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Price Response of Truck-Service Suppliers in an Unregulated Market

T.H. MAZE

The unregulated Florida produce truck-service market is studied to determine whether truck-service suppliers respond to competitive signals. Each year, Florida has two produce shipping peaks—one in winter and one in spring. Although weekly shipping volumes for the two peaks are approximately the same, the predominant truck-service buyers in the two peaks have very different price bidding behavior. The prices bid in the winter fluctuate with the quantity of truck service supplied, and there is a strong statistical relation between the two. The prices bid during the spring remain rigid, and spot shortages in truck service are generally observed in the spring. By using the winter shipping season as an example, truck-service supply is found to respond efficiently to competitive price signals. This implies that, if spring prices were bid with respect to market conditions instead of at rigid levels, shortages could be alleviated. This finding also provides an example of the efficient response of unregulated truck service to price signals.

Studies in favor of trucking-industry deregulation have generally found that on the average prices will fall and truck services will improve through deregulation. In a previous paper, I postulated that there were two trucking-industry regulation-deregulation issues that have not been investigated (1). Because these areas have been overlooked, arguments for less regulation of the trucking industry are based on a simplified view of average traits of unregulated service. Furthermore, the fact that traits are based on averages could lead to the misconception that generally prices will fall and service will improve through deregulation.

The purpose of this paper is to determine whether truck-service buyers will be able to barter for truck-service quantity and quality through an unregulated market. Pricing determined through an open market is generally ignored in the existing literature. This can best be seen in studies of prices of exempt agricultural truck service (2) and prices of localized, unregulated truck service (3) that are modeled with a nonmarket variable (distance). The use of distance rather than relative scarcity of truck service assumes that prices in unregulated sectors are a function of average costs, much the same as truck-service prices in the regulated sector. Of course, this is not true.

It is important to know whether truck-service suppliers react to price fluctuations (a) for the purpose of making estimates of the benefits (cost savings) of not regulating currently exempted markets and (b) for making forecasts of the benefits of deregulating currently regulated markets. Clearly, if unregulated truck-service supply does not respond to price fluctuations, this must be accounted for in benefit estimates and forecasts. However, because studies of unregulated markets view prices as being a function of average costs, the performance of supply, in an unregulated context, has not been examined. Therefore, benefit studies implicitly assume that, once markets are deregulated, suppliers will efficiently adjust equipment allocations with respect to price fluctuations. Yet this has not been shown to be true. Thus, this paper investigates the truck-service supply response to prices in an unregulated market and specifically models the unregulated Florida produce truck-service response to fluctuations in competitive prices.

FLORIDA MARKET

The volumes of Florida produce truck shipments change dramatically throughout the year. As can be seen in Figure 1, Florida has a large and lengthy peak in the late spring. In 1978, the spring shipments peaked during the first week of June with a weekly volume of 7157 truckloads. The spring peak is largely caused by a peak in vegetable and melon harvesting. For instance, in 1978, Florida shipments of sweet corn, cucumbers, potatoes, and tomatoes peaked in May and watermelon shipments peaked in June (4). Shipping volumes fall off sharply in late June as the harvesting season moves northward.

Florida also has a winter shipping-volume peak in December. Although the winter peak is more short-lived than the spring peak, shipment volumes during the respective peak weeks are almost the same. The winter peak is largely due to increases in the shipments of fresh citrus. For instance, 1978 shipments of oranges, tangerines, and tangelos all peaked in December (4).

Although both peaks have approximately the same intensity and shippers during both peaks use the same pool of trucking firms, the predominant truck-service buyers in the market behave quite differently during the two seasons. The winter season normally passes smoothly, and all shipments are generally hauled without major commodity losses. This is not the case in the spring. The spring shipping peak generally passes with a number of spot shortages of truck service. In expectation of the spring peak, the state government usually puts on an advertising campaign to make trucking firms aware that the Florida peak is coming. In the spring of 1979, the governor even declared a state of emergency and rolled back the state weight laws. In addition, the Florida Farm Bureau generally sets up a station at a freeway rest stop to direct trucks to areas in need of truck service. In spite of such efforts, there generally are at least spot shortages in truck service.

Figure 1. Florida weekly shipments by truck: 1978-1979.

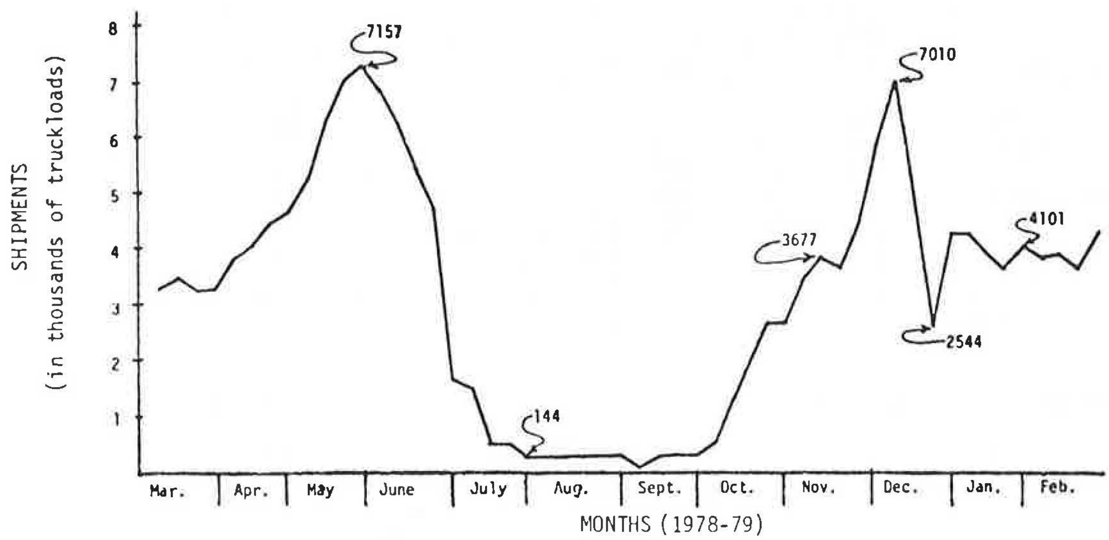
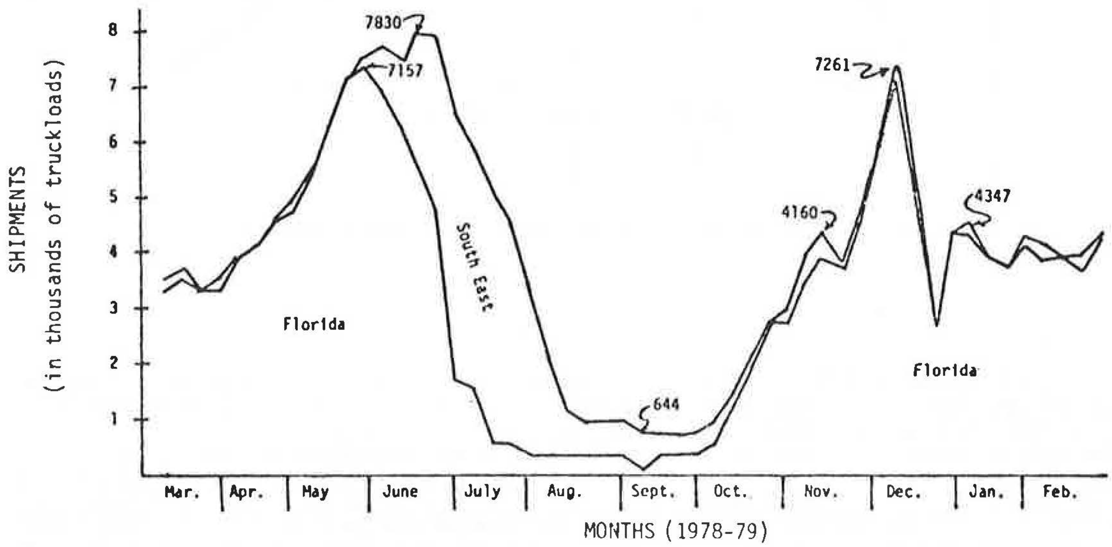


Figure 2. Weekly produce shipments by truck: 1978-1979.



On the surface, there seems to be a very simple reason for the cause of Florida's spring dilemma. The end of Florida's spring peak overlaps shipping peaks in southeastern states to the north. Truck shipments for Florida and those for Florida plus the southeast region are plotted in Figure 2. Note that just after Florida's peak the entire southeastern area peaks, and, because Florida is farthest south, it is believed that trucks that would have returned to Florida stop at states farther north and thus a shortage results in Florida.

This explanation would seem logical and straightforward, but in fact the situation is more complex. The buyers of truck service for commodities whose shipments peak in the winter and commodities whose shipments peak in the spring exhibit completely different buying behavior, and it is believed that this difference is the cause of the problems in the spring.

BUYING BEHAVIOR

In investigations of Florida produce truck-service buyers, it became apparent that not all buyers showed the same price bidding behavior. Buyers of truck service for commodities whose shipments peak during the spring appeared to be bidding a rigid price throughout the year. In contrast, buyers of truck service for commodities whose shipments peak during the winter appeared to be bidding nonrigid, competitive prices.

To illustrate the difference, monthly Florida freight rates taken from U.S. Department of Agriculture (USDA) reports and converted to an approximate price per mile are given in Table 1. The table gives monthly freight rates for a commodity that peaks in winter--oranges from the Lakeland area--and a commodity that peaks in spring--celery from southern Florida. Shipments of Florida oranges typically increase during November, peak in December, and decrease from January into the spring months (4). Shipments of Florida celery typically increase during the late winter months, peak during April or May, and fall off sharply in June.

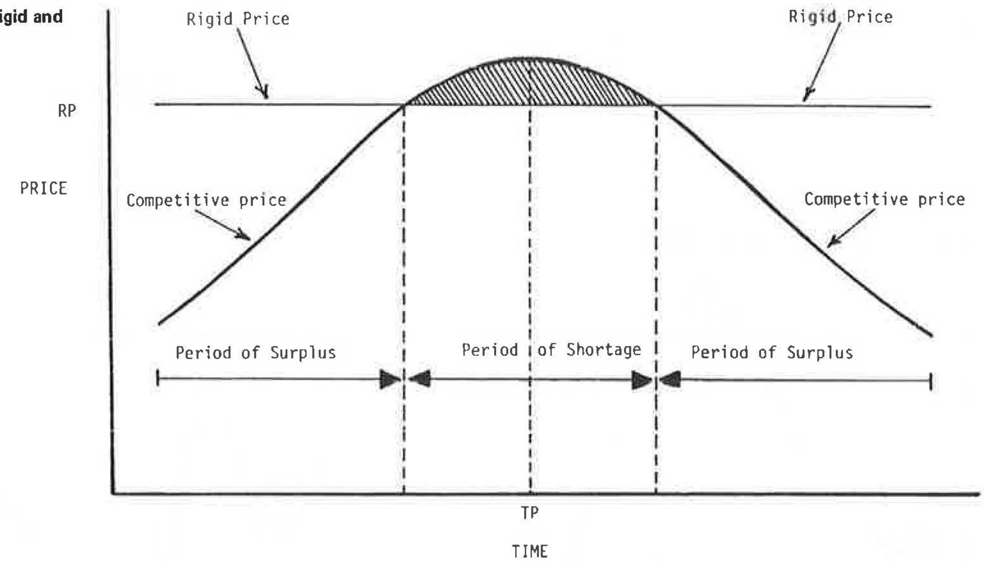
Uniform freight rates were reported for celery in

Table 1. Monthly truck service rates: 1976.

Commodity	Origin	Destination	Rate ($/mile)							
			January	February	March	April	May	June	November	December
Oranges	Lakeland, Florida	Atlanta	0.66	0.66	0.66	0.70	0.91	-	0.83	0.83
		Chicago	0.75	0.75	0.75	0.77	0.90	-	0.75	0.79
		New York City	0.79	0.80	0.80	0.83	0.98	-	0.77	0.80
		Pittsburgh	0.86	0.86	0.88	0.88	1.05	-	0.84	0.88
Celery	Southern Florida	Atlanta	1.51	1.51	1.51	1.51	1.51	1.51	-	1.51
		Chicago	1.00	1.00	1.00	1.00	1.00	1.00	-	1.00
		Dallas	0.96	0.96	0.96	0.96	0.96	0.96	-	0.96
		New York City	0.96	0.96	0.96	0.96	0.96	0.96	-	0.96
		Washington, D.C.	1.11	1.11	1.11	1.11	1.11	1.11	-	1.11

Note: No prices were listed for July through October.

Figure 3. Relation between rigid and competitive prices.



every month of 1976 and are given in Table 1 (5). However, the monthly freight rates for citrus were not uniform. It is evident that freight rates for celery were rigid but freight rates for oranges were not. This contrasting behavior in freight rates between commodities that peak in spring and those that peak in winter was also observed in all years examined. In addition, in all months except May 1976, truck-service prices for oranges to New York City, Chicago, and Atlanta are greater than truck-service prices for celery to the same cities. The only time they come close to the same level is during the late spring months, which is the period when the spring peak usually falls (4).

Two important characteristics of the buying behavior of buyers of truck service for spring-peaking commodities and winter-peaking commodities are illustrated through the USDA truck rate reports:

1. Buyers of truck service for spring-peaking commodities are bidding a rigid price, whereas the buyers of truck service for winter-peaking commodities are not.
2. The prices of truck service for spring-peaking commodities were always higher than those for winter-peaking commodities except when they rose to nearly the same level around the late spring months.

Because of these characteristics, the prices bid for truck service for winter-peaking commodities are believed to be competitive (the lowest value the market could bear and still clear) whereas prices bid for truck service for spring-peaking commodities appear to be set with respect to something other than competitive considerations.

Figure 3 shows the differences in buying behavior and what these differences mean with respect to the Florida truck-service market. The horizontal axis shows the time of the peak in shipment volume (TP), and the vertical axis shows the rigid price (RP). As time approaches the peak, more and more truck service is needed. To attract more truck service, the competitive price increases. The competitive price reaches a peak at TP, when the largest quantity of truck service is needed. If the rigid price is above the competitive price throughout the peak, then enough trucks are attracted to carry all Florida produce shipments even during the peak. If the rigid price were to fall below the competitive price, as shown in Figure 3, a shortage would result around the time of the shipping peak.

The differences in buying behavior are largely caused by the widespread use of rate sheets by truck brokers who work as middlemen for vegetable and melon truck-service buyers. Rate sheets list the prices of truck services that can be obtained through the truck broker and are given to customers. Once these sheets are published, the prices of truck services are fixed until another superseding sheet is published. The practice of rate-sheet pricing has quite questionable antitrust implications and, although the U.S. Department of Justice investigated truck brokers and indicted a few, rate sheets in the industry still persist. However, the subject of

this paper is to investigate the supply response to price changes and not the reasons for price rigidity in the spring-peaking truck-service market.

Regardless of the cause of price rigidity, it is fairly safe to conclude that the spring season is not indicative of competitive conditions. Noncompetitive buyer behavior (including truck brokers) precludes the truck-service market from performing with competitive efficiency even if it could. Therefore, it is impossible to ascertain whether truck-service suppliers will respond efficiently to prices by using the spring market as an example. Instead, the winter market is used to determine whether truck-service suppliers respond efficiently to competitive price signals. However, if winter truck-service suppliers are responsive to price signals, it would appear that the cause of spring truck-service shortages is the rigidity of prices for truck service for spring-peaking commodities.

AGGREGATE SUPPLY-RESPONSE RELATION

Two characteristics of truck-service supply make the decision to respond to prices with equipment allocations different from the typical decision to supply a good or service. First, the trucking-firm decisionmaker must judge the desirability of accepting a price bid in one direction with respect to the desirability of the origin of the reverse trip. For instance, a firm might accept an offer to haul a load from a northern city to Florida (a produce hauler's backhaul); the acceptance of this load also implies an allocation of equipment to the destination region (Florida) for a fronthaul load. The decision to haul in one direction must be made not only in light of the desirability of the current haul but also in light of the joint output of the reverse haul. Therefore, trucking-firm decisionmakers must judge the profitability of accepting one load based on the outcome of a truck cycle tour (a fronthaul plus a backhaul). Second, Florida buyers of truck service forecast prices to a number of destinations. The response of allocating equipment to Florida may partly be a result of any one of these prices. Furthermore, the supplier may be equally willing to accept loads going to a number of destinations. These two characteristics make truck service unlike most goods or services, whose suppliers need to consider only one sale price for their output.

Because of these atypical characteristics, supply modeling structures typically used to study the supply of most goods and services are not applicable. Hence, a conceptual structure tailored to the unusual nature of trucking is constructed to give guidance to the empirical modeling of a truck-service supply response to competitive prices. In structuring the conceptual model, a theory on how the individual trucking-firm decisionmaker reacts to price stimulus in equipment allocation decisions is defined, and it is proposed that trucking-firm decisionmakers in the aggregate will react similarly to the same stimulus. The variables used in the hypothesized individual decision process are thus used in modeling the aggregate equipment allocation.

The development of the equipment allocation process is based on the neoclassical theory of the firm, which assumes that firm decisionmakers act as if they are maximizing profits. Decisionmakers are assumed to judge the profitability of accepting a load in the light of the revenue and costs expected in both directions. In other words, a load is accepted based on the expected outcome of a complete truck cycle tour. Since the object of the model is to investigate the truck service supplied to Florida, the conceptualization of the process must start at the point in a truck cycle tour where the decisionmaker decides to allocate his or her equipment to Florida. The decision to enter Florida must be made at the beginning of the trip immediately preceding the acceptance of a Florida load (the backhaul trip).

Not all truck cycle tours take the same length of time, and the total expected profit for a short tour may not be as great as that for a longer tour. To find a common measure for tours of different lengths, the decisionmaker is assumed to judge backhauling options on the expected profit per time period. Thus, decisionmakers will allocate equipment to Florida based on the expected profitability per time period of a truck cycle tour that starts with a Florida-bound backhaul.

Once attracted to Florida, the decisionmaker faces the problem of deciding exactly which price bid to accept. A trucking-firm decisionmaker will accept a Florida bid price to one destination instead of another only because one destination's expected profit per time period is greater. If Florida buyers need more service to one destination, they will bid up prices to that destination to attract more service and thus increase the expected profits per time period. Higher expected profits will attract trucks to serve that destination until the expected profits per time period of the last firm to enter are only a small increment greater than its anticipated profits from serving another destination.

In aggregate, the expected profits per time period of serving a destination may be considered to form a distribution. If buyers bid up the price of servicing one destination, then the mean expected profits per time period (expected value) of firms already servicing that destination will be temporarily adjusted upward. New firms that found the new expected profits per time period greater than those for other destinations would enter. New firms would continue to enter until expected profits per time period, on the average, were no greater than those of other destinations. In terms of the distribution of expected profits per time period, after all new firms have entered, the mean of expected profits per time period will be no greater at the destination with an increased bid price than that of other destinations.

If it is assumed that bid price changes take place in small increments and that firm decisionmakers respond instantly, the quantity of service to each destination would change in relation to the quantity of service to other destinations. However, the expected values of the anticipated profits of serving all destinations adjust together. This property is called "intramarket equilibrium".

This relation should be quite sensitive to relative price changes for two reasons:

1. In view of the fact that the services offered by and the operating characteristics of these trucks are quite standard, the differences in the decisionmakers' expected truck-cycle-tour profit per time period to be earned by starting the next truck cycle tour with carrying a truckload to any one destination should be quite similar among decisonmakers. In other words, the distribution of decisionmakers' expected profits per time period should be narrow. Thus, it should take only small increases in expected profit per time period to make that destination more attractive compared with other destinations for a great many trucking firms that serve Florida.

2. Intuitively, it can be seen that because of the tremendous flexibility of truck service it should require little incentive (increased price) to

cause decisionmakers to choose to serve one destination over another, especially those destinations that are quite similar in terms of service characteristics (i.e., location and length of haul). Therefore, the linkage between the number of trucking firms serving Florida to one destination and the number of firms serving all other destinations should be quite sensitive (elastic) to changes in their relative profitability.

ABSTRACT CONCEPTUAL MODEL SPECIFICATION

It is hypothesized that decisionmakers respond to the expected profit per unit of time when allocating equipment. The individual decisionmaker is assumed to calculate the difference between expected truck-cycle-tour revenue and costs to arrive at an expected profit per truck cycle tour for all available backhaul alternatives. The expected profit per truck cycle tour is divided by an anticipated duration for each alternative, and the decisionmaker selects the alternative that offers the greatest expected profit per time period. In the aggregate, these expected profits can be described by the mean expected profits per time period. Thus, the quantity of truck service supplied (equipment allocated) to Florida depends on the mean expected profit per time period of allocating equipment to a Florida-bound backhaul versus the mean expected profit per time period of allocating equipment to other areas. The dependence on these variables of truck service supplied to Florida is expressed by the following equation:

$$Q_i = F(PB_i, PA_{1i}, PA_{2i} \ldots PA_{ni}) \quad (1)$$

where

- Q = quantity of truck service supplied (equipment allocated) to Florida,
- F = abstract aggregate supply function,
- PB = mean profit per unit of time expected from allocating equipment to a truck cycle tour starting with a Florida-bound backhaul,
- PA = mean profit per unit of time expected from allocating equipment to a truck cycle tour starting with a backhaul bound for an area competing for truck service with Florida,
- i = time period over which all variables are measured, and
- n = number of areas competing with Florida for truck service.

EMPIRICAL ESTIMATION OF SUPPLY-RESPONSE RELATION

By using the abstract model for guidance, an empirical econometric model can be derived that is suited to satisfying the original objective in studying the supply-response relation. Specifically, do truck-service suppliers adjust equipment allocations with respect to changes in competitive prices? Because there were few available data, the development of the empirical model is also partly constrained by the data sets that could be collected during the research effort.

Some of the variables specified in the abstract conceptual model are not measurable (expected profits), and data are unavailable for others (backhaul price and prices in agricultural transportation markets outside of Florida). Furthermore, because an econometric model relates changes in the dependent variable (in this case, the quantity of truck service supplied to Florida) that result from changes in the value of the independent variable or variables, only those variables of the conceptual model or inputs to the conceptual variables that do not remain unchanged over the data collection period are useful in describing changes in the dependent variable during the same period (6, p. 200). This does not mean that variables that remain unchanged are unimportant in modeling the quantity supplied; rather, it means that, within the context of econometric modeling and during that particular data collection time period, unchanged variables are not useful in describing changes in the dependent variable. In light of these data considerations, a model structure has to be defined that satisfies the original modeling objective. But first, the time period over which the quantity of truck service supplied is to be modeled has to be specified.

Price bids of buyers of truck service for spring-peaking commodities are generally above competitive levels and rigid. Because the response to competitive prices is of interest here, noncompetitive prices bid by buyers of truck service for spring-peaking commodities would not be useful in describing changes in the dependent variable. Therefore, the competitive prices of buyers of truck service for winter-peaking commodities are targeted for analysis. Prices were collected from buyers beginning at the start of the seasonal increase in shipments in the fall and ending weeks after the typical winter peak (7). The resulting data collection period covered 21 weeks of the 1978-1979 winter Florida shipping season (October 1978 through February 1979).

To determine the impact, if any, of dropping some of the abstract variables or inputs to the abstract variables from the empirical model, assumptions were made regarding economic conditions at the time:

1. Inflation was less than 1 percent/month (8). Because the data collection period preceded the Carter Administration's deregulation of petroleum fuel prices and because inflation was insignificant compared with other model inputs (e.g., Florida shipments varied from 460 to 7010 truckloads/week), costs are assumed to have remained nearly constant.
2. Most of the firms that carry Florida produce were found to be small owner-operator firms (7). The predominant business option for these firms, other than hauling produce, is to lease themselves to regulated carriers. Although the prices under which leases are arranged are unregulated, the prices paid to lessors are generally set by the lessee at a fraction of the regulated price or with respect to the length of haul (9). Thus, prices paid to lessors are set with respect to the regulated revenue the lessee receives or with respect to nonmarket considerations (distance). Because aggregate regulated commodity flows are fairly uniform throughout the year, it is reasonable to assume that lease prices are uniform throughout the data collection period (10).
3. Exempt produce truckers have two options when they obtain a return load (backhaul): (a) lease to a regulated carrier or (b) carry an exempt commodity. Although lease prices should be uniform throughout the data collection period, prices for truck service for exempt loads into or toward Florida may change over time. This change in prices is due to the dramatic changes in the volume of shipment of agricultural freight flowing toward Florida. Examples of commodity flows toward Florida that fluctuate would be iceberg lettuce from California or apples from Washington. During the winter data collection period, only minor quantities of agricultural commodities were shipped from areas near those midwestern and northeastern cities that consume the majority of Florida produce. Thus, trucks returning to Florida from these destinations should be unaffected by price fluctuations of agricultural return-trip freight markets.

Based on these assumptions, minimum data requirements necessary to model the supply response can be defined. First, because expected values are not measurable, actual changes in independent variables must be used. The changes in actual profits are the changes in the relative values of expected revenues (price bids) and costs. Costs are assumed to remain constant throughout the time of data collection; thus, changes in price bids should define changes in profit per time period, and costs can be dropped with little impact on the results. Second, price time-series data from backhaul and regulated markets are unavailable. However, prices in these markets are assumed to remain uniform throughout the period of data collection, and not having these data available for modeling should have little impact on the results.

By using these minimum data requirements, the information necessary to investigate the supply response to prices can be summarized. The changes in each area's agricultural bid prices are used in lieu of mean anticipated profits per time period. Dropping variables from the empirical specification will affect how much of the variance of the dependent variable is accounted for in the resulting model and the bias created in its estimates of parameter variance (11). If some of the variance in the dependent variable is explained by a variable that is dropped from the model, then that variance is not accounted for. The lost explained variance will affect the magnitude of the percentage of account for variance (the coefficient of determination). Bias is the difference between the mean of a given parameter estimate and the true value of the parameter. When a variable that should be included is dropped from a model, the variance of the dropped variable becomes part of the residuals (error). Greater model error will put a greater load on the variance of the parameter estimates for the remaining variables. Thus, the estimates of the variance of model parameters will be biased upward, and the result will be conservative tests of the significance of parameter estimates. Once the empirical model is estimated, the impact of dropping variables can be determined by investigating the model statistics.

Weekly price information for Florida produce truck service was derived by asking Florida businesses what they paid to have produce shipped by truck. However, information on the amount paid per week to ship agricultural commodities by truck from origins outside Florida was unavailable at the time of the study, and there were no resources to permit the collection of data outside Florida. A number of proxy variables were used in lieu of unobtainable bid prices from sources outside the state. However, all attempts to account for the variability of prices outside Florida failed, and thus prices bid from other sources had to be omitted from the model. Again, the effect of the omission will be reflected in estimate bias and a loss in accounted-for variance.

DATA

Interstate shipments of fresh fruit and vegetables from all states and shipments entering the United States from Canada and Mexico are monitored by the Market News Branch, Fruit and Vegetable Division, USDA. The shipment data supplied by this organization are in the form of a preliminary compilation of shipments of produce from all shipping origins by all modes (truck, rail, air, and boat). The availability, service quality, and price of service of modes other than trucking would affect the demand for truck service. However, because the focus of this study is on the supply of truck service and not the demand for truck service, the other modes are ignored.

Prices actually paid for truck service during the 1978-1979 winter peak shipping period were solicited from truck brokers, receivers, and shippers. The sources of prices used in this study indicated during the introductory contact or in follow-up contacts that they priced with respect to "what the market would bear". Because the prices of these sources fluctuated with respect to the buyers' perception of market conditions, they were assumed to be indicative of competitive, market-clearing prices. However, a problem arose regarding how to treat the slight variations in freight rates. This is dealt with by weighting sources with respect to the share of shipments estimated by produce industry observers from the Florida Department of Agriculture and Consumer Services. The freight rates are estimated to be the truck-service prices for at least 50 percent of Florida fresh citrus shipments.

EMPIRICAL MODEL ESTIMATES

The objective of the empirical model is to determine whether there is a relation between competitive prices and the quantity of truck service supplied and, if such a relation exists, to determine its sensitivity. A relation of this nature is known as a supply-response relation (13). This is the quantification of supply's response to price change when other things are not held constant. However, the problem remains of determining which prices to which destinations or combination of destinations are most indicative of the price changes in the Florida market.

The prices thought to be bid at competitive levels were for truck service to six eastern and midwestern cities and one southeastern city: Atlanta, Boston, Chicago, Cleveland, Montreal, New York, and Washington, D.C. Earlier in the discussion, intramarket equilibrium defined the linkage between prices to all destinations. It was hypothesized that prices to various destinations should be closely linked and that, if in fact there is a strong relation between price changes, then the change in all prices should equally describe the change in quantity supplied. Thus, one model was specified by using the price to each city as the independent variable in a linear regression with the aggregate quantity of truck service supplied to Florida as the dependent variable. The results of the regressions, in which a Cochrane-Orcutt iterative technique was used to correct for autocorrelation, are shown in Equations 2-8. Another similar model is estimated with prices weighted by the proportion of the total produce loads delivered to all seven destinations that were delivered to those particular destinations during the 21 weeks. This model is shown in Equation 9, where the weekly prices for truck service to the seven cities are multiplied by their fraction of deliveries to all seven cities from Florida--10, 17, 11, 6, 9, 33, and 14 percent, respectively--and are totaled for each week (14). The result is used as the independent variable of the regression, and the aggregate quantity of truck service supplied to Florida is used as the dependent variable (t-statistics are shown in parentheses below the parameter estimates):

$$Q_t = -2331.1 + 6161.5\, X_{t,1} \qquad R^2 = 0.68 \qquad (2)$$
$$(1.01) \qquad (2.74) \qquad DW = 1.66$$

$$Q_t = -22\,954.5 + 25\,711.0\, X_{t,2} \qquad R^2 = 0.69 \qquad (3)$$
$$(2.33) \qquad (2.73) \qquad DW = 1.60$$

$$Q_t = -22\,632.1 + 24\,226.1\,X_{t,3} \quad R^2 = 0.77 \quad (4)$$
$$(3.70) \quad (4.43) \quad DW = 2.62$$

$$Q_t = -13\,105.6 + 14\,954.0\,X_{t,4} \quad R^2 = 0.69 \quad (5)$$
$$(2.17) \quad (2.83) \quad DW = 1.62$$

$$Q_t = -16\,125.3 + 16\,750.5\,X_{t,5} \quad R^2 = 0.69 \quad (6)$$
$$(2.32) \quad (2.89) \quad DW = 1.66$$

$$Q_t = -12\,679.2 + 15\,109.9\,X_{t,6} \quad R^2 = 0.70 \quad (7)$$
$$(2.25) \quad (2.95) \quad DW = 1.61$$

$$Q_t = -22\,728.4 + 21\,773.3\,X_{t,7} \quad R^2 = 0.75 \quad (8)$$
$$(3.38) \quad (3.96) \quad DW = 2.25$$

$$Q_t = -18\,965.5 + 20\,632.6\,AX_t \quad R^2 = 0.77 \quad (9)$$
$$(3.17) \quad (3.83) \quad DW = 1.54$$

where

Q = equilibrium quantity of truck service supplied,
t = time period (week),
X = competitive price from Florida to each city ($/mile),
1 = Atlanta,
2 = Boston,
3 = Chicago,
4 = Cleveland,
5 = Montreal,
6 = New York,
7 = Washington, D.C., and

$$AX_t = 0.10X_{t,1} + 0.17X_{t,2} + 0.11X_{t,3} + 0.06X_{t,4} + 0.09X_{t,5} + 0.33X_{t,6} + 0.14X_{t,7}.$$

INTERPRETATION OF FINDINGS

All regressions account for 68-77 percent of the variance in the independent variable, which indicates that competitive prices account for most of the change in the quantity of truck service supplied. The omitted variables and error account for the remaining variance in the dependent variable. Therefore, competitive Florida price changes are by far the most important determinant of the quantity of truck service supplied. Furthermore, because in all eight regressions the independent variable parameter estimate is significant at the 98 percent confidence interval or greater, the bias of omitting other variables does not appear to have affected the estimates of the relation. The relatively good statistical properties of the estimates are interpreted to mean that supply does respond to competitive price signals and that truck-service buyers can express their desires for truck service through an unregulated market.

The price elasticities of each supply-response function are elastic and vary at the midpoint (3701 truckloads/week) from a low of 1.6 when Atlanta prices are used to a high of 7.2 when Boston prices are used. The supply-response function with weighted prices has a price elasticity of 6.1. An elastic supply would tend to agree with the results of trucking-industry cost studies; that is, in a competitive industry the supply curve of one firm will be that firm's marginal cost curve (13). An aggregate supply curve (all firms) is the summing, with respect to quantity, of the marginal cost curves of all firms (15, p. 251). Although some studies have found no economies of scale in the trucking industry (constant average costs) (16-18) and some have found slight economies of scale (19-21), there do not appear to be diseconomies of scale. Therefore, at a minimum, marginal cost curves should be constant (flat) and certainly not increasing. The summing of flat marginal cost curves should result in a relatively elastic supply curve.

In summary, the empirical findings show that, on a limited basis, truck-service suppliers do respond to competitive price signals and supply response is relatively elastic. In terms of Florida produce industry policy, these findings indicate that, if truck-service prices for commodities that peak in the spring fluctuated with respect to current market conditions instead of remaining at their rigid level, truck-service suppliers would respond. In other words, common spring shipment peak-period shortages could be avoided by not pricing at rigid levels and instead increasing prices to attract additional truck service. In terms of trucking industry regulatory policy, the findings indicate that, if suppliers and buyers are left to barter for services, truck-service markets should allocate resources efficiently in response to competitive price signals. However, these findings are derived from a limited study of aggregate prices and aggregate quantity supplied in a market that deals with one commodity (produce), where buyers and sellers have historically had fair to good market information. More study should be done in more diversified markets where market information is not so readily available and with greater and more comprehensive price, cost, and quantity data.

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Value of Overweighting to Intercity Truckers

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An analysis of the problem of truck overweighting is presented. Legal and illegal overweighting and current enforcement procedures are discussed. The benefits to truckers of overweighting are shown by means of an incremental approach (decrease in transport cost per unit with increase in cargo weight) and by using specific cargo movements to calculate the incentives to overweight. The fine and penalty structures of various states are examined and are combined with the probability of being weighed to calculate the expected value of being weighed to the trucker. The net benefit of overweighting to the trucker is then shown by comparing the costs with the incentives. Finally, actual permit costs are examined in relation to the cost of additional pavement damage caused by overweight trucks. It is concluded that (a) economic incentives often exceed the expected costs of overweighting to the trucker, (b) current enforcement programs in some states are not effective, (c) fine structures should take account of both the amount of truck overweight and the number of miles traveled, and (d) the cost of overweight permits does not reflect the additional pavement damage caused by overweighting.

There is an ongoing controversy regarding the legal weight limits for trucks. An important part of this issue that is often overlooked is the problem of enforcement of weight limit laws. Enforcement programs are a critical part of efforts to control overweight trucks. Unless these programs are effective, truck weight limits are meaningless.

For any enforcement program to be effective, truckers must perceive the penalties for exceeding the weight limits as being greater than the economic benefits of overweighting. If truckers believe that the probability of being weighed is low and that the penalties for overweighting are low, they are more likely to run overweight. This situation will continue until effective disincentives are recognized by the trucker.

This paper demonstrates that in many cases there are economic incentives that far exceed the expected costs of overweighting. The analysis is performed by using a cost-benefit approach and specific examples.

The paper first discusses two types of overweighting: illegal and legal. Illegal overweighting subjects the driver to the possibility of fines and other penalties. Legal overweighting requires permits obtained from the individual states. The first section also deals with the enforcement process and the criteria required in order to assess the effectiveness of existing enforcement programs.

The second section presents an analysis of the benefits of overweighting. A general description of these benefits shows how transport cost per unit of weight decreases as cargo weight increases. This demonstrates the incremental advantages of overweighting to truckers. A second, more in-depth approach uses specific cargo movements to calculate incentives for the trucker to overweight.

The next section deals with the cost of illegal overweighting. Fines from different states are examined and combined with the probability of being weighed to calculate the expected value of weighing to the trucker. The costs are then compared with the incentives in order to show the net benefit of overweighting to the trucker. Other penalties, such as forced unloading and suspension of driver's license, are also examined.

The last section describes legal overweighting by the use of state-issued permits. The different types of permits and their respective costs are presented for 10 states, and an effort is made to determine whether the permit costs reflect the additional pavement damage that is caused by an overweight truck. If the cost of a permit does not reflect this additional damage, then the trucker is not paying a fair share in regard to damage to highways and bridges.

ISSUE OF OVERWEIGHTING

This paper discusses two types of overweighting: legal and illegal. Truckers can load above the maximum weight limits legally by the use of specially granted permits. There are generally two types of permits--single trip and annual (multiple) trip. The prices and availability of these permits vary from state to state.

Illegal overweighting occurs when the cargo characteristics are such that the state will not issue a permit. The issuance of permits is controlled by the individual states; therefore, the availability of permits varies among the states. Illegal overweighting subjects the driver to the possibility of fines and other penalties, but the incentives for overweighting usually exceed the expected costs of the fines.

An evaluation of permits and fines is important in determining disincentives to overweight. Permits should reflect the additional pavement damage caused by an overweight truck. Fines should be high enough