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

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This paper considers a class of contracts in which parties write detailed, long-term performance obligations that leave one or both parties with broad discretion to terminate the agreement on short notice with little or no penalty. I argue that formal contracts may be valuable, even where trade involves little or no relationship-specific investment and termination is the only remedy, as a way of economizing on the cost of determining prices for a series of heterogeneous transactions. Evidence from a survey of truck drivers shows both the general structure of contracts between freight carriers and drivers and the manner in which hauls are priced to be consistent with the goal of economizing on renegotiation costs. (*JEL* D86, L14, L91)

1. Introduction

The role of relationship-specific investment, or reliance, in motivating contracting is widely accepted in both economics and law. A party contemplating an exchange will be reluctant to make nonredeployable investments

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or otherwise 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., Lyons, 1994; 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 relationship-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 investment and termination is the sole remedy—as a way of economizing on the cost of pricing a series of heterogeneous transactions. The argument is analogous to the "search cost economizing" rationale for bundling diamonds (Barzel, 1982; Kenney and Klein, 1983); 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 in a series.

After developing the basic argument, I discuss, first, the benefits of "intertemporal bundling" (i.e., long-term contracting) 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 the long-term, but easily terminable, contracts described above. Evidence from a survey of truck drivers shows that variation in the methods by which long-haul truck drivers are compensated is consistent with the goal of economizing on renegotiation costs.

2. Pricing Principles

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, parties expect to do at least as well transacting with each other as they would do in their next best alternative (cf. Oyer, 2004). The processes through which parties arrive at and enforce the resulting prices are rarely discussed, but the presumption is that transactors costlessly settle on price and that courts then costlessly enforce whatever price they have agreed to (see Williamson, 1983, 1985; Masten, 2000).

In practice, of course, there are, as Ronald Coase famously observed, "costs of using the price mechanism," including "costs of negotiating and concluding a separate contract for each exchange transaction which takes place" (1937, p. 390). Arriving at an appropriate and agreeable price, and adjusting it 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 expected to be large, so will be the benefits of securing at the outset the price at which future transactions are to take place. In the now-standard formulation, gains to long-term contracting—a contract covering a series of future transactions—arise because (i) relationship-specific investments increase appropriable quasi-rents and, thereby, expected bargaining costs and (ii) such investments are often durable and thus capable of supporting production and exchange over an extended period. If trade requires no specific investments (reliance), there is little need for contracting; and if assets are specific but not durable (*transaction*- but not *relationship*-specific, one might say), then there is little to be gained from a contract that covers more than the immediate transaction.[1]

Although relationship-specific investments plausibly increase the costs of reaching agreement on price, their absence does not eliminate those costs entirely. 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 for goods that can vary widely in value. But even in cases where the costs of settling on price are not particularly large, savings from arrangements that reduce or avoid 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; see also Gallick, 1996). Although the phenomenon of bundling goods for sale at a point in time motivates these analyses, the savings in inspection and bargaining costs should also accrue to "intertemporal bundling," where parties anticipate a succession of similar but heterogeneous transactions and agree to a price (or a pricing mechanism) for multiple transactions over time.[2]

1. Williamson (1975, 1979) and Klein, Crawford, and Alchian (1978) are the classic citations. For the most part, the agency literature, including the property-rights/incomplete-contract framework (e.g., Hart and Moore, 1990) does not address multiperiod contracts. One exception is MacLeod and Malcomson (1993), which shows, among other things, that a multiperiod, fixed-price contract "ensures efficient general [i.e., non-specific] investments when there are [exogenous] turnover costs" (p. 832). The same result could also be achieved in their model, however, with a series of one-period contracts. Long-term contracting may also serve as a way for risk-averse agents to smooth income over time in the presence of imperfect capital markets (see, e.g., the discussion in Hart and Holmstrom, 1987).

2. Like the analysis below, Kenney and Klein explicitly situate their bundling analysis in a repeat transaction setting. See Kenny and Klein (1983, pp. 507–9). Even though Kenney and Klein seek primarily to explain the bundling of diamonds and movies at a point in time (id, pp. 510–15), they ultimately conclude that "it is the temporal conditional tie-in sale between periods . . . that is essential for [De Beers'] marketing arrangement" (1983, p. 515).

A second implication of costly pricing is that parties will have an incentive to choose prices in such a way that neither is tempted to renege on or seek to renegotiate the prices on which they have agreed. Agreement on a future 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. Court enforcement can make reneging more difficult, but a transactor dissatisfied with a contract's terms will often be able, given the cost and imperfections of court ordering, 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.[3] 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, p. 977), represent a form of rent-seeking, the cost of which diminishes the value of the transaction. This prospect introduces a third role for price: To the extent that the realized distribution of contractual surpluses affects the likelihood of conflict during contract execution—i.e., that parties greatly disadvantaged by the terms of a contract will seek 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) or, equivalently, to achieve what Oliver Williamson (1983) has called "hazard equilibration."[4]

Because, by hypothesis, the costs of reaching agreement on price, and the consequences of reneging on a previous agreement, are small in the transactions of interest here, the conventional role (in law and economics) of courts and contract law in protecting and motivating reliance is largely eliminated. Given that, and the expense of invoking legal sanctions, parties are likely to prefer self-help (such as termination) to court ordering in dealing with transgressions. With the loss of future cooperation serving as the principal deterrent of opportunism, the benefits of contractually bundling transactions will depend critically on keeping transactions within the "self-enforcing range" (Klein, 1992).

3. Goldberg (1985) and Goldberg and Erickson (1987) refer to efforts to evade contract obligations as "post-agreement jockeying." Other contracting research representative of this approach include Masten, 1988; Klein, 1992, 1996; and Crocker and Masten, 1991.

4. See, also, Goldberg, 1985; and Goldberg and Erickson, 1987. Oyer (2004) describes this third role of price as satisfying an "ex post participation constraint."

3. Price Determination and Long-Term Contracting

In this section, I develop a simple model that illustrates some of the arguments in the preceding section.[5] In the model, a buyer and seller expect to undertake a series of transactions indefinitely into the future, the value and cost of which are uncertain and depend on the realized attributes of each transaction. Specifically, let

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 $F(v,s)$.

To abstract away from risk-sharing and incentive-alignment considerations, I assume that the buyer and seller are risk neutral and that v and s are determined by factors outside the transactors' control. Trade between the buyer and seller is efficient if the expected joint surplus for a particular transaction is nonnegative, i.e., $\mathrm{E}(v - s) \geq 0$. Each party's willingness to transact, in turn, depends on its expected private surplus and, thus, on price. Let the negotiated price given v and s be

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

where $\gamma \varepsilon [0, 1]$ reflects the transactors' 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 a higher p'.

Consistent with the discussion in the preceding section, I assume that reaching agreement on price is, to some nontrivial degree, costly, reflecting such things as the time and effort required for sellers to communicate, and for buyers to assess, the attributes of each transaction and to settle on a price.[6]

5. The model is an extension of the analysis in Masten (1988) to repeat transactions.

6. The assumption of positive negotiation costs contrasts with the conventional agency theory assumption of either zero or prohibitive negotiation costs. Research that has taken a similar approach in explicitly positing positive negotiation or adjustment costs includes Wernerfelt (1997), Bajari and Tadelis (2001), and Oyer (2004).

Let n_B and n_S represent these costs to the buyer and seller, respectively. For the present analysis, I assume that the costs of reaching agreement on price are the same regardless of when negotiations take place and which transactor initiates a renegotiation.[7]

Because the model abstracts away from risk-sharing and incentive-alignment considerations, the costs of agreeing on price 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. Gains in the model arise only to the extent that transactors can devise arrangements that lower negotiation costs relative to that level.[8]

7. This assumption distinguishes the present analysis from the relationship-specific investment motivation for contracting, which turns explicitly on a "transformation" in the costs of reaching agreement on price taking place at the time specific investments are made, with the costs of negotiating price in the presence of large relationship-specific investments being substantially larger than the costs of agreeing on price *ex ante* (see, e.g., Williamson, 1985, pp. 61–62). Although it is possible (even likely) that costs of settling on price prior to versus at the time of an exchange may differ even in the absence of relationship-specific investments, the size and direction of such differences are not clear a priori. The assumption in the current model—that the costs of reaching agreement are the same regardless of their timing—assures that the value of forward pricing does not turn on arbitrarily assumed differences between *ex ante* and *ex post* negotiation costs.

8. Because there is no investment, effort, or other substantive actions in the model, substantive incentive issues do not arise in the analysis. The motive for bundling and for price adjustment in the model is therefore exclusively the avoidance of post-agreement conflict. Oyer (2004) has analyzed the implications of an "ex post participation" motive for managerial compensation arrangements. In addition to positing positive renegotiation costs, Oyer's analysis 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 as opposed to transaction heterogeneity. More recently, Hart (2009) develops a model in which dead-weight losses arising when price deviates from an agreed-upon reference price motivate price indexing. See also Baker, Gibbons, and Murphy (2005) and Hart and Moore (2006).

3.1. "Hazard Equilibration"

As suggested above, one way that transactors may be able to reduce negotiation costs is by "bundling" two or more transactions and agreeing to a uniform price, say p_k, for each. By setting a price $p_k = \mathrm{E}(p')$, the parties will do as well, in expected terms, as if they had negotiated each transaction separately but will, at least potentially, avoid the costs they would have incurred negotiating a price for individual transactions contemporaneously, thereby leaving a larger aggregate surplus to divide between them. If the parties were to agree to price for all future transactions this way, and if they always honored their agreement, the savings from bundling transactions would equal the present value of the negotiation costs avoided for the transactions included in the bundle, less the initial cost of reaching agreement on the contract price, or $[(n_\mathrm{B} + n_\mathrm{S})/r] - (n_\mathrm{B} + n_\mathrm{S}) = (n_\mathrm{B} + n_\mathrm{S})(1 - r)/r$.

As a rule, however, transactors cannot be expected to honor their price agreements faithfully: Except in cases where $p_k = p'$ (i.e., the agreed-on price exactly equals the price that they would have negotiated given realized v and s), one or the other party will discover that the agreed-on price is a bad deal relative to the negotiated price. More precisely, the party wishing to renegotiate will find that reopening an agreement in hopes of eliciting a better price is worthwhile whenever the expected private gain from renegotiation is enough to cover the private cost of renegotiation.[9] Looking at a single transaction in isolation, the seller would prefer to renege on its promise and renegotiate price if

$$p' - p_k > n_\mathrm{S}, \tag{1}$$

and the buyer would if

$$p_k - p' > n_\mathrm{B}. \tag{2}$$

The areas of performance and rejection implied by this structure are depicted in Figure 1. For large p's, the seller will wish to renegotiate price, and for low p's, the buyer will seek renegotiation.

The expectation of repeat dealings, however, implies that transactors may be further deterred from reneging on their price agreements by the threat

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

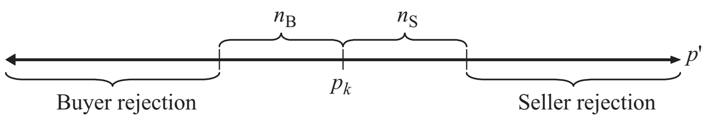

Figure 1. The effects of price on buyer and seller rejection.

of lost future cooperation. Assuming the potential to trade indefinitely, the buyer's and seller's 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), that is, the discounted stream of expected future profits from ongoing exchange.[10]

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. Because renegotiation costs are the only source of inefficiency in the model, the parties want 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

$$\min_{p_K} \left[\int_{p' \notin \varphi^*} (n_S + n_B) dG(p') \right]. \tag{3}$$

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

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

that is, the optimal contract price equates the marginal probability of buyer and seller reneging and, in this sense, "equilibrates hazards" (Williamson,

10. W_s and W_B are defined more explicitly below.

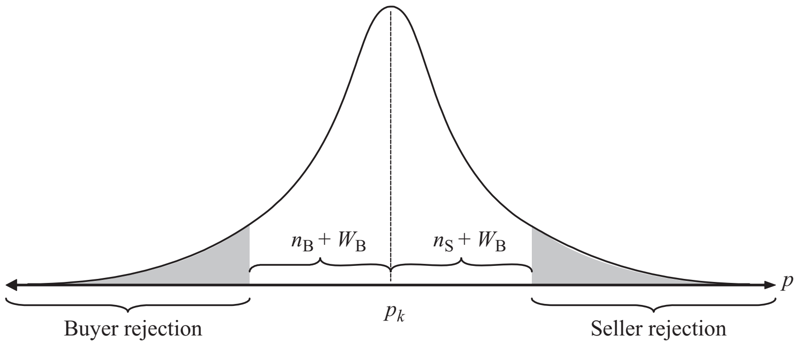

Figure 2. Hazard equilibration and expected renegotiation costs.

1983). In the symmetric case—that is, under symmetric negotiation costs and distribution of p'—this optimal forward price is $p_k = \mathrm{E}(p')$, that is, the expected negotiated price over the set of potential (surplus-generating) transactions. Figure 2 illustrates the solution for this special case by superimposing the probability density of p', $g(p')$, on Figure 1.

3.2. The Benefits of "Intertemporal Bundling"

Taking into account the possibility of reneging, the expected per-period savings to the transactors from agreeing on price ex ante becomes the sum of (per-transaction) renegotiation costs, $n = n_B + n_S$, times the probability that the renegotiated price lies within the self-enforcing range, or $n \times \Pr(p' \in \varphi^*)$. Under the assumption that the parties incur costs to reach agreement on a contract price in the first place, transactors will not find it advantageous to forward price (i.e., to choose p_k prior to realizing v and s) if they expect to transact only once because the *ex ante* cost of agreeing on the contract price plus the expected cost of *ex post* renegotiation, $n + (n \times \Pr(p' \notin \varphi^*)/(1 + r))$, will always be greater than the cost of simply negotiating price at the time of the transaction, n.[11] Hence, contracts in the

11. Again, I am assuming that the cost of agreeing on price is the same regardless of timing. The result that transactors would never forward contract on price for a single transaction in this model is consistent with the implication of standard transaction cost analysis that no benefits accrue to long-term contracting if exchange requires no relationship-specific investment and, thus, no "transformation" from competition to bilateral exchange occurs.

setting of this model must always be long-term in the sense that they must cover (bundle) at least two periods (transactions).

Bundling multiple transactions increases expected surpluses, and makes contracting more attractive, in two ways: First, adding one more transaction to a bundle of τ transactions (extending the duration of an agreement from τ to $\tau + 1$) saves $n \times \Pr(p' \in \varphi^*)/(1 + \mathrm{r})^{\tau + 1}$, the expected reduction in renegotiation costs in period $\tau + 1$ (discounted to present value). Second, covering an additional transaction also increases the self-enforcing range, φ^*, by increasing the level of reputational capital, $W = W_S + W_B$, in periods already covered by the contract.[12]

If the distribution of negotiated prices, $G(p'_t)$, is stationary (identical for all periods), increasing contract duration is always beneficial. Consequently, if transactors contract, the optimal contract will of indefinite duration (have

12. The size of each party's reputation capital depends on the transactors' defection strategies. If the best response to defection by the other party is reversion to period-by-period pricing, the cost of defection (and hence the reputational capital at stake) will equal the resulting increase in expected renegotiation costs in future periods. If, by contrast, the best response is termination, the cost of defection will be the difference between the defecting party's expected surplus if it continued to cooperate with its current trading partner and what it would expect to earn with its next best alternative, less any switching or turnover costs. Either way, the size of the transactors' reputational capital will be greater the more efficient the current relationship. Specifically, if we denote the (net) value of a transactor's next best alternative as R, the reputational capital of the seller and buyer at the time of contract formation will be

$$W_s = \sum_{t=1}^{\tau} \frac{p_k - s_t - n_s \Pr(p'_t \notin \varphi^*)}{(1-r)^t} + \sum_{t=\tau+1}^{\infty} \frac{p'_t - s_t - n_s}{(1-r)^t} - R_s,$$

and

$$W_{\mathrm{B}} = \sum_{t=1}^{t} \frac{v_t - pk - n_{\mathrm{B}} \Pr(p'_t \notin \varphi^*)}{(1-r)^t} + \sum_{t=\tau+1}^{\infty} \frac{v_t - p'_t - n_{\mathrm{B}}}{(1-r)} - R_{\mathrm{B}}.$$

Adding transaction $\tau + 1$ to the bundle increases total reputational capital in period τ, as viewed from the current period, by

$$\frac{n \times \Pr(p'_{\tau+1} \in \varphi^*)}{(1+r)^{\tau+1}}.$$

In addition, however, the increase in reputational capital in period τ (again, viewed from time 0) increases reputational capital in period τ–1, which increases it in τ–2, and so on, so that

$$\frac{\Delta W_0}{\Delta \tau} = \frac{n \times \Pr(p'_{\tau+1} \in \varphi^*)}{(1+r)^{\tau+1}} + \sum_{t=1}^{\tau} \frac{n}{(1+r)^t} \times \frac{\Delta \Pr(p'_t \in \varphi^*)}{\Delta W_{t+1}}.$$

no specific termination date).[13] The decision to contract, then, will depend on the present value of expected negotiation costs with and without a contract, with contracting preferred if

$$n + \frac{n \times \Pr(p'_t \notin \varphi^*)}{r} \leq \frac{n}{r},$$

which, after manipulation, reduces to $\Pr(p'_t \in \varphi^*) > r$. In words, transactors will prefer an agreement of indefinite duration to no contract (period-by-period negotiation) if the probability of being within the self-enforcing range is greater than the relevant discount rate. Because the relevant discount rate depends on the interval between transactions, this condition will be more easily satisfied, other things being the same, the more frequently transactions recur.

13. Recall that the agreements envisioned here, consistent with the contracts discussed in Section 1, are easily terminable by either party. The ability to terminate without penalty means that many of the contracting hazards that limit the duration of conventional, court-enforced contracts—rigidity and potential litigation costs—are not present. Although adding another transaction to the bundle is always beneficial, the benefit decreases with contract duration when the stationarity assumption on $G(p'_t)$ is relaxed. To see this, let μ and σ represent the mean (expected value) and standard deviation of the renegotiated price, p', and assume that $\mu_{t+1} = \mu_t + \varepsilon$, where μ_t represents the mean of $G(p'_t)$ and ε is a random variable with mean zero and standard deviation σ_ε. This process has two consequences. First, the variance of p_t' increases proportionally to the number of time periods forward (the further into the future) we look. Specifically, the variance of p_t' in period t' viewed from period 0 will be

$$\sigma_{t'}^2 = \sigma^2 + \sum_{t=2}^{t'} \sigma^2\sigma_\varepsilon^2 = \sigma^2 + \sigma^2(t'-1)\sigma_\varepsilon^2 = \sigma^2\left(1 + (t'-1)\sigma_\varepsilon^2\right)$$

Because the probability of being within the self-enforcing range for any given contract price decreases as the variance of p'_t increases, and because σ_t^2 increases with t', the expected gain from forward pricing falls as t' increases. Second, even though, under the process defined above, the expected (mean) renegotiated price in any future period, as viewed from any given period, is the same for all periods (i.e., $E(p'_t) = \mu_t = \mu$, for all $t \geq 1$), the expected value of p'_t may shift as time passes: because the mean of the distribution of p'_t in periods $t > 1$ depends on past realizations of ε (is path dependent), the price that turns out to minimize expected future negotiation costs going forward may not be the price that was expected to do so in earlier periods. And because the variance of μ_t increases as we look at more distant dates, the probability that μ_t will deviate from μ grows as we look further forward as well. Hence, the likelihood that the parties will find it desirable to renegotiate the contract price (or price formula), in addition to individual transaction prices, increases with contract duration, reducing further the expected benefit of bundling transactions at more distant dates.

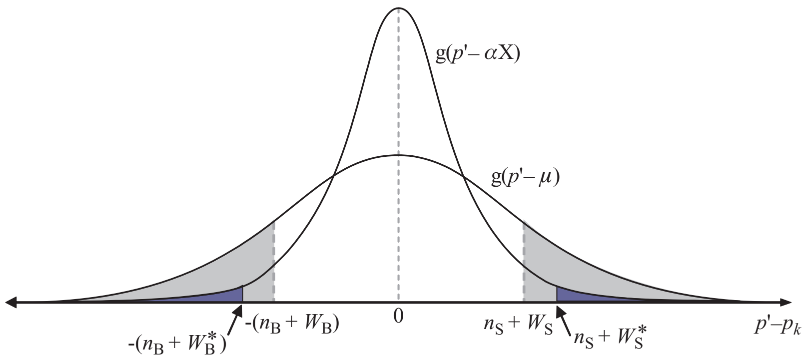

Figure 3. The effects of price adjustment on expected renegotiation costs.

3.3. Price Adjustment

The same considerations that motivate bundling of sequential transactions also create an incentive to devise low-cost ways (relative to renegotiation) of adjusting the contract price during the term of the contract. In particular, to the extent the parties can identify a set of transaction attributes, X, that are correlated with p'_t, transactors can reduce the probability of finding themselves outside of the self-enforcing range by relating the contract price p_k to X.[14] As illustrated in Figure 3, setting $p_k = \alpha X$ affects expected renegotiation costs (assuming $\sigma_{p'X} \neq 0$) in two ways: (i) it reduces the variance of $(p'\text{-}p_k)$ (represented as the change from $g(p'-\mu)$ to $g(p'-\alpha X)$ in Figure 3); and (ii) it increases W_B and W_S and, thus, the size of the self-enforcing range (depicted along the horizontal axis). The combined effect is a reduction in the probability of being outside the self-enforcing range equal to the difference between the light and dark shaded areas of Figure 3.

As in other settings, the choice of variable(s) to which to relate price will involve a tradeoff between accuracy (how well X correlates with p'_t) and the costs of implementing the price adjustment formula, particularly the ability of the parties to manipulate and verify the chosen measure(s).[15] Other things

14. In principle, more complex (e.g., nonlinear or state-contingent) price adjustment methods could also be devised but doing so involves a tradeoff between greater accuracy and increased formation or implementation costs. For a general discussion, see Crocker and Masten (1991).

15. See, for example, Goldberg (1985, p. 533): " While indexing would be the easiest price adjustment mechanism to implement, it has the obvious disadvantage of tracking

the same, the larger the variance of p'_t (σ_t^2), the greater the value of more accurate price adjustment (choosing X with high $\sigma_{p'X}$).

4. The Governance of Carrier-Driver Relations in U.S. Trucking

In the remainder of the paper, I examine the nature of contracts between truck drivers and carriers in light of the previous analysis.[16] 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), which contains information on, among other things, the characteristics of drivers, their equipment, and their most recent hauls.[17]

4.1. Industry Background

The U.S. trucking industry is highly competitive, consisting of more than 90,000 "for-hire" trucking companies, or carriers (U.S. Census Bureau, 2000). In addition to firms whose main business is trucking, trucking transportation is also provided "in-house" by nontrucking 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 such as petroleum and natural gas, with pipelines.

changing conditions imperfectly. Cost-plus pricing tracks cost changes more closely, but is more subject to manipulation; it also gives the seller poorer incentives to control costs, and requires that the parties devote more resources to monitoring performance." See also, Crocker and Masten (1991), and, in an employment context, Milgrom and Roberts (1992, p. 215): "To base a compensation formula on something that is not objectively measurable is to invite disputes and unhappiness among employees," presumably because of concern that difficult to verify measures may be reported strategically.

16. A number of recent studies have examined various aspects of trucking organization. See, in particular, Arrunada *et al*. (2004), Baker and Hubbard (2004, 2005), Hubbard (2001, 2003), and Nickerson and Silverman (2003).

17. 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 specifically sought to target over-the-road truck drivers, who are much more likely than local drivers to use the services offered at truck stops. For more information, see Belman *et al*. (1998).

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.[18] 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 the least, the matching of hauls, clients, and drivers must be performed and continually revised in light of the ever-changing weather, traffic, equipment, and road conditions.[19]

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

19. To help carriers and shippers estimate shipping costs, the Commodity Classification Standards Board of the National Motor Freight Traffic Association publishes a guide, the National Motor Freight Classification (NMFC) containing "descriptions of more than 10,000 commodities or articles, classification ratings (Classes), rules (primarily protective packaging rules), and specific protective packaging requirements for named products" (Bohman, 2009). Intended to "greatly simplif[y] the comparative evaluation of the many

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.[20] Trailers, moreover, can be hitched to and pulled by almost any truck tractor.[21] Finally, cargo-handling skills and the knowledge required to operate trucking equipment, however specialized, are rarely specific to a shipper or carrier. Because of this fungibility in use and mobility, trucks have often been held out as quintessential nonspecific assets—literally assets on wheels.

4.2. Carrier-Driver Contracts

4.2.1. General features. 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.[22] Table 1 contains summary statistics on the characteristics of drivers, their equipment, and terms of employment from the UMTIP survey. Of the 1,019 truck drivers interviewed,

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thousands of products moving in today's competitive marketplace," the NMFC, despite its breadth, provides only "a standard by which to *begin negotiations*" (National Motor Freight Transportation Association; emphasis added).

20. Some transportation assets, such as rail lines and loading equipment, are sometimes specific to a particular shipper (see Pittman, 1992; 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 automobiles or chemicals, are rarely specific to a particular shipper or carrier.

21. Some recent research has sought to relate organization in various segments of the trucking industry to, among other factors, imperfect substitutability of trucks and trailers (e.g., Nickerson and Silverman, 2003, 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., Arruñada *et al.*, 2004 and Hubbard, 2001; see also Pirrong, 1994, on the organization of ocean shipping.) The rents resulting from these considerations in trucking, 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 in comparison to other industries where asset specificity is important.

22. By definition, permanent leases must be for at least 30 days.

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

	Over-the-Road, For-Hire Drivers	Owner-Operators	Employee Drivers
Number 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[a]			
By mile	513 (67%)	95 (46%)	418 (74%)
Percent revenue	213 (28%)	98 (48%)	115 (20%)
By hour	13 (2%)	0 (0%)	13 (2%)
Other	28 (4%)	12 (6%)	16 (3%)
Trailer type			
Dry van	426 (54%)	111 (49%)	315 (55%)
Flatbed	156 (19%)	55 (24%)	101 (16%)
Refrigerated	130 (16%)	32 (14%)	98 (17%)
Tank	31 (4%)	6 (3%)	25 (4%)
Others[b]	52 (6%)	21 (9%)	31 (5%)

Percentages in parentheses are, in the first row, the percentage of owner-operators and employee drivers among all respondents and, in the remaining rows, the percentage of responses relative to the total number of observations in the corresponding column. Percentages may not add to one hundred because of rounding.
[a]Total excludes 31 observations that indicated pay both by mile and as a percentage of revenue.
[b]Includes 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.

798 were for-hire, over-the-road (i.e., long distance) drivers.[23] Of the latter, 572 (72%) were employee drivers, meaning that they drove trucks owned by the carrier, and the remainder, 226 (28%) were owner-operators, drivers who own and operate their own trucks. Over 70% of the owner-operators acquired their loads under a permanent lease. Of the remainder, most acquired shipments either under contracts directly with shippers (10%) or from freight brokers (13%).

23. 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. These sectors do not face (at least not to the same extent) the matching and coordination problems that characterize the for-hire sector.

The UMTIP survey did not collect information on lease duration or termination provisions, but other sources indicate that permanent leases range from 30 days to indefinite term (Lafontaine, 2000) and, though nominally long term, "typically can be terminated by either party at will, except mid-haul" (Nickerson and Silverman, 2003, p. 94; see also, Lafontaine, 2000). Less drastic than termination, drivers might alternatively reject, or seek to renegotiate, the fee for an assigned haul that fell outside the self-enforcing range. As shown in Table 1, 76% of owner-operators in the UMTIP survey indicated that their leases afforded them some rights to influence which loads they carried. But even drivers who reported that they had no control over load assignments did not necessarily just passively accept undesirable loads: When asked what the driver would do when a dispatcher or shipper assigned an unrealistic delivery, of the 53 owner-operators who reported that they had no control over load assignment, 29 said that they would "renegotiate the time," five that they would "refuse the load," and one that he would "fight it" or "argue with" the dispatcher.

Although company (employee) drivers were much less likely than owner-operators to have formal discretion over load assignments — less than a third indicated a right to choose or reject hauls—many nevertheless indicated a willingness to challenge undesirable assignments: Of the 365 employee drivers who reported that they had no control over load assignments, a majority (203) said they would "renegotiate the time," another 36 that they would "refuse the load," and eight that they would "fight it" or "argue with" the dispatcher if assigned an unrealistic delivery. Ultimately, of course, an employee driver dissatisfied with a carrier's load assignments can reject undesirable load assignments by quitting (termination).

4.2.2. Haul pricing. If the central substantive problem in freight hauling is logistical—i.e., 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.[24] With such a

24. This is, in fact, how truckers who work through brokers are normally paid. A contract for a single haul is known as a trip lease.

large number of heterogeneous hauls, however, negotiating 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, 1999, p. 1). A fixed, per-haul fee for every load would avoid the "nightmare" of haul-by-haul pricing but would likely result in frequent renegotiation given the wide disparity in haul characteristics as either drivers rejected or dispatchers withheld grossly under- or overpriced hauls. A pricing formula that automatically related fees to the expected costs of individual hauls would stand to reduce the incidence of haul rejection and renegotiation relative to either a fixed fee or haul-by-haul pricing.[25]

The problem, as indicated earlier, is finding a formula that accurately tracks drivers' costs but is resistant to driver and carrier manipulation. As in many occupations, hours worked is an important component of driver costs; time on the road or waiting to load or unload is time not available for other productive activities or for leisure. Over-the-road truck drivers are rarely paid on an hourly basis, however, because time "working" is easily manipulated by drivers: Dispatchers cannot easily distinguish hours legitimately incurred working from hours taken as leisure or resulting from poor judgment in route choice or from simple misreporting. (Certainly, the problem of driver speeding would be reduced.) Similarly, miles traveled also correlates with driver costs, including such things as fuel costs and equipment wear and tear as well as work time. But, again, miles traveled is subject to driver manipulation: A driver scheduled to complete a delivery late

25. 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, 1999, pp. 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, 1999, p. 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 will find themselves outside the self-enforcing range and will either reject hauls or quit.

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.[26]

Consistent with this, long-haul truckers are rarely paid on an hourly or actual miles-driven basis. Panel 3 of Table 1 shows the compensation methods reported by over-the-road, for-hire drivers in the UMTIP sample.[27] None of the 226 owner-operators and only 13 of the 572 employee drivers reported being paid on an hourly basis.[28] The most common compensation method, "by mile," bases fees on mileage but uses standardized mileage, or so-called "bureau miles," rather than actual miles. While correlated with actual miles, and thus with drivers' costs, bureau miles are outside a driver's control and therefore are not subject to driver (or carrier) manipulation.

Though important, distance captures only one determinant of drivers' costs, omitting such other factors as delays owing to traffic, lack of customer cooperation, loading and unloading times, number of stops, time of day, cargo weight and fragility, special handling needs, and route.[29] The second most common compensation method, "percent revenue," pays drivers a percentage of the freight bill, the fee that a carrier charges the shipper. Compared to mileage-based fees, compensating drivers as a percentage of carrier revenue has the advantage that, in negotiating freight bills with shippers,

26. The recent development and adoption of on-board computers and global positioning devices undoubtedly enhance the ability of dispatchers to monitor driver behavior. On the effects of these new technologies on the governance of trucking, see Baker and Hubbard (2004).

27. The distribution of compensation methods in the UMTIP survey is broadly consistent with those found in other surveys (see Griffen and Rodriguez, 1992; Owner-Operator Independent Drivers Association, 2000).

28. Approximately half of the local pick-up-and-delivery drivers surveyed, by contrast, reported being paid on an hourly basis (Belman and Monaco, 1998, p. 42). Compared to over-the-road drivers, local drivers both spend less time driving and, having fixed routes or territories, are easier to monitor.

29. See Goodson (2000). Drivers do sometimes receive performance bonuses (for mileage, safety, etc.) and are also sometimes paid for specific tasks such as loading and unloading and other contingencies such as extra stops or trips in particularly congested cities (see Goodson, 1999). Consistent with the argument that mileage is a less accurate proxy for costs than carrier revenue, such "extra pay" is more frequently observed with mileage-based compensation. As long as such contingent payments do not accurately price all cost contingencies, the possibility that freight transactions will end up outside the self-enforcing range remains and, hence, the greater accuracy of revenue-based compensation remains valuable. Or put another way, the likelihood of finding systematic differences in the use of mileage- and revenue-based pay is reduced to the extent that contingent payments substitute for the greater accuracy of revenue-based compensation.

carriers can take into account the full range of factors that affect cost as well as distance, resulting in a price that is less likely to cause driver (or carrier) dissatisfaction. The greater accuracy of percent-revenue compensation is offset, however, by the fact that freight bills are vulnerable to potential manipulation by carriers who, despite federal regulations requiring carriers to make their freight bills available to drivers (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. Industry participants report that driver suspicions about this sort of carrier opportunism is an obstacle to more extensive use of revenue-based compensation: "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).[30]

Presumably, driver resistance to the use of percent-revenue haul pricing can be overcome where greater pricing accuracy is sufficiently valuable, however. According to the theory, the value of accurate pricing should be related to variance in haul characteristics: The larger the variation in relevant haul attributes (i.e., attributes that affect the cost or value of providing transportation services), the greater the likelihood of transactors finding themselves outside of the "self-enforcing range," and therefore the higher the value to the parties of pricing arrangements that more accurately track their reservation values.[31]

30. For an example of litigation alleging carrier misreporting of revenue, see *Strickland et al. v. Truckers Express, Inc.*, No. CV95–62M-RFC (filed U.S. District Court, Montana).

31. Note that the substantive incentives of drivers under mileage and percent-revenue pricing are identical: Under both schemes, driver compensation is determined and fixed *ex ante*. A driver paid as a percentage of revenue knows exactly how much money a particular load will yield since both the percent and the freight bill are known at the time a driver takes the load. Similarly, because by-mile payments are based on "bureau miles" rather than actual miles driven, the compensation that by-mile drivers receive 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. By varying the applicable

Table 2. Time Spent on Nondriving 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 nondrive work (5 + 6 + 7)	669	85	172.4	22	2250
9. Total waiting + nondrive work time (4 + 8)	610	367	684.3	5	9210

Although many factors affect driver costs, the most important (nonmileage) factor affecting the desirability of a haul, according to industry accounts, is the amount of time the driver must spend performing nondriving activities[32] Table 2 reports descriptive statistics for a set of nondriving activities recorded in the UMTIP survey. As seen in the table, 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 six days for dispatch and three days to load or unload. Less than a third of drivers reported not having to wait to load or unload their last haul, and only 20% reported not having to wait for their most recent haul assignment. In addition to waiting, drivers also often had to spend time on various nondriving tasks, including time actually loading and unloading and connecting or disconnecting trailers (dropping and hooking). As shown in row 8 of Table 2, drivers reported spending an average of 85 minutes, and as much as a day-and-a-half on such nondriving tasks. Overall, drivers reported having spent an average of 10 hours, and as much as six days, on nondriving activities and waiting on their most recent trip.

To see whether the distributions of nondriving times differed systematically, I first performed a series of Kolmogorov–Smirnov (KS)

rate-per-mile or driver's share of the freight bill, the two arrangements can be made to generate the same expected payments.

32. See, for instance, Goodson (2000). Most of the haul attributes identified by Goodson as "driver unfriendly" relate to time spent on nondriving 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.

tests on various partitions of the sample.[33] Column 1 in panel A of Table 3 compares the distributions of total time spent on nondriving activities (row 9 of Table 2) for percent-revenue and by-mile drivers. The null hypothesis is that the distributions of nondriving time are the same or, more specifically, that $F_r(x) = F_m(x)$, where $F_r(x)$ is the empirical (observed) distribution of nondriving time for drivers compensated as a percentage of revenue and $F_m(x)$ represents the corresponding distribution for drivers paid by mile. The first D value represents the largest positive difference and the second D value the largest negative difference between the distributions of nondriving times for drivers paid by mile relative to those paid as a percentage of revenue, while the corresponding p-values indicate the significance level of each difference. The test rejects the null hypothesis of equal distributions well beyond the 0.01 level, and the relatively large (in absolute value) and significant negative D value indicates that the distribution of time on nondriving activities for drivers paid by mile is substantially lower than the distribution for drivers paid by mile.

To help visualize the difference, Figure 4 shows the estimated distributions of nondriving times for percent-revenue and by-mile drivers based on estimated means and standard deviations of nondriving time for a left-censored (at 0) normal distribution. For percent-revenue drivers, the estimated mean and standard deviation were 505 and 1,050 minutes ($n = 162$), and for by-mile drivers 280 and 485 ($n = 411$). Consistent with the theory, drivers paid as a percentage of revenue appear to experience a significantly greater variance in nondriving times than do drivers paid by mile (equality of the variances rejected beyond the 0.001 level).

The fact that variance in nondriving time outcomes is greater for percent-revenue drivers than by-mile drivers does not explain, however, why nondriving times vary more for some drivers than others. Ideally, to test the theory, we would like to be able to observe the heterogeneity of the population of hauls from which each driver's hauls are selected. Even though the UMTIP survey contains information only on the attributes of a driver's

33. The Kolmogorov–Smirnov test is a nonparametric test of the equality of two distributions. In a nutshell, the method tests whether the maximum vertical differences (both positive and negative) between two cumulative distributions—the D values—are statistically significant. For a concise description and additional references, see StataCorp., 2007, vol. 2, pp. 107–110.

Table 3. Kolmogorov–Smirnov Nondriving Time Equality of Distribution Tests

Panel A: Comparisons by Payment method and Driver Type

					Paid by Mile		Paid Percent Revenue	
	(1) By mile (433) vs. Percent Revenue (155)		(2) Employees (446) vs. Owner-Operators (164)		(3) Employees (340) vs. Owner-Operators (89)		(4) Employees (97) vs. Owner-Operators (81)	
D:	0.014	**−0.166**	0.005	**−0.114**	0.011	−0.099	0.028	−0.135
p-value	0.957	**0.001**	0.993	**0.045**	0.983	0.249	0.934	0.199

Panel B: Comparisons by Trailer Type: Dry Van v. Nonvan

	Dry Van (366) v.							
	(1) Nonvan (265)		(2) Flatbed (117)		(3) Refrigerated (102)		(4) Tank (28)	
D:	0.000	**−0.198**	0.006	**−0.187**	0.000	**−0.213**	0.074	**−0.240**
p-value	1.00	**0.000**	0.995	**0.002**	1.0000	**0.001**	0.755	**0.050**

Panel C: Comparisons by Trailer Type: Flatbed, Refrigerated, and Tank Trailer

	(1) Flatbed (117) vs. Refrig.(102)		(2) Flatbed (117) vs. Tank (28)		(3) Refrig.(102) vs. 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

Number of observations are in parentheses.
Significance at the 0.05 level indicated in bold.

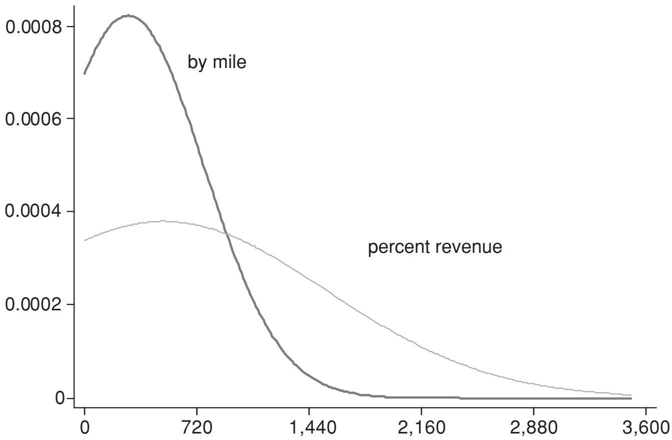

Figure 4. Estimated distributions of total nondriving minutes, percent revenue versus by mile.

most recent haul, we may nevertheless gain insights into the source of haul heterogeneity to the extent that (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 which the haul was drawn. We might, for example, expect distributions of haul characteristics to be more alike within than between trailer types because of the nature of the 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). If haul attributes do differ by trailer type, we should expect to see corresponding differences in haul pricing methods.

The bottom panel of Table 1 shows the types of trailers UMTIP-surveyed drivers pulled on their last load.[34] Dry vans are the most common type of trailer in the sample (54%), followed by flatbeds (19%) and refrigerated

34. Although the data show that employees are slightly more likely than owner-operators to pull dryvan than flatbed trailers, the difference in the types of trailers pulled does not appear to be the main determinant of carrier decisions to use owner-operators or employee drivers.

trailers (16%).[35] Because restricting the analysis to owner-operators would greatly reduce the sample size and, thus, the number of observations in each category cell, it would be helpful if observations for owner-operator and company drivers could be pooled. Columns 2–4 in panel A of Table 3 reports result of KS tests on the distributions of total nondriving time for employees and owner-operators. Column 2 compares the distributions of nondriving time for all owner-operators and employee drivers. The test rejects the null hypothesis of equal distributions at the 0.05 level, that is, the distribution of nondriving times is significantly lower for employees than for owner-operators. We know from Table 1, however, that employees are more likely than owner-operators to be paid by mile. Comparing nondriving time distributions for employees and owner-operators who are paid the same way (columns 3 and 4 of panel A), we see that the null hypothesis that non-driving time observations for similarly compensated owner-operators and employee drivers are drawn from the same distribution cannot be rejected. In other words, drivers who are paid the same way appear to draw hauls from the same distribution regardless of whether the driver is an employee or owner-operator.

Panels B and C of Table 3 report results of KS tests of the equality of distributions of nondriving time between trailer types. As previously noted, industry sources suggest a greater variance in time on nondriving activities for flatbeds and, to a lesser extent, for refrigerator and tanker trailers, than for standard dry vans. Panel B shows that the distribution of nondriving times for dry vans is significantly lower than for the three other trailer types, both combined (column 1) and individually (columns 2–4), while panel C indicates that the hypothesis that nondriving time observations for flatbed, refrigerated, and tanker trailers all come from the same distribution cannot be rejected.

Figure 5 depicts the differences in the estimated distributions of non-driving times for van and nonvan trailers based on the estimated means and standard deviations of nondriving time for a left-censored (at 0) normal distribution. For dry vans, the estimated mean and standard deviation were 279 and 558 minutes ($n = 366$), and for nonvans 448 and 843 ($n = 265$). Again, as expected, nonvan trailers exhibit a significantly wider distribution

35. Included in the flatbed category are 19 drop-deck trailers, which are similar to flatbeds but with lower beds, allowing them to carry taller loads.

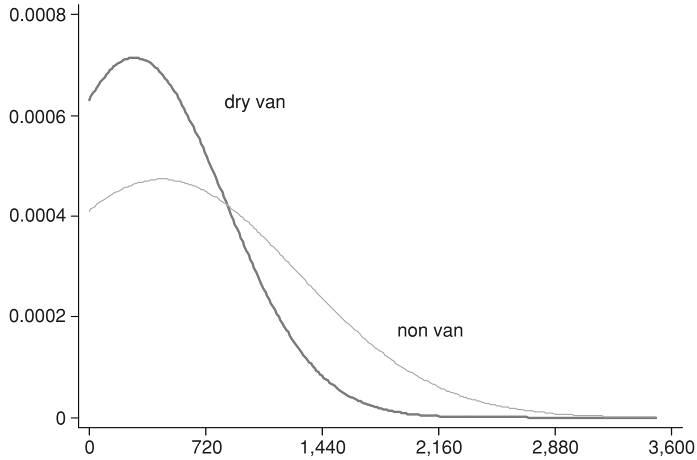

Figure 5. Estimated distributions of total nondriving minutes, van versus non-van.

Table 4. Probabilities of Drivers Being Paid Percent Revenue

	Dry Van Percentage	Marginal Probability Relative to Dry Van			
		Non Van (all types)	Flatbed	Refrigerated	Tank
All drivers ($n = 743$)	0.29	**+0.26**	**+0.35**	**+0.17**	**+0.29**
		(7.61)	**(7.80)**	**(3.43)**	**(3.18)**
Owner-operators ($n = 204$)	0.50	**+0.18**	**+0.21**	+0.08	**+0.38**
		(2.59)	**(2.69)**	(0.77)	**(2.87)**
Employees ($n = 539$)	0.22	**+0.27**	**+0.40**	**+0.22**	**+0.32**
		(7.48)	**(7.15)**	**(3.90)**	**(2.98)**

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

of nondriving times than do dry vans (equality of the variances rejected beyond the 0.001 level).

Given the finding that the variance of nondriving time is greater for nonvan trailers than dry vans, the theory predicts that percent-revenue haul pricing should be more prevalent for nonvan trailers than for dry vans. Table 4 shows estimated differences in the use of percent-revenue pricing between trailer types. The first column shows the percentage of dry-van drivers paid percent-revenue, first, for all drivers (first row) and, then, for owner-operators and employees separately (second and third rows). The remaining columns show the corresponding difference in the probability of percent-revenue compensation, first, for all nonvan trailers and, then, for each nonvan trailer type separately, relative to dry vans. The comparisons indicate that, with the exception of refrigerated trailers driven by owner-operators, the difference in the likelihood of a driver of a nonvan trailer being paid a percentage of revenue relative to a dryvan driver is large, positive, and significant (at the 0.01 level).

As one final test, I estimated the likelihood, contingent on trailer type, of a driver being paid by percent revenue as a function of the driver's own reported total nondriving 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 nondrive time and a dummy for nonvan trailers were

$$\begin{array}{llll} \text{PCTREV} = -1.055 & +\ 0.0003^{*}\text{NONDRIVET} & +\ 0.7723^{*}\text{NONVAN} & \text{Pseudo } R^2 = 0.09 \\ \quad\ (-11.99) & \ (2.78) & \ (6.52) & \\ & & X^2 = 57.39 \text{ with 2 d.f.} & n = 557 \end{array}$$

Again, the results show that the adoption of percent-revenue haul pricing is associated with greater attribute heterogeneity, as predicted.

5. Conclusions

The role of relationship-specific investments, or reliance, in motivating contracts has been extensively analyzed and shown to be empirically important. Transactors also sometimes contract, however, in settings that do not seem to involve significant relationship-specific investments. Such contracts tend also to be unusual in that, though long term, they typically 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 examined one potential reason for contracts with these features: economizing on the cost of determining prices for heterogeneous transactions. This motive for contracting is essentially a variant of the search- or sorting-cost economizing rationale for bundling suggested by Barzel (1982) and developed by Kenney and Klein (1983) extended to sequential transactions. Essential to that rationale is that the attributes of the bundled products be inherently variable and that buyers value quality similarly. Because price affects the payoff to each transaction, each buyer has an incentive to inspect the product in an attempt to determine its true value and an appropriate price. But because buyers all value the product similarly, price affects the distribution of the surplus but not the efficiency of a transaction. As a result, time and effort spent appraising and pricing individual items are largely wasteful, and the gains from trade will be increased to the extent arrangements, such as bundling, can be devised that reduce these costs.

Except that exchange takes place sequentially, transactions between carriers and over-the-road truckers broadly conform to the search cost economizing model. Hauls are intrinsically heterogeneous, varying in time, weight, bulk, origin and destination, and shipper and receiver characteristics, among other features that affect transportation costs. Although the large number and high fungibility of transportation assets assures that most hauls could be carried by a number of different drivers at similar cost, determining that cost for a given haul is a nontrivial matter. Agreements between carriers and truckers to adopt a formula for determining prices on a series of hauls reduce the need to price each haul individually, leaving both parties potentially better off. Consistent with this, the evidence shows a tendency for freight carriers to pay drivers to carry more heterogeneous hauls as a percentage of the freight bill, which can more accurately reflect costs but is more susceptible to carrier manipulation, rather than on the basis of "bureau miles," which cannot be manipulated but do not account for the many other determinants of driver costs. In this regard, the analysis and findings add to a growing body of evidence indicating a role for price in avoiding contract evasion and post-agreement frictions (see, e.g., Oyer, 2004, and Crocker and Masten, 1991).

Although "intertemporal bundling" as a motive for contracting appears to fit the circumstances of long-haul trucking reasonably well, it is not, and is not meant to be, a general theory of contracting. Equipment leases and franchise agreements, for instance, are often long-term (and easily terminable) but are more likely motivated by information-transfer considerations than the heterogeneous-transaction pricing issues emphasized here (see, e.g., Masten and Snyder, 1993). More generally, the protection and motivation of relationship-specific investments (or reliance) is undoubtedly the most general and prevalent function of contracting. What this analysis does suggest is that not all contractual relationships fit the reliance-protection model. To the extent that contract law and judicial enforcement policies are designed with that model in mind, the existence of other motives for contracting may justify the tailoring of rules or more discriminating enforcement to reflect differences in contract functions.

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