Refrigerated Trucking Revisited

Trucking is the dominant transport mode in the United States for foodstuffs, particularly those with high value and requiring controlled temperature and humidity. For example, 95% of all interstate produce shipments are by truck. To understand better this segment of the motor carrier industry, during the 1980s surveys were conducted of long-distance truckers exiting the Florida Peninsula. That work helped establish baseline data about the industry, including its structure, pricing, impacts of regulations, etc. After nearly 15 years, a similar survey was conducted in 2001-2002 of more than 1,600 drivers of long-distance refrigerated trucks. Issues addressed included: use of brokers and the Internet to arrange loads, importance of owner-operators and their ability to operate independently versus under lease to larger carriers, equipment replacement and utilization, and lumping.

by Richard Beilock and James Del Ciello

Trucking is the dominant mode for transporting refrigerated commodities in the United States as over 95% of all interstate produce movements are by truck (U.S. Department of Agriculture 2002). The industry, however, faces significant challenges and opportunities. Technological changes, particularly those related to communications, load and vehicle tracking, and data interchange may transform the structure of the industry. In addition, trucking may be still adjusting to the economic reforms and deregulation during the 1980s and 1990s.

In this paper are presented the results of a study of long-distance, refrigerated trucking. The primary objective of the study was to identify changes since the 1980s which could indicate if, and the extent to which, technological and other factors are transforming this segment of the trucking industry. Four areas were examined:

1. Owner-operator importance and independence:

   One-truck firms[1] have long been viewed as key for providing flexibility and maintaining competitive pressures. For example, Wycoff and Maister (1977) estimated that owner-operators accounted for between 25% and 40% of intercity truck transportation and were significant in reducing industry concentration levels. In these regards, owner-operators are most important in the truckload (TL) sector, though their presence is also felt in less than truckload (LTL) sector, primarily through leasing.

   Deregulation and technological changes since the early 1980s may have altered economies of size in the trucking industry. Such changes could have impacted on the viability of owner-operators and/or their ability to operate independently of larger carriers.

2. Load arrangement methods:

   Since at least the mid-1970s, motor carriers have relied on intermediaries, truck brokers, to arrange the majority of their produce loads, e.g., see Gaibler (1977). The ability of carriers, regardless of size, to secure loadings through brokers may have reduced economies of size in the produce market relative to segments in which carriers rely primarily on their own

resources to market their services. Technological advances, such as cell phones and expanded availability of faxes, may have reduced the importance of brokers by lowering barriers for direct contacts between carriers and shipper/receivers. The Internet is frequently touted for its ability to facilitate transactions across space and/or with several potential buyers and sellers. For more than a decade, researchers and others have predicted growing use of this technology for arranging loadings (e.g., see Shell 1990) and, indeed, several such services exist.[2]

3. Equipment replacement and utilization:

   Key indicators of the health of any industry are the rates of equipment replacement and utilization. Equipment replacement is particularly important for motor carriage as having older equipment may raise concerns about safety and pollution, as well as efficiency and financial viability. Utilization rates are of interest because these are, arguably, the most important determinants of costs per revenue mile (e.g., see Beilock and Stegelin 1982). For any given amount of freight, lower utilization rates, i.e., higher percentages of empty movements, means more vehicle miles with the attendant pollution and safety concerns. Moreover, one of the main rationales for the economic deregulation of the 1970s and 1980s was improving equipment utilization. Investigating if and to what extent utilization gains have been realized and maintained is of interest.

4. Lumping:

   Lumping refers to loading or, more commonly, unloading performed by freelance laborers. For decades there have been allegations that drivers are sometimes coerced into using these services and that fees can be exorbitant. Despite specific outlawing of coercive practices related to loading/unloading in the Motor Carrier Act of 1980, concerns have persisted, e.g., see Mahan and Beilock (1990).

DATA

Data for the study are from interviews with 1,642 drivers of semis with refrigerated trailers conducted at the Florida Agricultural Inspection Stations along U.S. highways I-10, I-75, and I-95. All trucks are required to stop at these stations which are always open and cover all exits from the Florida Peninsula. There were four interview periods between November 2001 and June 2002. All drivers of semis with refrigerated trailers were invited to participate.[3] To encourage participation and mitigate response bias, drivers were told that the survey was voluntary, anonymous, and given by students of the University of Florida. In all cases interviews were conducted out of hearing of the Inspection Officers. While it proved impossible to calculate exact refusal rates, at all stations and during all interview periods, refusal rates were well under 10% and there were no indications of non-response bias. To identify trends, comparisons are made among the results of the 2001-2002 survey and similar surveys conducted in 1982-1983 (see Beilock and Fletcher 1983) and 1985-1986 (see Beilock, MacDonald, and Powers 1988).

INDUSTRY STRUCTURE: IMPORTANCE AND INDEPENDENCE OF OWNER-OPERATORS

The importance of owner-operators for refrigerated haulage appears to have increased modestly since deregulation. In the early and mid 1980s, owner-operators accounted for between 50% and 53% of the refrigerated trucks exiting the Florida Peninsula. In the 2001-2002 survey, 57% of the trucks were driven by owner-operators.

Operational Independence. The continuing, even growing, importance of owner-operators suggests that, at least in this segment of the motor carrier industry, the events of the past

two decades have not eroded the competitive positions of small firms. With regard to haulage of produce and perhaps some other commodities which never fell under Federal regulation and which normally are transported in truckload-sized shipments, this is probably an accurate conclusion. However, refrigerated carriers normally must also haul other types of cargoes if they are to avoid excessive amounts of empty movements. For example, drivers in the 2001-2002 survey were asked what they were carrying when they entered Florida. Of these loads, 74% formerly were subject to economic regulation. Relatively few owner-operators ever had ICC Authority to haul regulated commodities (e.g., only 18% of those in the 1982-1983 survey, see Beilock and Fletcher 1983). Carriers without authority could not haul regulated commodities unless they were under a lease with a carrier possessing the appropriate authority or the owner of the goods (i.e., a private carrier).

Legally a carrier under lease is still an independent firm, in many regards, however, the carrier is little more than part of a larger carrier's fleet. Normally, carriers under a lease still makes their own decisions regarding equipment maintenance and replacement and licenses and taxes. However, the lessee hauls loads at the direction and in the name of the lessor and may be subject to the lessor regarding routings, driving times, and speeds. As such, a clearer picture of the degree to which owner-operators are maintaining their competitive positions can be obtained through examining their reliance on leasing.

With the effective sunsetting of economic regulations, the legal impetus to operate under a lease disappeared. As such, it would be expected that the frequency of leasing by owner-operators would have diminished. However, leasing may still be attractive for owner-operators if larger carriers have comparative advantages with regard to marketing. In addition, leasing can give owner-operators access to linehauls for less-than-truckload movements. Nevertheless, unless these other reasons have increased in importance, the ending of the legal imperative for carriers without authority either to lease or markedly limit the scope of cargoes hauled should have resulted in reduced reliance on leasing by owner-operators.

Surprisingly, leasing has become much more common. In the 1982-1983 survey, 35% of owner-operators were then operating under a lease agreement. Despite the elimination of legal restrictions which encouraged leasing, 65% of owner-operators in the 2001-2002 survey were under a lease. This probably reflects the ability of larger carriers to exploit new technologies to provide just-in-time, electronic data interchange, and other services increasingly demanded by shipper/receivers. Moreover in the post-regulation era, larger carriers may utilize leasing as a strategy to minimize fixed and quasi-fixed costs, facilitate more rapid expansions and contractions in capacity, and reduce reliance on unionized labor (e.g., see Belzer 2000).

If owner-operators are able to move readily from one lessor to another, as well as operating independently, the increased reliance on leasing may be an appropriate and efficient way for owner-operators to access marketing and other services which would not be cost-effective to provide. To the extent leases are short term [trip] leases, increased leasing may reflect larger carriers acting as full service logistics providers and, in effect, being the dispatchers for their client shippers, rather than a real change in owner-operator independence. In other words, instead of the owner-operator contacting the shipper directly for a load, the contact is made with the carrier handling logistics for that shipper with that same movement structured as a lease. On the other hand, the increase in leasing may constitute a *de facto* increase in concentration and/or be indicative of reduced profitability and flexibility for owner-operators. Unfortunately, the answers to these questions were beyond the scope of this study.

LOAD ARRANGEMENT METHODS

Brokers. Brokers have traditionally been the dominant method for arranging transport of produce (e.g., see Taff 1979). The frequency of their use for produce haulage from Florida has remained essentially unchanged for the past 20 years. In the 1982-1983 survey, 59% of these loads were arranged by brokers, compared to 62% in 2001-2002. As might be expected, owner-operators are more likely to use brokers than larger carriers, however the difference is small, 66% and 58%, respectively. With development and expanded use of communications technologies, such as cell phones, faxing, and the Internet, the ability of brokers to maintain their market share is somewhat surprising. Added to this, on average brokers are charging more for their services. In the 1980s, an 8% fee was by far the most common, with some charging as high as 10%, but rarely higher, e.g., Shell, 1990. In the 2001-2002 survey, the average brokerage fee was 11%. Of those using brokers, 56% reported fees of 10%, with an eighth of these drivers reporting 8% fees and another eighth being charged 12%.

Premiums for Directly Arranging Loads. Four percent of those hauling produce or ornamentals indicated that their firm owned the cargoes. For the other 96% of these carriers, loads were arranged either through direct contacts between carriers and shipper/receivers or through brokers. A multivariate model was developed and estimated to explore the determinants of freight rates for produce and ornamentals loads, see Appendix. The results of that work suggested that carriers dealing directly with shipper/receivers averaged $138.43 more than those using brokers, see Appendix, Table 2A, Model 3. This does not necessarily indicate that a carrier which does not already have established relationships with shipper/receivers would do better contacting potential clients directly, rather than through a broker. The cost of such a search, particularly if the truck and driver are idled, could easily exceed whatever premium the carrier might glean from a direct search. Moreover, much or all of the $138.43 differential likely reflects higher payments because of established relationships, with the carrier providing assured carriage and, perhaps, special services. In the absence of such arrangements, brokers may be the best alternative. Indeed, the very high frequency of their use and the high fees they command clearly indicate that the majority of carriers value brokerage services highly.

The Internet. But what about the Internet? When asked if they ever have used the Internet to hunt for loads, two thirds of the owner-operators responded positively. However, the Internet appears to be of marginal importance at best. Less than 1% of the owner-operators indicated that the load on their trucks, at the time of the interview, had been secured through the Internet.

EQUIPMENT UTILIZATION

One of the key determinants of a transport system's efficiency is the ability to utilize its capacity over a large percentage of movements, that is, to have low percentages of empty movements. The assertion that elimination of regulatory controls would improve equipment utilization was one of the primary arguments in favor of deregulation, e.g., Felton (1981). As previously noted, refrigerated carriers primarily haul never-regulated cargoes from Florida and formerly-regulated cargoes into the state. To the extent regulatory controls impacted equipment utilization, these impacts would be expected to be evident for inbound, but not outbound loadings (at least not to a significant extent).

In the early years of the regulatory reforms which led to deregulation, the percent of refrigerated trucks entering Florida empty was four times as high as for their movements out of the state (34% versus 8%, respectively, in 1982/83). That these high empty movement rates into Florida were, in large measure, due to regulation was strongly suggested by the fact that Florida is a net importer of goods

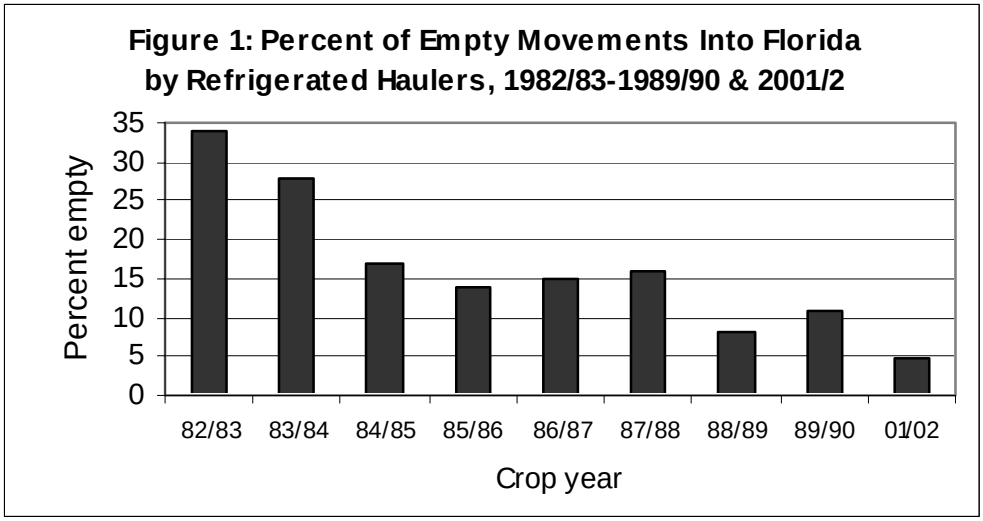
from virtually every other U.S. state and Canadian province (Kilmer, Ramirez, and Steglin 1983).[4]

Consistent with the assertion that reduced regulatory controls improved utilization rates, the percentage of empty outbound movements (primarily of never-regulated commodities) remained in the 8% to 11% range, while the percentage of empty inbound movements fell from a third of all trucks in 1982-1983 to around 10% by the end of that decade, see Figure 1.

An important question addressed in the 2001-2002 survey was if the improvements in utilization rates witnessed in the 1980s have been maintained. The results suggest further improvements with regard to movements of formerly-regulated cargoes into Florida. Outbound, the empty movement rate has remained at levels seen in the 1980s, 11%. Inbound, slightly less than 5% of the refrigerated trucks entered Florida empty, half the rate attained at the end of the 1980s, see rightmost column in Figure 1. But are the 'correct' empty movements being made? Beilock and Kilmer (1986) presented theoretical arguments that efficient transport systems would be characterized by higher empty movement rates for shorter, rather than longer, distances.[5] They also observed this in the 1980s with regard to movements by refrigerated carriers into Florida. Similar results were found for the 2001-2002 survey. For outbound movements with loads, the average distance was 1,258 miles, versus 557 miles for empty movements. With regard to inbound movements, the averages were 943 and 584 miles, respectively, for full and empty trucks.

These results suggest that the benefits of deregulation have been substantial. It should be stressed, however, that some of the observed improvements could be due to technological developments. However, it seems likely that if technology were the primary cause, improvements in utilization would also have been observed with regard to outbound movements.

Figure 1: Percent of Empty Movements Into Florida by Refrigerated Haulers, 1982/83-1989/90 & 2001/2



Source: Jones, Fullerton, and Beilock and 2001-2002 Driver Survey

UTILIZATION RATES OF OWNER-OPERATORS AND COMPANY DRIVERS

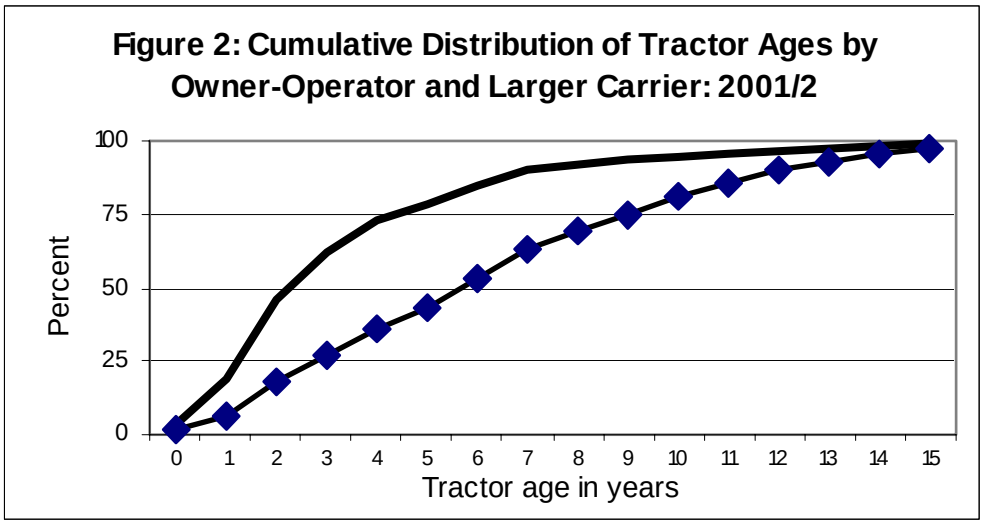
The incidences of empty movements outbound from Florida are nearly identical between owner-operators and company drivers, 10.2% and 11.9%, respectively. However, the average empty outbound movement by owner-operators is somewhat longer than those made by company drivers, 925 versus 800 miles. Multiplying empty movement frequency by distance, the average owner-operator traveled empty from Florida 94 miles, versus 95 miles for the average company driver. So, with regard to outbound movements, owner-operator utilization rates are effectively identical to those of company drivers.[6]

For inbound movements, there are differences between the company drivers and owner-operators. Just under 7% of the inbound movements by owner-operators were empty, compared to 3.2% for company drivers. These results indicate substantial improvements for owner-operators, both absolutely and relative to company drivers. In the early 1980s, empty inbound movement rates for owner-operators hovered around 40%, nearly four times the rate for company drivers. Also, while the incidence of empty inbound movements is still higher for owner-operators than for company drivers, the average empty movement is shorter, 511 and 687 miles respectively. Therefore, the average owner-operator traveled empty towards Florida 35 miles, compared to 22 miles for the average company driver.

EQUIPMENT AGES

A potential indicator of financial condition, as well as safety, is the age of the equipment used, the tractor and trailer. It should be stressed, however, that this is an imperfect measure as good maintenance and driving practices can greatly lengthen the useful lives of equipment. For example, the world's largest trucking company, UPS, consistently ranks as one of the safest and oldest fleets in North America.

Equipment ages were not analyzed for refrigerated carriers operating into and out of Florida during the 1980s. However, at the same survey sites used for the refrigerated carrier surveys, in 1987 there was a survey of all long distance carriers (Beilock 1988). In that survey, the average tractor was 4.9 years old and the average trailer was 5.0 years old. Owner-operators had somewhat older equipment than larger carriers: respectively, 6.2 and 4.0 years for tractors and 6.0 and 4.4 years for trailers. The results for 2001-2002 survey are similar. The average tractor was 4.9 years old and the average trailer was 6.2 years old.[7] Also as in the 1987 survey, owner-operators were found to have older equipment, on average, than larger carriers. The average tractor driven by an owner-operator was 6.2 years old, compared to only 3.8 years old for larger carriers. As can be seen in Figure 2, the median tractor age for owner-operators was more than 5 years, effectively twice that for larger carriers. Trailers pulled by owner-operators were, on average, 6.75 years old, versus 5.3 years old for larger carriers. Overall, the equipment ages suggest that the industry has been able to replace its equipment in a timely fashion. Without further research, it is impossible to assess the significance of differences between owner-operators and larger carriers, particularly with regard to tractor ages.



LUMPING

Lumping refers to the practice of casual (i.e., independent, freelance) workers offering loading or, more typically, unloading services at loading docks. The practice is believed to be very common in the produce industry (e.g., see Hagen et al. 1999). Lumping is a perennial issue in transportation because of evidence that drivers are sometimes extorted to use these services and that fees may be exorbitant (e.g., see Mahan and Beilock (1990), Interstate Commerce Commission (1982), and Committee on Small Business (1978). Despite the explicitly outlawing of coercive practices associated with loading/unloading in the Section 15 of the Motor Carrier Act of 1980, concerns persist.

For the Florida driver surveys, drivers with produce loads at the time of the interview were asked if they anticipated using lumper services and, if so, their estimate of the fee. In the very large number of cases it seems that drivers would likely be familiar with the destination and/or would have obtained information from the broker, receiver, or other drivers regarding these charges. In the 2001-2002 driver survey, 38% of all drivers with produce loads anticipated that they would use lumpers and the average anticipated fee was $87.42, see Table 1. Owner-operators were more likely than other drivers to use lumpers, but there was little difference across the carrier types with respect to average anticipated fees. Comparing these results with a similar survey at the same sites taken 16 years earlier suggests that the frequency of use of lumpers has declined, but average real charges have increased, see Table 1. A possible explanation for the declining use of lumpers is that it has become more common for receivers to offload vehicles, particularly when they are unitized (i.e., on pallets or slipsheets), with lumping more concentrated into offloading the more labor-intensive, hand-stacked and bulk cargoes.[8]

To the extent that lumpers charge more than the cost of unloading, which drivers would otherwise incur, freight rates would be expected to be higher. The results of the analysis of freight rate determinants suggest that this is not the case. The relationship is not significant between anticipated lumper charges and freight rates, see Appendix, Table 2A.

LUMPERS OR OPPORTUNISTIC DRIVERS?

Comparing the 2001-2002 Florida driver survey results with those from the 1999 California study suggests that lumper fees are comparable, but that drivers serving the California market are two-thirds again more likely than those serving Florida to use lumpers, see Table 1.[9] This might, in part, reflect greater use of lumpers in Western terminals. However, considering that much of California's produce goes to the same Midwest, Southern, and Eastern destinations served by the Florida produce industry, the differential seems much too large to be explained solely by this. Rather, the difference in frequency of using lumpers may be due to differences between the approaches used in the two studies and this, in turn, may suggest opportunistic behaviors by drivers and an exaggerated assessment of the extent of lumping in the industry. In the Florida study, drivers were asked about lumping by university students. Drivers had no financial incentive to respond in any particular fashion. On the other hand, in the California study, carriers were questioned about the frequency in which their drivers reported using lumpers. Many carriers reimburse drivers for payments made to lumpers. These casual workers normally would be paid in cash and either give no receipts or receipts that were handwritten, informal, and easily forged or altered. The incentive for drivers to over-report their use of lumpers to their superiors is clear.

TABLE 1: FREQUENCIES AND AVERAGE AMOUNT OF FEES FOR UNLOADING PRODUCE

	Survey site and year				
	Florida 1985/86[1]	Florida 2001/2[2]			California 1999[3]
	All carriers	Owner-operators	Larger carriers	All carriers	All[4] carriers
Frequency (% of time lumpers are used)	48%	43%	34%	38%	64%
Average fee (in 2002 dollars)[5]	$72.38	$85.38	$90.04	$87.42	$81.27

NOTES:
1. Source: Mahan and Beilock (1990).
2. Source: 2001-2002 Driver Survey.
3. Source: Hagen et al (1999).
4. Survey of larger carriers, rather than drivers. However, many of these firms likely use some owner-operators under lease agreements.
5. Using the Producer Price Index for all commodities.

CONCLUSIONS

Transport of refrigerated foodstuffs in the United States is almost totally dependent on trucking. To improve the understanding of this segment of the motor carrier industry, results were presented from a 2001-2002 survey of more than 1,600 drivers of long-distance refrigerated trucks as they exited the Florida Peninsula. Comparisons were made with similar surveys taken during the 1980s. The results suggest an intriguing mix of stability and change.

In terms of their share of refrigerated haulage, owner-operators have maintained and even increased their importance during the past two decades. However, roughly twice the percent of owner-operators reported they were leased to larger carriers as did in the 1980s. Without additional research, it is impossible to discern if this is a mutually beneficial adjustment for owner-operators and larger carriers to changed economies of size regarding marketing and communications, or alternatively, if it signals that the operational freedom and competitiveness of owner-operators are eroding.

Of some surprise, considering advances in communications, brokers are used to arrange approximately 60% of produce loads. Not only have these intermediaries maintained their share of the market, broker fees have increased, on average, from around 8% of the freight rate to 11%. Two-thirds of owner-operators reported using the Internet to search for loads, however less than 1% had secured through the Internet the load they were hauling at the time of the interviews. Exploring the reasons for the continued dominance of brokers and negligible impact of the Internet could be a fruitful avenue for investigation.

Equipment utilization levels, as gauged by percent of empty miles, improved throughout the 1980s, presumably due to reduced regulatory controls. The incidence of empty movements into Florida fell from a third in 1982-1983 to about 10% by the end of the decade. The results of the 2001-2002 survey indicate continued improvements, with empty inbound rates around 5%. Analyses of equipment ages suggest adequate-to-good replacement rates. Larger carriers have somewhat newer equipment than do owner-operators, on average.

Finally, the incidence of drivers using lumpers has fallen since the 1980s, though average fees have risen modestly. There were no indications that using lumpers is associated with higher freight rates, suggesting that their fees are consistent with alternatives available to drivers.

Appendix: Freight Rate Determinants

A model was developed to explore the determinants of freight rates for produce and ornamentals shipped from Florida during the 2001-2002 shipping season. The freight rates employed were per truckload. For produce, differences in vehicle sizes were deemed to be unimportant. The trailers in the sample ranged from 39 to 53 feet in length, with 97% being 48 feet or more. As produce tends to be quite dense, in virtually all cases weight, rather than volume, would have been the limiting constraint. The much less dense ornamentals loads are distinguished by a binary variable in the independent variables.

The independent variables and the expected signs of associated parameter estimates are summarized in Table 1A. Reasons for selecting these variables are briefly discussed below.

Considering the competitive structure of produce trucking, freight rates were assumed primarily to be functions of factors affecting the cost of providing these services. Most prominently, these would be the distance of the haul (DISTOT) and the number of pickups and drops (PKNUM and DRPNUM, respectively). Some researchers have noted a tapering effect in rates with distance. That is, there may be a tendency for freight rates to rise more slowly per mile the longer the distance of the movement, e.g., see Bressler and King (1978) and Wilson (1982). To test for this, DISTOT squared (DISTOT2) was also employed as an independent variable. In some instances drivers pay individuals, known colloquially as lumpers, to unload their vehicles. Those services may be contracted for voluntarily or under some duress, e.g., see Mahan and Beilock (1990). To the extent that lumpers charge more than the cost of unloading which drivers would otherwise incur, freight rates would be expected to be higher. To explore this, the lumper charge anticipated by each driver (LUMPER) is included.

Costs, such as fuel, as well as overall market conditions may vary across time. For this, binary variables were specified for the first three survey periods (NOV, JAN, and APRIL) to capture differences relative to the June survey period. For spatial variations in costs and market conditions, binary variables were specified for vehicles exiting from Florida to the west (I10) and to the northwest (I75) to capture differences relative to those traveling to the northeast. Another source of freight rate variation could be between produce and ornamentals. Handling characteristics can be different between these, for example special trays are needed, in some instances, for ornamentals. For this reason, a binary variable was designated to indicate if the load was ornamentals (ORN).

Naturally, there is no freight rate when the carrier also owns the load (4% of all produce/ornamentals hauls). Therefore, the loads represented in the freight rate estimation were arranged either through a broker or directly with the shipper/receiver. To test if either arrangement method tends to result in higher freight rates, a binary variable was specified (DIRECT) equal to one if the load was arranged directly with the shipper/receiver and zero otherwise. Since there are likely to be differences between owner-operators and larger carriers with respect to marketing, there may be differences in their abilities to secure higher freight rates. This is investigated with a binary variable (OWNOP) equal to one if an owner-operator and zero if not (i.e., if a larger carrier). Finally, to test if the ability of owner-operators to acquire loads with higher freight rates varies with experience, a variable indicating the years of experience as an owner-operator is included (OWNYR). For larger carriers OWNYR equals zero.

The results, using Ordinary Least Squares, are presented in Table 2A. Model 1 includes all variables discussed above. As DISTOT2 proved to be insignificant, suggesting that freight rates are, essentially, linear functions of distance, this variable is dropped in Model 2. Finally, as the effects of I10 and I75 as well as NOV and JAN were effectively identical, each pair is combined into one variable (I1075 and NOVJAN) in Model 3. In Model 3, all the explanatory variables are statistically significant except LUMPER, and all have the theoretically expected sign.

Table 1A: Summary of Independent Variables for Freight Rate Estimation

Independent variables	Description	Expected Parameter Sign (+ or -) & Rationale
DISTOT	Distance in miles	+ Approximating per mile marginal costs
DISTOT2	DISTOT squared	- If there are significant economies related to longer hauls.
PKNUM	Number of pickups	+ Approximating the marginal cost of a pickup.
DRPNM	Number of drops	+ Approximating the marginal cost of a drop.
LUMPER	Anticipated unloading charges, if any, by lumpers.	+ If lumpers charge more than alternative unloading costs. The parameter estimate would approximate the proportion of that differential.
ORN	Binary variable, equal to one if an ornamentals load and zero otherwise.	+ Reflecting the additional service requirements (i.e., special racks, caution regarding mechanical damage on and off-loading, etc.).
DIRECT	Binary variable, equal to one if load arranged directly between the carrier and shipper/receiver and zero otherwise.	+ If premiums are paid to carriers familiar to the shipper/receivers and/or if brokers tend to handle less desirable hauls.
OWNOP	Binary variable, equal to one if driver an owner-operator and zero otherwise.	? Parameter would reflect overall advantage/disadvantage of these carriers, relative to larger carriers, in securing higher freight rates.
OWNYR	Number of years as an owner-operator.	+ Reflecting rate enhancing advantages from experience.
NOV	Binary variables, equal to one if survey during the indicated month(s) and zero otherwise. The omitted category is June.	- Previous research suggests that freight rates are positively related to total volumes shipped and (early) June is the peak shipment time.
JAN		
NOVJAN		
APRIL		
I10	Binary variables, equal to one if survey at the indicated Interstate and zero otherwise. The omitted category is I95.	- Previous research suggests that freight rates are highest for shipments along US I 95, perhaps due to poorer prospects regarding backhauls.
I75		
I1075		

Table 2A: Freight Rate Estimation

Independent variables	Model 1	Model 2	Model 3
Intercept	741.74 *** (141.25)	824.21 *** (88.60)	825.85 *** (88.29)
DISTOT	.99 *** (.16)	.87 *** (.044)	.87 *** (.044)
DISTOT2	-.000037 (.000049)		
PKNUM	65.47 *** (12.26)	66.59 *** (12.17)	66.57 *** (12.15)
DRPNM	70.83 *** (9.76)	70.77 *** (9.77)	70.67 *** (9.74)
LUMPER	.52 (.41)	.54 (.41)	.54 (.41)
ORN	222.58 *** (85.85)	215.92 *** (85.35)	219.57 *** (84.40)
DIRECT	140.25 *** (47.63)	139.00 *** (47.58)	138.43 *** (47.44)
OWNOP	-156.17 *** (55.89)	-156.41 *** (55.87)	-155.21 *** (55.39)
OWNYR	5.37 ** (2.61)	5.33 ** (2.60)	5.33 ** (2.60)
NOV	-241.04 *** (66.53)	-241.47 *** (66.50)	
JAN	-229.65 *** (70.26)	-229.81 *** (70.23)	
NOVJAN			-236.62 *** (60.78)
APRIL	-145.15 ** (66.11)	-141.08 ** (65.86)	-143.35 ** (65.23)
I10	-217.84 *** (58.98)	-223.42 *** (58.49)	
I75	-201.92 *** (50.70)	-206.42 *** (50.33)	
I1075			-212.97 *** (44.24)
Equation statistics			
F statistic	40.45 ***	43.55 ***	51.63 ***
R^2	.51	.51	.51
Number observations	563	563	563

NOTE: ** and *** denote statistically different from zero at the .05 and .01 levels, respectively.

Endnotes

1. Some sources define owner-operators as firms having up to three trucks, with the owner also being one of the principal drivers.

2. For example, Getload.com The Internet Load Board available at http://4truckloads.com/index htm.

3. Unless there was no available parking space.

4. In other words, judging simply by the relative volumes of cargoes moving in each direction, it would be expected that there would be a higher percentage of empty outbound than inbound movements, the opposite of what was found for refrigerated haulers.

5. They argued that there are normally some carriers committed to travel between two points regardless of whether they can acquire a load or not. Reasons for this include repositioning to the pickup point for an assigned load and returning to home base. For such committed carriers, the marginal cost of acquiring a load are the distance-unrelated cost of discovery and negotiation, pickups, and drops and distance-related costs which are the incremental per mile costs associated with traveling full, rather than empty (primarily additional fuel usage and wear and tear). Increases in freight rates associated with additional distance virtually always exceed the distance-related costs incurred by committed carriers. As such, incentives to acquire loadings increase with distance.

6. That is, assuming that the times are the same in which both types of drivers are able to secure loads or decide to move empty.

7. Comparisons might also be made with equipment ages reported in a 1999 study of trucking serving the California produce industry, see Hagen, Minami, Mason, and Dunton (1999). They found average tractor and trailer ages of 3.0 and 4.7 years, respectively. However, the representativeness of these estimates is questionable as their survey included a fairly small number of trucking firms (44) which were all members of an American Trucking Association's conference.

8. In the 1985-1986 study, lumping charges were identified by loading method. In terms of 2002 dollars, the average fees were: $62.83 for unitized loads, $74.98 for hand-stacked, and $121.73 for bulk loadings (primarily watermelons).

9. This was derived by dividing the California frequency (64%) by that for Florida (38%).

References

Beilock, R. 1987 RCCC Motor Carrier Safety Survey. Regular Common Carrier Conference, Alexandria Va., 1988.

Beilock, R. and G. Fletcher. "Exempt Agricultural Commodity Haulers." Transportation Research Forum 24,1(1983):444-50.

Beilock, R. and R. Kilmer. "The Determinants of Full-Empty Truck Movements." American Journal of Agricultural Economics 68,1(1986):67-76.

Beilock, R., J. MacDonald, and N. Powers. An Analysis of Produce Transportation: A Florida Case Study. ERS, USDA Agricultural Economic Report 597, 1988, 43 pp.

Beilock, R. and F. Stegelin. "The Impact of Fuel Costs, Distance-to-Market and Equipment Utilization on the Relative Costs of Trailer-on-Flatcar and Truck Transportation in the South for Fresh Fruits and Vegetables." Southern Journal of Agricultural Economics 14,2 (1982):111-17.

Belzer, M. Sweatshops on Wheels: Winners and Losers in Trucking Deregulation. Oxford University Press, Oxford, UK, 2000.

Bressler R. and R. King. Markets, Prices, and Interregional Trade. John Wiley and Sons, Inc., New York, 1978.

Committee on Small Business. Small Business Problems in the Marketing of Meat and Other Commodities, part 2: Extortionate Meat Unloading Practices-Lumping. Committee on Small Business, U.S. Congress, Washington, DC, 1978.

Felton, R. "Seasonal Variations in Demand and the Economic Regulation of Trucking." Logistics and Transportation Review 16, 3 (1981): 243-63.

Fullerton, H. "Labor Force Projections to 2008: Steady Growth and Changing Composition." Monthly Labor Review (November 1999): 19-32.

Gaibler, F. "Truck Brokers: An Integral Part of Exempt Agricultural Commodity Movements." AGERS-34 Economic Research Service, United States Department of Agriculture, Washington DC, 1977.

Hagen, J., D. Minami, B. Mason, and W. Dunton. California's Produce Trucking Industry: Characteristics and Important Issues. California Institute of Technology Report 990301, Fresno Calif., 1999.

Interstate Commerce Commission. Report to Congress on Study of Loading and Unloading Practices in the Motor Carrier of Property Industry. Ex Parte 410, 1982.

Jones, J., R. Fullerton, and R. Beilock. U.S. Trucking Review: Performance, Structural Change, and Deregulation. Canadian Institute of Guided Ground Transport Report No. 92-3, Queen's College, Kingston, Ontario, 1992.

Kilmer, R., H. Ramirez, and F. Steglin. Economic Impact of Empty Backhauls in Florida Fresh Fruit and Vegetable Truck Transportation. Florida Experiment Station Bulletin No. 833, University of Florida, Gainesville, Fla., 1983.

Mahan, R. and R. Beilock. "Unloading Practices for Produce Revisited." Journal of the Transportation Research Forum 30, 2(1990):239-46.

Shell, T. Brokerage and Electronic Marketing. Masters Thesis, University of Florida, Gainesville, FL, 1990.

Taff, C. "A Study of Truck Brokers of Agricultural Commodities Exempt from Economic Regulation." Transportation Journal 18 (1979): 5-15.

United States Department of Agriculture. Fresh Fruit and Vegetable Shipments: by Commodities, States, and Months. Agricultural Marketing Service, USDA, Washington DC, 2002.

Wilson, G. Economic Activity of Intercity Freight Transportation. Indiana University Press, Bloomington Ind., 1982.

Wycoff, D. and D. Maister. The Motor Carrier Industry. Lexington Books, Lexington Mass., 1977.

Richard Beilock *is a professor of food and resource economics at the University of Florida.*

James Del Ciello *is a transportation specialist for the U.S. Department of Transportation.*