Why Use Requirement Contracts? The Tradeoff between Price Premium and Breach

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Abstract

A requirements contract is a form of exclusive dealing in which the buyer promises to buy a particular product only from one seller, who agrees to fulfill all of that buyer's needs. A common-sense motivation for such contracts is that the buyer wants to ensure a reliable supply at a pre-arranged price. In the absence of transaction costs, however, a fixed-quantity contract is better for that purpose. This paper shows that the common-sense motivation makes sense, however, if the buyer is unsure of his future demand, he wishes the seller to make a buyer-specific investment, and the transaction costs of revising or enforcing contracts are high. If transaction costs make efficient breach too costly, option and requirements contracts have the advantage of not inducing inefficient performance. A requirements contract has the further advantage that it balances the profits of the seller across states of the world and thus allows for a price closer to marginal cost.

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I.1. Introduction

In a requirements contract, the buyer agrees to purchase all of his requirements for a particular product from a given supplier for a specified length of time. Exclusive dealing, of which this is one form, has been much studied because of the variety of its motivations, some efficiency-enhancing and some strategic, as summarized in Ramseyer & Rasmusen (2015). The common-sense explanation for a requirements contract is that the buyer wishes to lock in a price and his demand is uncertain. As we will see, however, this explanation falls apart if transaction costs are low, and it does not explain why an exclusive contract, instead of just the option to buy at a fixed price, is used. The common-sense explanation does make sense, however, if demand is uncertain, the cost of renegotiation and litigation is high, and the buyer wishes the seller to make a specific investment.

This explanation presents a contrast with the well-known efficiency-enhancing motivation of inducing relationship-specific investments by eliminating the "hold-up problem," a line of thought going back to Klein, Crawford & Alchian (1978). The hold-up problem arises from the difficulty of determining whether a contract was breached. Exclusivity helps if courts cannot tell whether the correct product has been delivered but can tell which supplier delivers it. The seller will be reluctant to make a relationship-specific investment if the buyer can speciously claim quality is low and refuse delivery unless the price is dropped. The seller exclusive right to supply the buyer helps because it closes off the buyer's outside option and he cannot bargain the seller down to as low a price. This is the theme of the literature based on Hart & Moore (1990). Segal & Whinston (2000) model it with one seller and two buyers, one of whom can make a relationship-specific investment. In the three-person bargaining specification employed, a contract binding the seller and that buyer does not change the level of investment. De Meza & Selvaggi (2007) revisit the situation with a different bargaining specification and find that exclusivity does promote investment. Other papers in this literature in-

clude Bolton & Whinston (1993) on vertical integration for supply assurance and Noldeke & Schmidt (1995) on the use of option contracts.

In the present paper, neither hold-up because of unenforceability nor incentives for promoting a product will play a role. The motivation will be hold-up, but on the opposite side: the buyer will fear being held up because of the seller's relationship-specific investment. If the buyer needs a product with a specific investment and the seller is the only firm that makes that investment, buyer and seller will be in a bilateral monopoly. Once one supplier incurs the fixed cost to design a particular component that fits the particular needs of manufacturing firm, no other supplier will wish to enter for fear of head-to-head competition. Thus, the buyer will want a long-term contract, one that will provide at lowest cost the right incentives to the seller to invest and the right incentives to himself to buy once the investment is completed. Various long-term contracts are possible, however, and we will address the question of how the parties choose between an option contract (the buyer has the option to buy a specified amount at a specified price), a requirements contract (which adds exclusivity to the option contract) and a fixed-quantity contract (in which the exact quantity is specified as well as the price).

We will compare the buyer's choice of contract in two situations, the first with zero transaction costs and the second with high organizational costs of breach. With zero transactions costs, a fixed-quantity contract will create more surplus than an option or requirements contract because it compensates the seller even if the buyer's demand turns out to be low. Under an option contract, the buyer would be free to buy a cheaper unspecialized product if it turned out he did not need the specialized feature, so the contract price would have to be higher to compensate for the specialized investment. Under a requirements contract, the seller is compensated more often, but not as often as with the fixed-quantity contract because the buyer can still choose to buy nothing.

The advantage of the fixed-quantity contract relies on efficient breach. We will next assume that the parties have personal reasons for not wishing to breach the formal terms of the contract, an assumption discussed in Section IV with references to the literatures on relational contracting. If the parties do not breach, then the fixed-quantity contract has the disadvantage of inflexibility. The buyer will feel compelled to buy even when the product is worth less than the contract price to him, and even when it is worth less than marginal cost. The fixed-quantity contract retains its benefit of paying the seller under the greatest variety of circumstances, but this may well be outweighed by the cost of wasteful production. Thus, we return to the common-sense idea that a requirements contract is superior because it is more flexible when demand is uncertain.

I.2. An Illustrative Example

Let us start with an example. The conflict between Tampa Electric Company and the Potter Towing Company in 1955 led to a well-known antitrust case. Tampa Electric was building a coal-fuelled power plant and wanted to use a requirements contract for its coal supply. The Supreme Court describes the contract thus:[1]

> The agreement, dated May 23, 1955, embraced Tampa Electric's "total requirements of fuel . . . for the operation of its first two units to be installed at the Gannon Station . . . not less than 225,000 tons of coal per unit per year," for a period of 20 years. The contract further provided that "if during the first 10 years of the term . . . the Buyer constructs additional units [at Gannon] in which coal is used as the fuel, it shall give the Seller notice thereof two years prior to the completion of such unit or units and upon completion of same the fuel requirements thereof shall be added to this contract." It was

[1] Unless noted otherwise, all the facts of the case come from the Supreme Court opinion, *Tampa Electric Co. v. Nashville Co.*, 365 US 320 (1961).

> understood and agreed, however, that "the Buyer has the option to be exercised two years prior to completion of said unit or units of determining whether coal or some other fuel shall be used in same." Tampa Electric had the further option of reducing, up to 15%, the amount of its coal purchases covered by the contract after giving six months' notice of an intention to use as fuel a by-product of any of its local customers. The minimum price was set at $6.40 per ton delivered, subject to an escalation clause based on labor cost and other factors.

Potter Towing transferred its contract and eventually the Nashville Coal Company succeeded to its contractual position as seller.[2] Tampa Electric built its power plant, at a cost of $3,000,000 more than the cost of an oil-burning plant, and the sellers spent $7,500,000 readying themselves to perform the contract. Just before the first coal was to be delivered, the sellers said they would not deliver the coal. They also said that the contract violated the antitrust laws and hence was not enforceable, because it foreclosed a substantial amount of the market for coal in Florida. Tampa Electric sued. It lost in the trial and appellate courts, but won in the Supreme Court, which ruled that the contract did not violate the antitrust laws. In the meantime, Tampa Electric and the Love and Amos Coal Company had agreed to a similar requirements contract:

> [O]n December 23, 1957, a purchase order contract for the total coal requirements of the Gannon Station was made with Love and Amos Coal Company. It was for an indefinite period cancelable on 12 months' notice by either party, or immediately upon tender of performance by respondents under the contract sued upon here. The maximum price was $8.80 per ton, depending upon the freight rate. In its purchase order to the Love and Amos Company, Tampa estimated that its requirements at the Gannon Station would be 350,000 tons

[2] *Tampa Electric Co. v. Nashville Coal Co.*, 168 F.Supp. 456, 456 (1958).

> in 1958; 700,000 tons in 1959 and 1960; 1,000,000 tons in 1961; and would increase thereafter, as required, to "about 2,250,000 tons per year."

These coal contracts are the kind of requirements contract to be explained. Why was there a contract at all, rather than buying coal on the spot market? Why wasn't the quantity pinned down precisely in the contract? Why was the contract exclusive rather than giving Tampa Electric the option to buy elsewhere if it could find a better price? Note that there was no attempt to use nonlinear pricing– the per-ton price was the same for all quantities. And there were no lump-sum transfers. Tampa Electric could have used a contract in which it paid Potter Towing a lump sum to obtain the contract and then received a low price per ton that just covered marginal cost, but instead it compensated them with a higher price.

I suggest that a requirements contract was used because Tampa Electric wanted a long-term contract to assure its supply at a low price rather than be faced later with a possible tight market with no seller or just a few sellers who had prepared for that eventuality and could charge high prices. Potter Brothers might have prepared to be the only seller in a tight market anyway by making customer-specific investments without a contract, but Tampa Electric preferred a contract with a predetermined price. A fixed-quantity contract would have required renegotiation later, since Tampa Electric did not know its own future demand precisely. Renegotiation would take up management time in the haggling and require replanning of anything in the business that depended on the original contract. An option contract would not need renegotiation but it would need high prices to compensate for Potter Towing's risk that Tampa Electric would buy from someone else. A requirements contract does not have these disadvantages. It does not require renegotiation, and the price that yielded the market rate of return to the supplier could be lower because with outside supply ruled out, the Potter Brothers could expect to sell a bigger quantity. That is the story we will now

proceed to model.

II. The Model

The buyer's value for the single unit he might buy of a good is v, unknown at the time of contracting and distributed with density $f(v)$ on the support $[0, \overline{v}]$, where $f > 0$. We will make the conventional assumption that $-2f(v) - vf'(v) < 0$ so that expected revenue will be concave in price and profits will be rising in price up to the monopoly price. The good's marginal cost is c. With probability θ, the market is "thin" and no supply is available unless some seller has invested fixed amount I to provide it in this special circumstance. With probability $(1 - \theta)$, the market is "thick" and the buyer can buy it from any of N suppliers who compete in simultaneous contract offers. Both players are risk neutral. Each side captures half the surplus if bargaining takes place. We will assume that contracts use linear pricing and do not use lump-sum payments.

Note that we exclude the solution of vertical integration, which can solve any contracting problem. Also, we assume the relationalship-specific investment is not contractible and is not always useful ex post. This investment could consist in capacity excess of normal or in the seller's refusal to accept orders from other buyers that might overwhelm his capacity, as in the model above. Or, it could consist in the usual example in economic models, that the buyer needs a special product, except that in the present model we would add that with some probability the buyer turns out not to need the special feature.

II.1. Outcomes without Contracts: First-Best, Decentralized Optimum, and Spot Sale

The first best. The first best maximizes the sum of the social surplus in the thin market when the specialized product is needed and successfully produced plus the surplus when the market is thick, minus the investment cost. This is

the surplus that would be achieved by vertical integration if the buyer could make the investment and produce the product himself. Alternatively, it is the outcome if the price were set at c and the buyer paid the seller I conditional on his making the investment. The first two terms are the surplus in a thin and a thick market (probabilities θ and $1-\theta$) for purchase when $v \geq c$ and the third is the necessary investment.

$$Surplus = \theta \int_c^{\overline{v}} (v-c) f(v) dv + (1-\theta) \int_c^{\overline{v}} (v-c) f(v) dv - I \qquad (1)$$

The decentralized optimum. If the price equals marginal cost, the seller who invests will earn negative profit. Consider a social planner who can set prices p_{thick} and p_{thin} but cannot force firms to buy, sell, or make investments. In this "decentralized optimum," the social planner wishes to induce a seller to invest but he cannot control which firm serves the buyer or force the buyer to purchase. The buyer's surplus will be

$$Surplus(buyer) = \theta \int_{p_{thin}}^{\overline{v}} (v - p_{thin}) f(v) dv + (1-\theta) \int_{p_{thick}}^{\overline{v}} (v - p_{thick}) f(v) dv \qquad (2)$$

This is subject to the constraint that the seller earn non-negative profit. Assume that if the buyer is indifferent among sellers they each have an equal chance of being selected. If N_{thin} sellers invest I, then each will have to satisfy a participation constraint of non-negative profits:

$$\pi^s(invest) = \frac{1}{N_{thin}} \theta \int_{p_{thin}}^{\overline{v}} (p_{thin} - c) f(v) dv + \frac{1}{N} (1-\theta) \int_{p_{thick}}^{\overline{v}} (p_{thick} - c) f(v) dv - I \geq 0 \qquad (3)$$

The sellers will also have to satisfy an incentive compatibility constraint that the profit from investing is at least as great as from selling only in the thick market:

$$\pi^s(invest) - \pi^s(not\ invest) = \frac{1}{N_{thin}} \theta \int_{p_{thin}}^{\overline{v}} (p_{thin} - c) f(v) dv - I \geq 0 \qquad (4)$$

If the incentive compatibility constraint is satisfied then so is the participation constraint, since expression (4) is less than expression (3) if $p_{thick} > c$. The buyer surplus is declining in the two prices, so since p_{thick} is absent from the more stringent incentive compatibility constraint the social planner will pick $p_{thick} = c$, the lowest level that will content sellers in the thick market. Since it is sufficient for one seller to make the investment, the social planner should set p_{thin} low enough that the incentive compatibility constraint is satisfied exactly for $N_{thin} = 1$, so

$$\pi^s(invest) = \theta \int_{p_{thin}}^{\overline{v}} (p_{thin} - c) f(v) dv - I = 0 \tag{5}$$

We will denote the value of p_{thin} that satisifies equation (5) as p^*. This is the "price equals average cost" of rate-of-return regulation. The social planner sets price equal to marginal cost in the thick market and enough higher in the thin market that the seller's expected profit net of his investment is zero. Surplus will not be as high as in the first-best since the buyer will buy inefficiently little at any price above marginal cost.

It could happen that p^* is greater than the monopoly price and equation (5) cannot be satisfied, in which case it is impossible to induce investment in the decentralized optimum, but we will ignore that possibility for the rest of the paper.

Spot markets. A third way the market could be organized is using a spot market. With no contract and thus no pre-set price, only one seller will invest, since if two did they would compete the price of the specialized good down to marginal cost, c.[3] With one seller and no contract, the price will be the result of bargaining. Under our assumption on bargaining, the price splits the current gains from trade equally (ignoring the sunk cost I), so

[3]We will ignore the mixed-strategy equilibrium where two or more sellers invest with positive probability, with resulting waste and with the price either c or $\frac{v+c}{2}$. This too is an equilibrium the buyer would wish to prevent by contracting in advance.

$p = \frac{v+c}{2}$. The seller will have profit

$$\pi^s_{spot} = \theta \int_{\frac{v+c}{2}}^{\overline{v}} \Big(\frac{v+c}{2} - c \Big) f(v) dv - I \tag{6}$$

Recall that we denoted the decentralized optimum's zero profit price by p^*. If $(v+c)/2 < p^*$, the seller will not invest at all, because the price is less than his average cost. Here we have an example of the common hold-up explanation for long-term contracts: if investment costs are sunk at the time of bargaining over price, investment will be inefficiently low. If $(v+c)/2 > p^*$, on the other hand, the seller would make a profit. This too is a problem from the point of view of the buyer, who would prefer to keep all the surplus, To be sure, total surplus would equal the first-best, since monopoly with bargaining amounts to price discrimination in which the seller sells for all values of v down to c, steadily reducing the price as the buyer's value falls. This achieving of the first best must be treated with caution, however. If we go outside the model and ask why $v > c$ for a business purchase, it will usually be that the buyer has gone to some effort to find or invest in a profit opportunity. If that is the case, the more surplus the buyer loses to seller monopoly rents, the less incentive he has to create the opportunity. Thus, buyer surplus is a more appropriate target than total surplus in this context.

The hold-up of the buyer illustrates a point Goldberg (1976) makes verbally: a relationship-specific investment creates a natural monopoly, which creates the potential for the buyer to be held up. The ordinary hold-up problem is that the party making the investment will receive too low a price from bargaining once his cost is sunk. The hold-up problem here is that the party *not* making the investment will pay too high a price from bargaining, because the investment opportunity is a natural monopoly, a tiny, firm-specific industry with room for only one firm. From the seller's point of view, sunk costs are bad for bargaining, but good for deterring competition. As Demsetz (1968) points out, one solution to the problem of natural monopoly is to auction off the right to be the monopolist, awarding the contract to the seller

who will commit to the lowest price. We thus observe long-term contracts not because the spot market is so disadvantageous to the seller but because it is so costly for the buyer. The observable implications are much the same as with hold-up of the seller— we will see long-term contracts when one or both parties need to make relationship-specific investments— but the motivation is different. Since Goldberg's point is underappreciated, I will flag it here:

Observation. *If a business relationship requires a relationship-specific sunk investment by one party and the gains from trade are large relative to the investment, the* other party *may wish to use a long-term contract to protect himself from bilateral monopoly.*

II.2. The Model with Zero Transaction Costs

We will now look at the contracts the buyer might use to protect himself from hold-up. We will start by assuming zero transaction costs. Zero transaction costs does not mean a player can breach without consequence; he must meet his legal obligations. Those legal obligations can be met, however, at zero real economic cost to either party. Managers do not need to hire lawyers, discuss breach with each other or subordinates, estimate their own and the other party's costs from breach (either at the time of making the contract or after breach) or haggle over out-of-court settlement.

The fixed-quantity contract. Consider a fixed-quantity contract for one unit. We will let the price be conditioned on whether the market is thin (p_{thin}) or thick (p_{thick}). If the buyer breaches, he will be liable to the seller for damages of ($p_{thin} - c$) or ($p_{thick} - c$). As a result, he will breach if $v < c$. In a thin market, if v is between c and p_{thin} he will wish to buy because his consumer surplus would be $v - p_{thin}$, which though negative would still be higher than $-(p_{thin} - c)$. In a thick market, if v is between c and p_{thick} he will be indifferent between buying and paying damages. Buying from the contractual seller would yield a payoff of $v - p_{thin}$, whereas if he bought in the marketplace and paid damages his payoff would be $(v - c) - (p_{thin} - c)$. For concreteness, we will assume he buys, since it will not matter to either party's incentives whether he buys or pays damages.

The seller will thus have expected profit consisting of four terms: (1) the profit from selling in a thin market, (2) the damages from buyer breach in a thin market, (3) the gain from selling in a thick market, (4) the damages from buyer breach in a thick market, minus (5) the investment cost. Putting

these together we have:

$$\begin{aligned}\pi^s_{fq}(I) &= \theta\int_c^{\overline{v}}(p_{thin}-c)f(v)dv+\theta\int_0^{c}(p_{thin}-c)f(v)dv \\ &\quad +(1-\theta)\int_c^{\overline{v}}(p_{thick}-c)f(v)dv+(1-\theta)\int_0^{c}(p_{thick}-c)f(v)dv-I \\ &= \theta\int_c^{\overline{v}}(p_{thin}-c)f(v)dv+(1-\theta)\int_c^{\overline{v}}(p_{thick}-c)f(v)dv-I \end{aligned} \tag{7}$$

The buyer's maximization problem in writing a contract is to maximize by choice of p_{thin} and p_{thick}

$$Surplus(p_{thin},p_{thick})=\theta\int_{p_{thin}}^{\overline{v}}(v-p_{thin})f(v)dv+(1-\theta)\int_{p_{thick}}^{\overline{v}}(v-p_{thick})f(v)dv \tag{8}$$

such that seller profit is

$$\pi^s=\theta\int_c^{\overline{v}}(p_{thin}-c)f(v)dv+(1-\theta)\int_c^{\overline{v}}(p_{thick}-c)f(v)dv-I\geq 0. \tag{9}$$

The first order conditions are, denoting the Lagrange multiplier by μ,

$$\begin{aligned} Surplus'_{p_{thin}} &= \theta\Big(-(p_{thin}-p_{thin})f(p_{thin})-\int_{p_{thin}}^{\overline{v}}f(v)dv\Big)-\theta\mu=0 \\ Surplus'_{p_{thick}} &= (1-\theta)\Big(-(p_{thick}-p_{thick})f(p_{thick})-\int_{p_{thick}}^{\overline{v}}f(v)dv\Big)-(1-\theta)\mu=0 \end{aligned} \tag{10}$$

Except for the multipliers θ and $1-\theta$, the first order conditions for p_{thin} and p_{thick} in equation (10) are the same, so $p^*_{thin}=p^*_{thick}$. Let us call this optimal price p^*. The result that the price should be equal whether the market is thick or thin is an application of the same idea as Ramsey pricing in utilities: two medium price distortions are preferable to one big and one small distortion because surplus loss rises with the square of the distortion.

This principle will apply to all the contracts we will see later in the paper, but we will from now on omit the proofs and only consider uniform prices.

The seller now has two incentives to make investment high. First, if the buyer has a high enough valuation for the specialized product, the seller sells it at a profit. Second, if the buyer has a lower valuation, he breaches and pays the seller damages.

The price is lower than in the decentralized optimum. In the decentralized optimum, the seller makes a profit only by selling in the thin market, so the zero-profit condition is

$$\pi^s_{do} = \theta \int_{p^*}^{\overline{v}} (p^* - c) f(v) dv - I = 0. \tag{11}$$

This has the same first term (with p^* in place of p_{fq}) as the fixed-quantity profit in the first line of equation (7), but it omits the thick-market profits and the two damage terms. The seller earns revenue more often under the fixed-quantity contract, and this permits the break-even price to be lower. At the same time, the buyer only actually purchases the item if his value exceeds marginal cost, so there is no overproduction.

We are used to seeing how long-term contracts increase surplus by averting hold-up, but the mechanism here is quite different. Contracts alleviate hold-up by preventing the buyer from bargaining down the seller to a low price, but in the decentralized optimum there is no bargaining. Rather, the advantage here is that the contract gives the seller a flow of profits with higher probability so the level of the flow can be smaller. Under the decentralized optimum, the seller only receives revenue when the buyer's value is high enough for him to make a purchase. Under the fixed-quantity contract, the seller also receives revenue from damage payments, so the product price can be reduced and the seller can still break even.

The option contract. Under an option contract at price p_{oc}, the buyer has the

option to buy or not buy from the contractual seller so there is no possibility of breach. The seller will have expected profit composed of the profit in the thin market minus the investment cost:

$$\pi^s_{oc} = \theta \int_{p_{oc}}^{\overline{v}} (p_{oc} - c) f(v) dv - I \tag{12}$$

This is exactly the same as in the decentralized optimum, so $p_{oc} = p^*$. The only difference is that the seller has made himself liable for damages if he breaches in the out-of-equilibrium case in which he has failed to invest and the buyer wishes to buy in a thin market. Since the buyer must set p_{oc} high enough to satisfy incentive compatibility anyway, the only effect of the potential damages is to make the seller's profit strictly negative instead of zero if he fails to make the investment.

The requirements contract. Under a requirements contract at price p_{rc}, the buyer is free to buy or not, but if he buys it must be from the contractual seller, not the marketplace. The seller will have expected profit composed of (1) profit when the market is thin, (2) profit when the market is thick, minus (3) the investment cost.

$$\pi^s_{rc} = \quad \theta \int_{p_{rc}}^{\overline{v}} (p_{rc} - c) f(v) dv + (1 - \theta) \int_{p_{rc}}^{\overline{v}} \Big(p_{rc} - c) f(v) dv - I. \tag{13}$$

This profit expression adds sales in the thick market to the thin-market revenue stream in the decentralized optimum. Thus, the requirements contract price can be lower and still yield zero profit.

We can now prove Proposition 1.

Proposition 1: *With zero transaction costs, the fixed-quantity contract generates higher surplus than the requirements or option contracts.*

Proof. In equilibrium, competition among sellers will result in zero profits at the lowest price for a given type of contract that satisfies the seller's

participation constraint. Total surplus will equal the gains from trade, $v-c$, minus the investment cost. The gains from trade will be realized under different values of v for the three contracts. For the fixed-quantity contract, total surplus will be

$$Total\ Surplus\ (fq) = \theta \int_{c}^{\overline{v}} (v-c) f(v) dv + (1-\theta) \int_{c}^{\overline{v}} (v-c) f(v) dv - I \quad (14)$$

The contract requires the buyer to always buy, regardless of v, or breach and pay damages. He will breach if $v < c$ but will always buy otherwise. The limits of integration in (14) are thus c and $\overline{v}$, with $v-c$ representing the social surplus for a given value of v.

Under the option contract, total surplus is

$$Total\ Surplus\ (oc) = \theta \int_{p_{oc}}^{\overline{v}} (v-c) f(v) dv + (1-\theta) \int_{c}^{\overline{v}} (v-c) f(v) dv - I \quad (15)$$

The buyer will purchase from the seller in a thin market whenever his value exceeds p_{oc}, obtaining $v-c$ when he purchases. In a thick market, the buyer will buy from the marketplace at c. The first term is less than the first term under the fixed-quantity contract and the second terms are identical, so surplus is higher under the fixed-quantity contract.

Under the requirements contract, surplus is

$$Total\ Surplus\ (rc) = \theta \int_{p_{rc}}^{\overline{v}} (v-c) f(v) dv + (1-\theta) \int_{p_{rc}}^{\overline{v}} (v-c) f(v) dv - I \quad (16)$$

Under the requirements contract, each of the first two terms is less than under the fixed-quantity contract, because the buyer only buys if $v \geq p_{rc}$ instead of $v \geq c$. Thus, the requirements contract also has lower surplus than the fixed-quantity contract. □

III. The Model with High Breach Costs

We will now assume that both parties make every effort to avoid breach because the transaction costs we assumed away in Section II are high enough to make undesired performance preferable to breaching. We will discuss the realism of this assumption in Section IV but proceed directly to the analysis here.

The fixed-quantity contract. The fixed-quantity contract requires one unit to be traded at price p. The value of p is chosen so that the seller's expected profit is

$$\pi^s_{fq} = (p_{fq} - c) - I = 0. \tag{17}$$

The p that solves this is

$$p_{fq} = c + I. \tag{18}$$

The total surplus is as usual equal to the buyer's surplus, the seller's surplus having been reduced to zero by choice of p.

$$\begin{aligned} \text{Total surplus}_{\text{fq}} &= \int_0^{\overline{v}} (v - p_{fq}) f(v) dv \\ &= \int_{p_{fq}}^{\overline{v}} \Big(v - p_{fq}\Big) f(v) dv - \int_0^{p_{fq}} \Big(p_{fq} - v\Big) f(v) dv \end{aligned} \tag{19}$$

The first part of the surplus is positive, the consumer surplus when the buyer's value is above the contract price. The second is negative, because the buyer continues to buy even if the price is above his value. An equivalent expression is

$$\text{Total surplus}_{\text{fq}} = \int_c^{\overline{v}} (v - c) f(v) dv - \int_0^c (c - v) f(v) dv - I. \tag{20}$$

This second formulation shows how, as before, the advantage of the fixed-quantity contract is that trade occurs whenever it would be efficient, but now inefficient trade also occurs and drags down the surplus.

The option contract. Our second possibility is an option contract giving the buyer the right to choose the quantity traded at price p_{oc}. The seller will have expected profit

$$\pi^s_{oc} = \theta \int_{p_{oc}}^{\overline{v}} (p_{oc} - c) f(v) dv - I \tag{21}$$

and the buyer will choose p to make seller profit equal to zero.

If we substitute the equilibrium value of the fixed-quantity price p_{fq} into profit expression (21) we get

$$\pi^s_{oc} = \theta \int_{c+I}^{\overline{v}} (c + I - c) f(v) dv - I, \tag{22}$$

which is negative because $\theta < 1$ and the lower bound of the integral is not 0, but $c + I$. The option price must be higher than the fixed-quantity price because the seller only earns it with probability θ and only if the buyer's value exceeds the contract price.

The total surplus equals the buyer surplus, which is made up of consumer surplus in the thin market with probability θ at a price of p_{oc} and in the thick market with probability $1 - \theta$ at a price of c in the marketplace.

$$\text{Total surplus}_{\text{oc}} = \theta \int_{p_{oc}}^{\overline{v}} (v - p_{oc}) f(v) dv + (1 - \theta) \int_{c}^{\overline{v}} (v - c) f(v) dv \tag{23}$$

The requirements contract. The requirements contract allows the buyer to choose the quantity traded at price p_{rc} but forbids him from buying in the marketplace. The seller will have expected profit

$$\pi^s_{rc} = \int_{p_{rc}}^{\overline{v}} (p_{rc} - c) f(v) dv - I \tag{24}$$

and the buyer will set this equal to zero in the contract.

The surplus is the buyer surplus from purchasing at a price of p_{rc} if $v \geq p_{rc}$:

$$\text{Total surplus}_{\text{rc}} = \int_{p_{rc}}^{\overline{v}} (v - p_{rc}) f(v) dv \tag{25}$$

How does this compare with the option contract? Under the requirements contract, the buyer always faces price p_{rc}, but under the option contract, the buyer faces the higher thin-market price p_{oc} with probability θ and the lower thick-market price c with probability $1 - \theta$. It turns out that the single moderate price creates higher surplus.

Lemma 1: *When breach costs are high, the requirements contract has higher surplus than the option contract.*

Proof: Jensen's inequality tells us that if function $h(\cdot)$ is strictly concave then

$$\theta h(x) + (1 - \theta) h(y) < h(\theta x + (1 - \theta) y) \tag{26}$$

We know that profits are zero under both contracts. We have assumed that expected revenue is concave in price, so the function $h_1(p) = \int_p^{\overline{v}} (p - c) f(v) dv$ is also concave. Writing the profits using that function,

$$\pi_{oc}^s = \theta h_1(p_{oc}) + (1 - \theta) h_1(0) - I = \pi_{rc}^s = h_1(p_{rc}) - I < h_1(\theta p_{oc} + (1 - \theta)(0)) \tag{27}$$

where the last step applies Jensen's inequality. But that means $p_{rc} < \theta p_{oc} + (1 - \theta)(0)$: the expected price is lower under the requirements contract.

It remains to connect the expected price to surplus. Define $h_2(p) = \int_p^{\overline{v}} (v - p) f(v) dv$. Its derivatives are $h_2'(p) = (p - p) f(p) + \int_p^{\overline{v}} f(v) dv$ and $h''(p) = -f(p) < 0$, so $h(x)$ is concave. Using this function in the surplus functions

(23) and (25), Jensen's inequality, and our finding that $p_{rc} < \theta p_{oc} + (1-\theta)(0)$,

$$\text{Total surplus}_{\text{oc}} = \theta h_2(p_{oc}) + (1-\theta)h_2(c) < h_2(\theta p_{oc} + [1-\theta]c) < \text{Total surplus}_{\text{rc}} = h_2(p_{rc}) \tag{28}$$

Thus, surplus is higher under the requirements contract than under the option contract. □

Comparison of the requirements and fixed-quantity surpluses is less unambiguous. An alternative way to represent total surplus under the requirements contract is in terms of the gains from trade.

$$\text{Total surplus}_{\text{rc}} = \int_{p_{rc}}^{\overline{v}} (v-c)f(v)dv - I \tag{29}$$

The difference between this requirements surplus and the fixed-quantity surplus in equation (20) is

$$\text{Total surplus}_{\text{rc}} - \text{Total surplus}_{\text{fc}} = \int_0^c (c-v)f(v)dv - \int_c^{p_{rc}} (v-c)f(v)dv \tag{30}$$

Combining equation (30) with Lemma 1, we obtain Proposition 2.

Proposition 2: *When breach costs are high, the requirements contract is superior to the option contract. It is superior to the fixed-quantity contract if the surplus loss from overproduction is large enough relative to the loss from underproduction, that is, if*

$$\int_0^c (c-v)f(v)dv > \int_c^{p_{rc}} (v-c)f(v)dv \tag{31}$$

It is somewhat surprising that when breach costs are high the requirements contract is not always superior to the fixed-quantity contract but now that we have gone through the analysis the reason will be apparent. The advantage of the requirements contract over the option contract is that it

gives the seller profits even when circumstances are such that the special investment was unnecessary ex post. These extra profits substitute for paying a lump sum as compensation for investment; instead, the buyer commits to pay above the market price even if the market is thick. The fixed-quantity contract adds even greater probability of making a sale because the buyer purchases even when his value is below the market price. Those extra sales do create negative surplus as a direct effect, but if it is not very negative it is outweighed by the requirement contract's distortion of a price higher than marginal cost.

The left term in inequality (31) is the surplus loss from producing too often under the fixed-quantity contract. The right term is the surplus loss from producing too seldom under the requirements contract. The two terms are analogous to the triangle losses in a supply-and-demand diagram from producing more than the equilibrium quantity or less. Note that which contract is better does not depend on fixed-quantity contract price, because that price does not affect when the product is bought; its only importance is to induce the seller to participate. A high requirements contract price does matter because it increases the requirement contract's curtailment of sales. A high investment cost I hurts the requirements contract, as one would expect, because p_{rc} must be higher.

The connection between the surplus and the shape of the value distribution $f(v)$ distribution is complex. Even in an example with uniform distribution for $f(v)$, the results depend on the parameters. When $f(v) = 1/\overline{v}$, it can be derived that the requirements contract generates higher surplus if the following expression (the seller's profit when the two contracts generate equal surpluses) is positive:

$$\frac{2c^3 - 3c^2 - I\overline{v} + c(I + \overline{v})}{\overline{v} - c} \tag{32}$$

The denominator of (32) is positive since $\overline{v} > c$. The numerator becomes larger, to the advantage of the requirements contract, if I is smaller. An

increase in c favors the requirements contract if c is sufficiently large but disfavors it if c is sufficiently small. Increasing $\overline{v}$ favors the requirements contract if $c > I$ because for the uniform distribution that is equivalent to increasing v's support. If c is relatively high the increase in the waste of overproduction dominates, but if I is high the decrease in the probability of a sale dominates.

Inequality (31) shows more intuitively what features of $f(v)$'s shape favor each contract. The key is how $f(v)$ behaves near $f(c)$. For all buyer values below marginal cost the seller gets no sales under the requirements contract, which drives up p_{rc}, but there is overproduction loss under the fixed-quantity contract. Thus, a high probability of $v < c$ increases the welfare loss from both contracts. If the probability of values just below c is low but of values far below is high, however, that drives up overproduction loss relative to underproduction because only the total probability of $v < c$ matters to the value of p_{rc}, not how it is distributed. In contrast, the shape of $f(v)$ for values just above c does not matter to overproduction, but high probability there does increase the loss from $p_{rc} > c$ because a small price increase above marginal cost causes a big reduction in sales. The buyer will decide on a contract based on which concern predominates.

IV. Discussion of the Use of Contracts in the Absence of Courts

Section III assumes that managers have a high cost of breach yet they care about the terms of the contract. This may be explained by the costs that negotiation over any changes in plans create: managerial time and attention for discussion, bargaining breakdown, changes of plans in coordination with other divisions of the business, and new analysis of the other party's cost or demand functions. These costs are all hard to forecast, adding still another layer of trouble for the manager planning to breach or to cope with breach.

It has long been observed that although many businesses devote great

care to writing legally enforceable contracts with each other, they rarely go to court to enforce them except in endgames— bankruptcy, or the collection of bad debts after a relationship is severed. Macaulay (1963) is the standard cite. In a later article, Macaulay (1977) says (citing Llewellyn [1931] and Kurczewski & Frieske [1977]),

> The contract litigation process may also maintain a vague sense of threat that keeps everyone reasonably reliable (see Llewellyn, 1931:725 n.47). For this process to operate, it is not necessary that business managers understand contract norms and the realities of the litigation process. Perhaps all that is needed is a sense that breach may entail disagreeable legal problems. The Polish managers described by Kurczewski and Frieske reflect this when they tell us that "one needs to threaten [to use contract penalties] intelligently." The authors go on to remark, somewhat paradoxically, that the "system works well so long as the penalties [for breach of contract] are not actually applied. They work well as a threat, but their application will injure the relationship with the cooperating enterprise so that in the future it will seek contacts with other directors who have a more conciliatory approach" (1977:497).

The contract operates to establish the duties of each party, setting out the moral obligations of each side. One way to understand this is as setting the equilibrium trigger strategies of a prisoner's dilemma. As explained in Bull (1987), MacLeod & Malcomson (1988, 1989), and Baker, Gibbons & Murphy 1994), the two parties both wish the relationship to continue, and fear of falling into mutual distrust can prevent either from taking the small windfall profit from breaching or from not having prepared well enough to be able to perform. Later articles show how writing a legally enforceable contract can be useful even if it is the threat of dissolving the relationship rather than the threat of court that is fundamental to maintaining cooperation. See Bernheim & Whinston (1998a), Baker, Gibbons & Murphy (1999, 2002, 2011), Levin(2003), Gilson, Sabel & Scott (2010), Baker & Choi (2014), and

Gil & Zanarone (2014). A distinct though complementary motivation for good behavior is fear of losing not just the particular relationship but one's reputation with outsiders, the argument from the literature starting with Klein & Leffler (1981) which is surveyed in MacLeod (2007) and Malcomson (2012).

The idea of the informal "relational contract" is that its most important features concern governance and termination, not specific transactions. In the extreme, options would not be enforced, nor requirements, nor quantities— in fact, none of those things would be specified. The agreement would be like a partial merger of the two parties, a way to convert Coase's 1938 external transaction contracts outside the boundary of the firm into his internal command-and-control governance— though not, here, within the boundary. The threat of the legal consequences of breach of transaction-specific terms would not even be a starting point for renegotiation. Many contracts that are apparently fixed-quantity, option, or requirements contracts are really like this. Such a fixed-quantity contract would *not* necessarily result in the buyer accepting delivery out of a desire to avoid breach, or the seller building wasteful capacity to avoid being unable to deliver the quantity the buyer needs. In the ideal relational contract this would all be worked out efficiently. See, e.g., Goldberg (1985) and Bernstein (2015). Such contracts do allow for efficient breach; it is just that the threat is not going to court. The parties have little reluctance to breach, and pay each other damages, but the "breach" must be mutually beneficial. The Uniform Commercial Code may not determine the damages, but surplus maximization does. Thus, we can interpret the present model's case of zero transaction costs as either zero costs of going to court or zero costs of renegotiation within a perfect relational; contract. The model's case of high breach costs rules out breach or renegotiation either in the shadow of the court or within a relational contract, and is independent of whether the terms would be enforceable in court.

Why, then, would a party not engage in efficient breach? I suggest it

is because relational contracts do not work so smoothly in practice. The Coase Theorem says that in the absence of transaction costs the parties will renegotiate the promised performance does not maximize surplus. It also says that transaction costs can block efficient renegotiation. The transaction costs of going to court can prevent efficient breach in non-relational contracts, but so too can the costs of going to the other party to request mutually beneficial modifications in relational contracts. Requesting *any* change in a relationship is disruptive. It requires the parties to rethink their actions and to re-open negotiations over how to split a surplus. These renegotiations are about "taking surplus" rather than "making surplus" and though businesses have no qualms about taking surplus, they know that it is a zero-sum game. The function of the contract is to minimize taking and maximize making, putting everything possible of the taking effort into the initial negotiation rather than performance.

When we consider the repeated games models that are often used to model relational contracts we can see a reason why renegotiation creates difficulty. How would a trigger strategy build in efficient breach? "Break the relationship if one party breaches the contract" is a simple trigger. "Break the relationship if one party breaches the contract without adequately compensating the other party" is not. The key is "adequately". It is not enough to require that the injured party agree to overlook the breach and not invoke the punishment. Punishment of even uncompensated breach by breaking a relationship is costly, and if there were wiggle room to preserve the relationship the injured party would, ex post, wish to overlook the breach rather than invoke the punishment. If that is allowed, the trigger strategy becomes useless to enforce cooperative behavior. Thus, a trigger strategy allowing efficient breach would have to specify exactly what damages would be appropriate. Pre-specified liquidated damages would do this, but the exact size of damages— including not only the direct loss from the missed transaction but all the organizational costs of adapting to it— is costly to determine ex ante. Thus, the trigger must be pulled whenever there is breach, since to

allow renegotiation would result in uncompensated forgiveness that would undermine the trigger. Without renegotiation, though, the parties will review their contractual obligations very carefully to avoid pulling the trigger of relationship breakdown.

Bozovic & Hadfield (2015) and Bernstein (2015) have studied business to business contracts by means of interviews and the examination of particular contracts. Managers pay close attention to contracts even when they do not intend to go to court and they expect each other to perform according to the terms. It is routine for businesses to negotiate detailed contracts that they never intend to enforce in court. Whether businesses use detailed contracts, spot purchases, or simple purchase orders, and how closely the actual transactions follow the written records depends on the type of business. A common practice is to write down all relevant details for the planned relationship so that both sides are clear about what is expected, but not because they intend to use the document in court (with the important exception of what happens if the relationship terminates). Rather, once the expectations are set, both parties try hard to meet them, and while many details must be left incomplete because they depend on as-yet-unavailable information, they depend heavily on each other doing what is promised. The biggest risk to reputation is conceivably that of being unable— as opposed to unwilling— to meet expectations. As a result, businesses are reluctant not only to break agreements but to suggest that performance is so difficult for them that they wish to drop a requirement in exchange for voluntary damages. They want to know their exact obligations, so they can avoid conveying negative information by failing to meet them. Bozovic & Hadfield (2013) for example, say

> The formal contracts that the businesses involved in innovation-oriented relationships spend significant resources to create and amend are not documents that lie dormant in a drawer once they have been drafted. Instead, we heard, they are frequently consulted by these businesses to understand their own obligations and those of their partners. They are expressly brought out to help settle disputes that arise

during the course of the relationship.

Managers for online collaboration platforms told them that:

> I would use [the contract] as a reference document. It wouldn't be I never go back to these things, they are in a file drawer. I dig them out when I have to, when there is some reason: what did we do? I can't remember, what did we agree to? Oh, that's what we agreed to. All right, well that's the deal. Get on it with it. (appendix item 26)

and

> [You find yourself] calling these lawyers [for advice in the context of a dispute] who say these are non-enforceable contracts... I always hear lawyers say: don't do MOUs—memoranda of understanding—they are worthless; they are not legally enforceable by law. Well they're right. They are not. But that's not why we're doing it. This memorandum of understanding—it's a memo that says what we've been talking about, what we agreed to, and we want to be clear with each other. So it's all about clarity... and so those types of things become useful instruments for communication clarity. [Even if they] become a contract; well, I'd argue they are still for communication clarity. (appendix item 43)

These businesses write contracts carefully and keep referring to them. The reason is to establish clear expectations rather than to prepare for court battles, as managers from two high-tech consumer electronics firms told Bozovic and Hadfield:

> I cite contracts all the time; you are in breach of this and that... but I've never actually said we are going to use the contract to extract something from you and enforcing it in a court of law. I have never done that. (appendix item 22)

> Have I ever thought I would end up in court? No! We have spent a lot of time on [the contract] and neither party has any intent to use this contract because by the time you get to the point where you are [going to court], now you have a public relations issue. We are a consumer electronics company. You view those kinds of things. . . 'it has impact far beyond the contract: other people don't want to do business with you, you could stifle innovation, you could have a public relations or consumer products problem. . . (appendix item 34)

Ideally, the transactions turn out automatic and smooth, without non-performance, haggling, and delay. The biggest concern is predictability and speed. An online collaboration platform said:

> The fundamental problem [with litigation], and again, this is very much a Silicon Valley perspective, is: the things that delay you are as bad as the things that don't happen. They're kind of equivalent. So, the minute you open litigation, you've put in this time delay. [Moreover] if [your customers see you involved in all kinds of legal problems, they start to wonder] 'what's going on?'. . . then they [decide] I'm not going to do business with them." If somebody views you as high-risk it's absolutely deadly for small companies to start up in anything to do with litigation. . . (appendix item 31)

Bernstein pays particular attention to the extraordinary documentation that procurement managers provide their suppliers for education, not as constraint. The manufacturer wants the components it needs to arrive on time to enter into a complex production process. Even if the supplier is trying its best, it is still useful for the buyer to teach the seller what to do. Scorecard reports are a common means of informing suppliers of how well they are doing. As in school, a major purpose of grades is to let the subject of the grade know whether he needs to work harder. The grades are helpful to the supplier by showing him how to increase the gains from trade, and they even help him do better in selling to other customers:

> The incentives created by the scorecard are reinforced by buyers practice of granting status designations, like "partner-level supplier or "certified supplier to suppliers who continue to meet or exceed specified performance criteria. Some of these designations come with a valuable benefits, such as better or more extensive information sharing, more frequent contact, dock-to-stock status, and the award of business even when they are not the low bidder so long as they are within a specified range of the low bidder. In addition, some buyer questionnaires for new suppliers ask if the supplier is a "certified supplier to any of its customers, thereby making such certification a valuable business asset.

The concern is as much with information and ability to perform as with incentives in these contracts. The supplier who fails to meet expectations cannot simply offer monetary compensation. Monetary compensation for slack performance may be in some scorecards, but it is not really a "performance criterion". A supplier who fails can expect to eventually be terminated.

> Under the scorecard system, the highest rated suppliers are eligible for new business. Those with adequate ratings can keep their existing levels of business, but are expected to improve. And suppliers with lower ratings are warned that their business will decrease if improvements are not quickly made. It is only after a few rounds of low ratings (accompanied, in transactions with the largest buyers, by consulting services designed to improve their operation) that suppliers are terminated.

When contracts do specify damages, it is sometimes for information, not compensation or incentivization. Damages provide a dollar summary of poor performance. Stuart, Deckert, Mcutcheon & Kunst (1998, p. 85) say that a manufacturer of factory automation parts would notify suppliers of the dollar cost of remedying the defect, but would not make them actually pay. The idea was "to use the figures to foster awareness rather than to assess penalties,"

like a boss who tells a blundering employee how much the mistake cost the company. Bernstein (2015) also found this: "As one procurement manager explained, her firm tended to impose these fines only when the relationship with the supplier was deteriorating and/or she wanted to get the attention of managers higher up in the organization in the hope that they would correct the underlying problem."

Finally, Bozovic and Hadfield tell us that though trust is key, that doesn't mean renegotiation is easy. Parties do not want to reveal adverse information to each other even if they trust each other to keep promises. The business relationship is not so much like marriage as like trying to get asked out on another date. The parties conceal their weak points as far as they can. Admitting failure is often worse than muddling through and taking a short-term loss.

> What is revealing about our interviews is the emphasis respondents placed on the barriers they perceived to ex post negotiation and recontracting. It was very clear that at the time of initial contracting, the parties who described innovative relationships to us often felt they knew little about what it would be best to do in the future. They anticipated that each of the contracting parties would learn more privately as the future unfolded. But, they reported, sharing information with a contracting partner ex post is potentially very costly; there are lots of reasons, they indicated, for continuing to withhold information even if it would improve ex post decision-making. One source of such costs is somewhat mundane: engaging in ongoing negotiations and recontracting burns time and money and generates delay; with complex interactions and many dimensions of uncertainty, it is simply not worth discussing everything. More fundamentally, however, ongoing uncertainty about the durability of the relationship makes it costly to reveal one's thinking as private information about the costs and benefits of the collaboration accumulates, particularly relative to alternative oppor- tunities such as taking a piece of the currently-contracted work in-house or adding it to the scope of the collaboration

with another contractual partner.

If, as these considerations suggest, there are many contracts in which managers wish to avoid renegotiation, it is worthwhile to analyze what happens in that case. The theoretical model above shows one result: requirements contracts become attractive relative to fixed-quantity contracts.

V. Concluding Remarks

A simple explanation for requirements contracts is that the buyer does not know his future demand but wants to have an assured supply, and the seller does not want to be locked into a requirement to sell at a certain price unless he has assurance that the buyer will not buy elsewhere if the market price turns out to be lower. That is one way to state the explanation of this paper, but there are important caveats and the one-sentence explanation does not do justice to the mechanisms at work. First, the explanation needs to engage with the possibility of efficient breach. In the absence of transaction costs, a fixed-quantity contract would works just as well in giving flexibility. It, too, allows for flexible quantities, by letting the parties renegotiate the quantity using the initial contract as a starting point.

Second, we must think about why the seller does not want to be locked into selling to this buyer. If the contract price were high enough, the seller would be compensated enough for providing the buyer with an option to buy, even if the option were seldom to be exercised. The difficulty arises because if the contract price is high, the buyer will buy inefficiently little. Thus, an attractive feature of a contract is that it pay the seller with high probability, allowing the price to be lower and closer to marginal cost. A fixed-quantity contract is ideal in that respect because the seller's revenue does not depend on the buyer's demand. Either the buyer purchases, or the buyer pays damages.

Even before distinguishing between contracts, we need to ask why the

buyer wants a contract at all, rather than using the spot market. A contract becomes attractive when not only is demand uncertain but the buyer needs the seller to make a relationship-specific investment. He fears that if he does not contract in advance, only one seller will make the investment, who will be able to hold him up for a high bargained-over price as in a natural monopoly, or, if information is poor, that no seller will make the investment. Instead, the buyer wishes to choose which seller occupies the natural monopoly by auctioning off a contract in advance.

If, in addition, the parties have a high cost of breaching and renegotiating contracts, whether for reputational or internal transaction costs reasons, a fixed-demand contract has the disadvantage of the buyer purchasing the fixed quantity even when his benefit is less than its marginal cost. If the contract simply gave the buyer to option to buy, granting him entire authority over the quantity to be traded, that would avoid inefficient purchases, but it would also allow the buyer to purchase from other suppliers if they turned out to be available. The requirements contract has the option contract's advantage of flexible demand plus the fixed-quantity contract's advantage of paying the seller his price with high probability. If the buyer's value for the product is below marginal cost, he need not buy at all. Otherwise, even if cheaper suppliers turn out to be available, if the buyer wishes to purchase any quantity at all, the seller will receive revenue. This high probability of making a sale allows his price to be lower and encourages him to invest more in the relationship.

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