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CONTRACTING IN THE ABSENCE OF SPECIFIC INVESTMENTS AND MORAL HAZARD: UNDERSTANDING CARRIER-DRIVER RELATIONS IN US TRUCKING

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Contracting in the Absence of Specific Investments and Moral Hazard: Understanding Carrier-Driver Relations in US Trucking*

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Abstract

This paper considers functions of contracting other than the protection of relationship-specific investments and the provision of marginal incentives, and applies the theory to explain variation in the form of compensation of over-the-road truck drivers in the U.S. Specifically, we argue that contracts in this industry serve to economize on the costs of price determination for heterogeneous transactions. We show that the actual terms of those contracts vary systematically with the nature of hauls in a way that is consistent with the theory. By contrast, we find that vehicle ownership, which defines a driver's status as an owner operator or company driver, depends on driver, but not trailer or haul, characteristics.

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1. Introduction

Over the last twenty years, transaction-cost economics and agency theory have been used to analyze organization and contracting practices in a wide range of industries. Despite significant progress overall in our understanding of organization and contracting practices, however, some industries and practices have resisted such analysis. One such industry is freight hauling. Although a number of authors have analyzed the governance of freight transactions in transaction cost (e,g, Palay, 1984; Pirrong, 1993; Nickerson and Silverman, 1999; and Hubbard, 2001) or agency (Baker and Hubbard, 2000, 2001) terms, neither relationship-specific investments nor incentive alignment — traditionally the focal concerns of these two approaches — provide fully satisfactory explanations for the range of organizational arrangements observed in the industry. Recent efforts to expand the concept of asset specificity to accommodate the use of long-term contracts and vertical integration in freight hauling notwithstanding, the quintessential redeployability of assets used to transport freight, and the short-term, repeat nature of freight transactions, make it hard to believe that protection of relationship-specific investments against appropriation is a dominant concern of freight transactors. Agency theory, meanwhile, seems unable to account for observed variations in some of the industry's most salient organizational features. Differences in driver compensation arrangements, for example, appear to bear little or no relation to the incentive functions traditionally ascribed to compensation schemes in the agency literature: Regardless of the basis on which trucker compensation is determined, the fees truckers ultimately receive for any given haul are (almost always) fixed ex ante and, thus, are unaffected by—and therefore cannot affect—the level of effort the trucker expends carrying out the haul in question.

Without denying the importance of these frameworks in general, we emphasize an alternative motivation for contracting that better relates observed patterns in the governance of freight hauling transactions with the fundamental features of the industry. Specifically, we argue that the central substantive problem in freight transportation generally, and trucking in particular, is the logistical one of assigning heterogeneous drivers and trucks to hauls and that, corresponding to this, a central organizational problem is that of determining the fees that carriers pay drivers for each haul. Our argument is most closely related to the analysis of price determination mechanisms in the transaction cost literature[1] and, more recently, to Oyer's (2000) analysis of managerial compensation, which emphasizes the role of the participation constraint, as opposed to marginal incentives, in agency relationships.

The paper is organized as follows. In the next section, we explain in more detail why we believe asset specificity and marginal incentive concerns, which dominate the existing literature on contracting and organization, do not provide good explanations for the observed variation in governance arrangements in trucking. In section 3, we provide an overview of the trucking industry and describe the coordination and pricing problems inherent therein. In section 4, we develop a more formal model and derive from it a set of testable hypotheses. We describe our data in section 5, followed, in section 6, by our empirical analyses and results. Consistent with the predictions of our model, we find that arrangements for determining driver compensation are related to the heterogeneity of haul attributes: (i) hauls carried by flatbed, refrigerated, and tanker trucks exhibit greater variance in attributes affecting drivers' costs than do hauls carried in standard dry vans, and (ii) drivers of flatbed, refrigerated, and tanker vehicles are more likely, relative to dry van drivers, to be paid a percentage of the carrier's revenue than on the basis of

[1]See Goldberg (1985); Goldberg and Erickson (1987); Williamson (1985); Klein (1992; 1996); Masten (1988); and Crocker and Masten (1991).

mileage. In addition, unlike some previous studies of organization in the trucking industry, we find no significant difference in vehicle ownership associated with the types of trailers drivers pull, suggesting that differences in asset characteristics are not an important determinant of asset ownership in this industry. Driver ownership of trucks does, however, appear to be a function of driver wealth and experience, which is consistent with findings in the literature on self-employment.[2] We discuss implications of our results for the study of organization and contracting issues more generally in the final section.

2. Specific Investments and Incentives in Trucking and Transportation.

Relationship-specific investments. The use of long-term contracts and vertical integration to govern transportation services represents a puzzle to transaction cost economists because the assets involved in transportation typically exhibit none of the four main types of asset specificity identified in the transaction cost literature: physical, site, or human asset specificity and dedicated assets (see Williamson, 1985). The primary physical assets used for hauling freight — ships, barges, trains, trucks, and aircraft — are obviously mobile and are typically general purpose in function. A standard railroad boxcar or a truck trailer, for example, is little more than a covered platform on wheels capable of carrying a wide range of cargo. Each boxcar or trailer, moreover, is essentially interchangeable and can be hitched to and pulled by most any locomotive engine or truck tractor. By the same token, the navigation and cargo-handling skills and knowledge required to operate such equipment, however specialized, are rarely specific to a shipper or carrier.

[2] See, for instance, Dunn and Holtz-Eakin (2000), Evans and Leighton (1989), and Holtz-Eakin, Joulfaian, and Rosen (1994).

To be sure, not all transportation assets are perfectly fungible. Some assets, such as rail lines and loading equipment, may be specific to a particular shipper (see Pittman, 1992; and Saussier, 2000). In addition, vehicles may, on occasion, be designed to carry specific loads for particular shippers, as were automobile carriers and some chemical tank cars in Palay's (1984) study of rail transport. Consistent with the relationship-specific investment hypothesis, the evidence from these studies shows that such assets are more likely to be owned by the shipper or the transaction protected by long-term contract. Nevertheless, the great bulk of freight-hauling assets, even those specially designed to carry a particular type of *cargo*, such as cars or chemicals, are rarely specific to a particular *shipper or carrier.* Yet the governance of transactions supported by these assets varies considerably.

Attempting to resolve this puzzle, several researchers have recently suggested that governance differences in freight transactions might be the result of transitory quasi-rents arising from the temporary lack of substitute trading partners or from "temporal specificity," a condition that occurs when the timing of delivery is so important that the threat of delay becomes a tactic for extracting rents (see, generally, Masten et al. 1991). As Hubbard describes it (2001:372):

> Once a truck arrives at a haul's origin to be loaded, it is costly for the carrier to use that truck to serve another shipper. It must identify an alternative customer and incur time and transportation costs to receive the load. Moreover, it may be costly for the shipper to be served by another carrier, also because of search and time costs.

According to this argument, the size and duration of these transitory quasi-rents will tend to vary over time and with the location and characteristics of cargo: In general, specialized cargo carriers (i.e., vehicles designed to carry a particular cargo but not specific to a particular shipper) will generate larger transitory rents than general-purpose vehicles (Pirrong, 1993). In trucking, refrigerated trailers, specialized car-hauling trailers, and chemical tankers would tend to be less readily available on short notice than general-purpose vans (Fernandez et al., undated).

Similarly, transitory rents might also result from differences in optimal tractor configurations for pulling different types of hauls (Nickerson and Silverman, 1999: 16):

> The fuel efficiency of a tractor is highly dependent on the match between characteristics of the haul (e.g., city vs. highway driving; long hauls vs. short hauls; heavy freight vs. light freight) and the tractor's drive-train configuration. . . .[A] truck not optimally configured for a haul could experience fuel efficiency of fewer than 4 miles per gallon, as compared to 7-10 miles per gallon for an optimal configuration — a severe penalty, given that fuel costs comprise more than one-fourth of total trucking operating costs.

Following this argument, tractors with "mid-range" configurations, which have "the widest operating range with the least cost penalty for minor variations in haul characteristics," will tend to be most common and generate the fewest quasi-rents, while tractors with configurations designed for atypical loads will have fewer uses and less availability and, thus, be more subject to hold up (Nickerson and Silverman, 1999: 16).

Finally, as industry experts have observed, the cost of a delay of a given duration, and thereby the potential for opportunistic behavior, may also vary among transactions depending on the time sensitivity, or temporal specificity, of the cargo:

> We knew more about trucks and tight schedules than any company in the country. So we looked over the market and decided to put a little squeeze on here and there. . . .For example, milk spoils pretty fast and so does bread and vegetables. In no time at all, we had a lock on three of four of the biggest fresh-food businesses in America. . . .After all, nothin' spoils faster'n fish.[3]

Although such transitory appropriation hazards have the potential to explain some of the observed governance arrangements in freight transportation, it seems to us highly unlikely that relationship-specific investments can account for variations in contracting and organizational arrangements in the vast majority of trucking transactions for two reasons. First, compared to the amounts at stake in other settings where specific investments are normally thought to be a problem, the size of appropriable quasi-rents in trucking transactions is minuscule. Investments

[3]"Management expert" (and mobster) Lucky Luciano, as quoted in Gosch and Hammer, 1974.

in special tooling in automotive production, for example, often run into the millions of dollars, while appropriable quasi-rents associated with site specificity in transactions between coal mines and mine-mouth power plants (as in Joskow, 1987) can easily run to tens of millions of dollars per year and hundreds of millions over the life of a plant.

In trucking, by comparison, the *total* cost of a shipment is typically only a few hundred dollars. On a typical haul between, say, Atlanta and Chicago (736 miles), a company driver could expect to earn about $220 (at $.30 per mile; Goodson, 1999b), and an owner-operator about $600 ($.82 per mile; Heine, 1999). Even if an owner-operator could find no alternative haul, the *most* that a carrier could hope to appropriate on this hypothetical haul, after taking into account distance-related operating costs, would be about $400, or less than 1% of owner-operators' average annual net income (Owner-Operator Independent Driver Association, 2000). By the same token, the amount that a driver could hope to appropriate from a carrier — and hence the effort and expense that a driver would be willing to incur trying to effect such a hold up — is limited to the cost and inconvenience a carrier would have to incur to induce another driver to take the haul on short notice. Even if the carrier had to double the going rate to assure on-time delivery, no more than a few hundred dollars would be at stake. In the more likely (but still uncommon) scenario that the carrier would be forced to employ a tractor with a suboptimal drive train to haul the load, the cost penalty, by Nickerson and Silverman's figures, would be less than 20%, or under $60 on our hypothetical Atlanta-Chicago haul.

Second, and perhaps more important, is the relatively short-term, repeat nature of trucking transactions. Whereas a typical model cycle in automotive production is three years and electric power generators may operate for thirty years or more, the appropriable quasi-rents in trucking are highly transitory, lasting only the time it takes — hours or, at most, days — to find and redeploy a suitable vehicle. The punishment for holding up a trading partner in trucking, if not instantaneous, is thus likely to be prompt. No doubt, significant hold-up opportunities may occur in cases of extreme and unanticipated delay costs and truck or driver scarcity. In the vast majority of transactions, however, the high speed and low cost of punishment (including termination), combined with the small gains to hold up, seem likely to deter most egregious manifestations of opportunism, making differences in hold-up opportunities among freight transactions an unlikely determinant of observed organizational structures in everyday trucking activities.

Moral hazard. If asset specificity does not explain trucking governance, might agency theory do better? On the surface, truck transactions do appear to fit the standard agency model. The effort expended by over-the-road truck drivers is clearly costly to monitor directly; by its very nature, the work of these "last cowboys" (LeDuff, 2001) takes drivers large distances at all times of day, making it difficult for shippers or carriers to assess not only their driving behavior — speed, accident prevention, treatment of the truck, and so forth — but also other decisions such as choice of route, timing and length of breaks, and care expended in minimizing cargo damage or loss.[4] At the same time, truck drivers, whether employees or owner operators, might reasonably be presumed to be more risk averse than shippers or carriers, for whom any given shipment is likely to be a small item in a large portfolio. Trucking transactions thus appear to pose the standard risk-incentive tradeoff of agency theory, and one might therefore expect asset ownership and compensation/sharing rules between truck drivers and carriers to vary with the relative importance of risk and moral hazard across transactions.[5]

[4] Baker and Hubbard (2000) note that the introduction of on-board computers and GPS tracking systems may be reducing the cost of monitoring at least some aspects of drivers' behavior.

[5] Hidden information and selection issues, which have also been a concern of agency theorists, are unlikely to be a major concern in light of the high frequency of transactions in trucking.

The fact that truck ownership and driver compensation co-vary systematically would appear, on first impression, consistent with agency considerations. As table 1 shows, over-the-road company drivers (employees who drive carrier-owned trucks) are typically compensated on the basis of mileage whereas owner-operators (independent contractors who own their own vehicles) are more likely to be paid a proportion of the revenues (freight bill) received by the carrier for the haul.[6] Such a correlation might be expected, for example, if both vehicle ownership and driver compensation methods are responses to the same underlying incentive needs of the transaction.

TABLE 1: PAYMENT METHODS: COMPANY DRIVERS AND OWNER OPERATORS

	Company Drivers	Owner Operators	
	UGPTI* 1992	UGPTI* 1992	OOIDA** 1998
Per mile	87.9	35.5	33.9
% of freight bill	5.2	54.4	46.3
Per trip	0.9	5.4	18.4
Hourly	7.2	4.4	na

*Upper Great Plains Transportation Institute (Griffen and Rodriguez, 1992).

**Owner-Operator Independent Drivers Association (2000).

An agency interpretation of this variation confronts two problems, however. The first is the general problem of relating variations in ownership and surplus-sharing arrangements to differences in relative risk preferences or in the marginal productivity of transactors across transactions. While risk or incentive considerations may provide plausible rationalizations for a particular ownership or sharing arrangement, explaining *variation* in those arrangements requires

[6] Engel (1998) estimates that there are about 300,000 owner operators in the U.S. trucking industry, mostly in the over-the-road (long distance) sector. The vast majority of owner operators (75-80%) operate under “permanent leases” under which they agree exclusively to carry a specific carrier’s hauls for an extended, often indeterminate, period. For additional information on the terms of these agreements, see Lafontaine (2000).

identification of *differences* in the parties' relative risk preferences or the relative productivity of their (off-equilibrium) efforts (see, for instance, Whinston, 2000).

The second problem, more specific to trucking, concerns the fact that driver incentives under the two main compensation methods — mileage- and revenue-based pay — are identical: Under both schemes, driver compensation is determined ex ante and is unaffected by driver behavior at the margin. In the case of revenue-based pay, a driver (whether an employee or owner operator) receives a pre-agreed percentage of the freight bill, the amount charged to the shipper for the haul; since both the percent and the freight bill are known at the time a driver takes the load, the driver knows exactly how much money a particular load will yield. The same is true of mileage-based pay, however. Because the amount a driver receives is set according to "bureau miles" rather than actual miles driven, the compensation of drivers paid on a mileage basis is independent of route selection or other decisions that a driver makes during the haul.[7] With their compensation fixed ex ante, drivers effectively become residual claimants on each haul, leaving them with high-powered incentives to select the best possible route given road conditions, to avoid accidents and other sources of delays, and otherwise to undertake any activity that lowers the cost of current loads or advances the acquisition of future ones. But whether mileage or revenue is the basis for setting driver compensation, the incentives to expend effort on such activities are exactly the same.[8]

[7] Major sources for these standardized distances include Rand McNally's Household Good Miles, and PC*Miler from ALK Associates.

[8] The incentive properties of mileage- and revenue-based compensation also apply for less frequently used per-load lump sums but not for drivers paid an hourly wage. Consistent with the difficulty of monitoring driver activities on long hauls, hourly pay is rarely used for over-the-road drivers.

3. The Assignment and Pricing of Hauls.

To understand organizational arrangements in trucking, we need first to understand the trucking industry and the problems that transactors in the industry need to solve. We argue here that the central substantive problem in freight hauling is logistical — the coordination of a large number of small, heterogeneous transactions — and that the central *organizational* problem, rather than protecting specific investments or aligning marginal incentives, is one of price determination for driver services.

Viewed in the aggregate, the scheduling of transportation services so that the right commodities arrive at the right location at the right time and at the lowest possible cost is a coordination problem of enormous proportions. Each year, truckers carry millions of hauls over millions of miles for millions of customers between thousands of locations.[9] Even under the assumption that all cargos and suppliers of transportation services are interchangeable, determining the optimal route structure and assignment of hauls constitutes a classic logistical problem requiring considerable time and expertise to solve. In actuality, however, hauls vary significantly in size, weight, distance, route, back-haul potential, and the extent to which they require special care (because of fragility or perishability, for example) or special equipment (such as car carriers, refrigerated trailers, or oversize or flat bed trailers). Moreover, the efficient assignment of hauls often depends on characteristics of consumers and suppliers of freight services as well as of cargos and routes. On the demand side, shippers and receivers differ with respect to, among other things, the premium they place on speed or on-time performance relative to price, their reliability in meeting schedules, the predictability of their shipments and flexibility

[9] It is estimated that 7.7 billion tons of freight were transported by truck in the United States during 1997 (U.S. Department of Commerce, 1999). An average payload of about 15 tons would thus imply something on the order of 500 million hauls per year.

in accommodating pickups and deliveries, and their staffing of, and congestion at, loading docks. On the supply side, drivers, who, in the first instance, bear the costs of hauling freight, differ in their preferences over such things as routes, night driving and haul lengths as well as in their ability and dependability. Last but not least, the matching of hauls, clients, and drivers must be performed and continually revised in light of ever-changing weather, traffic, equipment and road conditions.

In the U.S., solving this coordination problem is the principal activity of the more than ninety-thousand firms that make up the for-hire trucking industry (U.S Department of Commerce, 2000). These companies, or carriers, function essentially as brokers or middlemen, identifying and selling transportation services to shippers and hiring drivers or owner-operators to perform those services.[10] Unlike at least some other middlemen, however, carriers buy and sell services whose characteristics are neither determinate nor fully under their control. The quality of the service that shippers receive depends in large measure on the actions and decisions of drivers, while the cost to drivers of carrying a particular haul often depends on the cooperation of shippers and receivers.[11] Given the highly competitive nature of freight hauling, a carrier's survival will depend heavily on its ability, first, to recruit dependable drivers and, then, to keep "drivers and operators happy" by assigning them profitable hauls.[12]

[10] In addition to freight carried by for-hire trucking companies, a substantial amount of freight is also carried by private, "in-house" truck fleets of non-trucking firms. Private fleets accounted for approximately $200 billion worth of transportation services in 1997, or about 58% of the $347 billion total spent on motor carriage in that year (Standard and Poor's, 1998). Although the operation of private fleets involves some of the logistical problems described here, the problem of identifying and coordinating *shippers* is obviously not relevant to in-house transportation. Partly for this and partly for data reasons, our analysis focuses on for-hire firms and drivers.

[11] Robert Rothstein, general counsel for the Truckload Carriers Association, observes, "Some of these guys love their own employers but can't stand the customers they deliver to" (*Wall Street Journal*, 2001).

[12] Goodson, 2000: 12. Estimates place the cost of recruiting and training a new driver, including advertising and a typical two-to-three day orientation, "at close to $2,000" (Goodson, 1999a: 8). The economic cost of driver turnover would also include foregone earnings of drivers between jobs.

In principle, it would seem that carriers could make drivers happy to carry any haul simply by paying drivers an amount commensurate with the cost of the haul: Hauls that require additional time loading or waiting for delinquent customers or that are otherwise unattractive to drivers should command a premium over more "driver friendly" hauls.[13] With such a large number of heterogeneous hauls, however, discovering and settling on an acceptable level of driver compensation for each haul would add yet another dimension to the carrier's already complex logistical problem. And indeed, carriers consider such haul-by-haul pricing impractical: "The feeling in dispatch is that having different pay rates becomes a nightmare of trying to sell loads to drivers" (Goodson, 1999b: 1). To avoid the hassle of negotiating individual rates with each driver for each haul, standard industry practice is, as we saw in table 1, for each carrier to pay its drivers for all loads according to a single pricing rule, typically either per mile or in proportion to the freight bill.[14]

A drawback to the use of such pricing rules is that the resulting prices may not accurately reflect the actual costs of a particular haul, making some hauls more attractive than others. Table 2 identifies a variety of haul attributes commonly regarded as "driver unfriendly" (Goodson, 2000). As the list reveals, most of the attributes that drivers consider unattractive relate to time spent on non-driving activities: Hand loading and unloading, freight sorting and segregating, numerous stops, city driving, and customer inflexibility or failure to honor schedules all keep the driver off the road and add to the time it takes to complete a haul.[15] Haul length can also affect

[13] This issue is hardly unique to freight transactions: Consider, for instance, the allocation and pricing of faculty course and committee work. On the problems of governing academic transactions, see Masten (2000).

[14] Mileage and percentage rates are generally higher for owner operators than for company drivers, but all company drivers or owner operators of a given carrier typically receive the same rate.

[15] Certain cities in particular, such as New York, are known to involve longer waits for unloading and for reloading of backhauls and are avoided by truckers (Goodson, 2000). Overall, it is estimated that truck drivers spend an average of about 25% of their time on non-driving work (Belman et al., 1998).

TABLE 2. "DRIVER-UNFRIENDLY" LOAD CHARACTERISTICS

Loading/unloading conditions:	Hand loading or unloading Sorting and segregating on dock
Scheduling:	Appointment schedules not honored by customer (driver on time must wait) Lack of flexibility in appointment schedules (late driver must wait 24 hours)
Haul lengths:	Short hauls (less than 400 miles) Low productivity hauls (between 600 - 800 miles) "Short weekend" hauls (less than 800 miles)
Other:	Excessive stops City driving Night driving

Source: *National Survey of Driver Wages* (Goodson, 2000)

the proportion of a driver's time spent on the road and, thus, the "productivity" of the haul. As a rule, over-the-road drivers prefer a single long haul to a series of shorter hauls of equal mileage because they can cover more territory in less time: On an 1800 mile haul, a driver is likely to be able to average 60 miles per hour, whereas average speed on a haul of 300 miles falls to only 33 miles per hour (Sign Post Solutions, 2000). But there are also exceptions to this rule. Because U.S. hours-of-service rules require an 8-hour rest for every 10 hours of driving, hauls of around 400 miles tend to leave a driver too little time to obtain and complete a second haul the same day, limiting the driver's earnings relative to what he could have earned on the 500-to-600 miles coverable in a full day of driving. Similarly, hauls of 600 to 800 miles tend to be unattractive because they are too long to complete in a single day but not long enough to occupy two full days, while weekend hauls of 800 miles are likely to keep the driver away from home for the whole weekend yet are not long enough to keep the driver busy the whole time either.[16] At some cost, the parties can, and do, attempt to incorporate additional observable cost determinants in their agreements (see Lafontaine, 2000). As long as pricing formulae do not fully capture all

[16] Loads that would normally be considered unattractive may become attractive under certain conditions or to some drivers. A short haul that would be unattractive in the middle of the week, for instance, might be valued by a driver looking to fill out his schedule at the end of a week, and a "500-mile load tendered on Monday through Thursday is high utilization [whereas on] Friday, it can represent poor weekend utilization" (Goodson, 2000: 12).

such factors, however, drivers will prefer some hauls to others and reject, or at least resist, unattractive haul assignments.

Because of the failure of the "pricing mechanism to compensate drivers for undesirable loads, dispatchers have to go to great lengths to find drivers to get these loads moved" (Goodson, 1999b: 1, 12). One such length is to promise drivers that take unattractive hauls "better-than-usual" hauls later on: "It is common practice for dispatchers to promise to take care of drivers who haul the undesirable loads.…[T]his constant swap of favors is how a lot of difficult hauls get moved" (Goodson, 1999b: 12). By allocating hauls in this way, carriers are able to balance out profitable and unprofitable hauls, leaving drivers as well off on average as they would have been had each haul been priced individually. At the same time, however, the discretionary assignment of hauls introduces other frictions as drivers find it difficult to distinguish valid quid-pro-quos from opportunism: "Because it is not done in full view, other drivers cannot see the difference between repaying a favor and favoritism to a particular driver" (id.). Drivers that perceive that their haul assignments contain too many undesirable, low-paying loads are likely to quit, generating turnover costs for both themselves and the carrier.[17] In the end, the choice of methods for pricing driver services must balance the tensions inherent in getting drivers to accept unprofitable hauls at a fixed rate against the cost of negotiating prices for individual hauls. "At some point the question has to be asked, is the effort involved in getting company drivers to haul loads at the same rate less than the effort required of offering different rates of pay for loads?" (Goodson, 2000).

[17] To eliminate the perception of dispatcher favoritism and the problems it causes, some companies have tried instituting policies, such as priority (e.g., first-available haul) allocation systems, that limit dispatcher discretion in the assignment of hauls among drivers. Carriers also try to keep their load composition secret to impede drivers from drawing equity inferences from comparison of their hauls with the aggregate (Goodson, 1999b).

4. The Pricing of Driver Services: A Model

In this section, we develop a simple model that captures what we perceive to be the essential features of carrier-driver transactions. Consistent with industry usage, we define a haul as the transportation of a particular cargo from one specified location to another. As noted in the previous section, however, hauls differ in many ways besides origin and destination, including characteristics such as time of pick-up and delivery, special handling requirements, and responsibility for other activities such as loading and unloading, tarping, and so on. The value and cost of each haul thus depends on its attributes and on their relation to the characteristics of the carrier and driver. We define, for any given future haul,

v = the uncertain value (net revenue) of the haul to the carrier (gross of payments to the driver),

and

s = the uncertain cost to the driver of carrying the haul,

which we assume to be jointly distributed as $F(v,s)$.

To abstract from risk-sharing considerations, we assume that both drivers and carriers are risk neutral. Hence, a transaction between any given driver and carrier is efficient if expected joint surplus (conditional on observable haul attributes) for a particular haul is nonnegative, i.e., $E(v-s) \geq 0$.[18] Driver and carrier acceptance of a haul, on the other hand, depends on each party's expected private surplus and, thus, on how driver services are priced.

The most important assumption of our model is that reaching agreement on fees is, to some nontrivial degree, costly, reflecting such things as the time and effort required for carriers to communicate, and for drivers to assess, the attributes of each haul and to settle on a price.

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[18] Understanding v and s as each party's opportunity cost of accepting this transaction and, thus, as what this party could have earned in its next best alternative, this condition assures that a haul generates at least as much surplus in this transaction as it could if reallocated to another driver.

Even though the costs of bargaining over fees for individual hauls may be small in absolute terms, the large number of hauls that carriers and drivers engage in may nevertheless make those costs important in the aggregate. We define n_c and n_d to be the costs to the carrier and driver, respectively, of settling on a price for driver services for any given haul, and assume for simplicity that these costs are the same for all hauls. Because the model abstracts away from all other incentive considerations and any risk effects, these costs represent the only source of deviation from the maximum joint surplus available to a carrier and driver on a haul. Thus, were the parties to negotiate prices on a haul-by-haul basis, the potential present discounted value of surpluses over the (indefinite) life of the carrier-driver relationship would be reduced by a total of

$$\Sigma(n_d+n_c)/(1+\mathrm{r})^{\mathrm{t}} \text{ over } \mathrm{t} \in [0, \infty)$$

$$= (n_d+n_c)/\mathrm{r} ,$$

where r is the one period discount rate.[19] Although, as we previously noted, driver services are rarely priced this way, such "spot" or contemporaneous pricing of individual hauls represents a natural default arrangement; carriers and drivers stand to improve their payoffs to the extent they can agree on pricing arrangements that avoid or reduce these costs. In what follows, we consider the potential gains associated with ex ante (or forward) pricing of hauls. For simplicity, we consider first the case of carriers and drivers agreeing ex ante to a single uniform payment per haul for all future hauls. We then extend the model to consider the type of pricing most often observed in practice, namely, contingent — either mileage or revenue-based — pricing.

[19] For simplicity we abstract away from differences in haul durations and assume that each haul takes one period.

4.1. Uniform Pricing.

To illustrate the principles at work, consider the choice of a forward fee, $\hat{p}$, to be paid by a carrier to a driver for all future hauls regardless of the characteristics of any individual haul. Agreement on a uniform price to apply to all hauls eliminates the need to set fees on individual hauls in the future and, thus, leaves a larger aggregate surplus to divide between the carrier and the driver.[20] Despite agreeing on a fee for future hauls, however, both parties retain the right not to transact if they perceive the transaction to be a bad deal: The driver may reject a particularly unattractive haul, or the carrier may withhold a haul that it perceives to be especially valuable to assign to another, more profitable driver.[21] Of course, rejection or retention of a load does not necessarily imply either termination of the relationship or reassignment of the haul to another driver but may instead simply constitute an invitation to renegotiate.[22]

Looking at a single haul in isolation, a party will reject a particular transaction whenever the private gain from renegotiation is greater than the private cost of renegotiation. If we let p' represent the price that would result from renegotiation, the driver will reject a haul when

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[20] If the parties must incur one-time ex ante negotiating costs of $n = n_d + n_c$ to reach agreement on the price to apply to future hauls, the savings from setting price ex ante relative to negotiating price haul by haul would be $(n/r) - n = n(1-r)/r$. This assumes that the cost of reaching agreement on a fee is the same regardless of whether the fee is negotiated ex ante or ex post. If, as might be expected, parties expend more time and effort negotiating a forward price for multiple future hauls (see, e.g. Goldberg, 1985), savings from negotiating price ex ante remain as long as the cost of doing so are smaller than n/r.

[21] We assume, again for simplicity, that the cost that party i incurs, n_i, if a haul is rejected is the same as the cost of negotiating the price for the haul ex ante and is independent of whether it is the driver that rejects or the carrier that withholds the haul. We also abstract here from any differences between owner operators and company drivers in the extent to which they can reject loads. In practice, that ability is similar: Although owner operators retain the contractual right to refuse loads tendered by the carrier (see Lafontaine, 2000), operators that do so are likely to face retaliation from carriers in the form of poor future load assignments or non-renewal of their contracts. Conversely, even though company drivers are nominally not permitted to refuse loads, their ability to quit gives them a *de facto* right of rejection.

[22] In this respect, n_d and n_c can be thought of as the minimum of the costs to the parties of renegotiation or of haul reassignment (compare Oyer, 2001). In addition to positing renegotiation costs, Oyer's analyis of managerial compensation resembles the present analysis in (i) ruling out marginal incentive considerations and (ii) the absence of significant relationship-specific investments. His treatment differs, in part, in its assumption of agent risk aversion and in its emphasis on variation in agents' outside options vis-à-vis our focus on transaction heterogeneity.

$$p' - \hat{p} > n_d \,, \tag{1}$$

and the carrier will retain a haul when

$$\hat{p} - p' > n_c \,. \tag{2}$$

The areas of performance and rejection implied by this structure are depicted in figure 1.

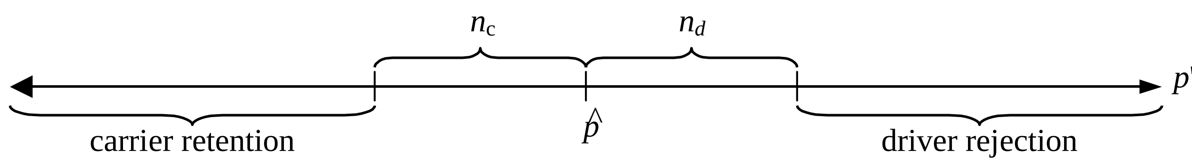

Figure 1

Thus, by agreeing on price ex ante, that is, before the attributes of a haul are known to either party, the parties avoid the need to discover and settle on a mutually acceptable haul-specific price for a range of potential hauls whose negotiated price would lie between $\hat{p} - n_c$ and $\hat{p} + n_d$.

The savings from ex ante pricing stand to be even larger once the repeat nature of trade is taken into account. If we assume the potential for trade indefinitely into the future, the rejection decisions become

$$p_0' - \hat{p}_0 > n_d + W_d \tag{1'}$$

and

$$\hat{p}_0 - p_0' > n_c + W_c \,, \tag{2'}$$

where a zero subscript denotes current period prices, and W_d and W_c represent driver and carrier "reputational capital" (Klein, 1992), the discounted stream of expected future profits from continued cooperation.[23] Inequalities (1') and (2') implicitly define what Klein (1992) refers to as the "self-enforcing range" of a transaction, represented here by the set

[23]The value of continued cooperation will depend on the parties' defection strategies. For example, the cost of defection (foregone gains from not cooperating) will be the increase in expected renegotiation costs in future periods if the best response to defection by the other party is reversion to the single-period haul rejection strategy

$$\phi^* = \{p' : \hat{p} - (n_c + W_c) \le p' \le \hat{p} + (n_d + W_d)\}.$$

The higher the probability that the renegotiated price, p', falls within ϕ^*, the smaller the number of cases where renegotiation must occur, and thus the greater the proportion of potential joint surpluses the parties actually realize. Accordingly, other things the same, the parties would like to minimize the likelihood that transactions fall outside this range.

In general, the forward price that minimizes this likelihood depends on the costs of negotiation, n_d and n_c, and on the distribution of p'. Defining $\gamma \in [0,1]$ to be the share of the surplus accruing to the driver, we can write p' as a function of v and s as $p' = \gamma v + (1-\gamma)s$. This relation can, in turn, be used to define a distribution G over p' that maps the joint distribution of v and s, $F(v,s)$, into $G(p')$.[24] The problem for the driver and carrier then is to choose a forward price, $\hat{p}$, that minimizes expected negotiation costs over all hauls, or

$$\min_{\hat{p}} \left[\int_{p' \notin \phi^*} (n_d + n_c) dG(p') \right]. \qquad (3)$$

The first-order condition characterizing the solution to this problem is simply

$$g(\hat{p} - n_c - W_c) = g(\hat{p} + n_d + W_d). \qquad (4)$$

In the symmetric case, that is, under symmetric negotiation costs and distribution of p', this optimal forward price is $\hat{p} = E(p')$, the expectation of negotiated prices over the set of potential (surplus-generating) hauls.[25] Figure 2 illustrates the solution for this special case by superimposing $g(p')$ on figure 1.

(characterized by equations (1) and (2)) and will be the cost of turnover if a party's best response to the other's defection is termination.

[24] For convenience, we assume that γ is the same for all hauls and is invariant to the size of the surplus.

[25] This result illustrates what Williamson (1985: 34) refers to as "equilibrating hazards."

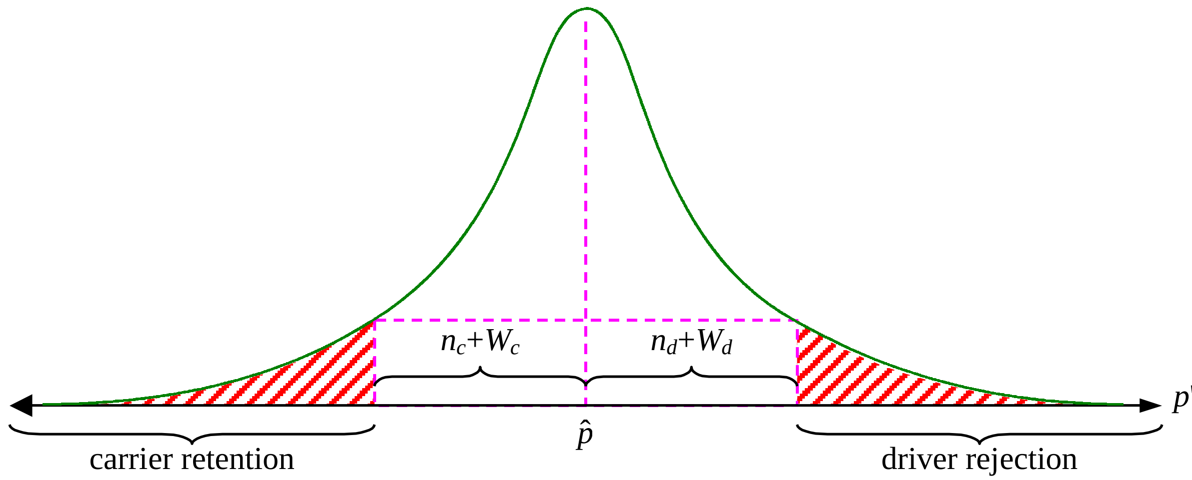

Figure 2

In sum, by agreeing ex ante to a fee that leaves both parties with positive *expected* surpluses for all hauls over the duration of the carrier-driver relationship — in effect, bundling hauls of varying characteristics — a carrier and driver can reduce the need to set fees on individual hauls and leave a larger aggregate surplus to divide between them.[26]

4.2. Contingent Pricing.

Since negotiation costs are incurred in those cases where $| p' - \hat{p} |$ is sufficiently large, the parties could further increase available surpluses by finding a way to tie $\hat{p}_t$ to p'_t. Specifically, the parties can do better if some observable attribute of hauls correlated with p' exists to which they can relate $\hat{p}$. Tying price to observable attributes correlated with v and s, however imperfectly, reduces expected negotiation costs by (i) reducing the gain to reneging (the left-hand side of (1') and (2'); and (ii) increasing W_c and W_d and, thus, the penalty for reneging (the right-hand side of these conditions). Formally, the parties would like to identify a set of objective haul attributes, X, and a parameter vector, α, such that $\hat{p} = \alpha X$ minimizes expected

[26] In this respect, the analysis here is analogous to the "over-search" argument for bundling of diamonds (Barzel, 1982), movies (Kenney and Klein, 1983), and tuna (Gallick, 1996).

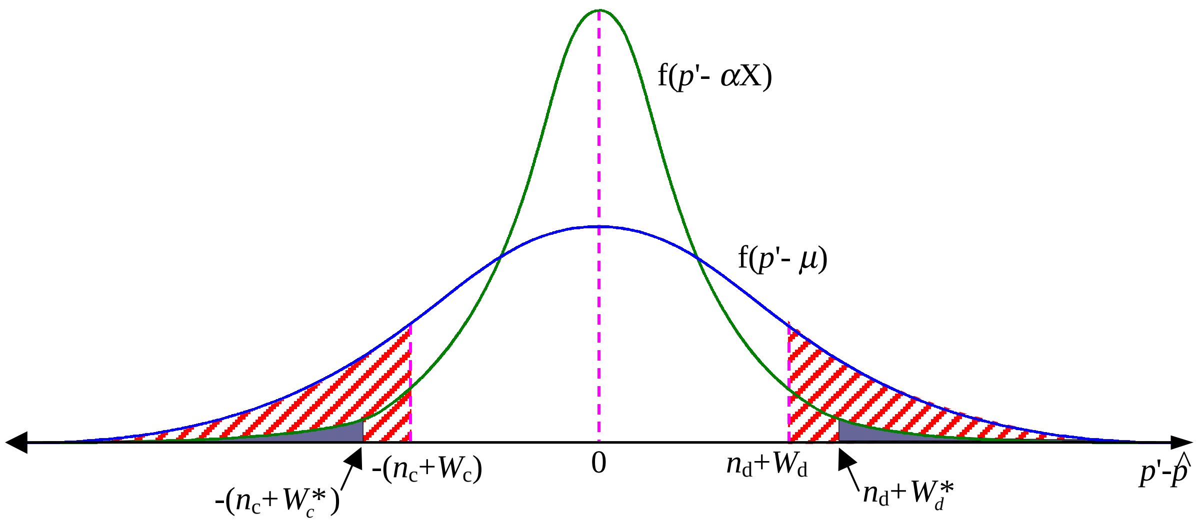

Figure 3

renegotiation costs as per equation (3).[27] Figure 3 illustrates the effect of setting $\hat{p}$ = αX for the symmetric case, assuming $\sigma_{p'X} \neq 0$. By reducing the variance of (p'- $\hat{p}$) and increasing W_c and W_d, setting price on observable haul attributes correlated with *v* and *s* reduces the likelihood that hauls lie outside the self-enforcing range (the shaded area) relative to agreeing to a uniform fee per haul of μ = E(p') (represented by the hashed area in figure 3).

Given the value to transactors of agreeing ex ante to a formula for setting prices for future transactions, the remaining question concerns the choice of X. Recalling that *p*' is a function of *v* and *s* (i.e., $p' = \gamma v + (1-\gamma)s$), and noting that *v* and *s* must themselves be highly correlated in a competitive market such as trucking, candidates for X consist of a set of haul attributes that correlate with either carrier's revenue or driver's costs. As discussed in section 3, this set includes such factors as distance, route, weight, and the time it takes to complete a haul. In the abstract, the best of this set would be the haul attribute (or attributes) most highly correlated with

[27] For simplicity, we use a linear pricing rule. Nothing precludes X from including non-linear transformations of observable attributes, however.

v and *s*. In practice, however, candidates for X must also be objective and difficult for the parties to manipulate.[28] Thus, although time spent on the job is one of the most important determinants of driver costs (see table 2), over-the-road truck drivers are rarely paid on an hourly basis because of the difficulty of distinguishing hours legitimately incurred working from hours taken as leisure or resulting from poor judgment in route choice or from simple misreporting. Similarly, miles traveled correlates with such things as fuel costs and equipment wear and tear as well as work time but, again, is subject to driver manipulation; compensating drivers on the basis of actual miles traveled reduces driver incentives to take the most direct and economical route.[29] As in other price determination settings, the choice of formula for setting driver compensation involves a tradeoff between the "accuracy" of the formula (the correlation between $\hat{p}$ and p'), on the one hand, and the ability of the parties to verify and manipulate the chosen measure(s), on the other.[30]

In this light, the use of "bureau" miles, rather than actual miles traveled, in mileage-based pay schemes has the advantage that, while correlated with actual miles and, thus, with driver's cost, bureau miles are outside the driver's (and carrier's) control. As our earlier discussion indicated, however, that correlation is imperfect inasmuch as drivers' costs vary with traffic, customer cooperation, loading time, and so forth. The greater the variation in drivers' costs relative to bureau miles, the less successful mileage-based pay will be in keeping freight transactions within the self-enforcing range. Basing driver pay on carrier revenue, by contrast, is

[28] Cf. Milgrom and Roberts (1991: 215): "To base a compensation formula on something that is not objectively measurable is to invite disputes and unhappiness among employees."

[29] A driver scheduled to complete a delivery late enough in the day to preclude picking up another load might, for instance, choose to take a "scenic route" to the destination to run up compensation.

[30] Note that in pick-up-and-delivery carriage, where drivers cover relatively fixed and/or local routes, drivers have less discretion and therefore driver opportunism in reporting hours is less of a problem. Accordingly, drivers involved in this type of carriage, unlike long-haul truckers, are more often paid on an hourly basis.

less likely to result in driver (and carrier) dissatisfaction with price since the freight bill negotiated between a shipper and a carrier can reflect non-mileage determinants of cost as well as distance. Carrier revenue, however, is vulnerable to manipulation by carriers who, despite federal regulations requiring carriers to make their freight bills available to drivers paid as a percent of revenue (49 *Code of Federal Regulations* 376.12), have been known to underreport, divert, or otherwise conceal the true freight bill in order to lower a driver's compensation. The difficulty of verifying carrier revenue is widely viewed as a deterrent to the more extensive use of revenue-based compensation.[31]

Based on these considerations, we expect the choice between mileage- and revenue-based driver compensation to reflect the heterogeneity of haul attributes. Mileage-based compensation is likely to be chosen for hauls where the variation in haul attributes (around a linear function of bureau miles) is relatively small while the use of revenue-based fees will be reserved for transactions for which the distribution of haul attributes around mileage is diffuse. We explore this relationship empirically below. We do this first by showing that there are significant differences in haul characteristics between main categories of long-haul trucking, namely dry van, flatbed, refrigerated, and tankers, and then showing that the incidence of the two main pay bases varies significantly across these categories as well.

5. The Data

The data for this study come from a survey of drivers conducted under the University of Michigan Trucking Industry Program (UMTIP). The survey, designed to elicit detailed

[31] Statements like the following are indicative of driver suspicions: "There is a mistrust of how carriers represent their rates to owner-operators, says Glen Rice, a consultant and former driver adviser for Landstar Inway. 'Are they lying? They could be,' he says. 'Are they taking a little off the top? Not showing all the charges?'" (Heine, 1999). For an example of litigation alleging carrier misreporting of revenue, see Strickland et al. vs. Truckers Express, Inc., No. CV95-62M-RFC (filed US District Court, Montana).

information on truck drivers and their jobs, was conducted in two waves, the first during the summer of 1997 and the second in August and September of 1998. The survey was carried out under a two-stage randomized design: In the first stage, truck stops were randomly selected as interview sites to be representative of the volume of truck traffic across the Midwest. In the second stage, respondents were chosen at random at the selected sites. This sampling procedure was meant specifically to target over-the-road truck drivers, who are much more likely than local drivers to use the services offered at truck stops. In the end, 1019 truck drivers — 748 of whom were over-the-road drivers operating in for-hire trucking — at 22 different truck stops took approximately 45 minutes each to answer over 220 questions on topics such as compensation, driving and non-driving work hours and hours of rest, work duties, work history, and demographic characteristics.[32] Among the set of questions asked was a series of specific inquiries about the characteristics of the last load carried by drivers. We rely on this part of the survey extensively in our analyses.

6. Data Analyses and Results

6.1 The Variance in Haul Characteristics.

The main prediction of the theory is that driver compensation is more likely to be set as a percentage of the freight bill (revenue) rather than mileage the greater the variation in haul attributes, especially attributes not highly correlated with official bureau miles. Conceptually, the relevant measure of haul variation for this purpose is the variance (or heterogeneity) of the population of hauls from which a particular carrier draws in selecting and assigning hauls to a particular driver. Our data, however, contain information only on the attributes of each driver's most recent haul. As an approximation to heterogeneity in the pool of potential hauls for each

[32] See Belman et al. (1998) for a summary report on the first wave of interviews.

driver-carrier pair, we look at differences in the heterogeneity of haul characteristics for identifiable sub-populations of haul types on the assumption that serial haul assignments are more likely occur within than between sub-populations. Based on interviews with industry experts and our examination of trade publications, we expect greater variation in the attributes of hauls carried by flatbed and, to a lesser extent, refrigerator and tanker trailers, than in standard dry vans. Flatbed loads, for instance, often are "over-dimensional and short-haul, tend to be high value, and sometimes require slower speeds, alternate routes and even escorts" (Heine, 1999). Dry van hauls, in contrast, are often described as "plain vanilla" hauls.

Our earlier discussion identified several haul attributes that drivers consider unattractive (see table 2). Our data allows us to measure several of those attributes, identified and defined in table 3.[33] The first four variables describe the amount of time spent by a driver either waiting for or performing non-driving activities, including loading and unloading. Since drivers are not compensated for this time under mileage-based pay, drivers find hauls with large values of these variables unattractive.[34] The next four variables measure time waiting and time spent performing non-driving activities as a proportion of mileage, driving time per mile (the inverse of average speed) and, finally, total trip time divided by miles driven, which captures the overall "productivity" of the haul: For drivers compensated on the basis of mileage, the longer it takes overall to complete a haul of a given distance, the lower is the driver's (implicit) compensation per hour (holding rate per mile constant). The last variable is time away from home, an attribute

[33] The survey only contains data on "driver unfriendly" haul attributes (the right-hand tail of figure 2) and not information on haul characteristics or their values that would be likely to cause carriers to want to retain loads (the left-hand tail). Our empirical analysis accordingly focuses on the upper tail of the distribution.

[34] In addition to the main compensation factors, drivers sometimes receive performance bonuses (for mileage, safety, etc.) and are sometimes paid for specific tasks (loading/unloading, extra stops, New-York trip). Consistent with the argument that mileage is a less accurate proxy for costs than revenue, Lafontaine (2000) documents that bonuses and extra pay are used more in combination with mileage-based compensation. To the extent that the use of such additional payments substitutes for the greater accuracy of revenue-based compensation, the likelihood that we will find systematic differences in the use of these two pay forms in our data is reduced.

identified by the Truckload Carriers Association as the second most cited reason (behind excessive waiting time) for driver turnover (*Wall Street Journal*, 2001).

Table 3. Haul Characteristics

Characteristic	
Wait: load/unload	Minutes waiting for loading and unloading
Wait: total	Minutes waiting for loading and unloading + minutes waiting for other reasons*
Time: load/unload	Minutes spent loading and unloading
Time not driving: total	Minutes loading and unloading + minutes spent on other non-driving work**
Waiting per mile	Wait: total / miles driven
Time not driving per mile	Time not driving: total / miles driven
Time driving per mile	Time driving / miles driven
Total time per mile	Total time / miles driven
Last home	Number of days since home for 24 hours

*Includes time waiting for dispatch, truck breakdown or maintenance, fueling, traffic, parking/loading space, inspections, and cargo problems.
**Includes time spent on drop and hook up, truck maintenance, fueling, paperwork, tarping/chaining, and residential delivery.

Our interest is in the upper tail of the distribution of undesirable haul attributes (as illustrated in figure 3) for different trailer types, and our expectation is that the frequency of undesirable attributes will be higher (the upper tail of the distribution thicker) for non-dry van hauls than for dry van hauls. To assess this supposition, we first test for differences in the distributions of these variables across trailer types using Kolmogorov-Smirnov tests.[35] The null hypothesis is that the distribution of these characteristics are the same or, more specifically, that $f_i(x) = f_v(x)$, where $f_v(x)$ represents the density of characteristic x for dry vans and $f_i(x)$, i = f, r, t, represents the corresponding density for flatbed, refrigerated, and tanker trucks, respectively. Results of these tests are reported in table 4. For each haul characteristic, the first D value (first row) represents the largest positive difference and the second D value (second row) the largest

[35] The Kolmogorov-Smirnov test is a non-parametric test of the equality of two distributions. See http://www.physics.csbsju.edu/stats/KS-test.html.

negative difference between the distributions for dry vans and each of the "specialized" haul categories, while the corresponding p-values indicate the significance level of each difference.

TABLE 4. KOLMOGOROV-SMIRNOV EQUALITY OF DISTRIBUTION TESTS
(comparisons to dry vans)

	flatbed		refrigerated		tanker	
	D	p-value	D	p-value	D	p-value
Wait: load/unload	0.02	0.89	0.00	1.00	0.04	0.93
	-0.15	**0.02**	**-0.21**	**0.00**	-0.13	0.41
Wait: total	0.01	0.99	0.00	1.00	0.07	0.78
	-0.15	**0.03**	**-0.27**	**0.00**	-0.09	0.70
Time: load/unload	0.02	0.92	0.00	1.00	0.02	0.97
	-0.32	**0.00**	-0.11	0.11	**-0.30**	**0.01**
Time not driving: total	0.014	0.97	0.05	0.62	0.03	0.94
	-0.23	**0.00**	-0.09	0.25	-0.17	0.22
Wait per mile	0.00	1.00	0.01	0.98	0.09	0.72
	-0.16	**0.03**	**-0.14**	**0.07**	-0.14	0.44
Time not driving per mile	0.00	1.00	***0.14***	***0.05***	0.08	0.74
	-0.29	**0.00**	-0.02	0.92	-0.21	0.13
Time driving per mile	0.03	0.86	0.10	0.22	0.02	0.98
	-0.09	0.27	-0.02	0.91	**-0.26**	**0.05**
Total time per mile	0.00	1.00	0.03	0.90	0.95	0.92
	-0.19	**0.01**	-0.06	0.58	-0.24	0.13
Last home	0.07	0.50	0.01	0.98	0.13	0.50
	-0.04	0.74	**-0.14**	**0.06**	-0.02	0.99

Values significant at the .10 level in bold

The results in the first column of table 4 support our contention that the variance in haul attributes is greater for flatbed than for dry van hauls. For six of our eight variables, there is a significant difference in the distributions (at the .10 level or better, indicated as bold type in the table), and in all of these cases the results imply that the distribution from which dry van attributes were drawn contains smaller values (D is negative) than does the distribution for flatbed trucks. The results for refrigerated and tanker hauls are less striking but still broadly confirm our expectations. Of the five comparisons between refrigerated and dry van haul attributes for which the null hypothesis of equal distributions is rejected, four are significantly negative (the exception being time spent on non-driving work per mile), indicating that the corresponding distributions tend to contain smaller values for dry vans than for refrigerated trailers. The fewness of tanker observations (only 21 to 29, depending on the variable, compared to 271-376 observations for dry vans, 81-124 for flatbeds, and 87-117 for refrigerated trailers (see table 5)) reduces the power of the test for differences in the attribute distributions for tankers versus dry vans. Still, the data reject the null hypothesis of equivalent distributions for two of the variables and, in both cases, attributes for tankers are estimated to be drawn from a distribution with higher values than the distribution of those attributes for dry vans. Overall, the evidence is broadly consistent with the proposition that attributes of flatbed hauls and, to a lesser extent, those of refrigerated and tanker hauls, are distributed differently from the attributes of dry van hauls, and specifically that non dry-van hauls tend to exhibit higher levels of undesirable attributes.

Table 5 provides additional information on the distribution of haul attributes across trailer types in the form of descriptive statistics. In addition to mean, median, and number of observations, the table includes four measures of dispersion. The first of these, in column 4, is the standard deviation. The remaining three columns contain alternative measures of the thickness of the upper tail of the distribution of each attribute: the proportion of observations with positive values; the proportion of the hauls with attribute values more than a standard deviation away from the mean (where both the standard deviation and the mean are calculated across all hauls and trailer types); and the value of the 90^{th} percentile. Although there are

TABLE 5. DESCRIPTIVE STATISTICS FOR HAUL ATTRIBUTES

	obs.	mean	median	s.d.	%>0	%>μ+σ	90th percentile
Wait: load/unload							
Van	376	101.9	30	209.4	64	7.3	240
Flatbed	119	138.8	60	325.2	74	6.7	300
Refrigerated	116	205.3	97.5	205.3	82	18.9	450
Tanker	29	105.3	60	137.6	66	10.3	390
Wait: total							
Van	334	229.0	60	462.4	77	6.3	555
Flatbed	106	355.4	120	619.0	81	12.3	1410
Refrigerated	97	477.0	180	1,120	92	11.3	1050
Tanker	26	167.1	60	256.6	81	3.9	390
Time: load/unload							
Van	376	39.5	0	125.5	26	5.4	120
Flatbed	121	52.4	30	73.7	48	5.0	150
Refrigerated	117	89.9	0	281.8	36	8.5	180
Tanker	29	53.6	5	79.7	55	6.9	210
Time: total							
Van	346	70.1	30	138.6	79	5.0	180
Flatbed	111	90.9	60	105.7	82	7.2	240
Refrigerated	108	126.7	30	310.3	74	11.1	300
Tanker	28	75.4	52	86.7	79	7.1	225
Wait per mile driven							
Van	290	0.45	0.12	1.01	na	4.1	1.16
Flatbed	89	0.85	0.24	2.28	na	7.1	1.76
Refrigerated	90	0.58	0.21	1.61	na	3.3	1.24
Tanker	23	0.36	0.12	0.54	na	4.3	0.79
Time not driving per mile							
Van	300	0.13	0.05	0.09	na	6.9	0.35
Flatbed	92	0.20	0.12	0.300	na	9.8	0.41
Refrigerated	101	0.12	0.04	0.263	na	5.9	0.30
Tanker	25	0.20	0.10	0.310	na	12	0.57
Time driving per mile							
Van	317	1.21	1.11	0.53	na	8.3	1.60
Flatbed	102	1.23	1.14	0.46	na	9.8	1.65
Refrigerated	106	1.23	1.12	0.54	na	9.4	1.64
Tanker	26	1.29	1.17	0.64	na	7.7	1.62
Total time per mile							
Van	271	1.76	1.38	1.25	na	3.7	2.91
Flatbed	84	2.31	1.62	2.73	na	9.5	3.43
Refrigerated	87	1.94	1.44	1.81	na	8.0	3.18
Tanker	22	1.89	1.54	1.11	na	13.6	4.01
Last home for 24 hrs.							
Van	304	9.41	4	19.54	na	5.9	21
Flatbed	100	9.42	4	20.56	na	4.0	14.5
Refrigerated	97	13.30	6	18.25	na	12.4	30
Tanker	21	6	4	7.66	na	4.8	14

exceptions (particularly for the tanker category, which contains relatively few observations), these statistics generally indicate that the distributions of the attributes of non-dry van hauls exhibit greater variability and, despite their smaller numbers in our data, higher extreme values than do the corresponding distributions of dry van attributes.

6.2. The Determinants of Driver Compensation and Truck Ownership.

To the extent that flatbed, refrigerated, and tanker hauls are in fact more heterogeneous than dry van hauls, the theory predicts that driver compensation will be based on revenue more often for these non-dry van trailer types than for dry vans. Table 6 shows the breakdown of compensation forms by trailer type in our data. Consistent with the theory, driver compensation is far more likely to be tied to carrier revenue for flatbed, refrigerated, and tanker hauls than for dry vans: While about 16 percent of drivers of dry vans report being paid as a percentage of revenue, a third of drivers of refrigerated vans and approximately half of flatbed and tanker drivers are paid on a percentage basis.

TABLE 6: COMPENSATION FORMS BY TRAILER TYPE

	Compensation basis		
Trailer type	mileage (no. of cases)	% revenue (no. of cases)	proportion of cases % revenue
Dry van	307	58	0.16
Flatbed	54	61	0.53
Refrigerated	74	39	0.33
Tanker	15	14	0.48

Source: UMTIP Driver Survey Data

Although these data patterns are consistent with the theory, it is possible that factors other than haul heterogeneity, yet correlated with trailer type, explain the differential use of percentage pay across these categories of hauls. Among such possible influences, we know from table 1 that the incidence of revenue-based compensation differs between company drivers and owner-operators. This is also true in our data; whereas only about a fifth of company drivers (93 out of 457) are paid as a percentage of revenue, nearly half (79 out of 165) of owner-operators receive revenue-based compensation. To the extent that truck ownership varies among trailer types, and compensation form is related to truck ownership, the correlation between compensation forms and trailer types reported in table 6 might simply be the result of differences across trailer types in the propensity for drivers to own their own trucks.

To investigate this possibility, we use a bivariate Probit regression model to estimate the determinants of compensation form and truck ownership. We do this first as a function only of trailer types and then with a set of additional potential determinants of organizational form. Consistent with the previous table, the first column of table 7 shows significantly greater use of revenue-based compensation for non-dry van than for dry van hauls. No significant difference, however, exists in the likelihood of drivers working as employees (as opposed to independent owner-operators) among trailer types, as indicated by the estimates in column 2. Of note, the value of ρ and its χ^2 statistic indicate a significant correlation in the disturbances in the compensation-form and truck-ownership equations, indicating that compensation form and truck ownership are affected by a common set of unobserved variables. Our results show that the observed correlation between revenue-based pay and driver ownership of trucks (see table 1) is *not* the result of differences in attributes associated with trailer type, however.

The third and fourth columns of table 7 report results obtained after adding to the estimation a set of driver characteristics to control for the possibility that truck ownership and compensation form reflect driver preferences (for, say, risk or independence) or wealth constraints. These additional variables are driver's experience (years driving trucks), marital status, and non-driving family income.[36] The results with respect to trailer type are unaffected by the inclusion of these variables; trailer type continues to have a significant relation to compensation but remains unrelated to the truck ownership decision.

TABLE 7. BIVARIATE PROBIT OWNERSHIP AND PAY FORM ESTIMATES

	% revenue	company driver	% revenue	company driver
Constant	-1.008*	0.638*	-1.062*	1.278*
	(-12.70)	(8.99)	(-8.19)	(9.50)
Flatbed	1.08*	-0.185	1.065*	-0.241
	(7.69)	(-1.32)	(7.33)	(-1.63)
Refrigerated	0.612*	0.943	0.593*	0.019
	(4.23)	(0.64)	(3.92)	(0.12)
Tanker	0.970*	0.190	0.947*	0.187
	(3.913)	(0.70)	(3.80)	(0.67)
Experience			0.008	-0.027*
			(1.37)	(-4.80)
Married			-0.091	-0.221**
			(-0.72)	(-1.72)
Other income			0.001	-0.006*
			(0.38)	(-2.03)
ρ:	-0.479		-0.492	
	$\chi^2(1)$: 47.55*		$\chi^2(1)$: 44.89*	
log likelihood:	-666.72		-601.18	
	χ^2 (6): 74.00*		χ^2 (12):103.38*	
n:	622		579	

t-statistics in parentheses
*: significant at the .05 level.
**: significant at the .10 level.

As for the driver-specific variables themselves, the results show no relation between compensation form and any of the driver characteristics. Driver experience, non-driving income and (at the .10 level) marital status are, however, all significantly correlated with drivers owning

[36] In unreported estimations, we also included driver's age, educational level, and number of children. Coefficients on education and number of children were never significant; driver age had a significant effect only if driver experience (which is highly correlated with age) is excluded. We use non-driving income, rather than total income, because of the (greater) potential endogeneity of driver income from trucking.

their vehicles and, thus, their status as owner operators. Truck ownership, it appears, has more to do with the characteristics of drivers than of vehicles.

6.3. Interpretation.

The finding that driver compensation is more likely to be based on carrier revenue for non-dry van hauls than for dry van hauls, combined with the evidence that the former tend to exhibit higher levels and greater variance of "driver-unfriendly" haul characteristics, is consistent with the price-determination theory advanced in this paper; freight transactors are willing to sacrifice the greater objectivity of mileage-based compensation for the greater accuracy of revenue-based compensation where noncontractible haul attributes vary widely. The results are also consistent with our contention that asset specificity is not a major determinant of governance arrangements in freight hauling; the lack of correlation between trailer types and truck ownership indicates no significant difference in the difficulty of arranging alternative transportation for hauls carried by specialized versus non-specialized vehicles.[37] Our theory, developed to explain driver compensation arrangements in trucking, does not, however, address the issue of vehicle ownership and therefore does not explain the correlation between truck ownership and driver characteristics observed in our data.

One possible interpretation of the vehicle ownership results suggested by the negative correlation between drivers' non-driving income and company-driver status is that truck ownership (hence, employment status) reflects differences in driver risk aversion; to the extent that drivers who are less dependent on income from trucking are less averse to the risk associated with truck ownership, drivers with more income from other sources should be more inclined to

[37] The only case in which a coefficient on vehicle type is even nearly significant (less than .90 confidence) as a determinant of driver status is the coefficient for flatbed in the specification including driver characteristics (column 4), and that coefficient is negative, implying that drivers that pull flatbed trailers are more likely to be own their trucks, the opposite of the relationship typically hypothesized.

own and operate their own vehicles. The fact, however, that young, unmarried drivers — presumably the greater risk takers — are more likely, other things the same, to drive employer-owned vehicles seems contrary to a risk-sharing motivation.[38]

An alternative explanation that aligns better with the data is that wealth constraints present a significant impediment to truck ownership: More experienced, married drivers with other sources of income are more likely to have the capital, or be able to obtain the financing, necessary to own their own trucks. In this respect, our findings accord with the sizable literature on self-employment, in which wealth and human capital are important determinants of the decision to be self-employed (Dunn and Holtz-Eakin, 2000; Evans and Leighton, 1989; and Holtz-Eakin, Joulfaian, and Rosen, 1994; among others).[39]

7. Conclusion

The role of relationship-specific investments in the choice and design of organizational arrangements is by now well established. A careful survey of the organizational terrain, however, reveals a variety of organizational practices that do not readily fit the conventional model. The use of long-term contracts or vertical integration in settings, like equipment leasing and franchising, where relationship-specific investments are small or absent is one such anomaly; the phenomenon of contracting parties going to the trouble of specifying complex, detailed price and performance obligations yet leaving one or both parties broad discretion to terminate the agreement — equipment leases and franchise contracts again being examples — is

[38] The fact that ownership is not related to vehicle type, despite the differential variance in driver costs among vehicle types, also runs contrary to the risk-sharing hypothesis. At the same time, the absence of correlation between driver characteristics and compensation form suggests that drivers' wealth or their preferences for risk or independence are not important determinants of compensation arrangements.

[39] Supporting this interpretation of the results is the prevalence of carrier-operated lease purchase and rent-to-own programs in the industry, which are promoted as a form of driver recruitment (see The National Survey of Driver Wages, 2001, p. 6).

another. The coincidence of highly redeployable assets and detailed, long-term but easily terminable contracts found in equipment leasing and franchising is also a feature of the freight transactions we examined in this paper. Although vehicles and the skills needed to operate them are rarely specific to any particular carrier or shipper, owner-operators typically operate under so-called “permanent leases” that constrain the trucker to carry exclusively a specific carrier’s hauls for an extended period but that also allow either party to terminate the agreement, typically with thirty or fewer days notice. In other cases, carriers integrate the provision of freight services, owning their own trucks and hiring drivers as employees — again in a setting with no major, discernable specific investments. To explain these practices, we clearly need to look elsewhere.

Agency theory, which has dominated analyses of, among other areas, franchise contracting and incentive compensation, is one alternative. But puzzles remain. Basic implications of the standard agency model have been challenged by empirical findings showing a positive relationship between the use of sharing rules and "risk" (see Lafontaine and Bhattacharyya, 1995; Lafontaine and Slade, 2001; and Prendergast, forthcoming) and by the widespread use of “incentive pay” schemes that have no plausible incentive effects (Oyer, 2001). In a similar way, marginal incentive considerations, which likely explain why drivers’ fees per haul are (almost always) fixed ex ante (making drivers residual claimants on each haul), cannot explain *differences* in the *bases* used to determine those fees since the incentive implications of the fees are identical regardless of the basis on which they are determined.

In this paper, we explore a third explanation for the contracting practices observed in road transport. Specifically, we have argued that contracts between carriers and drivers in the trucking industry serve primarily to economize on the costs of price determination in heterogeneous transactions. Applying this argument, we predict that mileage pay, which has low implementation costs but is also a relatively low accuracy predictor of driver costs, will be used to compensate drivers when the variance in non-mileage related haul attributes is relatively low, and conversely, carriers and drivers will tend to adopt percentage pay — the higher cost but also higher accuracy predictor of driver costs — in situations where haul characteristics vary more widely across hauls. Consistent with these predictions, we find that mileage pay is in fact used much more frequently in the dry-van segment of the industry, where loads are more similar, and less frequently for hauls carried by specialized trailers, especially flatbed trailers, where hauls tend to vary more along dimensions not related to mileage.

Consistent with our claim that asset specificity is not a major determinant of governance form in trucking, we also found that truck ownership is not related to vehicle types in our data but, rather, depends on individual driver characteristics such as experience and access to other income. In this respect, the factors that lead drivers to own their own trucks, and hence, to become independent owner operators, appear to be similar to the human and financial capital variables that have been shown to explain the self-employment decision and to wealth constraints that lead to the separation of ownership and control of corporate assets despite the incentive advantages of combining the two.

In addition to increasing our understanding of contracting practices in the trucking industry, the broader goal of this paper has been to highlight motives for contract terms that have received less attention in the literature to date. Among other applications, we believe that the factors emphasized in this paper provide a potential resolution of the previously noted puzzle concerning the positive relation between risk and sharing rules in the empirical literature. The desire to "equilibrate hazards" in this framework may also explain the concern for "fairness" and “equity” often expressed by contracting parties (see Masten, 1988; Lafontaine, 1992).[40] Our hope is that others also will consider such alternatives when confronted with observed organizational arrangements or empirical results that do not fit the traditional models.

[40]Out of 130 respondents in Lafontaine's (1992) survey of franchisors, 23 said they used royalties based on sales rather than a fixed price because “Fixed fees would be *unfair* for fluctuating sales, for low volume and/or new outlets,” 32 responded that “Both parties *share* in the success or failure of the outlet,” and 24 indicated they felt like the resulting fees were “Based on performance and *ability to pay*” (italics added).

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Data Appendix

Sample Description and Exclusions

As noted in the text, the UMTIP Survey of Truck Drivers covered a total of 1019 drivers. Of these, 748 classified themselves as full-time, for-hire, over-the-road company drivers or owner operators. This group subdivided by trailer type, based on their current haul, into: dry vans, 402; flatbeds, 128; refrigerated, 124; and tanker, 31. The remaining 63 observations either fell into trailer categories with few observations (dropdeck, 19; autocar, 5; containers, 3; bobtail, 3; and other, 26) or contained missing or invalid values. The 685 company drivers and owner operators in the four largest haul segments form the basis for the analysis of haul characteristics in tables 4 and 5. Missing or invalid values account for further reductions in sample size for specific characteristics.

For purposes of analyzing compensation arrangements and driver status (truck ownership), the sample of valid observations was further reduced from 685 to 622 by the following exclusions: Drivers paid some other way, 30 observations; drivers reporting both mileage- and revenue-based pay, 24 observations; drivers reporting both owner operator and company driver status, 4 observations; and, finally, 5 observations for missing or invalid values of other variables. Missing driver characteristics (mostly for the variable “Other income”) resulted in the 579 observation total in the second specification in table 7.