the success of the regulatory reforms in improving the motor carrier industry's efficiency. Of particular note is the fact that these carriers tend to be small. This suggests that some of the benefits of the reforms have been realized by smaller carriers and, therefore, that an evolution towards a more concentrated industry may not occur.

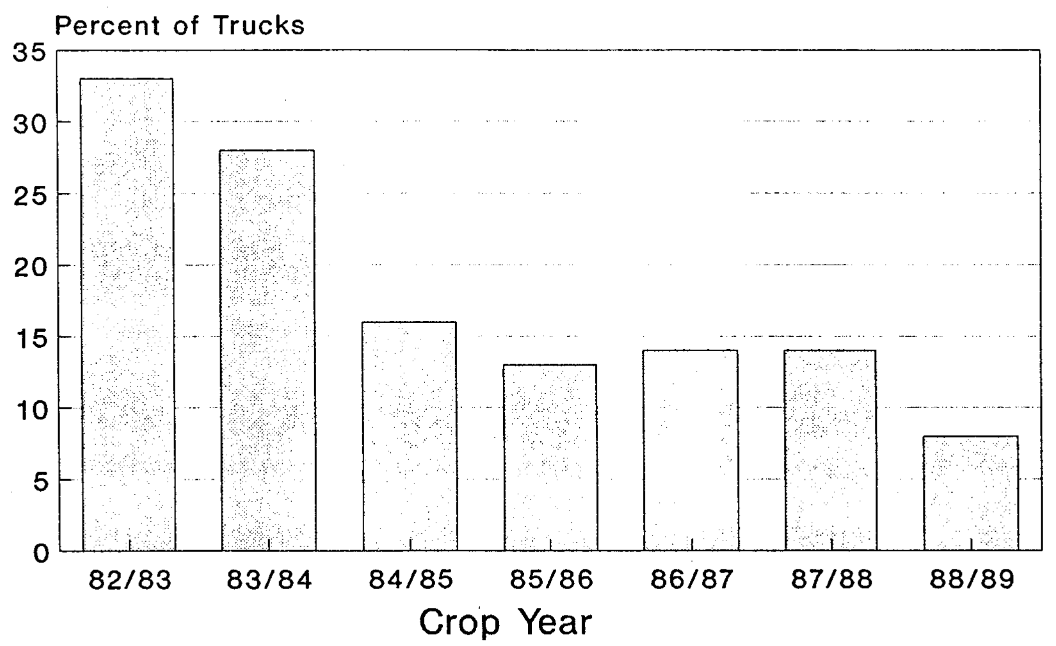
CLOSING COMMENTS

The primary goal of this study was to determine if, over the past decade, there has been a deterioration in the adequacy of motor carrier services for the interstate transportation of produce. The large bulk of the evidence points to adequate supplies of motor carriage for produce haulage throughout this period and no marked deteriorations. Indeed, there are indications of modest improvements. Moreover, supplies of truck services appear responsive to seasonal and unexpected variations in demand. These conclusions are based, primarily, on the stability of real freight rates for produce. In the absence of government-enforced price controls, shortages would be expected to be accompanied by real price



Source: Produce Truck Survey

Figure 3. Real Per Mile Freight Rates: Florida Produce Haulers: 1982/83-1988/89



For haulers carrying produce from Florida.
Source: Produce Truck Survey

Figure 4. Percent Empty Inbound Movements into Florida

increases. As there were neither controls nor price increases, it can be inferred, indirectly, that there were no shortages (or, at least no increases in the severity of shortages). This record of performance by motor carriers explains, at least in part, the failure of the railroads to recapture a portion of this market, which it had lost over previous decades. It had been widely expected that, with their newly won freedom from rate regulation of produce haulage, the railroads would stage a renaissance in this type of carriage in the 1980s (see e.g., Beilock and Casavant and Progressive Railroading). Finally, the increasing frequency with which produce haulers serving the Florida produce industry have secured inbound, largely regulated loads suggests that regulatory reform has enhanced market access.

These positive conclusions regarding truck supplies in the 1980s do not necessarily mean there will not be problems in the future. Thanks largely to stable fuel prices in the 1980s, overall carrier costs did not rise sharply. However, the Gulf Crisis is a reminder of the potential volatility of the price of fuel. With an eroding transportation infrastructure, roadway user taxes are likely to escalate. Finally, many in the transportation industry predict a severe driver shortage in the 1990s, aggravated, perhaps, by stricter safety regulations. While the recent history of produce trucking indicates that motor carriers have met the needs of the produce industry, there are no guarantees for the future.

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