Long-Term Contracts and Short-Term Commitment: Price Determination for Heterogeneous Freight Transactions

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ABSTRACT

This paper considers a class of contracts in which parties write detailed, long-term performance obligations yet leave one or both parties broad discretion to terminate the agreement on short notice. If the purpose of formal contracting is to make agreements legally enforceable, why would transactors go to the trouble of specifying complex price and performance obligations that either party can walk away from at will? The paper shows that formal contracts may be valuable, even where termination is the only sanction available to the parties, as a way of economizing on the cost of determining prices for heterogeneous transactions. The theory is used to analyze price determination methods in contracts between freight carriers and drivers. The results are consistent with the premise that price determination costs can motivate contractual agreements supported only by termination.

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1. Introduction.

The role of relationship-specific investments, or reliance, in motivating contracting is widely accepted in both economics and law. A party contemplating an exchange will be reluctant to make non-redeployable investments or forego opportunities without reasonable confidence that the other party will uphold its end of the bargain when the time for performance arrives. Where reputational considerations are inadequate to deter reneging, contracts provide transactors recourse to the legal system to enforce performance. In addition to a wealth of case and anecdotal corroboration, statistical analyses have shown relationship-specific investments to be a major determinant of both the use and duration of contractual agreements (e.g., Lyon, 1994; and Joskow, 1987).

This conventional understanding of the motive for contracting leaves unexplained a class of contracts in which parties write detailed, long-term agreements yet leave themselves broad discretion to terminate the agreement on little or no notice and, indeed, often make termination the exclusive remedy in the event of dissatisfaction with the other party's performance. Examples can be found among franchise contracts, equipment leases, distribution and advertising agreements, and software licences. The settings in which such contracts appear, moreover, tend to involve little in the way of relationship-specific investments. All of which raises the question: If the purpose of formal contracting is to make bargains supported by specific investments legally enforceable, why would transactors go to the trouble of specifying complex price and performance obligations that either party can walk away from at will?

This paper emphasizes price determination as a motive for contracting. Specifically, I argue that formal contracts may be valuable — even where trade involves little or no specific investments and termination is the sole remedy — as a way of economizing on the cost of pricing heterogeneous transactions. The argument is analogous to the "search cost economizing" rationale for bundling diamonds (Barzel, 1982), movies (Kenney and Klein, 1983) and tuna (Gallick, 1996). Just as it may be beneficial to sell multiple items in a bundle to reduce privately profitable but jointly wasteful sorting and selection, transactors may gain from bundling multiple transactions over time to reduce the need to settle on a price for each transaction seriatim.

After developing the basic argument, I discuss, first, determinants of the efficient "bundle" (i.e., contract duration) and, then, the implications of the theory for price adjustment methods. Finally, I apply the theory to contracts between carriers and drivers in the U.S. trucking industry, which exhibit the coincidence of highly redeployable assets and long-term, but easily terminable contracts, described above.

2. Pricing Principles

Forward pricing as intertemporal bundling. Prices play two roles in the traditional economic theory of contract. The first, corresponding to the incentive compatibility constraint in contract theory, is incentive alignment, the focus of which is choosing prices that induce the most efficient level of substantive actions (consumption, production, investment and so forth) given the information available to the parties and the courts. The second role of price, corresponding to the participation constraint, is distributional: to divide surpluses in such a way that, at the time of contract formation, both parties expect to do as least as well participating as they would with their "outside option." The processes through which parties arrive at and enforce the resulting prices are rarely discussed, the presumption being that courts costlessly enforce whatever price or prices the parties settle on.

In practice, of course, there are, someone long ago observed, "costs of using the price mechanism," including "costs of negotiating and concluding a separate contract for each exchange transaction which takes place."[1] Arriving at appropriate and agreeable prices and adjusting them over time as the nature and circumstances of the transaction require involve time, attention and, potentially, all of the costs and perils of full-scale, zero-sum bargaining. When those costs are likely to be large – as when exchange requires major investments in relationship-specific assets — so too will be the benefits of securing the price, or a method

[1]Need I really say who?

of determining a price, at which future transactions will take place. The benefit of long-term contracts — contracts covering a series of future transactions — arises because relationship-specific investments are often durable and thus capable of supporting production and exchange over an extended period. If assets are specific but not durable (*transaction*- but not *relationship*-specific, one might say), there is little to be gained from a contract that covers serial transactions; and if trade requires no specific investments, then there is little need for (forward) contracting at all.

Specific investments increase the costs of reaching agreement on price, but their absence does not eliminate those costs completely. Every transaction involves at least some minimal amount of attention to determining what is being bought or sold and what the price is or should be. The time and effort devoted to such inspection and evaluation will usually be greater for complex goods and goods of a kind that vary widely in value. But even if the costs of settling on price are not particularly large, savings from arrangements that reduce those costs may still be significant if accumulated over large numbers of transactions. Such may be the case, as has been claimed for diamonds and movies, if the parties know the distribution of values but cannot determine the value of individual items without costly inspection. By bundling transactions and charging a uniform price for the bundle, the parties save the expense of inspecting and negotiating a price for each item individually (Barzel, 1982; Kenney and Klein, 1983). In principle, such savings should also accrue to "intertemporal bundling" where parties anticipate a succession of similar but heterogenous transactions and agree to a price (or a pricing mechanism) for all transactions over a period of time independent.

Hazard Equilibration. Agreement on a contract price is not a guarantee that exchange at that price will take place. A party to a contract may discover after the fact that the terms agreed to have become disadvantageous and prefer not to perform. And because contracts are incomplete and enforcement is costly and imperfect, a transactor dissatisfied with a contract's terms is often able to exploit gaps and ambiguities in an effort to contrive cancellation (Williamson, 1983), evade performance (Goetz and Scott, 1983) or otherwise force a renegotiation of those terms.[2] Because their objective is the redistribution of existing contractual surpluses, such efforts, "together with the other party's efforts to counteract them" (Goetz and Scott, 1983: 977) represent a form of rent-seeking and are thus to be avoided.

The prospect that parties may find themselves in conflict over contract terms during contract execution introduces a third role for price — in effect, an *ex post* participation constraint (cf. Oyer,2004). Because the realized distribution of contractual surpluses affects the likelihood of such conflict — parties greatly disadvantaged by the terms of a contract are more likely to want to evade or renegotiate a previous deal — contracting parties have an incentive to choose prices so as to divide ex post rents "equitably" (Masten, 1988), keep the relationship with the agreement's "self-enforcing range" (Klein, 1992), or, equivalently, achieve what Oliver Williamson (1983) has called "hazard equilibration."[3]

3. "Intertemporal Bundling"

In this section, I develop a simple model that illustrates some the arguments in the preceding section. In the model, a buyer and seller anticipate undertaking a series of transactions indefinitely into the future, the value and cost of which are uncertain and depend on realized attributes of the transaction in relation to the characteristics of the buyer and seller.[4] Let the value and cost of any given future transaction be

v = the uncertain value (net revenue) of the transaction to the buyer (gross of payments to the seller),

and

s = the uncertain cost of performing the transaction to the seller,

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

[2] Other contracting research representative of this approach includes Goldberg and Erickson, 1985; Masten, 1988; Klein, 1992, 1996; and Crocker and Masten, 1991. For a review and comparison of various perspectives on contracting, see Masten, 2000.

[3] See, in addition, Goldberg, 1985; and Goldberg and Erickson, 1987.

[4] This model essentially extends the analysis in Masten (1988) to repeat transactions.

To abstract from risk-sharing considerations, I assume that both the buyer and seller are risk neutral. Hence, a transaction between a buyer and seller is efficient if the expected joint surplus for a particular transaction is nonnegative, i.e., $E(v\text{-}s) \geq 0$. Buyer and seller willingness to transact, however, depends on each party's expected private surplus and, thus, on price. Let the negotiated price given v and s be

$$p' = \gamma v + (1-\gamma)s$$

where $\gamma \in [0, 1]$ reflects the parties' relative bargaining power. For a given γ, p' is a function of the realizations of v and s, implying a distribution G over p' that maps the joint distribution of v and s, $F(v,s)$, into $G(p')$ such that higher realizations of v or s imply higher p's.

Consistent with the discussion in the preceding section, I assume reaching agreement on price is, to some nontrivial degree, costly, reflecting such things as the time and effort required for buyers to communicate, and for sellers to assess, the attributes of each transaction and to settle on a price. Let n_B and n_S represent these costs to the buyer and seller, respectively, for an individual transaction, and assume for simplicity that these costs are the same for all transactions. 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 the buyer or seller. Thus, were the parties to negotiate prices on a transaction-by-transaction basis over the (indefinite) life of the buyer-supplier relationship, the realized present discounted value of the relationship would be reduced from its potential value by

$$\sum(n_B+n_S)/(1+r)t \text{ over } t \in [0, \infty)$$

$$= (n_B+n_S)/r,$$

where r is the one period discount rate.

3.1. The gains to forward pricing and "intertemporal bundling"

In this simple framework, the transactors stand to gain to the extent they can avoid the negotiation costs, n. As suggested in the previous section, one way to do this is to "bundle" two or more transactions and agree to a uniform price, say p_k, for each. By setting $p_k = \mathrm{E}(p')$, the parties will do as well, in expected terms, as if they had negotiated each transaction separately. But by agreeing to a uniform price for all transactions ex ante, the parties potentially avoid the costs they would have incurred settling on a price for individual transactions contemporaneously, leaving a larger aggregate surplus to divide between them. If the parties agreed to price all future transactions this way and always abided by their agreement, the savings from bundling transactions would be equal to the present value of the negotiation costs avoided for the transactions included in the bundle, or $(n_B+n_S)/r$.[5]

Except in cases where $p_k = p'$ (i.e., the agreed-to price exactly equals the price that would have been negotiated), however, one or the other party will discover that, ex post, the agreed-to price is bad deal relative to the price that would have been negotiated given the realized values of v and s. Depending on the cost of renegotiation, the disadvantaged party may find that reopening the agreement (induced through evasion or threats to contrive cancellation perhaps) in hopes of eliciting a better price is worth the cost of doing so.[6] For an individual transaction, a party would reject the agreed terms only if the expected private gain from renegotiation were greater than the private cost of renegotiation. Specifically, the seller would prefer to renege on its promise and renegotiate price if

$$p' - p_k > n_S \,, \qquad (1)$$

and the buyer would do so if

$$p_k - p' > n_B \,. \qquad (2)$$

[5]Determinants of the optimal bundle size, or contract duration, are discussed below.

[6]If agreeing on a price were costless, the parties would always renegotiate a contract price, but there would also be no reason to contract in the first place.

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

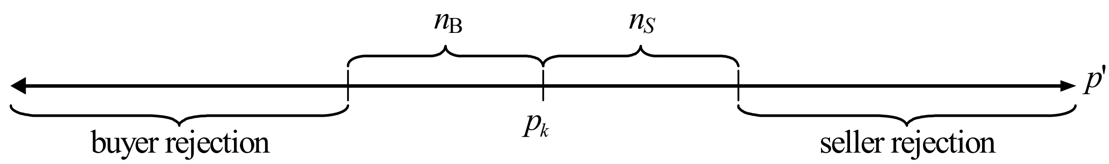

Figure 1

Taking into account the repeat nature of the transactions, however, transactors will be further deterred from reneging by the potential loss of future cooperation. Assuming again the potential for trade indefinitely into the future, the rejection decisions become

$$p_0' - p_k > n_S + W_S \tag{1'}$$

and

$$p_k - p_0' > n_B + W_B \tag{2'}$$

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

$$\varphi^* = \{p' : p_k - (n_B + W_B) \leq p' \leq p_k + (n_S + W_S)\}.$$

The higher the probability that the renegotiated price, p', falls within φ^*, the smaller the probability that renegotiation will occur and, consequently, the greater the proportion of potential joint surpluses the parties will realize. Accordingly, other things the same, the parties would like to minimize the likelihood that transactions fall outside this range. Formally, the buyer and seller wish to choose the price, p_k ,that minimizes expected negotiation costs over all transactions, or

$$\min_{p_k}\left[\int_{p'\in\varphi^*}(n_S+n_B)dG(p')\right]. \qquad (3)$$

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

$$g(p_k - n_B - W_B) = g(p_k + n_S + W_B).$$

In the symmetric case, that is, under symmetric negotiation costs and distribution of *p*', this optimal forward price is p_k = E(*p*'), that is, the expectation of negotiated prices over the set of potential (surplus-generating) transactions. Figure 2 illustrates the solution for this special case by superimposing *g*(*p*') on figure 1.

3.2. Contract duration [incomplete]

The preceding illustrates the potential gains from intertemporal bundling. If there were no costs of contracting, or more precisely, if the costs of extending the agreement to cover an additional transaction (or time period) were always lower than the benefits, parties would write contracts of indefinite (potentially infinite) duration. But contracting is, of course, costly and, more importantly, the hazards of contracting tend to grow with the duration of the contract. A reason for this is that uncertainty tends to increase the further into the future we look.[7] An economical way of capturing this evolving uncertainty is with a Markov process [martingale] of the form

$$p'_{t+1} = p'_t + \varepsilon_t,$$

where ε_t is a random variable with zero mean. Under this process, the expected price, *p*', is the same for every future period as for the next period (i.e., $E(p'_{t+a}) = \mu_{t+a} = p_t$, for all $a \geq 1$), but the variance increases

[7]Compare Coase (1937): " Now, owing to the difficulty of forecasting, the longer the period of the contract is for the supply of the commodity or service, the less possible, and indeed, the less desirable it is for the person purchasing to specify what the other contracting party is expected to do."

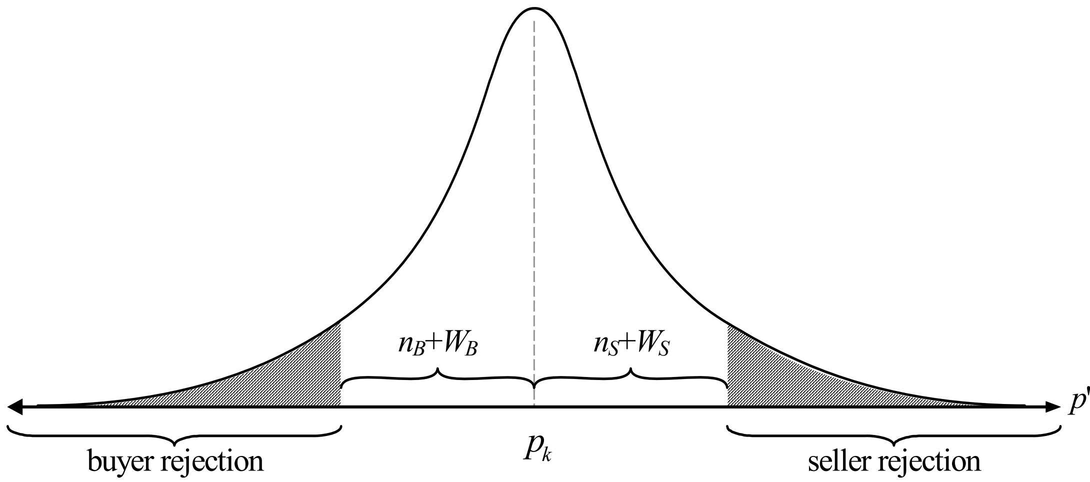

Figure 2

proportionally to the number of time periods forward we look (i.e., $\sigma_t, = \sum\sigma_\epsilon^2 = t\cdot\sigma_\epsilon^2$). As the distribution of possible outcomes becomes flatter with more distant horizons, two things happen: (1) the expected benefits of bundling an additional transaction (or period) falls (because $F(p'_t \in \varphi^*)$ decreases as t increases); and (2) the expected cost of a commitment to transact at contract price, p_k, increases (because the expected deviation between p_k and μ_t increases with t). [to be completed]

3.3. Price Determination.

Since negotiation costs are incurred in those cases where $| p' - p_k |$ is sufficiently large to move the contract outside of the self-enforcing range, the parties can further reduce the probability of incurring negotiation costs if they can find a way to adjust p_k to keep it close to p'. One way to do this is to relate the contract price to an attribute correlated with 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_B and W_S and, thus, the penalty for reneging (the right-hand side of

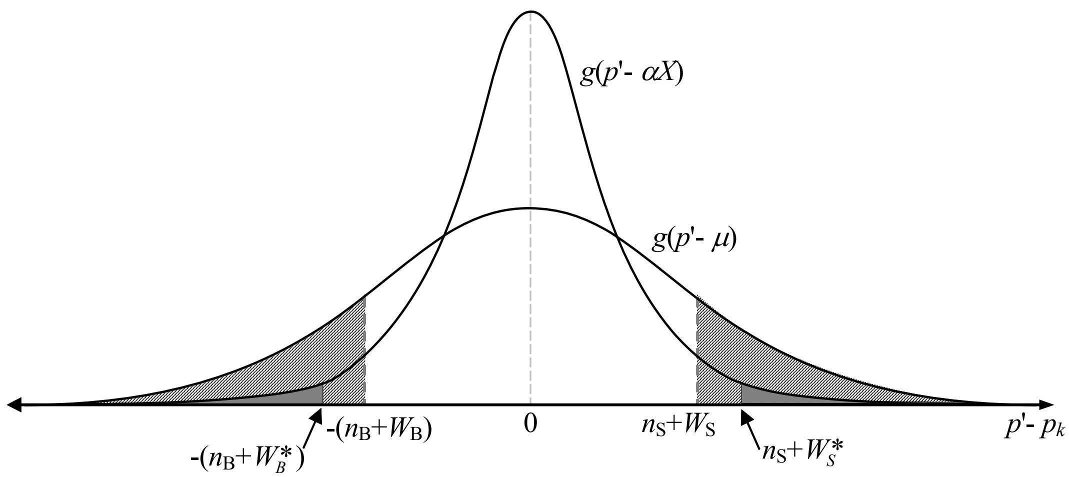

Figure 3

these conditions). Formally, the parties would like to identify a set of transaction attributes, X, and a parameter vector, α , such that $p_k = \alpha X$ minimizes expected renegotiation costs as per equation (3).[8]

Figure 3 illustrates the effect of setting $p_k = \alpha X$ (assuming $\sigma_{p'X} \neq 0$). By reducing the variance of (p'-p_k) and increasing W_B and W_S, making price a function of transaction attributes correlated with v and s reduces the likelihood that transactions will lie outside the self-enforcing range (the shaded area) relative to adopting a uniform price $\mu = E(p')$ (represented by the hashed area in figure 3).

The value of increasing the accuracy of the pricing mechanism (of increasing $\sigma_{p'X}$ through the choice of X) will depend on variance of p' (the size of σ_p^2). As in other price determination settings, the choice of formula for setting prices involves a tradeoff between the accuracy of the formula (the correlation between p_k and p'), on the one hand, and the costs of implementing the price formula, and particularly the ability of the parties to verify and manipulate the chosen measure(s), on the other (cf. Crocker and Masten, 1991).[9]

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[8][Kenney and Klein (1983) argue along these lines to explain why movie studios priced block-booked movies as a function of box office receipts.]

[9]Note that, because there is no investment, effort or other variable actions in the model, there is no issue of incentive alignment. The motive for adjusting prices in this model is exclusively the maximization of the "self-enforcing range" and, thereby, the avoidance of post-agreement conflict. More recently, Oyer (2000) has examined an ex post participation motive for managerial compensation arrangements. In addition to positing renegotiation costs, Oyer's analysis of managerial compensation resembles the present analysis in (i) ruling out marginal incentive considerations

[to be completed]

Summary. The preceding analysis provides a rationale for the use of long-term (multi-transaction) contracts even in the absence of relationship-specific investments. Specifically, transactors have an incentive to "bundle" a series of transactions as a way of economizing on the costs of determining prices when transactions are heterogeneous. Because the cost of legal enforcement is likely to exceed the value of the transactions themselves, such contracts are likely to rely instead on nonlegal sanctions and, in particular, termination. Finally, the larger the variation in transaction attributes, the greater will be the value of pricing arrangements that more accurately track the value of the transaction.

4. Carrier-Driver Contracts

In the remainder of the paper, I examine the nature of contracts between truck drivers and carriers in light of the previous discussion. I begin with an overview of the U.S. trucking industry and follow that with an analysis drawing on a survey of truck drivers conducted by the University of Michigan Trucking Industry Program (UMTIP) containing information on, among other things, the characteristics of drivers, their equipment, and their most recent hauls.[10]

4.1. Industry background

The U.S. trucking industry is highly competitive, consisting of more than ninety-thousand "for-hire" trucking companies, or carriers (U.S. Department of Commerce, 2000). In addition to firms whose main

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. Also see Baker, Gibbons and Murphy (2005).

[10] The survey, designed to elicit detailed 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.

business is trucking, trucking transportation is also provided "in-house" by non-trucking companies that maintain private truck fleets to transport their own goods. Trucking firms also compete with freight transportation by rail, water (ships and barges), and air, as well as, for commodities like petroleum and natural gas, pipelines.

Carriers function essentially as brokers or middlemen, identifying and selling transportation services to shippers, on one side, and matching those shipments with trucks and drivers — either employees who drive carrier-owned vehicles or owner-operators who provide their own trucks — on the other. 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 logistical problem of enormous proportions. Each year, truckers carry millions of hauls over millions of miles for millions of customers between thousands of locations.[11] Even if all cargos and equipment were interchangeable, determining the optimal route structure and assignment of hauls would constitute 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 flatbed 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 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

[11]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.

hauls, clients, and drivers must be performed and continually revised in light of ever-changing weather, traffic, equipment, and road conditions.

The primary physical assets used in trucking — trucks and trailers — are obviously mobile and are largely general purpose in function. Although some trailer types are better suited to some products than others — tank trailers for liquids and flatbed trailers for oversize loads, for instance — a given trailer can generally be used to serve a large number of shippers.[12] Trailers, moreover, can be hitched to and pulled by most any truck tractor.[13] Finally, cargo-handling skills and the knowledge required to operate trucking equipment, however specialized, are rarely specific to a shipper or carrier. Indeed, because of their fungibility in use and mobility, trucks have often been held out as quintessential non-specific assets — literally assets on wheels.

Despite the absence of large, durable relationship-specific investments, carrier-driver transactions are governed mainly through either vertical integration — employee drivers operating carrier-owned trucks — or long-term contracts called "permanent leases," under which an owner-operator agrees to pull a specific carrier's hauls exclusively for some (possibly indefinite) period.[14] Their nominal duration notwithstanding,

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[12]Some transportation assets, such as rail lines and loading equipment, are sometimes 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. 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.

[13]A number of papers have sought to explain organization in various segments of the trucking industry based on either imperfect substitutability of trucks and trailers (e.g., Nickerson and Silverman, 1999, who argue that differences in optimal tractor drive-chain configurations for pulling different types of hauls reduce the interchangeability of trucks and trailers) or short-term location- or "temporal specificity" (e.g. Arrunada et al.; and Hubbard [add cite]; cf. Pirrong, 1994, on the organization of ocean shipping.) The rents in trucking resulting from these considerations, however, are small (in the tens or possibly hundreds of dollars) and highly transitory (measured in hours or, at most, days) both in absolute terms and compared to other industries where asset specificity is important.

[14]Permanent leases are, by definition, for a minimum of thirty days. [add length of average trip/number of hauls per month] Lafontaine (2000) summarizes the terms of seventeen permanent leases and reports durations of "at least 30/31 days", 3 leases; "end of calendar year", 3; one year, 4; greater than one year, 1, "until cancelled", 4; and unspecified, 2. A contract for a single haul is known as a trip lease.

permanent leases typically allow either party to cancel the agreement on relatively short notice.[15] Furthermore, short of termination, owner-operators often retain the right under their agreements to reject hauls assigned by the carrier's dispatcher.[16] The prevalence of long-term (multi-transaction) contracts, short-term commitment, and lack of significant relationship-specific investments thus puts carrier-driver contracts within the class of contracts motivating this paper.

4.2. Haul pricing

If the central substantive problem in freight hauling is logistical — the coordination of a large number of small, heterogeneous transactions — the central organizational problem is one of pricing driver services given the heterogeneity of hauls. In principle, carriers could simply negotiate a fee with each driver taking into account the characteristics of each haul: Hauls that drivers considered costly or unattractive would command a premium over more "driver friendly" hauls. With such a large number of heterogeneous hauls, however, discovering and settling on an acceptable fee 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). Rather than negotiating a separate fee with each driver for each haul, standard industry practice is therefore for carriers to pay drivers for each load according to a pricing rule, the two most common rules being "by mile" and "percent revenue," the latter giving drivers a specified fraction of the freight bill the carrier charges the shipper.[17]

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[15] Lafontaine (2000) reports ten of the seventeen leases requiring notice of cancellation of less than thirty days, six of thirty days or more, and one note stated. Cancellation was permitted "without cause" in all but three leases, which could be cancelled for "breach only."

[16] See section 4.3 below. Company (employee) drivers are said to have less discretion to refuse loads assigned by dispatchers, but even if true, an employee dissatisfied with load assignments is always free to quit a carrier. Again, see section 4.3.

[17] Less commonly used are hourly and per-trip fees.

The substantive incentives of drivers under these two pricing arrangements 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 paid by the shipper to the carrier; 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. 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. Thus, whether driver compensation is based on mileage or revenue, the incentives to expend effort on such activities are exactly the same. And because expected payments can be adjusted by varying the applicable rate-per-mile or driver's share of the freight bill, the two arrangements are equivalent in (ex ante) distributional respects.

Where mileage-based and percent-revenue schemes differ is in (i) the accuracy with which they track driver's costs, and (ii) their costs of implementation. Not surprisingly, a driver's cost of carrying a haul — especially the driver's time, but potentially fuel costs and equipment wear and tear as well — is highly correlated with distance, making mileage a logical candidate for determining price. Using actual mileage, however, would distort driver incentives to find and take the most direct and economical route. Using standardized or "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.

Setting haul prices as a function of mileage is simple and easily implemented. Standardized mileage, however, does not capture other factors such as traffic, customer cooperation, and loading and unloading times, that also affect drivers' costs. The greater the deviation in a driver's actual costs not captured in standardized 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 less likely to result in driver (and carrier) dissatisfaction with price because, in negotiating freight bills with shippers, carriers can incorporate non-mileage determinants of cost as well as distance. The greater accuracy of percent-revenue compensation comes as at cost, however, in that the freight bill 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 under-report, 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.[18] Given the greater implementation costs of basing fees on revenue relative to mileage, percent-revenue pricing is most likely to be reserved for situations where the variation in haul attributes affecting drivers' costs, and thus the value of greater accuracy, are greatest .

4.3. Evidence from the UMTIP survey

The remainder of the paper exploits data from a survey of drivers conducted under the University of Michigan Trucking Industry Program (UMTIP).[19] The study interviewed total of 1,019 truck drivers, of

[18]Statements like the following are indicative of driver suspicions: "There is a mistrust of how carriers represent their [freight bills] 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).

[19]The survey was conducted in two waves, the first during the summer of 1997 and the second in August and September of 1998, and 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.

whom 798 were for-hire, over-the-road (i.e., long distance) drivers.[20] Table 1 contains information on the characteristics of these drivers, their equipment, and the terms of their employment. Of the 798 drivers, 72% (572) were employee drivers, meaning that they drove trucks owned by the carrier, and the remainder, 28% (226 drivers) were owner-operators, drivers who own and operate their own trucks. Of the owner-operators, over 70% acquired their loads under permanent leases with carriers, while most of the remainder (23%) acquired their shipments through freight brokers or contracts with directly with shippers.

The survey did not solicit information on the duration of the lease or contract under which independent truckers operated, but drivers were asked about their control of haul assignments. As shown in Table 1, 76% of owner-operators and 36% of employees indicated they had some ability to determine which loads they carried. But even drivers who reported that they had no control over the loads they were assigned by dispatchers did not necessarily just passively accept undesirable load assignments: When asked what the driver would do when a dispatcher or shipper assigned an unrealistic delivery, 41 (of which 36 were employees) of the 418 drivers who said they had no control over loads responded that they would "refuse the load," 232 (203 employees) would "renegotiate the time," and 9 (8 employees) said they would "fight it" or "argue with" the dispatcher.

Table 1 also shows the method by which drivers' compensation was determined in the UMTIP sample. The vast majority of for-hire, over-the-road drivers were paid either by mile or as a percent of the freight bill (revenue). [note: need to add percentages excluding multiple payment methods] The compensation of owner-operators is divided roughly evenly between by mile and percent revenue while employees are about three-and-a-half times more likely to be paid by mile than as a percent of revenue. Thus, although the percentage of drivers paid in one of these two forms is roughly the same for owner-operators and employees, employees are about fifty percent more likely than owner-operators to be paid by mile.

[20]Excluded from the present analysis are local-delivery-and-pick-up drivers and drivers who work for private fleets (i.e., companies with "in-house" transportation units) or for the government. Totals may differ because of missing values or, in some cases, because categories were not exclusive.

An implication of the price adjustment analysis in section 3 is that the method by which hauls are priced should be related to their heterogeneity: The greater the variation in relevant haul attributes (i.e., attributes that affect the cost or value of providing transportation services), and thus the greater the likelihood of transactors finding themselves outside of the "self-enforcing range," the greater the value to the parties pricing arrangements that more accurately track the parties reservation values. An important attribute of hauls affecting their desirability is the amount of time a driver spends performing non-driving activities[21]. Table 2 contains descriptive statistics for a set of non-driving activities recorded in the survey. The two largest causes of delays for drivers were waiting for dispatch to assign a load and waiting to load or unload. Drivers reported waiting two hours on average for each of these, and as much as 6 days for dispatch and three days to load or unload. Less than a third of drivers reported waiting no time to load or unload, and only twenty percent reported no time waiting to be assigned their most recent haul. In addition to waiting, drivers must spend time on a variety of non-driving activities, including time actually loading and unloading, connecting or disconnecting trailers (dropping and hooking), and a variety of other things. Drivers reported spending an average of 85 minutes, and as much as a day-and-a-half on non-driving tasks. Overall, drivers reported having spent an average of ten hours, and as much as six days, on non-driving activities and waiting on their most recent trip.

Conceptually, the relevant measure of haul variation for purposes of testing the prediction that haul pricing is related to haul heterogeneity is the variance of the attributes of the population of hauls from which each driver's own hauls are selected. The data do not contain that information, but the survey did collect information on the attributes of each driver's most recent haul, which may be used to assess the theory to the extent (i) the distribution of haul characteristics systematically differs between identifiable categories of hauls; or (ii) the attributes of a driver's most recent haul reflect, on average, the distribution of attributes from

[21]Most of the haul attributes identified by Goodson (2000) as "driver unfriendly" 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 of which keep drivers off the road and add to the time it takes to complete a haul.

which it was drawn. For example, distributions of haul characteristics are likely to be more alike within than between trailer types because of the nature of loads they carry: Because dry vans both carry a wide range of products and use standard loading docks and equipment, dry-van drivers may face fewer delays waiting for dispatch and require less time loading and unloading than, say, flatbeds, which carry loads that are often "over-dimensional and short-haul, tend to be high value, and sometimes require slower speeds, alternate routes and even escorts" (Heine, 1999). To the extent that distributions of haul attributes do differ by trailer type, we should expect to see corresponding differences in haul pricing methods.

The last set of entries in Table 1 show the types of trailers drivers pulled on their last load in the UMTIP survey.[22] Dry vans are the most common type of trailer in the sample (54%), followed by flatbeds (17%) and refrigerated trailers (16%). To see whether distributions of haul attributes differ by trailer type, I tested for differences in the distributions of total time spent on non-driving activities (row 9 of Table 2) using Kolmogorov-Smirnov (KS) tests.

For purposes of testing for differences in distributions, it is desirable that sample sizes be as large as possible. Restricting the analysis to owner-operators only greatly reduces the sample size and number of observations in each category cell. To see determine whether it would be appropriate to combine observations on owner-operators and company drivers, I first performed KS tests on the distributions of total non-driving time for employees and owner-operators. The null hypothesis is that the distributions of non-driving time are the same or, more specifically, that $f_e(x) = f_o(x)$, where $f_e(x)$ represents the density of non-driving time for employees and $f_o(x)$ represents the corresponding density for owner-operators. Results of this test are reported in the first column of Panel A of Table 3. The first D value represents the largest positive difference and the second D value the largest negative difference between the distributions for employees and owner-operators, while the corresponding p-values indicate the significance level of each

[22] Although the data show that employees are somewhat more likely than owner-operators to pull dry-van than flatbed trailers, the types of trailers pulled by company drivers and owner-operators are generally similar, suggesting that carrier choice of whether to use owner-operators or employee drivers is not driven by differences in the types of trailers used.

difference. The test rejects the null hypothesis of equal distributions at the .05 level. We know from Table 1, however, that employees are more likely than owner-operators to be paid by mile. If haul pricing is related to haul heterogeneity, as hypothesized, we would expect the distribution of non-driving time for drivers paid by mile to have smaller values than the distribution for drivers paid as a percent of revenue.[23] Comparing non-driving time distributions for employees and owner-operators who are paid the same way (the second and third columns of Panel A), the hypothesis that non-driving time observations for the two groups are drawn from the same distribution can no longer be rejected.

Panels B and C of Table 3 test for differences in non-driving time distributions between trailer types. Industry sources suggest a greater variance in time on non-driving activities for flatbeds and, to a lesser extent, refrigerator and tanker trailer, than for standard dry vans. Panel B shows that the distribution of non-driving time for dry vans has significantly lower values than the three other trailer types, while Panel C indicates the hypothesis that non-driving time observations all came from the same distribution cannot be rejected. Based on this rejection, the first column of Panel D reports the results comparing the distributions for dry-van and all non-van trailers. Again, the results indicate the distribution of non-driving time for dry vans to have significantly lower values than the distribution for non-van trailers.

To help visualize the difference in non-driving time distributions, Figure 4 shows the distributions of non-driving times for dry vans and non-van trailers based on the estimated means and standard deviations of non-driving time for a left-censored (at 0) normal distribution. For dry vans, the estimated mean and standard deviation were 280 and 558 minutes (n=366), and for non-vans 450 and 860 (n=247).

Based on the greater variance of non-driving time for non-van trailers, the theory predicts that percent-revenue haul pricing should be more prevalent for non-van trailers than for dry vans. Table 4 shows

[23]See below.

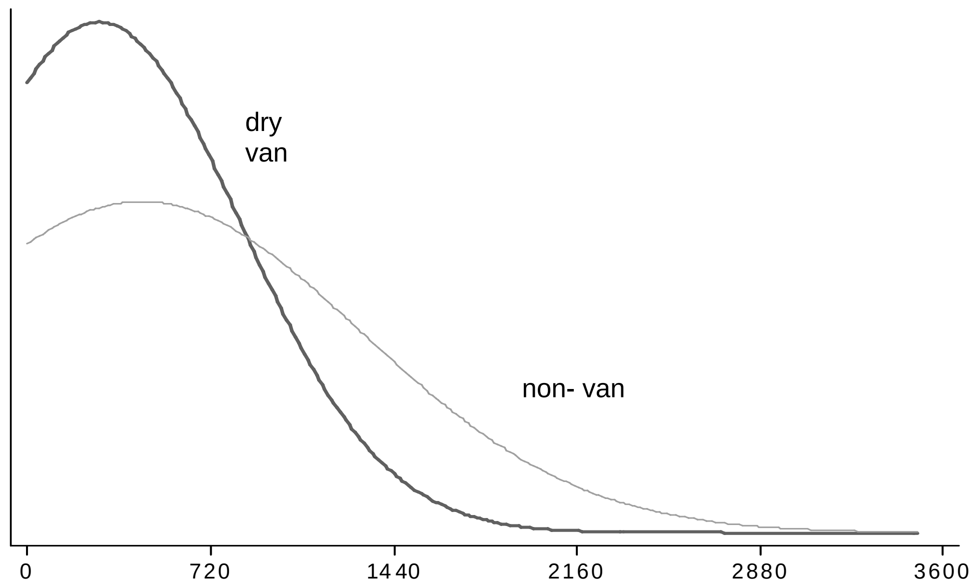

Figure 4. Estimated Distributions of Total Non-driving Minutes

differences in the use of percent-revenue pricing between trailer types. The first column shows the percentage of dry van drivers paid percent-revenue for all drivers and for owner-operators and employees separately. The remaining columns show the corresponding differences in the probability of percent-revenue compensation, first, for all non-van trailers and, then, for each non-van trailer type separately. The comparisons show that, with the exception of refrigerated trailers driven by owner-operators, the difference in the likelihood that a driver of a non-van trailer is paid as a percentage of revenue is large, positive and significant (at the .01 level).

Finally, the second column of Table 3, Panel D, compares the non-driving time distributions for the data partitioned by compensation method. Consistent with the theory, the distribution of non-driving times for drivers paid by mile has significantly lower values than the distribution for drivers paid as a percentage of revenue.

As one final test, I estimated the likelihood of a driver being paid by percent revenue as a function of the driver's own reported total non-driving time on the premise that the attributes of a driver's most recent haul will reflect, on average, the distribution of attributes from which it was drawn. The results of a probit estimation including non-drive time and a dummy for non-van trailers were

$$\underset{}{PCTREV} = \underset{(-11.99)}{-1.055} + \underset{(2.78)}{0.0003*NONDRIVET} + \underset{(6.52)}{0.7723*NONVAN} \qquad \text{Pseudo } R^2 = .09$$

$$\chi^2 = 57.39 \text{ with 2 d.f.} \qquad n = 557$$

Again, the results are consistent with the prediction that the adoption of percent-revenue hauls pricing is associated with greater attribute heterogeneity.

5. Conclusions [incomplete]

The role of contracts in protecting relationship-specific investments is well understood and has been shown to be empirically important. Transactors also contract sometimes, however, in settings that do not seem to involve significant relationship-specific investments. The contracts used in these settings are also unusual in that, though long term, they tend to leave the parties considerable discretion to walk away from the agreement and often make termination the sole remedy in the case of dissatisfaction.

This paper looks at one potential reason for using contracts with these features: economizing on the cost of determining prices for heterogeneous transactions. The use and terms of "permanent leases" in trucking transactions appears to be consistent with this rationale.

[to be continued]

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Table 1. Over-the-Road, For-Hire Driver Characteristics

	Over-the-road, for-hire drivers	Owner-operators	Employee drivers
No. of observations	798	226 (72%)	572 (28%)
Load Source:			
Permanent lease	—	159 (71%)	—
Broker	—	29 (13%)	—
Contract with shipper	—	23 (10%)	—
Other	—	14 (6%)	—
Last load assignment:			
Complete control	119 (15%)	64 (28%)	55 (10%)
Control with limitations	53 (7%)	22 (10%)	31 (5%)
Assigned with right to refuse	203 (25%)	85 (38%)	118 (21%)
Assigned	418 (52%)	53 (23%)	365 (64%)
Compensation method:*			
By mile	544 (68%)	116 (51%)	428 (75%)
Percent revenue	244 (31%)	119 (53%)	125 (22%)
By hour	41 (5%)	4 (2%)	37 (6%)
Other	28 (4%)	12 (5%)	16 (3%)
Trailer type:			
Dry van	426 (54%)	111 (49%)	315 (55%)
Flatbed	137 (17%)	46 (20%)	91 (16%)
Refrigerated	130 (16%)	32 (14%)	98 (17%)
Tank	31 (4%)	6 (3%)	25 (4%)
Other**	71 (9%)	30 (13%)	41 (7%)

*Observations sum to more than total because some respondents indicated more than one type of pay. The “other” category includes only responses for which compensation was determined exclusively on some other basis.
**Includes drop deck, 19; auto carrier, 14; straight truck, 10; bobtail (no trailer), 4; intermodal container, 3; hopper bottom, 2; and tanker, open box, double trailer, dump trailer, step deck, other truck (towing), furniture van, and bulk tanker, 1 each.

Table 2. Time Spent on Non-Diving Activities (in minutes)

	n	mean	s.d.	%=0	max
1. Waiting for dispatch	720	120	465.5	61	8640
2. Waiting to load/unload	720	127	301.6	31	4320
3. Waiting for other reason	637	40	205.8	84	2880
4. Total time waiting (1+2+3)	633	289	639.7	20	9060
5. Time loading/unloading	722	53	154.2	65	2250
6. Time dropping/hooking	716	16	46.5	51	960
7. Time on other work	672	18	51.2	75	480
8. Total time on non-drive work (5+6+7)	669	85	172.4	22	2250
9. Total waiting + non-drive work time (4+8)	610	367	684.3	5	9210

Table 3. . Kolmogorov-Smirnov Non-Driving Time Equality of Distribution Tests

PANEL A: EMPLOYEES V. OWNER-OPERATORS

			Paid by Mile		Paid Percent Revenue	
	Employees (446) v. Owner-operators (164)		Employees (340) v. Owner-operators (89)		Employees (97) v. Owner-operators (81)	
D:	0.005	**–0.114**	0.011	–0.099	0.028	–0.135
p-value	0.993	**0.045**	0.983	0.249	0.934	0.199

PANEL B: DRY VANS (n=366) V. FLATBEDS, REFRIGERATED, AND TANK TRAILERS

	Flatbed (117)		Refrigerated (102)		Tank (28)	
D:	0.006	**–0.187**	0.000	**–0.213**	0.074	**–0.240**
p-value	0.995	**0.002**	1.0000	**0.001**	0.755	**0.050**

PANEL C: FLATBED, REFRIGERATED, AND TANK TRAILER COMPARISONS

	Flatbed (117) v. Refrig.(102)		Flatbed (117) v. Tank (28)		Refrig.(102) v. Tank (28)	
D:	0.167	–0.114	0.065	–0.132	0.227	–0.125
p-value	0.282	0.558	0.628	0.144	0.104	0.505

PANEL D: DRY VAN V. NON-VAN AND BY-MILE V. PERCENT REVENUE

	Dry van (366) v. Non-van (247)		By-Mile(483) v. Pct. Rev. (186)	
D:	0.000	**–0.195**	0.019	**-0.1621**
p-value	1.00	**0.000**	0.921	**0.003**

Table 4. Marginal Probability of Percent Revenue (Relative to By Mile) for Non-Van Trailers (Relative to dry vans)

		Marginal Probability Relative to Dry Van			
	Dry Van Percent	Non-van (all types)	Flatbed	Refrigerated	Tank
All drivers (n=664)	0.26	**+ 0.27 (7.63)**	**+ 0.38 (7.78)**	**+ 0.19 (3.69)**	**+ 0.34 (3.64)**
Owner-operators (n=169)	0.47	**+ 0.23 (3.01)**	**+ 0.26 (2.97)**	+ 0.13 (1.19)	**+ 0.42 (3.29)**
Employees (n=495)	0.18	**+ 0.28 (7.43)**	**+ 0.42 (7.10)**	**+ 0.23 (3.91)**	**+ 0.35 (3.22)**

t-statistics in parentheses; significance at the 0.01 level indicated in bold.