Governance Structure in the Deregulated Trucking Industry

Thomas N. Hubbard

UCLA and NBER

This paper uses a comprehensive survey of the entire U.S. trucking fleet to investigate patterns in the terms of trade between carriers and shippers during 1987 and 1992. Analysis of the 1992 data suggests that internal procurement and long-term contracts are used to alleviate hold-up problems associated with the use of specific trailers. The relationships between governance structure and measures of trailer specificity are weaker in the 1987 data. The empirical evidence indicates that changes in governance between 1987 and 1992 in part due to improvements in efficiency of contract carriage, especially for hauls using non-refrigerated vans. I propose that these improvements are attributable to long-run responses to regulatory reform and the availability of new technologies.

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1. Introduction

Three classes of governance mediate trade between shippers and carriers in the motor carriage industry: common, contract, and private carriage. These correspond to spot agreements, long-term contracts, and vertical integration, respectively. This paper investigates patterns in governance in this industry after deregulation, focusing on 1987 and 1992.

Part of the analysis investigates cross-sectional variation in governance during 1992. The primary issue is whether firms use hauls' governance to mitigate hold-up problems related to the use of specific assets. Institutional features of the trucking industry and the theoretical literature on contracting guide the analysis. Combined, these suggest that hold-up problems may be more severe when hauls use trailers for which there are few local alternative users. The empirical work measures relationships between hauls' governance structure and two sets of covariates: a vector of dummy variables which reflect the trailer used for the haul and measures of local market thickness. Finding that longer-term arrangements are used more when hauls use trailers which are more specific to uses in general and or which are locally uncommon provides evidence that hold-up problems arise due to trailer specificity, and firms use hauls' governance structure to mitigate them.

The rest of the analysis investigates changes in governance over time. Aggregate measures indicate that governance changed dramatically between 1987 and 1992. In 1987, about 40% of truck-miles were accounted for by trucks operating under common carriage. By 1992, this decreased to about 30%.[1] Roughly $25 billion in transactions – about the size of the entire rail industry – moved from spot markets to longer-term arrangements in the span of only five years. Furthermore, the changes in governance between 1987 and 1992 are strikingly different from the trends between 1982 and 1987. During the earlier period, the period which immediately followed deregulation of interstate trucking, the fraction of truck-miles in hauls governed by spot arrangements actually increased slightly.

I explore time trends by examining how the cross-sectional patterns differed between 1987 and 1992. This permits the identification of supply-side changes which affected certain classes of hauls and governance structures disproportionately. I first examine whether relationships between

[1]Bureau of the Census (1993).

governance and trailer specificity and local market conditions are similar in the two years. Where there are differences, I investigate whether sorting at the margin between common and contract carriage was similar to that at the margin between contract and private carriage. For example, I examine whether classes of hauls which moved disproportionately from common to contract carriage also moved disproportionately from contract to private carriage. The interesting circumstances are where this was not the case: where changes were not toward shorter- or longer-term arrangements in general. These indicate where the relative efficiency of the governance structures changed, and changed disproportionately for certain hauls. They provide evidence of important supply-side changes. Combined with evidence from the trade press, other industry sources, and other research, they provide a partial explanation for the broad changes in governance noted above.

The data are from the 1982, 1987, and 1992 Truck Inventory and Use Surveys (TIUS) taken by the Bureau of the Census. These data contain thousands of observations of trucks in each of these years. The sample used here is of truck-tractors: the front halves of tractor-trailer combinations. Variables describe trucks' characteristics and how they are used. The data indicate whether trucks operated mainly under private, contract, or common carriage, the state in which they were based, the type of trailer to which they were normally attached, the class of product they commonly hauled, and how far from home they were generally operated. Many previous studies of governance structure rely either on qualitative evidence or analyze relatively small data sets from particular regions or market segments. The size and scope of the TIUS data allows for an unusually comprehensive examination of contracting in an industry.

The results from the 1992 cross-section suggest that hold-up problems associated with trailer specificity exist, and firms use hauls' governance structure to mitigate them. When hauls require trailers that are specific to product classes (such as logging trailers or grain bodies), shippers tend to haul their own goods. Holding trailer type constant, shippers are more likely to haul their own goods in states when they did so in trailers which were locally uncommon. Similar results hold when examining the terms of trade, given external procurement.

Relationships between trailer specificity and governance are weaker in 1987. In particular, hauls using basic vans tended more toward internal procurement relative to other hauls than in 1992. Between 1987 and 1992, most hauls tended more toward longer-term arrangements in general.

Hauls using non-refrigerated vans did not. They tended toward contract carriage, but away from both private and common carriage. The efficiency of contract carriage increased disproportionately for these hauls. Below, I propose that this reflects long-run adjustments to deregulation – in particular, the removal of restrictions on the number of shippers individual carriers could serve under long-term contracts – and the new availability of on-board computers.

Along with the theoretical literature which relates asset specificity to governance (Klein, Crawford, and Alchian (1978), Williamson (1985), Grossman and Hart (1986)), this paper draws from the empirical literature on contracting. The empirical framework is similar in spirit to Joskow (1985, 1987). The analytic framework draws also from Palay (1984) and Pirrong (1993), who investigate contracting in rail and ocean shipping, respectively. The emphasis on local market conditions is similar to that in the latter. Several more recent papers have examined contracting in motor carriage, but the focus of these has been subcontracting within for-hire trucking firms rather than the terms of trade between shippers and carriers.[2] This paper's emphasis on changes between 1987 and 1992 makes it also related to a large literature which investigates the effects of regulation and deregulation.[3] This literature contains extensive work on deregulation's effect on prices, market structure, for-hire carriers' profits, and drivers' wages during the early 1980s. To date there has been less emphasis on contractual changes, or on changes that took place after the early 1980s.

The rest of the paper is organized as follows. Section 2 describes governance structure, regulatory policy, and recent trends in the trucking industry. Section 3 presents the analytic framework. Section 4 describes the data and presents the patterns in the data that drive the paper's main results. Section 5 presents and interprets the econometric analysis. Section 6 concludes.

2. Governance Structure, Institutional Features, and Trends in the Trucking Industry

The first part of this section discusses distinctions among private, contract, and common carriage. Although changes in regulatory policy have blurred distinctions among private, contract, and common *carriers*, distinctions among private, contract, and common *carriage* remain sharp and

[2]See Wittekind (1996), Fernandez (1996), Nickerson and Silverman (1996). The latter two emphasize issues related to asset specificity.

[3]This includes Felton and Anderson (1989), Friedlander and Spady (1981), Keeler (1989), Moore (1975), Rose (1985, 1987), Rothenberg (1994), Winston, et al (1990), Ying and Keeler (1991), and Zingales (1998).

are related to the industry's regulatory heritage. I then describe regulations which applied to common, contract, and private carriers before deregulation and the regulatory reforms which were implemented between the mid-1970s and the early 1990s. These changes have led to more efficient production under each of the three governance forms, and may also have changed their efficiency relative to each other. The rest of the section describes several recent industry trends. Together with the discussion of regulatory policy, this helps frame the empirical results.

Governance Structure, Regulation, and Deregulation

Three classes of governance structure are used in the trucking industry: private carriage, contract carriage, and common carriage. These correspond to situations where the terms of trade between carriers and shippers take the form of vertical integration, long-term contracts, and spot arrangements. Private carriage is when shippers haul their own goods. The terms of trade in contract and common carriage differ both in the length of the agreement and its specificity to shipper-carrier combinations.

Bills of lading contain the terms of trade under common carriage. These documents cover individual shipments and are largely standardized. They commonly contain the names of the shipper and carrier, the origin and destination, the volume, the type of commodity, the price (or "rate"), whether the shipment is prepaid or collect, and any equipment or handling requirements (such as for refrigerated or fragile goods). They also contain standard provisions which describe the extent of carriers' liability. They generally do not contain provisions which specify delivery times or schedules.[4]

Motor carrier contracts contain the terms of trade under contract carriage. These cover multiple hauls, and usually contain more or more detailed provisions regarding the responsibilities of carriers and shippers than bills of lading. For example, they often contain take-or-pay provisions which guarantee carriers minimum freight volumes. They may specify delivery windows and the penalties which apply when shipments are late. They may also contain provisions which restrict carriers' ability to use equipment to serve other shippers. Such provisions serve to "dedicate" part

[4]For example, the Uniform Straight Bill of Lading put forth by the American Trucking Associations states: "Unless arranged or agreed upon, in writing, prior to shipment, carrier is not bound to transport a shipment by a particular schedule or in time for a particular market, but is responsible to transport with reasonable dispatch."

of carriers' fleets to individual shippers. Finally, motor carriage contracts sometimes describe how carriers and shippers intend to exchange information: the format, content, frequency, and mode of communication. Such terms can facilitate the adoption of electronic data interchange (EDI) systems.[5] Contract carriage agreements' incentive-aligning features mean that they often support higher quality service than common carriage agreements.

Distinctions among the three governance forms have changed little over time, and follow distinctions laws and regulations made among firms when the industry was heavily regulated (roughly, between 1935 and 1980). During this time, firms were generally precluded from hauling goods under more than one governance form.

Common carriers were for-hire trucking firms which agreed to haul regulated commodities between states on a non-discriminatory basis according to rates that they filed with the Interstate Commerce Commission (ICC), the regulatory body responsible for the industry.[6] Common carriers were required to obtain operating authority to legally haul specific classes of regulated commodities between specific city-pairs or regions. Incumbent firms' ability to contest new applications meant that entry was rare. Common carriage rates were regulated by the ICC. Rate regulation generally took the form of price floors. Rate changes required 30-day notice and could be contested by competitors. Firms were permitted to review each others' rates in "rate bureaus" which were exempt from antitrust laws. These organizations facilitated collective rate-setting.

Contract carriers were firms which supplied high-volume or specialized carriage of regulated commodities to a limited number of shippers under long-term arrangements. Unlike common carriers, contract carriers were not restricted to offer the same services or prices to all shippers. Entry and prices were regulated by the ICC, but regulation was somewhat less stringent than for common carriers. Entry was more difficult to contest, and service heterogeneity made price regulation more complicated. Contract carriage rates could, however, be contested by competitors. The ICC tended to uphold rate protests, particularly when they came from incumbent common

[5]Braunschweig, Crum, and Allen (1995) report survey results which indicate that minimum volume, service quality, and dedicated service provisions are common elements of motor freight contracts.

[6]"Regulated commodities" included all commodities save those specifically exempt from ICC regulation. The most important classes of exempt goods included raw agricultural goods and newspapers. Hauls which crossed state lines but were within a single metropolitan region generally also were exempt from ICC regulation.

carriers. Federal law and ICC regulations restricted the scope of services contract carriers could supply and the number of shippers they could serve. Contract carriers could provide specialized service that common carriers would not supply, or service in which part of their fleet was reserved for the exclusive use of individual shippers. These restrictions prevented contract carriers from providing close substitutes to common carriage. They were allowed to serve a maximum of eight shippers (the "rule of eight"). This prevented many contract carriers from achieving scale economies.

Private carriers were firms which hauled their own goods. As long as they provided service that was considered incidental to their primary, non-transportation-related business, they were exempt from Federal regulation. They were generally precluded from hauling other firms' goods to fill "backhauls" (return trips) or to otherwise utilize their excess capacity. Private carriers also could not hire individuals who owned their own trucks – owner-operators – as subcontractors. Such arrangements only would have been legal when owner-operators had operating authority for the routes they would cover, which was rare.

Exempt carriers specialized in hauls for which ICC regulation did not apply. These included hauls of non-regulated commodities and hauls which did not cross state boundaries or were entirely within single metropolitan areas.

The ICC began the process of deregulation with a series of administrative decisions taken during the late 1970s.[7] Congress codified and extended these decisions with the passage of the Motor Carrier Act of 1980; the provisions of this act were implemented by the ICC during the early 1980s. Regulatory changes largely removed competitors' ability to contest entry and rates, reduced carriers' ability to use rate bureaus as forums for collective rate-setting, and enabled firms to adjust rates within a relatively wide range without prior ICC approval. Other reforms removed contractual restrictions. The most important of these rescinded the rule of eight, allowed carriers to haul goods under more than one governance form, and permitted firms operating private fleets to lease both drivers and equipment from non-regulated third parties such as owner-operators and equipment leasing firms ("single-source leasing"). These contractual reforms allowed firms supplying contract

[7]This section relies heavily on accounts from ICC Annual Reports during the 1980s. See also Rothenberg (1994).

carriage to achieve new economies of scale and led to new classes of entrants into contract carriage. Many firms which previously specialized in common carriage began to offer contract carriage service as well.[8] Removal of the prohibition on "single-source leasing" facilitated entry of leasing firms into the market for contract carriage. Single-source leasing arrangements between shippers and firms such as Ryder frequently led to more extensive subcontracting arrangements in which shippers outsourced dispatch and sometimes other logistics-related functions to leasing firms.

Many of the most dramatic and immediate effects of deregulation are well-documented. Industry structure changed quickly during the early 1980s as firms entered new markets and inefficient firms exited. The number of regulated motor carriers nearly doubled between 1980 and 1985. Rates decreased, particularly for truckload hauls. Productivity and service quality increased. In general, regulatory changes between 1975 and 1984 led to more efficient production under each of the three governance forms. The extent to which these changes affected their relative efficiency is an empirical issue.

Regulatory reforms during the second half of the 1980s were minimal. The main issue faced by the ICC was the so-called "undercharge crisis." Starting in the middle of the decade, bankrupt carriers began to sue their former customers, claiming that the rates they had negotiated (often years past) did not apply because the agreements were neither filed with the ICC as common carriage rates nor were part of agreements which met the stipulations of a motor carriage contract under transportation law. The plaintiffs sought the difference between the negotiated rate and the applicable common carriage rate. The ICC adopted a series of policies in which they ruled in favor of shippers when they could provide documentation of a negotiated rate, regardless of whether the agreement qualified as a motor carriage contract. However, in 1990, the Supreme Court struck down the "negotiated rates policy" on the grounds that the ICC did not have jurisdiction to override transportation law in such a manner. In response, the ICC eliminated all regulations governing motor carrier contracts in May 1992. Agreements between shippers and carriers were covered by general

[8]One regulation which survived through the early 1990s made it illegal for for-hire carriers to haul goods under contract and common carriage authority with the same truck at the same time. This is useful empirically, because it means that individuals at for-hire trucking firms were keenly aware which individual trucks were used for contract and common carriage. Data regarding the governance form covering hauls made by individual trucks are probably quite reliable.

contract law rather than transportation law. This formalized ICC policy by abolishing regulatory requirements that contracts be written. In late 1993, Congress passed the Negotiated Rates Act, which effectively restored the provisions that contracts be written, but provided the ICC jurisdiction for adjudicating undercharge claims.

The series of actions taken by the ICC and Congress were not substantive policy changes. Instead, they closed loopholes that opportunistic firms attempted to exploit. Nevertheless the undercharge crisis may have affected firms' choice of governance form. It may have led shippers seeking volume discounts to obtain them in writing or in more detailed agreements, thus moving them from common to contract carriage. However, it is not obvious that the undercharge crisis or its resolution affected the net benefits of using different governance structures heterogeneously for hauls which used different types of trailers or in different regions. I downplay the role of the undercharge crisis when interpreting the results because the main conclusions are based on changes in cross-sectional patterns over time.

Other Trends in the Deregulated Trucking Industry

The Organization of Logistics

One of the most-noted organizational trends over the last fifteen years has been the adoption of coordination-intensive production and supply chain management practices. These include just-in-time inventories (JIT), lean retailing, and modern manufacturing. Firms adopting these practices may place a premium on being able to coordinate closely with carriers as well as their suppliers or customers. They typically value short lead times, small delivery windows, and more frequent, detailed, or timely exchanges of shipment information. Anecdotal evidence suggests that adoption of such practices tended to be greater further down supply chains.[9] To the extent adoption of such practices raises shippers' valuation of high quality, information- and coordination-intensive shipping, and high quality shipping requires carriers or shippers to invest in relationship-specific assets, it may lead shippers and carriers to use longer-term governance structures.

EDI

[9]Unfortunately, while there are many case studies describing firms' adoption of JIT or similar practices, to my knowledge there has been no systematic study of the diffusion of such practices throughout the economy. If no such study exists, this represents a serious gap.

Declines in the price of information and communication technology led to the diffusion of Electronic Data Interchange (EDI) in the trucking industry beginning in the mid-1980s. EDI-capable trucking firms can exchange orders, bills of lading, and many other pieces of information electronically rather than by phone, mail, or facsimile. Electronic exchanges lower costs by eliminating reentry of data, and facilitate closer communication and coordination by providing a means by which firms can send and receive information in a more timely fashion. Adoption of EDI may involve investments that are specific to individual trucking firms or shippers, particularly when systems are not standardized. Although industry standards have begun to emerge, many early systems had proprietary features, and many continue to do so.

A series of papers by Crum, Allen, and others analyze surveys of large for-hire trucking firms, and provide some empirical evidence regarding the diffusion of EDI.[10] These studies produce several stylized facts. Very few for-hire trucking firms offered EDI during 1984. By 1990, most large for-hire trucking firms used EDI with some of their shippers, but most medium-sized firms did not.[11] Firms with EDI capabilities used them with only about 15% of their shippers on average, and for only about 18% of their business. Adoption of EDI involved relatively low initial investments for most of the firms in their sample – only $15,000 at the median. Annual operating costs were of about the same magnitude. Proprietary formats were common, and most EDI-capable firms reported using multiple formats to serve different shippers. However, these studies find no relationship between EDI use and contract length, and do not find differences in contract length associated with whether proprietary or standard formats were used. Although one cannot completely rule out relationships between changes in governance form and EDI diffusion, these studies do not provide evidence that suggests that such relationships are strong.

On-Board Computers

Two classes of on-board information technology (IT) have diffused in the trucking industry since the late 1980s: trip recorders and electronic vehicle management systems (EVMS). Trip recorders record variables which reflect the operation of the truck. These variables include speed,

[10]Johnson, Allen, and Crum (1992), Allen, Crum, and Braunschweig (1992), Crum and Allen (1996).

[11]Large trucking firms are defined here as those with more than $25 million in annual revenues; medium-sized trucking firms are those with between $5-25 million.

idle time, sudden accelerations or decelerations, and when trucks were turned on and off. Dispatchers receive the data trip recorders collect after trucks return to their base. EVMS record trucks' location as well as operating variables, and can transmit the data they collect to dispatchers along wireless networks. Dispatchers can receive the data EVMS collect in close to real time. EVMS also provide a means by which dispatchers can initiate communication with drivers while they are in their truck, even when they are outside of two-way radio range (approximately 25 miles). Trip recorders provide information which helps dispatchers monitor drivers, but does not help them coordinate schedules in the very short run. EVMS helps dispatchers monitor drivers and coordinate schedules. Coordination improvements may occur both within carriers and between carriers and shippers. For details, see Hubbard (1998).

These devices have been on the market for a relatively short time, but diffusion has been rapid. As late as 1987, less than 1% of tractor-trailers had either of these types of devices installed. By 1992, about 20% did, and anecdotal evidence indicates that this fraction has continued to increase since then.

3. Analytic Framework

This section presents the analytic framework. I assume that shippers and carriers make long-, medium-, and short-run decisions. Shippers' long-run decisions include entry into product markets and any large, sunk capital investments such as manufacturing plants. Similarly, carriers' long-run decisions include terminals and other infrastructural investments. Shippers and carriers make medium-run decisions taking these as given. Medium-run decisions are those which are made over horizons of roughly six months to one year. These include equipment purchases and any long-term contractual arrangements. Equipment purchases determine the size and composition of firms' owned tractor-trailer fleets. Contractual arrangements include those between shippers and for-hire carriers, and between firms and equipment leasing companies. Firms' medium-run decisions determine shipping transactions' governance structure. Shippers and carriers make decisions about equipment purchases and contractual arrangements based on demand forecasts and anticipating that short-run production-related decisions will be profit-maximizing, given the long- and medium-run decisions. These decisions determine, for each product class-distance combination and for each shipper, which hauls are shipped using private fleets, which are shipped under long-term contracts, and which are

shipped under spot market arrangements. When individual firms ship multiple products or ship products different distances, different governance structures may be used for different class-distance combinations. Medium-run decisions also determine how control rights are allocated across shippers, carriers, and equipment leasing firms with respect to the assets used in shipping. Cost minimization on the part of shippers and carriers implies that it is in their mutual interest to choose governance structures and allocate control rights efficiently, where efficiency reflects both production and transaction costs.

Governance structure may vary across hauls for reasons having to do with productive efficiency, particularly if for-hire carriers have a comparative advantage that allows them to serve multiple shippers at a lower cost than non-trucking-specialist private fleets. Unlike, for example, commodity exchanges, markets for motor carriage are not completely centralized. Shippers and carriers acquire information about potential trading partners and prices via search. Shippers may economize on search costs by contacting trucking specialists first. Even when they have similar production cost structures, firms which are not trucking specialists may be at a disadvantage in hauling other firms' goods because it is more costly for them to identify potential demanders; fewer demanders identify themselves.

This advantage tends to be greatest for hauls in which it is efficient to haul multiple shippers' goods on the same run: for less-than-truckload and long distance hauls. The comparative advantage for long distance hauls arises because of the "backhaul problem." Fronthauls (outbound hauls) create capacity for backhauls as a by-product. Carriers incur costs in learning about backhaul opportunities, and take them into account when deciding whether to seek backhauls or simply have trucks return empty. Filling backhauls lowers the effective marginal cost of fronthauls. The trade-off is such that it is rarely efficient to find backhauls for local hauls, but is usually efficient to do so for long distance hauls.[12] Trucking specialists tend to be better able to contract for backhauls directly for the same search-related reasons as for fronthauls. For-hire carriers' comparative advantage tends to be particularly high for long distance hauls as a consequence.

The cost of arranging backhauls may vary systematically with the trailer that is used for

[12]The exception to this is that firms do not actively seek backhauls when fronthauls use highly specific trailers.

fronthauls. Hold-up problems aside, it may be more difficult to line up backhauls for hauls which use trailers that are specific to individual classes of products. Backhaul markets are thinner when trailers are more specialized to uses. Costs thus may differ across trailer type, and by different magnitudes for trucking specialists than non-trucking specialists.

Cross-sectional differences in governance structure may reflect differences in transaction costs as well. Trailer types are specific to product classes in the sense that it is more efficient to use them to haul certain goods than others. Trailers' physical characteristics makes them specific to uses, although not necessarily users. When alternate users exist, but it is either costly to physically transport the trailer to serve them or it is simply costly to identify them, trailers are specific to users as well. Hold-up problems may arise for familiar reasons. Suppose using a specialized trailer maximizes productive efficiency for a given haul. Using a short-term contract (or a series of short-term contracts) with a for-hire carrier may be costly. If the for-hire carrier were to acquire and utilize productively-efficient specialized equipment, the shipper could appropriate the value of the equipment up to the carrier's cost of finding and serving another shipper. Using less specific equipment alleviates hold-up problems but sacrifices productive efficiency. This may make longer-term arrangements (which, for example, may include take-or-pay provisions) or internal procurement efficient relative to short-term arrangements.

The previous paragraph implies that trailers' specificity to users may be determined by factors other than their physical characteristics. The number and proximity of alternative users matter as well if they are correlated with the cost of finding and serving alternative users.[13] One implication is that specificity may not only differ across trailers, but across regions for individual trailer types as well. It is probably more costly to find an alternative user for a logging trailer in Kansas than in Oregon. The efficient governance structure for hauls which use particular trailer types may thus vary across regions because the density of alternative users varies. Local market conditions – the size and composition of the local shipping market – may affect how individual shippers and carriers organize transactions.

The tone of the discussion so far suggests that managing hauls under longer-term contracts

[13]Pirrong (1993) notes this in the context of ocean shipping markets, and finds evidence that local market thickness is correlated with differences in governance structure.

or internal procurement are the only means of alleviating hold-up problems associated with trailer specificity, if such problems potentially exist. However, it is certainly not the case that amending a haul's governance structure is the only institutional response to hold-up problems. One possibility is that multiperiod incentives discourage parties from behaving opportunistically. Alternatively, shippers may simply own specialized trailers and hire carriers to haul them. Such arrangements are common in the rail industry. (Palay, 1984) This would sharply diminish shippers' ability to hold up carriers. Shippers could lease trailers to carriers for the purpose of the haul. Moral hazard problems could be addressed by including provisions which assign liability for damages (much like arrangements with third party leasing firms) and restrict how trailers can be used.

But alternative institutional arrangements can be costly as well. Multiperiod mechanisms may not work well. New moral hazard problems may arise with respect to trailers' physical condition when for-hire carriers haul goods using shippers' trailers, and may be costly to alleviate. New hold-up problems may also arise within such arrangements. When shippers' trailers are hooked up to other firms' tractors, they are out of shippers' immediate control. Shippers cannot easily redeploy the trailer for hauls which do not use the incumbent carrier. Carriers may be able to hold up shippers by not returning trailers promptly. As a consequence, it may be efficient for shippers to manage hauls as well as own trailers when hauls require specialized trailers.

The empirical framework used in this version of the paper is simple. The specifications examine whether, holding constant shipment distance and size, hauls' governance structure varies with the type of trailer used.[14] They also examine whether, holding these variables constant, the governance of the haul is correlated with measures of local market thickness. These two cross-sectional relationships reflect both the magnitude of hold-up problems and the costs of using only organizational instruments other than the governance of the haul to alleviate such problems. If hold-up problems associated with trailers did not exist, or could be solved cheaply with instruments other than the governance of the haul, trailer characteristics would only be correlated with governance structure for reasons having to do with productive efficiency. Furthermore, all else equal, governance would be unaffected by local market thickness. Conversely, finding that all else equal,

[14]In specifications not reported in this paper, I have included dummy variables which indicate the class of product trucks haul as explanatory variables as well. None of the results change.

measures of market thickness are correlated with governance form implies both that hold-up problems exist with respect to trailer specificity and that firms use hauls' governance structure to alleviate them. Furthermore, it implies that cross-sectional correlations between trailer type and governance form are likely driven by hold-up related transaction costs as well as production costs.

4. Data

The data are from the 1982, 1987, and 1992 Truck Inventory and Use Survey (TIUS). The TIUS is a mail-out survey taken by the Bureau of the Census as part of the Census of Transportation. This survey is sent to a random sample of truck owners, and asks questions about trucks' characteristics and use. Characteristics include truck type (e.g., pick-up, truck-tractor), make, model, and equipment. Use variables include how far from home the truck operates, what kind of trailer it is commonly attached to, and what classes of products it normally hauls. It also asks whether trucks are part of private or for-hire fleets. If trucks are for-hire, it asks what percentage of the time they operate under contract and common carriage. This paper uses only observations of truck-tractors – the front halves of tractor-trailer combinations – and excludes truck-tractors used primarily for personal transportation, which are rented out by the day, which are used to haul waste, or which are not used to haul goods (for example, they are used to transport trailers which have cranes or large winches permanently attached). It also excludes the small fraction of trucks which are mainly used for exempt carriage. The final sample includes 17,347 trucks from 1982, 21,236 from 1987, and 32,015 from 1992.[15]

Table 1 shows basic patterns in contractual form during 1992.[16] Trucks are classified according to whether they were primarily used for common, contract, or private carriage. Overall, about 55% are used for private carriage. Slightly over half of the rest are used to haul goods under common carriage agreements. The bottom of the table breaks out these shares according to the type of trailer to which trucks are normally attached. "Specialized vans" include insulated, non-refrigerated vans, drop frame (side-loading) vans, and open top vans. "Specialized trailers" includes

[15]The Survey oversamples trucks registered in less-populous states. All of the analysis in this paper uses the weights provided by the Census to adjust for oversampling.

[16]Because the data are of trucks rather than hauls and the calculations do not adjust for differences and changes in intensity of use, the shares in tables 1 and 2 do not indicate output shares. Rather, they reflect capacity shares.

all trailer types not otherwise classified: grain bodies, livestock trailers, and logging trailers are the most common in this category. Trucks which are commonly attached to basic vans tend to operate under short-term arrangements more than trucks which are attached to most other trailers. Hauls which use specialized trailers and dump trailers tend to take place under private carriage.

Private carriage share is lowest for trucks commonly attached to auto trailers. This is surprising given that auto trailers are highly specific to uses. Interviews with various industry sources indicate that auto makers historically have been extremely averse to operating private fleets for reasons having to do with union relations. They are effectively constrained by the United Auto Workers to haul vehicles using unionized workers. However, they have been reluctant to do so in-house because they would then have to negotiate directly with the Teamsters. This has led to a situation where auto makers hire outside firms, often located cheek-by-jowl to plants, under long-term arrangements to haul their output. Throughout this paper, governance patterns with respect to hauls using auto trailers will appear as the exception to the rest of the analysis. The special institutional environment in which these hauls take place explains why.

Table 2 presents governance shares in 1982, 1987, and 1992. There was little change in the aggregate shares between 1982 and 1987, but a broad movement toward longer-term arrangements between 1987 and 1992. The private carriage share increased by almost five percentage points and the contract carriage share nearly doubled. The general movement toward long-term arrangements in general and contract carriage in particular appears across all trailer types except auto trailers. Hauls using basic vans also moved toward longer-term arrangements between 1982 and 1987, albeit to a much smaller degree. Hauls using the next four trailer types listed, however, moved from private to for-hire between 1982 and 1987. Changes in governance structure between 1987 and 1992 were a break from the period immediately preceding.

Trailer Type, Local Market Conditions, and Contractual Form

I now introduce the variables used to capture cross-sectional differences in local market conditions. One of these is "trailer density." The formula is:

$$TD_{jk} = \frac{number\ of\ state\ k\ trucks\ with\ trailer\ j\ as\ their\ principal\ trailer}{geographic\ area\ of\ state\ k}$$

I calculate the numerator from the individual observations in the TIUS and the sampling weights provided by the Census. Trucks' state corresponds to where they are based, not where they are registered or where the firm that owns them is headquartered. The denominator comes from the Statistical Abstract of the United States (1998). Trailer density captures both the composition and density of state k's fleet – state k's trailer and truck capacity normalized by geographic area. Because capacity measures reflect aggregate demand, trailer density (and other measures of local market conditions) have demand-side interpretations. The composition of the fleet reflects the composition of shipping demand. Likewise, fleet density reflects the density of shippers.

One can break trailer density down into components which reflect each of these:

$$TD_{jk} = \frac{trailers_{jk}}{area_k} = \frac{trailers_{jk}}{trucks_k}\frac{trucks_k}{area_k} = TS_{jk}TA_k$$

TS_{jk} is "trailer share": the fraction of state k's fleet which is principally attached to trailer type j. TA_k is trucks/area for state k. Note that $\ln(TD_{jk}) = \ln(TS_{jk}) + \ln(TA_k)$. This decomposition is analytically convenient for two reasons. First, it indicates that including ln(TD) in a model to capture differences in market thickness is identical to including both ln(TS) and ln(TA) and restricting their coefficients to be the same. One can test this restriction by including ln(TS) and ln(TA) separately and testing the equality of the coefficients. Finding differences implies that the composition and size of the market (as measured) affect governance structure differently. Second, it implies a simple way to measure the effects of the composition of the local market even if TD does not accurately reflect differences in local market thickness. One reason why TD is an imperfect measure is that it does not capture cross-state differences in the agglomeration of shipping markets (and economic activity in general). It makes markets look thin in states where there are both large cities and large open spaces (such as Texas and California) relative to states where economic activity has a more even geographic distribution (such as most eastern states). This mismeasurement may make it difficult to capture "market size" effects, and may bias the estimates of "market composition" effects in specifications which include ln(TS) and ln(TA). The decomposition suggests that one can control for cross-state differences in agglomeration by replacing ln(TA) with state fixed effects.

Tables 3-5 depict relationships between governance structure and both TA and TS during

1992. Table 3 reports private and common carriage shares for the bottom and top five states ranked by trucks/area. Trucks/area is lowest in unpopulated western states and is highest in eastern states.[17] % Private and % Common vary considerably among the states classified as "bottom five" and "top five." % Private tends to be higher for the "bottom five" than the "top five," but there is no difference for % Common. These figures suggest that shippers tend to haul their own goods in states with small trucking fleets relative to their geographic area. However, conditional on outside procurement, common carriage is not less prevalent than in states in which trucks/area is large.

Table 4 summarizes within-state trailer shares. Averaging across states, the mean share of basic vans is 29.2%. The mean share is lower for hauls using more specialized equipment, particularly for those grouped in "specialized vans" and "specialized trailers." For each trailer type, trailer shares vary considerably across states. This is particularly true for the most common trailer types. Basic vans' share ranges from 6.7% in Wyoming to 54.4% in Tennessee. The shares of refrigerated vans, platforms, and dump trailers vary considerably as well. The states in which the shares of the "specialized trailers" are highest are regions from which shipments of autos, grain, livestock, and logs tend to originate. Trailer shares reflect cross-sectional differences in what is shipped from each state. The right two columns show the class of products most commonly shipped on each trailer type, and a Herfindahl-like measure of trailers' specificity to product classes. The latter is constructed as follows. I classify the trucks according to trailer type, then within each class, I calculate the fraction which are used to primarily transport each product class in the data. Call this fraction s_{ij}, where i indexes the trailer type and j indexes the product class.[18] The concentration measure is $H_i = \sum_{j=1}^{J} s_{ij}^2$, where J is the number of product classes. This rough measure confirms the intuition that basic vans and platforms are least specific to product classes, and the trailers listed under "specialized trailers" are the most specific.

Table 5 shows the fraction of trucks which operate under private and common carriage, by trailer type, in 1992. The left column of each panel reports these fractions calculated across the

[17] Alaska is an outlier in both trucks/area and trailer density. None of the empirical results in section 5 change when omitting trucks based in Alaska.

[18] "Product classes" are those in Hubbard (1998). They are broadly defined: for example, "processed food," "building materials," "transportation equipment."

entire sample. Setting aside auto trailers, the fraction which operate under private carriage is strongly correlated with specificity to product class, as measured above. Basic vans operate under private carriage the least; specialized trailers do so the most. The right column contains analogous proportions calculated across only the three states for which trailer shares are highest for each trailer type. Private carriage has a much smaller than average share for the "top three states" than the sample mean for all of the vans and tank trucks except drop frame vans. Similar differences do not appear for the specialized trailers. These patterns suggest that make-or-buy decisions are influenced by trailer specificity and, for vans and tank trucks, the composition of the local trailer fleet. The right panel reports analogous common carriage shares. The figures in the left column suggest a relationship between contractual length and trailers' specificity to product classes. Comparing the two columns, common carriage has a higher average share for the "top three states" than the sample mean for all trailer types except platforms. This suggests that contractual form, given outside procurement, is influenced by the composition of the local fleet.

Taken together, Tables 3 and 5 suggest that relationships exist between governance structure and both the size and composition of local shipping markets during 1992. The next section reports results from more sophisticated empirical analysis. These investigate whether the 1992 patterns hold when controlling for additional variables. They also examine whether the cross-sectional patterns differ from those in earlier years. Because the largest aggregate changes in governance structure occurred between 1987 and 1992, the analysis focuses on these two years.

5. Results

Governance in 1992

Table 6 presents results from ordered logits. The dependent variable equals zero, one, and two if the truck was primarily used for common, contract, and private carriage, respectively. Let y represent an index of hauls' propensity toward long-term arrangements, where $y = X\beta + \quad$. Let $\quad_1$ and $\quad_2$ be thresholds at the margins between common and contract carriage, and contract and private carriage, respectively. This generates the following expressions for the probabilities of each governance form:

$$P(common) = P(y < \theta_1) = P(\beta < \theta_1 \quad X\beta)$$
$$P(contract) = P(\theta_1 < y < \theta_2) = P(\theta_1 \quad X\beta < \beta < \theta_2 \quad X\beta)$$
$$P(private) = P(y > \theta_2) = P(\beta > \theta_2 \quad X\beta)$$

In the first and third panels of Table 6, the thresholds $_1$ and $_2$ are constants and X includes a vector of explanatory variables. Positive estimates of β correspond to variables which are associated with longer-term arrangements. Including variables in X is equivalent to including them in linear specifications of both $_1$ and $_2$, but restricting the parameter estimates on each variable to be the same across the thresholds. I relax this restriction in the specifications in the second and fourth panels by allowing $_1$ and $_2$ to vary separately with each explanatory variable. In these specifications, I report the results after multiplying each of the parameter estimates on these variables by -1. I do this to maintain the convention that positive coefficients imply longer-term arrangements. (Factors which decrease the margins increase the probability of longer-term arrangements.)

The specification reported in the first panel uses dummies which indicate how far trucks operated from their home base, the class of trailer to which they were most commonly attached, and whether they were used to haul multiple shippers' goods at the same time ("mixed cargo") as explanatory variables.[19] The mixed cargo dummy is negative, significant, and large; trucks which haul general freight are rarely part of private fleets, and generally haul under common carriage. The distance dummies become more negative as trucks operate farther from home. Shorter-term arrangements are used for longer hauls. The magnitude of the distance coefficients imply that factors other than asset specificity affect the terms of trade between shippers and carriers in important ways. The coefficients on the trailer dummies are of primary interest. The omitted trailer dummy is "basic van." All but the tank truck and auto trailer coefficients are positive and significant. Controlling for distance and whether trucks haul mixed freight, trucks which haul goods using "specialized trailers" operate under longer-term arrangements more than trucks which do so using other types of trailers. Trucks which are attached to refrigerated or specialized vans, platforms, and dump trailers do so more than those which haul goods in basic vans or tank trucks. In the second panel, the parameter estimates on all of the trailer dummies except "auto trailer" are very similar with respect to the two margins. Figure 1 summarizes the predicted governance probabilities implied by these estimates, holding variables other than the trailer dummies at their sample means. The predicted probability

[19]Distance from home is reported as a set of dummies in the data. The classifications are more detailed in the 1992 data than in the 1987 data. In specifications which use data from both years, I use the 1987 classifications.

that trucks attached to basic vans are part of private fleets is 0.47. This figure is 0.77 for specialized trailers, 0.62 for refrigerated vans, 0.61 for specialized vans, and 0.56 for platforms. The pattern is similar when looking at the predicted probability trucks haul under common carriage. Taken together, these results are evidence against the proposition that governance is unaffected by trailer type. They suggest that trailers' specificity to uses affects governance in ways implied by transaction cost theory.

The third and fourth panels add ln(trailer density). The coefficient on this variable is negative and significant in each specification, and about the same magnitude at both margins. Trucks which haul goods using trailers which are locally (or regionally) uncommon tend to operate under longer-term arrangements. The magnitude of the coefficient is not large, however. Holding all other variables at their sample means, doubling trailer density decreases the probability trucks are part of private fleets by only 3.3 percentage points, or about 7 percent.[20] The trailer dummy coefficients decrease relative to those in the first two panels, but have a similar pattern. The fact that differences remain after including ln(trailer density) may reflect that trailer density imperfectly captures differences in market conditions across trailer-region combinations.

Table 7 contains results from specifications which include interactions between ln(trailer density) and the trailer dummies, and which replace ln(trailer density) with ln(trailer share) and ln(trucks/area). In the first panel, the point estimates of all of the interaction coefficients are negative at both margins, and most are statistically significantly different from zero. The relationship between governance and trailer density generally holds within trailer types. Looking at the estimates on the contract/private margin, five out of seven of the coefficients are negative and significant, but there is no relationship between trailer density and the make-or-buy decision for hauls which use "specialized trailers" or "specialized vans." Hauls which use these trailers tend to be completed by private fleets regardless of local market conditions.

The results in the second panel provide evidence that relationships between governance and trailer density reflect relationships between governance and the composition of local demand more than overall market size. The coefficient on ln(trailer share) is negative, significant, and statistically

[20]For most trailer types, doubling trailer density is about equivalent to moving from the 25th to the 50th percentile, or from the 50th to the 75th percentile state.

larger than that on ln(trucks/area) at both margins. Increasing trailer density by increasing trailer share (and holding trucks/area constant) has a larger effect on the governance of individual hauls than doing so by increasing trucks/area (and holding trailer share constant). The coefficient on ln(trucks/area) is negative and significant at the contract/private margin, but not the common/contract margin. This provides evidence that overall market size is associated with differences in the make-or-buy decision, but not the terms of trade given outside procurement. In specifications not shown here, I replace ln(trucks/area) with state fixed effects. The coefficients on ln(trailer share) fall in absolute value by about 20% to -0.317 and -0.181, respectively, but none of the qualitative conclusions change.

To summarize, analysis of the 1992 data provides strong evidence of relationships between both trailers' general specificity to uses and local market conditions and governance. Internal procurement tends to be used when hauls require trailers that are specific to product classes. When such hauls are not supplied internally, shippers and carriers tend to use long-term contracts. Conditional on trailer type, longer-term arrangements tend to be used more in states where the trailer is uncommon relative to the rest of the local fleet. This relationship is somewhat stronger at the margin between common and contract carriage than at that between contract and private carriage. Conditional on the composition of the local fleet, internal procurement is more likely in states where few trucks are based relative to their geographic area. Local market conditions tend to be a contributing, but not necessarily defining factor in how hauls are governed. For example, relatively large differences in "trailer density" – interquartile changes – are only associated with differences on the order of 5-10% in the probability shippers haul their own goods. Firms appear to use hauls' governance structure to alleviate hold-up problems associated with asset specificity. But it is important to keep in mind that other factors such as trucking specialists' (possibly search-related) comparative advantage have a large influence on hauls' governance.

1987 Patterns, and 1987-1992 Changes

Table 8 contains estimates from specifications which use the 1987 and 1992 data. I interact all explanatory variables except the mileage dummies with a dummy variable which equals one when observations are from 1992 and zero otherwise.

The (non-interacted) estimates in the top half reflect cross-sectional patterns during 1987.

The first panel restricts the parameter estimates to be the same across the two margins. The estimates on the trailer dummies are different than in the analogous 1992 specification (table 6, panel 3). Like in 1992, the "specialized trailer" coefficient is significantly greater than zero; hauls using these trailers are more likely to be governed by long-term arrangements. However, unlike 1992, those on the refrigerated van, platform, and dump trailer dummies are not; in fact, these are *negative* and significant. Hauls using these trailers were less likely to be governed by long-term arrangements than those using basic vans. The correspondence between trailers' general specificity to uses and governance is weaker in 1987 than in 1992. The coefficient on ln(trailer density) is negative and significant, and about the same magnitude of the 1992 estimate discussed earlier. The second panel allows the parameter estimates to differ across the margins; except for the coefficient on auto trailer, none of the estimates in the top half of the table differ much from those in the first panel. The third panel breaks ln(trailer density) up into its components. The parameter estimates on ln(trailer share) and ln(trucks/area) are of similar to each other, and are similar across the two margins.

The estimates in the bottom half of the table reflect changes in governance between 1987 and 1992. In the first panel, the parameter estimate on the interaction with C1 (the common/contract threshold) is negative and significant; that on the interaction with C2 (the contract/private threshold) is positive and significant. These reflect the general increase in contract carriage. The parameter estimates on most of the trailer dummies are positive and significant. Hauls using refrigerated vans, platforms, specialized trailers, tank trucks, and dump trailers moved more toward long-term arrangements than hauls using basic vans. The estimates in the second panel examine whether the patterns hold across both margins. These indicate that hauls using basic vans move from common to contract carriage during this time but hauls using most other trailers are moving across this margin even more. Hauls using basic vans move from private to contract carriage – toward outside procurement. However, subtracting the estimate on the C2 interaction from those on the trailer dummy interactions, hauls using most other trailers are moving the other way across this margin: toward internal procurement.

Table 9 summarizes the implications of these estimates. The first two panels report predicted probabilities of common and private carriage, respectively, assuming mixed cargo=0 and that the distance from home dummies are at 1987 sample means. Hauls using most trailer types moved

toward longer-term arrangements in general between 1987 and 1992. The predicted probability (truckload) hauls using dump trailers were governed by spot arrangements declined from 0.34 to 0.21; the predicted probability such hauls were procured internally increased from 0.48 to 0.57. The patterns are as if the thresholds which determine the margins between common and contract carriage and between contract and private carriage both decreased substantially. Similar changes in the thresholds are estimated for hauls using refrigerated vans, tank trucks, platforms, and specialized trailers. As suggested by the parameter estimates in table 8, hauls using basic and specialized – collectively, non-refrigerated – vans are the interesting exceptions. The predicted probabilities decrease for both common and private carriage. The patterns are as if the common/contract margin decreased and the contract/private margin increased.

The third panel of table 8 shows how the relationship between governance and local market conditions changed over time. Both of the coefficients on the ln(trailer share) interactions are negative and significant; the relationship between the composition of the local market and hauls' governance grew stronger between 1987 and 1992. Point estimates on the ln(trucks/area) interactions are positive; that with respect to the common/contract margin is statistically significant. Sorting at this margin was such that firms chose longer-term arrangements more in states with large trucking fleets relative to their area.

This analysis provides evidence of two important empirical patterns. First, hauls sorted among governance forms so that there was a stronger relationship between governance and trailer specificity in 1992 than in 1987. This is true both with respect to trailers' general specificity to uses and with respect to the degree to which trailers are common relative to the rest of the local market. Theory can explain the 1992 patterns more easily than the 1987 patterns; this suggests that some of the changes in governance during this time was due to the relaxation of constraints.

Second, the net effect of governance changes was different for hauls using non-refrigerated vans than other hauls. Hauls using non-refrigerated vans moved away from both common and private carriage to contract carriage. This pattern cannot be due solely to demand-side phenomena, assuming that demand-side factors would move hauls toward or away from long-term arrangements in general. It implies that some of the important changes that took place on the supply side were specific to contract carriage and were particularly relevant for hauls using non-refrigerated vans. The

patterns may reflect long-run adjustments to the elimination of the rule of eight. One advantage of outside procurement is that for-hire trucking specialists can aggregate demands of multiple shippers at low cost. Elimination of the rule of eight would have had the greatest effect where trucking specialists' comparative advantage was greatest: that is, where differences in carriers' information about demand had the greatest impact on their ability to aggregate demands. This may explain why during a time in which the general trend was toward longer-term arrangements, shippers began to use for-hire carriers more for hauls using non-refrigerated vans.

Attributing changes which occurred between 1987 and 1992 to regulatory changes which were first implemented during the early 1980s begs the question: why the lag? One answer is that efficient entry into contract carriage involved entry into new product markets rather than just geographic markets. One reason efficiency improvements in common carriage came relatively quickly was that many of the new, efficient entrants were existing carriers which expanded into new geographic markets. Reforms which relaxed restrictions on contract carriage also enabled entry by a new class of entrants with the potential to be more efficient than incumbent suppliers: firms with large fleets. For these new entrants, entry into contract carriage was more complicated than expanding existing service to serve new geographic markets. It involved the development and introduction of a new product. It is unlikely that these entrants were able to operate as efficiently soon after entering contract carriage markets as they could later on.

Another explanation of the lag is that changes in the efficiency of for-hire carriage – particularly high-quality for-hire carriage – were facilitated by the emergence of new technologies which were not yet available immediately after regulatory reforms were implemented. Preliminary evidence from other, related research indicates that the hauls which moved from private to common carriage between 1987 and 1992 were also those for which electronic vehicle management systems were adopted at high rates. Improvements in the efficiency of contract carriage between 1987 and 1992 may be attributable in part to these devices. The fact that the efficiency of contract carriage improved disproportionately relative to private carriage during this time may reflect that EVMS served to enhance for-hire carriers' comparative advantage in aggregating the demands of different shippers.

6. Conclusion

This paper presents empirical evidence about governance structure in the deregulated trucking industry. I find evidence that during 1992, firms used hauls' governance structure to alleviate hold-up problems associated with trailer specificity. This evidence appears both when considering the make-or-buy decision and the contractual form, given outside procurement. The magnitudes of the relationships imply that specificity is a moderately important determinant of hauls' governance structure.

Differences in the 1987 and 1992 cross-sectional patterns suggest that the trucking industry was adjusting to changes in regulatory policy during this time. Some of these adjustments may have been long-run responses to regulatory changes that were implemented well before 1987. In particular, deregulation-induced efficiency improvements in contract carriage may have involved long-run changes which took years to occur and may have been enhanced by technological adoption. This paper does not seek to provide a complete account or evaluation of the benefits of interstate trucking deregulation. However, one clear implication of its results is that researchers who seek to do so should account for adjustments that took place in the late 1980s and early 1990s as well as those which took place in the early 1980s.

References

Braunschweig, Charles D., Michael R. Crum, and Benjamin J. Allen, "Evolution of Motor Carrier Contracting," Transportation Quarterly, Spring 1995, 99-115.

Bureau of the Census, Truck Inventory and Use Survey: 1992, G.P.O, Washington, 1992.

Felton, John Richard, and Dale G. Anderson, Regulation and Deregulation of the Motor Carrier Industry, Ames, Iowa State, 1989.

Fernandez, Alberto, "Virtual Integration and Incentive Intensity in the Trucking Industry," mimeo, 1997.

Friedlander, Ann F., and Richard Spady, Freight Transport Regulation, Cambridge, MIT, 1981.

Grossman, Sanford, and Oliver Hart, "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration," Journal of Political Economy, 94:691-719.

Hubbard, Thomas N., "Why is Process Monitoring Valuable: The Use of On-Board Information Technology in the Trucking Industry," NBER Working Paper #6482, 1998.

Joskow, Paul L., "Vertical Integration and Long-Term Contracts: The Case of Coal-Burning Electric Generation Plants," Journal of Law, Economics, and Organization, Spring 1985, 33-80.

Joskow, Paul L., "Contract Duration and Relationship-Specific Investments: Evidence from Coal Markets," American Economic Review, March 1987, 168-85.

Keeler, Theodore E., "Deregulation and Scale Economies in the U.S. Trucking Industry: An Econometric Extension of the Survivor Principle," Journal of Law and Economics, October 1989, 229-53.

Klein, Benjamin, Robert Crawford, and Armen Alchian, "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process," Journal of Law and Economics, 21(2), 297-326.

Moore, Thomas Gale, "Deregulating Surface Freight Transportation," in Promoting Competition in Regulated Markets, ed. Almarin Phillips, Brookings, Washington, 1975.

Nickerson, Jack A., and Brian S. Silverman, "Determinants of the Employment Relation in For-hire Trucking," mimeo.

Palay, Thomas M., "Comparative Institutional Economics: The Governance of Rail Freight Contracting," Journal of Legal Studies, June 1984, 265-87.

Pirrong, Stephen Craig, "Contracting Practices in Bulk Shipping Markets: A Transactions Cost Explanation," Journal of Law and Economics, October 1993, 937-976.

Rose, Nancy L., "The Incidence of Regulatory Rents in the Motor Carrier Industry," Rand Journal of Economics, Autumn 1985, 299-318.

Rose, Nancy L., "Labor Rent Sharing and Regulation: Evidence from the Trucking Industry," Journal of Political Economy, December 1987, 1146-1178.

Rothenberg, Lawrence S., Regulation, Organizations, and Politics, Ann Arbor, University of Michigan, 1994.

Williamson, Oliver, The Economic Institutions of Capitalism, New York, Free Press, 1985.

Winston, Clifford, Thomas M. Corsi, Curtis M. Grimm, and Carol A. Evans, The Economic Effects of Surface Freight Deregulation, Brookings, Washington, 1990.

Wittekind, Marybeth, "Firm Adjustment Dynamics and Subcontracting: Evidence from the U.S. Trucking Industry, 1976-93," mimeo, University of Chicago, 1996.

Ying, John S., and Theodore E. Keeler, "Pricing in a Deregulated Environment: The Motor Carrier Experience," Rand Journal of Economics, Summer 1991, 264-73.

Zingales, Luigi, "Survival of the Fittest or the Fattest? Exit and Financing in the Trucking Industry," Journal of Finance, June 1998, 905-38.

Table 1
Contractual Form, by Trailer Type, 1992

	Common	Contract	Private	N
All	24.3%	21.1%	54.6%	32015
Basic Van	36.5%	24.7%	38.8%	9856
Refrigerated Van	20.1%	28.9%	51.1%	3920
Platform	19.9%	22.9%	57.2%	5200
Dump Trailer	15.9%	14.9%	69.2%	2670
Tank Trucks	24.3%	20.6%	55.2%	3224
Specialized Vans	24.3%	18.5%	57.3%	1252
Specialized Trailers	7.7%	6.7%	85.5%	5636
Auto Trailers	38.9%	50.6%	10.5%	257

Table 2
Contractual Form, By Trailer Type
1982, 1987, 1992

	Common Carriage			Contract Carriage			Private Carriage		
	1982	1987	1992	1982	1987	1992	1982	1987	1992
All	38.1%	38.0%	24.3%	10.7%	11.9%	21.1%	51.2%	50.1%	54.6%
Basic Van	55.0%	51.8%	36.5%	11.0%	13.1%	24.7%	33.9%	35.1%	38.8%
Refrigerated Van	33.7%	40.8%	20.1%	12.6%	14.0%	28.9%	53.7%	45.3%	51.1%
Platform	30.6%	37.7%	19.9%	11.5%	11.1%	22.9%	57.9%	51.3%	57.2%
Dump Trailer	20.2%	25.6%	15.9%	13.7%	12.2%	14.9%	66.1%	62.3%	69.2%
Tank Trucks	32.2%	33.9%	24.3%	9.2%	13.7%	20.6%	58.6%	52.4%	55.2%
Specialized Vans	49.2%	37.7%	24.3%	11.0%	8.9%	18.5%	39.7%	53.4%	57.3%
Specialized Trailers	12.1%	13.2%	7.7%	4.9%	5.2%	6.7%	83.0%	81.6%	85.5%
Auto Trailers	53.9%	35.4%	38.9%	33.3%	45.9%	50.6%	12.8%	18.7%	10.5%

	Changes, 1982 to 1987			Changes, 1987 to 1992		
	Common	Contract	Private	Common	Contract	Private
All	-0.1%	1.2%	-1.1%	-13.7%	9.2%	4.5%
Basic Van	-3.2%	2.1%	1.2%	-15.3%	11.6%	3.7%
Refrigerated Van	7.1%	1.4%	-8.4%	-20.7%	14.9%	5.8%
Platforms	7.1%	-0.4%	-6.6%	-17.8%	11.8%	5.9%
Dump Trailer	5.4%	-1.5%	-3.8%	-9.7%	2.7%	6.9%
Tank Trucks	1.7%	4.5%	-6.2%	-9.6%	6.9%	2.8%
Specialized Vans	-11.5%	-2.1%	13.7%	-13.4%	9.6%	3.9%
Specialized Trailers	1.1%	0.3%	-1.4%	-5.5%	1.5%	3.9%
Auto Trailer	-18.5%	12.6%	5.9%	3.5%	4.7%	-8.2%

Note: Includes tractor-trailers only. Uses Census weights.
Source: TIUS 1982, 1987, 1992.

Table 3
Fraction Private, Contract -- Selected States

	Trucks/ Area	% Private	% Common
Bottom Five			
Alaska	0.003	56.4	27.2
New Mexico	0.026	82.3	13.9
Wyoming	0.037	69.2	11.6
Montana	0.042	48.8	33.8
Nevada	0.054	67.3	21.4
Average		64.8	21.6
Top Five			
Ohio	0.905	43.9	22.5
Delaware	1.056	71.8	10.4
Pennsylvania	1.085	52.2	30.4
Rhode Island	1.156	60.7	22.5
New Jersey	2.901	50.6	23.1
Average		55.8	21.8

Table 4

Trailer Shares

1992, by home base state of truck.

Trailer Type	Mean Share	Std. Dev.	Max Share	Top 3 States	Min Share	Bottom 3 States	Top Product	Product Concentration
Basic Van	29.2%	12.2%	54.4%	TN, NJ, WI	6.7%	WY, ID, NM	Processed Food	0.087
Refrigerated Van	11.4%	5.2%	28.9%	UT, NE, MT	3.5%	NM, RI, HI	Processed Food	0.568
Platform	15.4%	4.1%	26.9%	HI, CA, MT	8.8%	NJ, WI, MA	Lumber	0.107
Dump Trailer	8.3%	5.9%	27.0%	NV, HI, WV	2.2%	ME, VT, GA	Building Materials	0.449
Tank Trucks								
Tank Truck/Liquid	7.5%	2.9%	15.0%	LA, VT, WY	3.3%	SD, OR, WI	Petroleum	0.308
Tank Truck/Dry	1.7%	0.7%	3.9%	MT, MD, NV	0.5%	RI, MI, HI	Building Materials	0.319
Specialized Vans								
Insulated Van	1.2%	2.1%	15.1%	UT, MN, ME	0.1%	NH, VT, MD	Processed Food	0.387
Drop Frame Van	2.5%	1.2%	6.0%	MS, CT, CO	0.3%	VT, HI, IA	Household Goods	0.256
Open Van	1.3%	1.3%	5.6%	OR, ID, ME	0.2%	NV, NE, DE	Logs	0.249
Specialized Trailers (selected)								
Auto Trailer	0.7%	0.5%	2.6%	MI, NY, FL	0.1%	IA, WY, WA	Trans. Equip.	
Grain Body	4.5%	5.5%	23.7%	ND, SD, NE	0.2%	ME, CT, WV	Farm Products	0.637
Livestock Trailer	1.7%	2.1%	9.3%	UT, WY, ID	0.1%	RI, MA, IL	Livestock	0.937
Logging Trailer	3.1%	3.5%	12.1%	OR, SC, ME	1.1%	RI, NY, KS	Logs	0.854

Table 5

Contractual Form Proportions, 1992

by Trailer

	Private		Common	
Trailer Type	All States	Top 3 States	All States	Top 3 States
Basic Van	38.8%	23.2%	36.5%	54.2%
Refrigerated Van	51.1%	24.7%	20.1%	40.8%
Platform	57.2%	63.8%	19.9%	18.9%
Dump Trailer	69.2%	63.4%	15.9%	17.6%
Specialized Vans				
Insulated Van	46.7%	10.6%	31.2%	76.3%
Drop Frame Van	55.5%	66.3%	29.8%	30.3%
Open Van	70.7%	50.7%	9.4%	25.9%
Specialized Trailers (selected)				
Auto Trailer	10.5%	9.0%	38.4%	56.6%
Grain Body	80.1%	80.5%	11.9%	12.8%
Livestock Trailer	75.3%	78.3%	16.1%	17.6%
Pole/Logging Trailer	83.1%	71.7%	6.2%	8.1%
Tank Trucks				
Tank Truck/Liquid	55.9%	45.7%	24.7%	28.4%
Tank Truck/Dry	52.6%	35.1%	22.5%	36.0%

Note: "Top 3 States" are the states in which trucks using the specified trailer make up the largest fraction of the state's tractor-trailer fleet.

Table 6

Ordered Logits – 1992

Dependent Variable: Governance Form

Margin	Both		Common/Contract		Contract/Private		Both		Common/Contract		Contract/Private	
	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.
C1	**-2.048**	**0.036**	**-1.650**	**0.041**			**-1.844**	**0.042**	**-1.456**	**0.048**		
C2	**-0.846**	**0.034**			**-0.940**	**0.036**	**-0.639**	**0.041**			**-0.710**	**0.043**
Refrigerated Van	**0.625**	**0.038**	**0.688**	**0.049**	**0.620**	**0.042**	**0.460**	**0.042**	**0.531**	**0.053**	**0.434**	**0.046**
Platform	**0.372**	**0.035**	**0.380**	**0.043**	**0.355**	**0.038**	**0.242**	**0.037**	**0.256**	**0.046**	**0.211**	**0.041**
Specialized Trailer	**1.339**	**0.048**	**1.113**	**0.061**	**1.338**	**0.049**	**1.042**	**0.058**	**0.834**	**0.073**	**1.003**	**0.060**
Tank Truck	-0.021	0.042	-0.066	0.050	0.002	0.044	**-0.259**	**0.049**	**-0.289**	**0.058**	**-0.266**	**0.053**
Specialized Van	**0.530**	**0.064**	**0.466**	**0.077**	**0.564**	**0.069**	**0.164**	**0.076**	0.127	0.090	0.148	0.081
Dump Trailer	**0.192**	**0.050**	**0.165**	**0.062**	**0.174**	**0.052**	-0.105	0.055	-0.023	0.067	-0.055	0.056
Auto Trailer	**-0.973**	**0.090**	**-0.551**	**0.106**	**-2.027**	**0.164**	**-1.352**	**0.099**	**-0.905**	**0.117**	**-2.469**	**0.171**
Mixed Cargo	**-2.341**	**0.052**	**-2.166**	**0.052**	**-2.191**	**0.066**	**-2.373**	**0.052**	**-2.195**	**0.053**	**-2.220**	**0.066**
50-100 Miles	**-0.300**	**0.040**	**-0.142**	**0.050**	**-0.337**	**0.041**	**-0.291**	**0.040**	**-0.130**	**0.050**	**-0.327**	**0.041**
100-200 MIles	**-0.667**	**0.042**	**-0.444**	**0.051**	**-0.701**	**0.043**	**-0.662**	**0.042**	**-0.437**	**0.051**	**-0.697**	**0.043**
200-500 Miles	**-1.103**	**0.038**	**-0.623**	**0.047**	**-1.259**	**0.041**	**-1.098**	**0.039**	**-0.615**	**0.047**	**-1.258**	**0.041**
>500 Miles	**-1.914**	**0.038**	**-1.339**	**0.045**	**-2.277**	**0.042**	**-1.918**	**0.038**	**-1.340**	**0.045**	**-2.286**	**0.042**
Ln(Trailer Density)							**-0.119**	**0.013**	**-0.112**	**0.015**	**-0.134**	**0.014**
-LogL	27562		27061				27519		27013			
N	32015		32015				32015		32015			

Table 7

Ordered Logits – 1992

Dependent Variable: Governance Form

Margin	Common/Contract		Contract/Private		Common/Contract		Contract/Private	
	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.
C1	**-1.490**	**0.057**			**-1.379**	**0.119**		
C2			**-0.672**	**0.054**			**-1.320**	**0.109**
Refrigerated Van	**0.533**	**0.187**	0.295	0.164	**0.262**	**0.060**	**0.337**	**0.052**
Platform	0.186	0.139	**0.268**	**0.120**	0.044	0.051	**0.137**	**0.044**
Specialized Trailer	**0.982**	**0.233**	**1.590**	**0.185**	**0.350**	**0.085**	**0.823**	**0.074**
Tank Truck	0.077	0.157	-0.162	0.144	**-0.761**	**0.074**	**-0.430**	**0.066**
Specialized Van	-0.306	0.369	0.598	0.332	**-0.601**	**0.115**	-0.096	0.105
Dump Trailer	**-1.225**	**0.216**	**-0.543**	**0.176**	**-0.391**	**0.077**	**-0.192**	**0.065**
Auto Trailer	**-1.911**	**0.488**	**-3.926**	**0.817**	**-1.722**	**0.143**	**-2.763**	**0.188**
Mixed Cargo	**-2.187**	**0.053**	**-2.222**	**0.066**	**-2.201**	**0.053**	**-2.219**	**0.066**
50-100 Miles	**-0.125**	**0.050**	**-0.322**	**0.041**	**-0.154**	**0.050**	**-0.333**	**0.041**
100-200 MIles	**-0.432**	**0.051**	**-0.692**	**0.043**	**-0.457**	**0.051**	**-0.701**	**0.043**
200-500 Miles	**-0.604**	**0.047**	**-1.248**	**0.041**	**-0.623**	**0.047**	**-1.259**	**0.041**
>500 Miles	**-1.339**	**0.045**	**-2.281**	**0.042**	**-1.315**	**0.045**	**-2.277**	**0.042**
Ln(Trailer Share)					**-0.385**	**0.031**	**-0.230**	**0.027**
Ln(Trucks/Area)					-0.020	0.017	**-0.099**	**0.016**
Ln(TD)*Ref. Van	-0.099	0.057	**-0.188**	**0.049**				
Ln(TD)*Basic Van	**-0.089**	**0.023**	**-0.152**	**0.023**				
Ln(TD)*Platform	**-0.123**	**0.045**	**-0.125**	**0.038**				
Ln(TD)*Spec. Trail.	-0.067	0.053	-0.003	0.041				
Ln(TD)*Tank	-0.002	0.039	**-0.113**	**0.035**				
Ln(TD)*Spec. Van	**-0.195**	**0.076**	-0.049	0.067				
Ln(TD)*Dump	**-0.470**	**0.065**	**-0.292**	**0.050**				
Ln(TD)*Auto	**-0.311**	**0.099**	**-0.424**	**0.152**				
-LogL		26974				26956		
N		32015				32015		

Table 8

Ordered Logits – 1987 and 1992

Dependent Variable: Governance Form

Margin		Both		Common/Contract		Contract/Private		Common/Contract		Contract/Private	
		Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.	Estimate	Std. Err.
	C1	**-1.538**	**0.047**	**-1.334**	**0.051**			**-1.807**	**0.128**		
	C2	**-0.895**	**0.047**			**-0.937**	**0.049**			**-1.477**	**0.125**
	Refrigerated Van	**-0.184**	**0.059**	**-0.268**	**0.063**	**-0.138**	**0.063**	**-0.302**	**0.073**	**-0.173**	**0.072**
	Platform	**-0.189**	**0.044**	**-0.278**	**0.048**	**-0.145**	**0.047**	**-0.292**	**0.051**	**-0.160**	**0.049**
	Specialized Trailer	**0.649**	**0.069**	**0.574**	**0.077**	**0.661**	**0.071**	**0.525**	**0.098**	**0.608**	**0.091**
	Tank Truck	**-0.579**	**0.063**	**-0.539**	**0.069**	**-0.593**	**0.066**	**-0.586**	**0.090**	**-0.642**	**0.085**
	Specialized Van	0.049	0.090	-0.026	0.096	0.112	0.095	-0.099	0.127	0.037	0.123
	Dump Trailer	**-0.440**	**0.066**	**-0.346**	**0.073**	**-0.463**	**0.068**	**-0.382**	**0.087**	**-0.502**	**0.081**
	Auto Trailer	**-0.861**	**0.116**	**0.297**	**0.139**	**-1.751**	**0.165**	**-0.379**	**0.167**	**-1.832**	**0.186**
	Mixed Cargo	**-2.312**	**0.049**	**-2.211**	**0.049**	**-2.434**	**0.059**	**-2.210**	**0.049**	**-2.433**	**0.059**
	Ln(Trailer Density)	**-0.088**	**0.016**	**-0.080**	**0.017**	**-0.090**	**0.017**				
	Ln(Trailer Share)							**-0.108**	**0.036**	**-0.119**	**0.034**
	Ln(Trucks/Area)							**-0.072**	**0.019**	**-0.082**	**0.019**
1992	C1	**-0.255**	**0.053**	**-0.205**	**0.058**			**-0.553**	**0.171**		
Interactions	C2	**0.281**	**0.054**			**0.260**	**0.055**			**-0.374**	**0.161**
	Refrigerated Van	**0.559**	**0.072**	**0.764**	**0.082**	**0.456**	**0.077**	**0.505**	**0.094**	**0.356**	**0.088**
	Platform	**0.466**	**0.058**	**0.583**	**0.066**	**0.385**	**0.062**	**0.359**	**0.072**	**0.296**	**0.066**
	Specialized Trailer	**0.475**	**0.088**	**0.291**	**0.104**	**0.426**	**0.092**	-0.214	0.129	0.227	0.116
	Tank Truck	**0.404**	**0.079**	**0.305**	**0.089**	**0.417**	**0.084**	-0.182	0.116	**0.235**	**0.108**
	Specialized Van	0.130	0.117	0.151	0.132	0.062	0.124	**-0.593**	**0.172**	**-0.213**	**0.161**
	Dump Trailer	**0.531**	**0.083**	**0.363**	**0.097**	**0.516**	**0.087**	-0.027	0.114	**0.363**	**0.103**
	Auto Trailer	-0.326	0.153	**-0.432**	**0.181**	**-0.573**	**0.238**	**-1.272**	**0.220**	**-0.914**	**0.265**
	Mixed Cargo	**0.016**	**0.070**	0.030	0.071	**0.265**	**0.088**	0.018	0.071	**0.260**	**0.088**
	Ln(Trailer Density)	-0.021	0.020	-0.020	0.023	-0.032	0.022				
	Ln(Trailer Share)							**-0.298**	**0.048**	**-0.137**	**0.044**
	Ln(Trucks/Area)							**0.074**	**0.026**	0.005	0.025
	50-200 Miles	**-0.424**	**0.026**	**-0.294**	**0.030**	**-0.451**	**0.027**	**-0.306**	**0.030**	**-0.456**	**0.027**
	>200 MIles	**-1.519**	**0.026**	**-1.162**	**0.029**	**-1.718**	**0.027**	**-1.155**	**0.029**	**-1.715**	**0.027**
	-LogL	45036		44410				44343			
	N	53251		53251				53251			

Table 9
Predicted Governance Shares, "Margin Changes"

	Predicted Pr(Common)		Predicted Pr(Private)		"Margin Changes"	
	1987	1992	1987	1992	Common/ Contract	Contract/ Private
Dump Trailer	0.34	0.21	0.48	0.57	-0.12	-0.09
Refrigerated Van	0.32	0.14	0.56	0.63	-0.18	-0.07
Tank Truck	0.38	0.26	0.45	0.51	-0.12	-0.06
Platform	0.32	0.17	0.56	0.62	-0.15	-0.05
Specialized Trailer	0.17	0.10	0.74	0.79	-0.06	-0.05
Specialized Van	0.27	0.19	0.62	0.60	-0.07	0.02
Basic Van	0.26	0.22	0.60	0.56	-0.05	0.04
Auto Trailer	0.21	0.24	0.21	0.11	0.03	0.10

Uses estimates from middle panel of Table 8.

Figure 1
Predicted Governance Shares, 1992