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Endogenous incomplete contracts: a bargaining approach

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Abstract. In this paper we argue that, by modelling the contracting process as a bargaining game, one can endogenize the choice between complete and incomplete contracts. This point is demonstrated within a stylized model in which agents can allocate an endowment stream either via a once-for-all bargain over the entire stream – a long-term contract – or through a series of bargaining rounds – a short-term contract. Within this structure, short-term contracts arise as equilibrium outcomes under very general conditions, because a short-term contract implies reduced bargaining costs for one of the agents. In essence, reduced 'transaction costs' produce a short-term contract. JEL classification: L14, C78

Contrats endogènes incomplets: une approche en terme de négociation. Ce mémoire montre qu'en modelisant le processus contractuel comme un jeu de négociation, on peut endogénéiser le choix entre contrats complets et incomplets. On fait la démonstration de cette proposition dans le cadre d'un modèle stylisé où les agents peuvent allouer les flux de ressources d'un actif soit via une seule négociation portant sur l'ensemble des flux (un contrat à long terme) soit via une série de rondes de négociation (un contrat à court terme). Dans le cadre de ce modèle, les contrats à court terme s'avèrent une solution d'équilibre dans des conditions très générales. La raison en est que le contrat à court terme implique des coûts de négociation réduits pour l'un des agents. Essentiellement, ce sont les coûts de transaction qui expliquent l'attrait du contrat à court terme.

When there are two objects to negotiate, the decision to negotiate them simultaneously *or in separate forums* at separate times *is by no means neutral to the outcome, particularly if there is a latent extortionate threat that can be exploited ... The protection against extortion depends on refusal, unavailability, or inability to negotiate.*

Schelling (1956; emphasis added)

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1. Introduction

Traditionally, economists have assumed that idiosyncratic exchange between individuals is governed by a complete contract. More recently, attention has turned to situations in which exchange takes place under less than complete contracts. The focus in this research has been on three issues: the impact that different forms of incompleteness have on the allocation of goods (Grossman and Hart 1986; Hart and Moore 1990); the role that contract renegotiation plays in situations where contracts are incomplete (Huberman and Kahn 1988; Hart and Moore 1988; Ma 1994; Aghion, Dewatripont, and Rey 1994); and the impact on the allocation of goods when agents are unable to commit to long-term contracts (Crawford 1988; Fudenberg, Holmstrom, and Milgrom 1990; Laffont and Tirole 1988).

While dealing with diverse issues, all of this research shares the feature that the nature of the contractual incompleteness is specified exogenously and is assumed to be the result of some cost that makes complete contracts infeasible. No attempt is made either to model these costs explicitly or to determine their impact on the form of the equilibrium contract. While the failure to model contracting costs explicitly by no means invalidates these analyses, it does raise a number of questions. For instance, if the cost of writing state contingent contracts is positive but not 'prohibitive,' should one expect to see the incomplete contract posited by the model? If so, in what environments should one expect this type of contract to arise; and if not, what form will the contractual incompleteness take instead (if contracts are indeed incomplete)? Also left unanswered is the question of how the form of the equilibrium contract varies with the economic environment. In essence, there is no way to test whether these models are useful descriptions of economic reality.

In this paper we attempt to address some of these questions by proposing a model of endogenous contract formation. In the spirit of Coase (1937), the model is focused on an explicit description of the transactions process between individuals and the contracts that arise endogenously from this process are derived. The transactions process considered is one in which all allocations between parties are determined via alternating-offers bargaining. This choice is based on the observation that contracts are, in general, the outcome of some bargaining process, with an alternating offers process being simply one that places the bargainers on relatively equal terms. The analysis takes as its starting point Schelling's observations referenced above. It goes on to show that different contract structures, by excluding/including different items in the bargaining process, can imply different costs to an agent of 'holding out' for favourable terms. In this sense, certain types of contracts are more costly for one agent than for another. The equilibrium contract results from each agent trying to implement a contract that is more favourable (less costly) to himself.

While a general 'theory' of contracts based on this approach would be ideal, in this paper we have the more modest goal of providing an example based on a particular bargaining model that serves to illustrate the point. The model is purposely simple in order to focus on the role of implied contracting costs in determining the equilibrium contract structure. We consider a pure exchange economy in which two agents must decide how to allocate one unit of each of two goods. The endowment process is such that one good arrives sequentially prior to the other. The size of each endowment, the order and dates of their arrival, and the agents' preferences and discount factors all are known with certainty by both agents. The transactions technology by which all decisions are made is offer-counter-offer bargaining in the style of Rubinstein (1982).

Within this simple structure, there are essentially two ways in which the agents can determine the allocation of goods. One is a process of negotiations that simultaneously determines an allocation of both goods. This process is the observational equivalent of a long-term contract for this environment. The alternative process determines the allocation of the good arriving first in a bargaining round separate and sequentially prior to that determining the allocation of the good arriving later. Under this process, the success or failure of the later bargaining round has no effect on the implementation of the earlier agreement. In this way, this process is the observational equivalent of a sequence of short-term contracts. Note also that, since the initial bargaining fails to specify an allocation for a good for which one could be specified, the latter process is an incomplete contracting structure within the context of this model. The former process is clearly a complete contract structure.[1] Which of these two contract types is adopted as the equilibrium allocation method is determined by a bargaining round as well, also of the offer-counter-offer type.

This model highlights several ways in which this bargaining approach to contract determination squares with traditional transaction cost arguments; however, it also points to some important differences. It is similar in that there must be some friction in the transaction process if one is to observe incomplete contracts. Specifically, when it is costly for agents to bargain in the sense that making a counter-offer is costly (in the model this is caused by discounting), then short-term contracts can arise in equilibrium. As bargaining becomes frictionless (the discount factor approaches 1), the long-term contract is implemented for certain. Also in keeping with transaction cost based intuition, as either bargaining becomes more costly or the date at which the second endowment arrives recedes into the future, the short-term contract is observed with greater frequency. In contrast to the transactions cost approach, however, no exogenous cost differential between complete and incomplete contracts is necessary for the latter to be observed. The model generates short-term contracts with positive probability even with identical costs of delay in both contracts. Furthermore, in a major reversal of transaction cost intuition, increasing the cost of a long-term contract (by requiring a longer delay between offers) relative to a short-term contract need not increase the likelihood of the short-term contract.

The latter two features of the equilibrium contract structure are a result of the fact that, in this model, the cost of transacting within a particular contract structure

1 See Busch and Horstmann (1994) for a model including uncertainty and complete versus incomplete contracts in their more traditional interpretation.

is given not just by the extent of the transactions frictions implied by the structure. Rather, the real costs to an agent of transacting are the costs to the agent of bargaining for a particular set of contract terms. These costs are determined by the way that the particular contract structure and the associated contracting frictions combine to affect the agent's ability to hold out for any given allocation. Heterogeneity in the relative valuation of the two goods across agents, for instance, can produce different costs to the agents of transacting via the same contract structure. It is this implied cost heterogeneity (not necessarily any exogeneous heterogeneity) that determines the equilibrium contract.

Our approach is not the only recent attempt to model the process by which contract structure is determined. Others have sought to specify particular costs of writing contracts and then examine how these costs affect contract structure. Dye (1985), for instance, considers a cost structure in which each clause in a contract results in added costs to the contracting parties. He shows that incomplete contracts arise in such an environment. Lipman (1992) presents a cost-of-contracting model in which states can be determined only at some cost. This structure implies that a contract specifying an allocation for all states is more costly than one that does not. Lipman shows that, as long as the cost of determining a state is positive (although possibly small), incomplete contracts arise in equilibrium. Anderlini and Felli (1994) consider incomplete contracts arising from costs of describing 'complex states.' Their costs assumption restricts all written contracts to being computable functions. Under this restriction they show that (i) there can be state-contingent contracts that cannot be represented by a computable function; (ii) even if there exist computable incomplete contracts that approximate the complete contract arbitrarily closely in terms of the agents' expected utility, there may be no computable process (contracting procedure) that will produce these contracts. As a consequence, the equilibrium contract is incomplete. Finally, Allen and Gale (1992) show that, if agents cannot write contracts contingent on states of nature but only on noisy signals of these states, then it is possible that the agents will choose non-contingent contracts in equilibrium.[2] This outcome arises because of both the ability of one of the agents to manipulate the noisy signal and the existence of incomplete information about this agent's type.

The basic thrust of this literature is to make Coase's initial insight about the importance of transactions costs for contract form operational. As different cost function specifications will lead to different results, the issue of natural restrictions on the cost-of-contracting function becomes crucial for this process. The problem is that many specifications, including all of the ones above, can be seen as natural.

Faced with this difficulty and not wishing to argue that our cost specification is 'more natural,' we have taken an alternative route in this paper, choosing to derive the relevant transactions costs and implied contract structure from an explicit modelling of the transactions process through which the contract is created.

2 The cost structure here and in Anderlini and Felli can be interpreted as one in which particular types of contracts are infinitely costly.

That is, while not denying the important role played by the direct costs of writing 'complex' contracts, we show that transactions processes themselves can generate implicit costs in their use, that these costs can differ across agents using the processes, and that such cost differences alone can generate incomplete contracts. By deriving contracting costs from the transactions process, not simply imposing a reduced-form structure, we seek to circumvent the usual criticism that any outcome can be an equilibrium if only the right cost function is specified. In addition, we believe that this approach makes more explicit the connection between the economic environment and the contract structure. In these ways, we would argue, this approach proves useful in operationalizing the transactions cost arguments of Coase.

We note, finally, that the analysis of the bargaining process in this paper is related to the agenda literature in bargaining. This literature, typified by the papers of Herrero (1989) and Fershtman (1990), compares bargained outcomes under various assumptions about the bargaining agenda (order in which issues are bargained and allocations produced), which is imposed exogenously.[3] In our analysis, by contrast, the agenda is set by the contract structure which is generated endogenously as an equilibrium outcome. Recent papers by Bac (1998), Bac and Raff (1996), Busch and Horstmann (1995, 1997a,b) and Lang and Rosenthal (1998) also provide bargaining models that endogenize the agenda choice. By delineating different circumstances under which rational bargaining parties choose to make and accept offers for only parts of the outstanding issues, these papers lend further credence to our approach, which views incomplete contracts as arising out of strategic considerations.

The remainder of the paper is structured as follows. The formal model is presented in section 2. In section 3 we analyse the equilibrium and, in so doing, make the above arguments more precise. In a concluding section we discuss the extent to which the results obtained are general and a way that the model can be adapted to a more comprehensive contracting framework. Derivations of various results are contained in the appendix.

2. The contracting problem[4]

Assume that there are two agents, 1 and 2, who are jointly endowed with a single unit of each of two distinct goods, X and Y. The endowment process is such that the agents obtain X sequentially prior to Y, with the dates of the endowments' arrival known with certainty by both agents, and given by t_X and t_Y, respectively ($t_X \geqq 1$). The agents determine (by a process to be specified below) an allocation of X and Y between them, with agent 1's share of X given by x and his share of Y given by y. Agent 2's shares are $(1-x)$ and $(1-y)$, respectively. The agents' preferences over an allocation (x, y) with X consumed at date $t \geqq t_X$ and Y consumed at date

3 Other papers in this area are Horn and Wolinsky (1988), Jun (1989), and Busch and Horstmann (1997c).

4 This set-up draws on work by Herrero (1989) and Fershtman (1990). See also Busch and Horstmann (1997c).

$\tau \geqq t_Y$ are given by the utility functions

$$U_1(x,t,y,\tau) = \delta^{(t-1)}ax + \delta^{(\tau-1)}y \quad (1)$$

$$U_2(x,t,y,\tau) = \delta^{(t-1)}(1-x) + \delta^{(\tau-1)}b(1-y). \quad (2)$$

Here, a and b are constants assumed to satisfy the conditions $a \geqq 1$ and $b \geqq 1+1/a$, while $\delta \in (0,1)$ is the agents' common discount factor. These functions are standard time separable utility functions. The restriction $a, b \geqq 1$ implies that, were the agents to consume X and Y at the same time, agent 1's marginal utility from X would be larger than that from Y; that is, agent 1 prefers X to Y. The opposite would be true for agent 2; that is, agent 2 prefers Y to X. The implications of the stronger restriction that $b \geqq 1 + 1/a$ will be explained later.

All decisions on allocations in this world are assumed to be determined by offer-counter-offer bargaining processes in the style of Rubinstein (1982). It is assumed that offers alternate, with agent 1 making offers in odd periods and agent 2 making offers in even periods. Since allocations must be determined for a sequence of two endowments, there are a number of possible offer-counter-offer procedures that the players could adopt. Two procedures arise naturally from the sequential nature of the problem, however, and attention is restricted to these two. The first procedure involves bargaining over the allocation of the entire endowment stream at once. An offer under this procedure is a pair (x, y) specifying a division of both goods. The two agents make offers and counter-offers of (x, y) until an agreement is reached. Once agreement is reached, the agreed upon allocations of goods X and Y are implemented. Should agreement be reached before X or Y arrives, the agreed-upon allocation is implemented once each endowment arrives. On the other hand, no allocations at all are made until agreement is reached on the division of both goods. In particular, none of good X can be allocated until agreement on both X and Y is reached. This procedure is labelled the LC procedure.

The second procedure involves a sequential determination of allocations, with the allocation of good X determined in a separate procedure from that determining the allocation of good Y. Given the structure of the endowment stream, the natural timing is for the two agents to bargain over the allocation of X first and only subsequently to bargain over the allocation of Y. In this second procedure, agents make offers and counter-offers on x until agreement. Once the agents reach an agreement on an allocation of X, the allocation is implemented. Bargaining between the agents resumes at time t_Y to determine the allocation of Y. Should agreement on X be reached at some time $t \geqq t_Y$, then bargaining on Y begins in the period after the allocation of X is reached.[5] Bargaining on an allocation of Y proceeds in a fashion analogous to that for X, and the allocation of Y is implemented once an agreement is reached. This second procedure is labelled the SC procedure.

5 Note that the restriction that bargaining on Y begins at t_Y is innocuous, since there is no cost to delay before t_Y. Note also that the agents are prohibited from switching to the LC procedure at time t_Y; that is, they can bargain only over X even if Y is already available.

Although there are other bargaining procedures one might imagine, LC and SC capture the essential differences between complete and incomplete contracts in this model. In particular, without uncertainty, the only contractual issue is whether allocations should be determined via a single long-term contract or a sequence of short-term contracts. The LC procedure corresponds to a long-tem contract in the sense that it requires the agents to commit, within a single contracting process, to allocations for a complete endowment stream. In contrast, the agents do not have to commit to allocations for all outcomes that they know they will face in the SC procedure. This procedure corresponds to a short-term contract in that the allocations of X and Y are made piecemeal. Since the SC procedure allows for an allocation of X to be implemented without agreement on an allocation of Y, the short-term contract procedure may be inefficient (i.e., lead to an allocation interior to the Pareto frontier).

Still undetermined is the means by which the agents decide which of these two bargaining processes is to be adopted as the process by which allocations of X and Y are determined. It is assumed that this question is also decided by a bargaining process. This bargain takes place sequentially prior to any bargaining over allocations of X and Y. An offer in this bargaining round is a number $\pi \in [0, 1]$, where π represents the probability that the LC procedure will be used. The randomization scheme π is assumed contractable and its outcome costlessly enforceable. In addition, its outcome is assumed to be known to the agents prior to entering into bargaining over X and Y.[6] As for the other bargaining rounds, it is assumed that the agents alternate in making offers, and that agent 1 offers in odd periods, while agent 2 offers in even periods.

For the purposes of this example, it is assumed that the initial bargaining process begins at date $t = 1$ (the first time period) and that $t_X = 2$. Bargaining on allocations of X and Y begin the period after the bargaining over π is completed. The predicted outcomes of this bargaining process are generated by the set of subgame perfect Nash equilibrium strategies.

3. Equilibrium outcomes[7]

Suppose, for now, that the realization of the randomization mechanism is such that the LC procedure is to be followed, and suppose further that the current period is $t = t_Y$. Then, should agreement be reached in the current or any subsequent period, the allocation of both X and Y can be made immediately. Figure 1 depicts the set of instantaneous utilities achievable from allocations (x, y) in this case. Under the

6 What is envisioned here is a procedure whereby the agents first decide what the subject of a particular bargaining round will be (i.e., what variables will be bargained over) and then decide the allocations for the variables in question. In many negotiations involving multiple issues, there is some pre-bargaining process in which the issues to be negotiated are determined. In some cases this pre-bargaining round is explicit, as here, whereas in others this round is implicitly embodied in the initial set of offers by the two parties. The latter process is the situation in collective bargaining. For a discussion of these issues see Edwards and White (1977).

7 For detailed derivations of the equilibrium shares see the appendix.

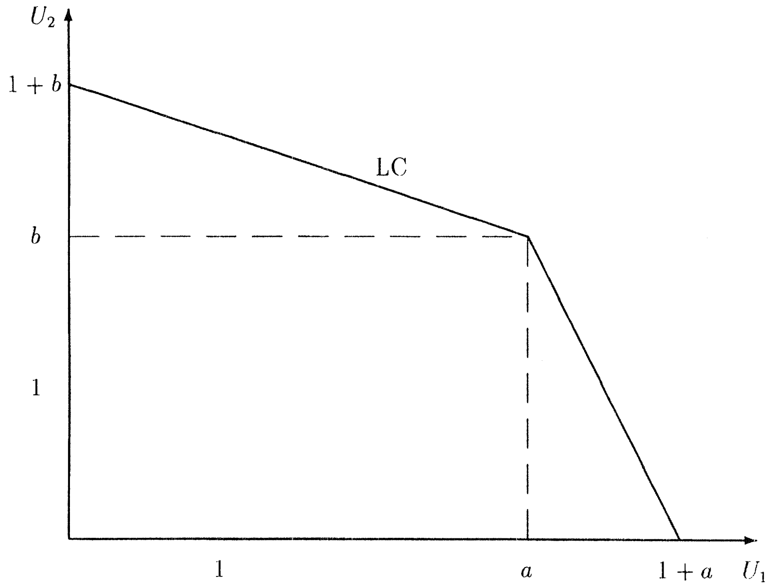

FIGURE 1 LC procedure utility frontiers

assumption that $a, b > 1$ the equilibrium offers will bracket the kink in the frontier and are given by

$$x^* = 1, \qquad y^* = \frac{a(1-\delta)(b-\delta)}{ab-\delta^2} \tag{3}$$

if agent 1 makes the offer (in odd periods) and by

$$x^{**} = \frac{\delta(b(a+1) - \delta(b+1))}{ab-\delta^2}, \qquad y^{**} = 0 \tag{4}$$

if agent 2 makes the offer (in even periods.)

The situation is somewhat different when $t < t_Y$. In this case, delay in reaching an agreement is costly only in terms of forgone consumption of X, but it does not result in forgone consumption of Y. As a consequence, the derivation of equilibrium offers in these cases involves a backward induction process from t_Y. This process yields an initial offer by agent 2 at time $t = t_X$ given by

$$\hat{x} = \left(\delta \sum_{i=0}^{(t_Y - t_X - 1)} (-\delta)^i\right) + \delta^{t_Y - t_X} x^{**}, \qquad \hat{y} = 0 \tag{5}$$

if t_Y is even and

$$\hat{x} = \left(\delta \sum_{i=0}^{(t_Y - t_X - 2)} (-\delta)^i\right) + \delta^{t_Y - t_X - 1} x^{**}, \qquad \hat{y} = 0 \tag{6}$$

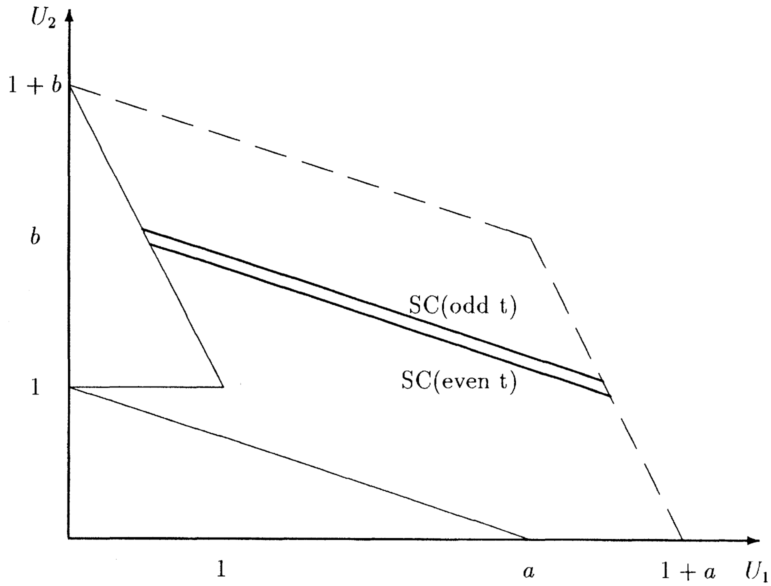

FIGURE 2 SC procedure utility frontiers

if t_Y is odd. The pair $(\hat{x}, \hat{y})$ is the equilibrium allocation of X and Y under the LC procedure.

Supposing that the SC procedure has to be followed, one finds that a similar analysis applies. First, consider situations in which an allocation of X has been determined and $t \geqq t_Y$. This case is a simple Rubinstein bargaining problem with the equilibrium allocation, y_S, given by the Rubinstein solution $y_S^* = 1/(1+\delta)$ if 1 makes the first offer and $y_S^{**} = \delta/(1+\delta)$ if 2 makes the first offer.

Next, consider those subgames for which no agreement on an allocation of X has been reached. As with the LC procedure, this problem can be broken down into two parts: those cases for which $t \geqq t_Y$ and those for which $t < t_Y$. In either case, the utility for the two agents should an agreement be reached on an allocation of X will take into account the (discounted) value of the (perfectly foreseen) future agreement on Y. The set of attainable utilities from bargaining over X has a shape as depicted in figure 2. As in the case of the LC procedure, delay in reaching agreement on an allocation of X imposes costs both in terms of forgone consumption of X and of Y if $t \geqq t_Y$. Under the restriction that $b > 1 + 1/a$, the equilibrium allocations of X are given by

$$x_S^* = 1 \qquad \text{or} \qquad x_S^{**} = \frac{\delta(a - 1 + \delta)}{a} \tag{7}$$

if t is odd or even, respectively. From above, the allocations of Y are given by $y_S^{**} = \delta/(1+\delta)$, or $y_S^* = 1/(1+\delta)$, respectively (since the bargain on Y starts 1 period later.)

For those cases in which $t < t_Y$, delay is costly only in terms of forgone X consumption, not forgone consumption of Y. Once again, the allocation of X at t_X is determined by a backward induction process (just as in the LC procedure). This process yields an allocation of X at time t_X given by $\hat{x}_S = \delta\Sigma_{i=0}^{t_Y-t_X-2}(-\delta)^i$ if t_Y is even and by $\hat{x}_S = \delta\Sigma_{i=0}^{t_Y-t_X-1}(-\delta)^i - \delta^{t_Y-t_X}(1-\delta)/a$ if t_Y is odd. The complete allocation under the SC procedure is then given by

$$\hat{x}_S = \left(\delta \sum_{i=0}^{t_Y-t_X-2} (-\delta)^i\right), \qquad \hat{y}_S = \frac{\delta}{1+\delta} \tag{8}$$

$$\hat{x}_S = \left(\delta \sum_{i=0}^{t_Y-t_X-1} (-\delta)^i\right) - \delta^{t_Y-t_X}\frac{(1-\delta)}{a}, \qquad \hat{y}_S = \frac{1}{1+\delta}, \tag{9}$$

depending on whether t_Y is even (equation (8)) or odd (equation (9)), respectively.

Before we proceed to the determination of the equilibrium contracting process, it is informative to compare the allocations under the two different bargaining procedures. The allocations for the LC procedure are given by one of (5) or (6), above, while for the SC procedure they are given by one of (8) or (9). Clearly, agent 1 gains under the SC procedure in terms of the allocation of Y, independent of who moves at t_Y. This gain results from the fact that bargaining over X has been split off from bargaining over Y, and therefore delay in reaching an agreement on an allocation of Y is not costly to 1 in terms of consumption of X (the good that 1 prefers).[8] The result is that it pays agent 1 to hold out for a positive share of Y in the SC procedure, whereas such behaviour is too costly in terms of forgone consumption of X under the LC procedure.

As regards the allocation of X, the appropriate comparisons are (5) versus (8) (t_Y even) and (6) versus (9) (t_Y odd). In the case of the X allocation, there are two potentially competing forces at work. Because agent 1 receives more of good Y under the SC procedure than under the LC procedure, it is less costly for 2 to delay agreement on X (and thus on Y) by holding out for a larger share of X. To agent 1, the increase in his share of Y means that delay on X becomes relatively more costly. Bargaining power over X is consequently transferred to agent 2, and therefore 2's share of X tends to increase.

A second effect results from the fact that, under the SC procedure, the rejection of a proposed allocation of X may result in the loss (for the rejecting agent) of the first-mover advantage in the proposal of an allocation of Y. This loss of first-mover advantage represents a delay cost for both agents; it represents a relatively larger cost for agent 2, however, since 2 values Y relatively more than 1. Thus, when $(t_Y - 1)$ is even, agent 1 faces the possible loss of first-mover advantage should he reject a proposed allocation of X. The cost associated with this outcome represents an additional cost of delay to 1 not faced by 2 and so reinforces the

8 For a detailed discussion of the relationship between bargaining procedures and cost differences see Busch and Horstmann (1997c).

increased cost effect, owing to 1's larger share of Y. As a consequence, 1's share of X decreases in moving from the long-term to the short-term contract when t_Y is odd. When $(t_Y - 1)$ is odd, agent 2 faces the cost associated with the loss of first-mover advantage, and these costs are larger than those faced by agent 1 when $(t_Y - 1)$ is even. In fact, 2's costs are sufficiently large that they more than offset the cost reduction for 2 resulting from the reduced share of Y. On net, agent 2 therefore receives less of both goods under the short-term contract if t_Y is even.

While a comparison of the actual allocations under the two contracts is of interest, the important comparison is between the utilities that the two agents obtain under each. Clearly, if t_Y is even, agent 1's utility is higher under the short-term contract, while agent 2's utility is higher under the long-term contract. If t_Y is odd, the agents' preferences over contracts are less obvious. Evaluation of equations (1) and (2) at the allocations implied by the LC and SC procedures reveals that, for sufficiently large values of δ, agent 1's utility is higher under the short-term contract, while agent 2 is better off under the long-term contract.[9] Therefore, as long as δ is large enough, agent 1 always prefers a short-term contract as the means of allocating X and Y, while agent 2 always prefers a long-term contract.

The reason for these conflicting preferences can best be understood in terms of the implied bargaining costs for the agents under the two procedures. Under the LC procedure, each agent has roughly the same cost of holding out for more favourable terms. Agent 1 finds it costly to hold out for a larger share of Y because doing so delays consumption of X. Agent 2 finds it similarly costly to hold out for a larger share of X. Under the SC procedure, agent 1's cost of holding out for a larger share of Y is reduced because the allocation of X has already occurred. Concessions in the bargain over X remain costly to agent 1, however, since X is the more highly valued good. For agent 2, delay in the bargain over either good continues to be costly since any delay (potentially) delays the allocation of Y. The net effect is that the SC procedure reduces 1's cost of holding out for a better deal relative to 2's and so gives 1 a bargaining advantage relative to 2. As a result, 1 does better under the SC procedure (and so prefers it) whereas 2 does better under the LC procedure. This disagreement over preferred procedures gives rise to the possibility of equilibrium short-term contracts.

If we turn, then, to the contract bargaining phase and let U_i^S and U_i^L represent agent i's equilibrium utility levels under the SC and LC procedures, respectively, an agent's expected utility for any offer π is given by

$$\mathbf{E}U_i = \pi U_i^L + (1 - \pi)U_i^S. \tag{10}$$

An equilibrium offer is a pair (π^*, π^{**}) representing an offer and counter-offer by agents 1 and 2, such that $\mathbf{E}U_2(\pi^*) \geqq \delta\mathbf{E}U_2(\pi^{**})$ and $\mathbf{E}U_1(\pi^{**}) \geqq \delta\mathbf{E}U_1(\pi^*)$, with each being an equality if $0 < \pi^*, \pi^{**} < 1$, and at least one being a strict inequality if either of π^* or π^{**} equals 0 or 1.

9 The exact condition on δ guaranteeing that agent 1 prefers the SC procedure to the LC procedure is that $\delta^2/(1+\delta) \geqq (1-\delta)((ba-\delta a)/(ba-\delta^2))$. For agent 2, the condition guaranteeing that LC is preferred to SC is $b/(1+\delta) \geqq (1-\delta)/a + (1-\delta)((b-\delta)/(ab-\delta^2))$.

Under this bargaining process, it must be that π^{**} equals 1. The reason for this outcome is as follows. Both points, U_i^L and U_i^S, are feasible offers in the LC bargaining procedure, as are all linear combinations of these points (by convexity of the utility space). The offer U_1^L would be accepted by agent 1 in the LC bargaining procedure, being at least as good as the best counter-offer 1 could make in the next period under this procedure. As the set of possible counter-offers in the contract bargaining round is a subset of the set of counter-offers in the LC procedure, 1's best counter-offer here can be no better than that in the LC procedure. Therefore, 1 will accept an offer of $\pi^{**} = 1$.

Given that $\pi^{**} = 1$, it is easy to calculate agent 1's equilibrium offer, π^*. This offer will be such that agent 2 is just indifferent between accepting it and waiting one period and offering $\pi^{**} = 1$ (as long as $\pi^* > 0$). This value of π is given by the expression

$$\pi^* = \frac{\delta U_2^L(3) - U_2^S(2)}{U_2^L(2) - U_2^S(2)}, \tag{11}$$

where the numbers inside the parentheses indicate the period in which the initial offer is made in the subsequent bargaining procedure. This expression is strictly less than one for all $\delta < 1$. Clearly, for small enough values of δ this expression becomes negative, implying that $\pi^* = 0$.[10] In either case, the implication of (11) is that short-term contracts will be used to allocate goods with positive probability in equilibrium.

To generate some intuition about these results and which features of the model are driving them, it is helpful to consider the model first in the limit as δ approaches 1. In this case, the equilibrium allocation under the long-term contract approaches the point $x = 1, y = 0$; under the short-term contract, the allocation approaches the point $x = 1, y = 1/2$. These points are depicted in figure 3, where the LC and SC frontiers are the ones given in figures 1 and 2, above, when $\delta = 1$. The assumption that $b > 1 + 1/a$ guarantees that $x = 1$ under the short-term contract, so that the allocation lies on the LC frontier (i.e., the short-term contract is efficient). As a result, the long-term and short-term contract allocations are Pareto non-comparable. Note, also, that the complete contract allocation coincides with the Nash bargaining solution for the set of feasible utilities given by the set of points beneath the LC

10 Substitution of the equilibrium values for x and y into agent 2's utility function results in a value of

$$\pi^* = 1 - \frac{1}{\delta^{(t_Y-2)}}\left[\frac{\delta b(ab-1)}{(ab-\delta^2)(1-\delta^2)} + \frac{ab}{(ab-\delta^2)}\right]$$

$$\left[\pi^* = 1 - \frac{1}{\delta^{(t_Y-1)}}\left[\frac{\delta(a+\delta)}{a(ab-\delta^2)} + \frac{b(ab+\delta^2-2)}{(ab-\delta^2)(1-\delta^2)}\right]\right]$$

if t_Y is odd (even). Given the restrictions $a, b > 1$, $b > 1 + 1/a$, $\pi^* < 1$ for all $\delta < 1$. Further, while it may not be readily apparent, it is possible to construct examples in which δ is both large enough that agent 1 prefers the SC procedure while agent 2 prefers the LC procedure, yet also small enough that $\pi^* = 0$.

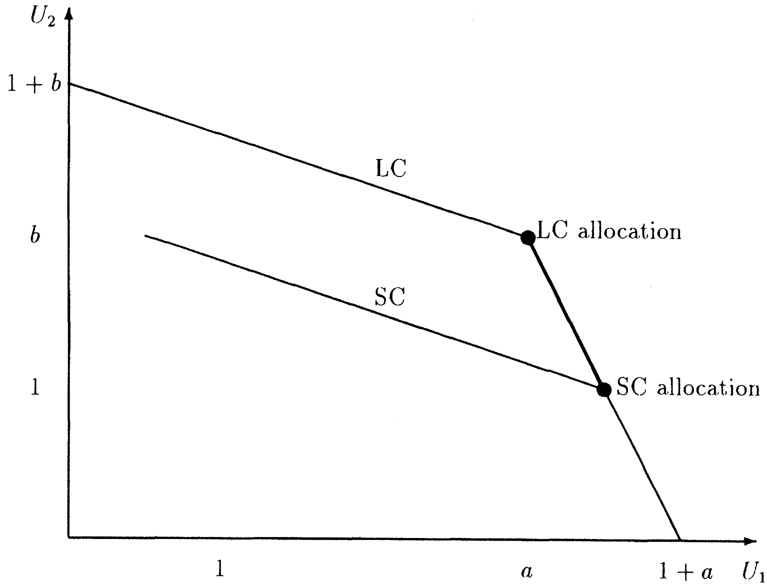

FIGURE 3 The procedure bargaining frontier

frontier.[11] Finally, from (11), as δ approaches 1, π^* also approaches 1 (recall that $\pi^{**} = 1$), so that the long-term contract is implemented with probability 1.

The interesting feature of the limiting equilibrium is that in spite of the disagreement between agents over the preferred contract and the fact that the allocations under both contracts are efficient, the long-term contract is implemented in equilibrium. In a world of no frictions, the alternating offers procedure of contract choice produces only the long-term contract. This result is intuitively appealing and is in keeping with the traditional transaction cost approach to contracting. In addition, it serves to confirm that the bargaining procedure by itself is not the source of contract incompleteness.

The formal explanation for this outcome can be found in the fact that the equilibrium allocation under an alternating offers procedure converges to the Nash bargaining solution as δ approaches 1. If we refer to figure 3, it is clear that, in the limit, the bargain over π converges to a bargain over a subset of the LC frontier that includes the Nash bargaining solution for the frontier. Since the equilibrium outcome of the bargain over π must converge to the Nash bargaining solution for this subset of the frontier, the only possible outcome is the point $x = 1$, $y = 0$, the Nash bargaining solution for the LC frontier.

11 The SC allocation will coincide with the Nash bargaining solution for the set of feasible utilities defined by the set of points beneath the SC frontier if $b > 2 + 1/a$. For $b \in [1 + 1/a, 2 + 1/a)$, the Nash bargaining solution understates agent 1's utility and overstates agent 2's utility. See Busch and Horstmann (1994) for a more detailed discussion of this point.

Of course, with δ bounded strictly away from 1, the story is different. While the fact that $b > 1 + 1/a$ continues to guarantee, at least for some range of δ, that the allocations under the two procedures are Pareto non-comparable, the allocation under the SC procedure may no longer be efficient. Instead, it may lie in the interior of the space of utilities achievable under the LC procedure. Nevertheless, because bargaining is no longer costless, the SC procedure is implemented with positive probability. Since it is costly for agent 2 to delay implementation of the contract, he sacrifices some utility to agent 1 by accepting (with a positive probability) the short-term contract outcome. The conflict in preferences over contract form between the two agents, which proved irrelevant when bargaining was costless, now leads to the possibility of implementation of a short-term contract.

It is instructive to see how, in the presence of contracting costs, the structure of the contracting environment affects the likelihood of adoption of a short-term contract. As a first, simple experiment, consider the effect on π^* of either a reduction in δ or an increase in t_Y. Inspection of the expression for π^* (see fn10) reveals that either of these changes increases the probability of the short-term contract. In each case, Y, the good that agent 2 values relatively more, is becoming less valuable. As a consequence, the value to 2 of holding out for a contract that allocates more of Y to him – the long-term contract – falls. In essence, the use of short-term contracts becomes less costly as the additional contingencies covered by the long-term contract become more distant in time.

In the above experiment, a reduction in δ has the effect not only of reducing the value of Y, but also of increasing the cost of the contracting process in general. It would be of interest to disentangle these two effects and determine what effect a change in contracting costs might have on the structure of contracts, holding the value of Y fixed. In particular, it is often argued that contractual incompleteness is a result of the fact that complete contracts are more costly to construct than incomplete ones (see, e.g., Dye 1985). Thus, one might want to consider the effect of making the long-term contracting process more costly relative to the short-term process.

These sorts of considerations can be easily incorporated into the preceding model using techniques employed in Binmore, Rubinstein, and Wolinsky (1986). Specifically, let the time between offers be given by Δ_L in the long-term contract bargaining process and by Δ_S in the short-term contract bargaining process.[12] To capture the notion that the long-term contract, by virtue of its complexity, is more costly to construct than any single piece of the short-term contract, let Δ_L be greater than Δ_S. Finally, let Δ_π be the time between offers in the contract structure bargaining round, and normalize it such that $\Delta_\pi = 1$.

Given this simple modification, the probability that the long-term contract is adopted is again given by equation (11), where, in the case of an even t_Y, the denominator and numerator of this expression are defined, respectively, by (12)

12 To maintain consistency with the previous model, it is assumed that all Δ are drawn from the set $\{\Delta_n = (2n+1)^{-1}, n = 0, 1, 2, \ldots\}$. Thus, 2 continues to make his offers in all even (integer) periods, and 1 in all odd (integer) periods.

and (13), below.

$$U_2^L - U_2^S = \frac{\delta^{\Delta_S} + \delta^{t_Y - 2}}{(1 + \delta^{\Delta_S})} - \frac{\delta^{\Delta_L} - \delta^{\Delta_L}\delta^{t_Y - 2}}{(1 + \delta^{\Delta_L})} + \delta^{t_Y - 2}\left(\frac{b\delta^{\Delta_S}}{1 + \delta^{\Delta_S}} - x^{**}\right) \tag{12}$$

$$\delta U_2^L - U_2^S = \frac{\delta^{\Delta_S} + \delta^{t_Y - 2}}{(1 + \delta^{\Delta_S})} - \frac{\delta - \delta^{\Delta_L}\delta^{t_Y - 2}}{(1 + \delta^{\Delta_L})} + \delta^{t_Y - 2}\left(\frac{b\delta^{\Delta_S}}{1 + \delta^{\Delta_S}} - x^{**}\right) - 1 + \delta. \tag{13}$$

It is easy to check in (12) that increases in Δ_L result in increases in the utility differential for agent 2 between the long-term and the short-term contracts. The effects of increases in Δ_L on equation (13) are less obvious. It can be shown, however, that the rate of change of the utility differential in (13) is smaller than that in (12) and that the one in (13) may, in fact, decrease. Should (13) be decreasing in Δ_L, then π must also decrease – the long-term contract becomes less likely to be used. This outcome is the expected one. As the long-term contracting process becomes more costly to engage in, short-term contracts become more prevalent.

However, this outcome is not the only possible one. It may be that (13) also increases when Δ_L increases. In this case, the value of π may increase or decrease. In the former case, the long-term contract becomes more, not less, prevalent in spite of the increased contracting costs. This counter-intuitive result stems from the fact that, up until the point t_Y, delay is more costly for agent 1 than for agent 2.[13] As a result, increases in Δ_L affect the two agents differently, possibly putting agent 1 at a greater cost disadvantage relative to agent 2 in the long-term contract. The result is that agent 2 may actually benefit from increased delay costs and so achieve his preferred outcome – the long-term contract – with greater frequency.

This result highlights the difference between a transaction cost approach to contracting that relies on the notion of pure costs of writing complex contracts (the approach in Dye 1985) and one that relies on the notion that complex contracts are more costly to *negotiate* because they require more time to analyse and respond to. Under the former interpretation, any process that reduces the cost of specifying contractual contingencies must necessarily increase the use of complex contracts. Under the latter interpretation (the one adopted here), processes that improve an agent's ability to analyse and respond to complex contracts may, in fact, reduce the use of such contracts because they provide relatively more substantial benefits to one agent over another.

4. Discussion

In the introduction we argued that the transactions cost approach to contract form can be operationalized without resort to exogenously specified and essentially arbitrary cost differences between contracts. By modelling the available transactions

13 This outcome is not possible if $t_Y - t_X < \Delta_\pi$, that is, if endowments of both X and Y arrive by the time bargaining on X begins.

technology and the commitments it allows and forbids, one can generate implicit cost differentials that drive the equilibrium contract choice. While the model we have employed to demonstrate this approach is highly stylized, it nevertheless provides useful insights. Several are worth highlighting. First, the model shows that, if there are many goods to allocate and if agents are heterogeneous, different contract forms can imply different bargaining costs even if there are no explicit cost differences between contracts. Second, again without explicit cost differences, the cost of bargaining implied by a *given* contract may differ across agents. Because contract form is determined jointly by the agents, this cost difference can result in use of a short-term (incomplete) contract even though a long-term (complete) contract is also available.[14] Finally, explicit costs that make a complete contract more costly to create than an incomplete contract do not necessarily imply reduced use of the complete contract. This departure from the usual transactions cost intuition is a result of the fact that, (i) when both the implicit and the explicit costs are accounted for, there may be no unequivocally cheaper procedure; (ii) the more expensive procedure may, by virtue of its cost, move bargaining power to one of the agents, thereby making it preferable to the lower (explicit) cost alternative.

Two questions raised by our bargaining-based model are (i) does one observe attempts by contracting parties to structure bargaining and (ii) what happens if the agents are not able to structure bargaining? As to the former, it is not uncommon for contract bargaining to be preceded by some initial negotiation phase dealing with the issues to be bargained over subsequently.[15] In some cases, the 'agenda-setting' negotiations are explicit. In others, particularly collective bargaining situations, while no explicit agenda bargaining occurs, an initial offer/counter-offer is used to set the agenda (in terms of issues to be negotiated) for all subsequent bargaining.

What if agents are unable to structure the contract bargaining process? Our approach is capable of handling such situations. An unstructured bargaining process can be modelled as one in which either agent could make an offer of either (x) alone, (y) alone, or a pair (x, y) and in which either agent can counter with any of these three possibilities independent of the type of the preceding offer. In such a situation, the model in section 2 will always generate the long-term contract allocation. The reason is simple. Under this procedure, each player's offer is necessarily drawn from the grand utility possibility frontier, resulting in the long-term contract allocation. This result serves to highlight the importance of Schelling's observation. However, this result is also due to the very simple setting we employ here. As the recent papers by Bac (1998), Bac and Raff (1996), and Busch and Horstmann (1995, 1997a,b) demonstrate, incomplete offers can occur in the equilibria of such unstructured bargaining problems in the presence of incomplete information, where the contract type offered may be part of signalling strategies. Lang and Rosenthal (1998) demonstrate that even complete information models may have such endogenously incomplete equilibria if payoff functions are not concave.

14 For a discussion of how this model might be generalized to allow for uncertainty and more general utility functions see Busch and Horstmann (1994).

15 See, for example, Edwards and White (1977, 48–58).

Finally, it is worth noting that, while the model presented here considers a simple endowment allocation problem, it can be adapted to the more traditional agency setting in which contracting issues are invariably discussed. Consider, for instance, a simple partnership setting in which there are two agents involved in the production of a single unit of output. Production requires the agents to undertake two tasks: a research task and a development task. Development cannot proceed until the research phase is completed, and each task requires one total unit of effort. This effort can come totally from agent 1, totally from agent 2, or partially from both. Agent 1 is more efficient at research, while agent 2 is more efficient at development; that is, the marginal effort cost of research to agent 1 is lower than it is to agent 2, and vice versa for development. The marginal cost of effort for each task and each agent is positive. The agents contract over how much effort to allocate to each task and how to divide revenues from the sale of output.

This problem can be mapped almost directly into the framework provided in section 2. Specifically, agent 2 will want a long-term contract that essentially requires each agent to work only on the task at which that agent is more efficient. Agent 1 will prefer a sequence of short-term contracts that result in both agent 1 and agent 2 working on the development task. As a result, in the contract structure bargaining phase, agent 1's demand will involve the short-term contracts with positive probability.

5. Conclusion

In this paper we have argued that new insights into contract formation, in particular, the use of incomplete contracts, can be obtained by an explicit modelling of the transactions process by which contracts are created. We have argued this point within the context of a simple model in which agents can agree to divide the surplus from an endowment stream either in a single, grand bargain over the entire stream or in a sequence of bargaining rounds as each surplus arrives. The former process is analogous to a long-term contract, the latter to a sequence of short-term contracts. We find that the structure of the contract affects the agents' relative costs of holding out for a good deal – their relative bargaining/transaction costs. It is these cost differences that determine equilibrium contract choice. Thus, for instance, because the short-term contract yields lower relative bargaining costs for one of the agents, it arises as an equilibrium contract structure.

While the model here is highly stylized and has been chosen to highlight the relevant points in the most simple fashion, we believe that it points to a potentially fruitful research avenue that allows for transactions costs to be generated 'naturally' from the procedures and processes which are assumed to be available to agents. The advantage of this approach, in our view, is that it may be easier to match the assumed stylized transactions processes to those observed in reality rather than to match transactions cost functions or degrees of limited rationality to whatever their real world counterparts may be.

Appendix

Consider the LC procedure at $t = t_Y$. The two agents' utilities at the time of agreement will be given by

$$U_1 = ax + y \tag{A1}$$

$$U_2 = (1 - x) + b(1 - y) \tag{A2}$$

Given that all offers (x, y) have corresponding utility offers (U_1, U_2) given by (A1) and (A2), bargaining in these subgames can be analysed in terms of (U_1, U_2) offers drawn from the set depicted in figure 1. Let (U_1^i, U_2^i) be an offer from U(LC) by agent i. An equilibrium offer will satisfy the conditions

$$U_1^2 = \delta U_1^1 \tag{A3}$$

$$U_2^1 = \delta U_2^2 \tag{A4}$$

(i.e., agent 1 (2) is just indifferent between accepting agent 2's (1's) offer or making his equilibrium counter-offer). Under the assumption that $a, b > 1$, an equilibrium offer by agent 1 will involve $x = 1, y > 0$, while an equilibrium offer by 2 will have $y = 0, x < 1$. In terms of figure 1, 1's offer lies on U(LC) to the right of the kink while 2's offer lies on U(LC) to the left of the kink. Employing these facts in (A3) and (A4), one can solve for the equilibrium allocations of X and Y when $t \geqq t_Y$. These allocations are given by (3) and (4) in the text. For $t < t_Y$, delay does not result in forgone consumption of Y. This requires us to use a backward induction process from t_Y, employing conditions analogous to (A3) and (A4) in order to determine the sequence of equilibrium offers and counter-offers. This construction is much the same as that in Shaked and Sutton (1984) and yields (5) and (6).

Supposing that the SC procedure has to be followed, one finds that a similar analysis applies. First one considers situations in which an allocation of X has been determined and $t \geqq t_Y$. This case is a simple Rubinstein bargaining problem with the equilibrium allocation, y_S, given by the Rubinstein solutions. Next, those subgames for which no agreement on an allocation of X has been reached are considered. As under the LC procedure, this problem can be broken down into two parts: those cases for which $t \geqq t_Y$ and those for which $t < t_Y$. In the former case, the utility for the two agents, should an agreement be reached on an allocation of X, is given by

$$U_1 = ax + \delta y_S \tag{A5}$$

$$U_2 = (1 - x) + \delta b(1 - y_S), \tag{A6}$$

The set of attainable utilities are depicted in figure 2. As in the case of the LC procedure, delay in reaching agreement on an allocation of X imposes costs both in terms of forgone consumption of X and of Y if $t \geqq t_Y$. Equilibrium offers must satisfy conditions (A3) and (A4), above, with the set of possible utility offers drawn from the SC frontier in figure 2. If t is odd, these offers result in equilibrium allocations of X given by $x_S^* = (1 + b\delta - \delta^2/a)/(1 + \delta)$ if $b < 1 + \delta/a$, and $x_S^* = 1$ if $b > 1 + \delta/a$. If t is even, the allocations are $x_S^{**} = \delta(1 + \delta b - 1/a)/(1 + \delta)$ if $b < 1 + \delta/a$ and $x_S^{**} = \delta(a - 1 + \delta)/a$ if $b > 1 + \delta/a$. The restriction that $b > 1 + 1/a$ implies that the equilibrium allocations of X are given by the latter values. For those cases in which $t < t_Y$, delay is costly only in terms of forgone X consumption, not forgone consumption of Y. Once again, the allocation of X at t_X is determined by a backward induction process (as in the LC procedure). This process yields an allocation of X at time t_X given by $\hat{x}_S = \delta\Sigma_{i=0}^{t_Y - t_X - 2}(-\delta)^i$ if t_Y is even and by $\hat{x}_S = \delta\Sigma_{i=0}^{t_Y - t_X - 1}(-\delta)^i - \delta^{t_Y - t_X}(1 - \delta)/a$ if t_Y is odd. The complete allocation under the SC procedure is then given by (9) and (8).

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