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CONTRACTUAL INTERMEDIARIES

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Abstract. This paper analyzes the role of third party intermediaries, such as courts and arbitrators, in contract enforcement. In our model, intermediaries compel contracted transfers and resolve disputes when requested to do so by the contracting agents. When the verifiability of information is limited, successful enforcement requires that dispute resolution costs be sufficiently great. Optimal enforcement systems economize on dispute resolution and information costs, and may involve establishment of specific systems tailored to particular groups. We show further that the "holdup problem" may be resolved via an appropriately designed dispute resolution system.

1. Introduction

Theoretical models of contracting have analyzed in detail a wide variety of interactions between contracting parties. However, much less attention has been paid to the *institutions* that enforce contracts.[1] In practical situations, enforcement institutions play a central role

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[1]An exception is the growing literature on community enforcement, as exemplified by Bendor and Mookherjee (1991), Ellickson (1991), Kandori (1992), Greif (1993), and Greif, Milgrom, and Weingast (1994). More centralized enforcement institutions have been examined by Milgrom, North, and Weingast (1990) and others. See also North (1990). Our work here addresses more direct external enforcement of contracts.

in the functioning of contractual relations. These institutions, as embodied in third parties (courts, arbitrators, attorneys, etc.), carry out a variety of activities, such as gathering information about the actions of the contracting parties; compelling enforcement of contractual provisions when requested to do so; and settling disputes that arise under the contract. This paper examines how the nature of contract enforcement, and the successful operation of contractual relationships, depend on the characteristics of enforcement institutions. More specifically, we argue that the active participation of external enforcement institutions plays an integral part in any contractual relationship.

As our point of departure, we hypothesize that contract enforcement is vested in third parties called *contractual intermediaries*. The intermediaries operate enforcement systems that are utilized by contracting agents. The activities of intermediaries are illustrated by the example of the National Grain and Feed Association (NGFA). The NGFA is a trade group of grain and feed dealers that maintains a private legal system, consisting of detailed sets of trade and arbitration rules together with a panel of arbitrators.[2] NGFA members frequently maintain long-term relationships involving repeated, highly standardized transactions. As a condition of membership, association members are required to appeal to the NGFA's arbitrators when they wish to enforce contractual provisions or officially resolve disputes. The arbitrators gather information about the nature of the disputants' written contract and the facts of the dispute; they impose binding settlements according to the terms of the contract and the rules of the association; and they keep official records about the dispute and its settlement. A variety of other trade groups operate analogous dispute resolution systems on behalf of their members.[3] Moreover, institutions as diverse as public legal systems and business firms follow the same basic pattern in settling disputes among their constituents.

[2]See Bernstein (1996) for an in-depth case study of the NGFA.

[3]Woodruff (1997) discusses systems employed by the American Spice Trade Association, the Popular Priced Dress Association, and other trade groups.

We develop a model of enforcement systems that explicitly captures the active roles played by intermediaries. In our model, contractual relationships are ongoing; the agents engaging repeatedly in a productive activity requiring private effort choices. Private payoffs have the structure of the prisoners' dilemma, so that maintaining cooperation is problematic. Contract enforcement is carried out by an intermediary, who may intervene at the agents' request during an enforcement phase that occurs prior to production in each period. The intermediary enforces contracted transfers between the agents, conditioned on verifiable information. The intermediary also maintains an official record of whether the relationship is in a dispute, as well as the nature of the dispute. At the agents' request, the intermediary carries out a dispute resolution process that may impose costs on the agents, in the form of direct monetary costs and delays in resuming production. The dispute resolution process culminates in official certification that the dispute has been resolved, which then allows the agents to use the enforcement system to enforce another contract in the future. Alternatively, the agents can elect to sever their relationship should a dispute arise.

In our model, the method of contract enforcement depends on the amount of information that can be verified to the intermediary as well as the costs of dispute resolution. Under *full verifiability*, the intermediary can observe which agent precipitated any dispute and enforce large penalties against that agent. Thus, contracts sustaining cooperation can be enforced without imposing dispute resolution costs. Under *limited verifiability*, in contrast, the intermediary can verify only that a dispute has arisen. The identity of the precipitating agent cannot be ascertained, and thus the transgressor cannot be isolated for punishment by the intermediary. In this case, cooperation can be sustained *if and only if* dispute resolution costs are sufficiently high. Here, costly dispute resolution serves as an implicit bond on the relationship. Since the agents know that certification of dispute resolution is costly, they are deterred from initiating disputes. We show further that even with full verifiability, costly dispute resolution may be necessary for sustaining cooperation when there are constraints on the size of contracted transfers that can be imposed by the intermediary.

Importantly, we argue that the agents cannot replicate such a dispute resolution mechanism on their own, since it would cost them nothing to change their own internal designation concerning the status of their relationship; i.e., between themselves they can resolve disputes costlessly. Thus, when the agents are embroiled in a dispute, the only alternative to severance is participation in the official dispute resolution process. In an environment of limited verifiability, enforcement systems instill value to dispute resolution precisely by making official designations costly to obtain, thereby providing incentives to avoid disputes.[4]

Our model is useful for understanding the design of optimal enforcement systems. Under either full or limited verifiability, an optimal system entails dispute resolution costs sufficiently small to ensure that agents will seek dispute resolution, rather than sever their relationship, should a dispute arise. Thus, an optimal system facilitates the preservation of relationships. Further, full verifiability imposes added ex ante information costs that may exceed the added ex post dispute resolution costs that arise when verifiability is limited. In this instance, an enforcement system that relies on limited information — and that tolerates occasional costly disputes — can be optimal due to economizing on information costs. Broadly used general enforcement systems, such as public courts, may be ill-suited to the particular features of given relationships, and may impose high information costs. In such cases, groups of agents may be willing to incur added overhead costs to establish specific enforcement systems that are better tailored to their own circumstances. Institutions such as the NGFA may be understood in these terms.

Dispute resolution processes can also play a role in resolving problems associated with

[4]It is important to distinguish dispute resolution costs, which are necessary for cooperation under limited enforceability, from renegotiation costs of the form studied by Green and Laffont (1994), Blume (1994) and McCutcheon (1997). In our model, agents are always able to costlessly renegotiate their joint decisions, including the parameters of their written contract and equilibrium selection. What matters is that there is a third party who places some designation on the relationship and who imposes costs for altering this designation.

incomplete contractibility of specific investments, known as "holdups." We extend our basic model of limited verifiability to incorporate a long-term, specific investment that is made by one of the agents at the outset of the relationship. Since this agent does not have all the bargaining power in the relationship, he prefers an investment level that is too small relative to the efficient level. As investment rises, however, the relationship becomes more valuable, and cooperation becomes easier to sustain. If the level of dispute resolution costs is lowered, the agent can be forced to raise his investment level in order to preserve the feasibility of subsequent cooperation. We demonstrate that an appropriate choice of dispute resolution costs can implement the efficient investment level through this mechanism.

Our paper features a theoretically innovative approach to modelling ongoing relationships, based on methods drawn from standard contract theory. The literature on specific investment and holdups generally employs a cooperative bargaining solution to describe the outcome of ex post negotiation.[5] Bargaining weights and a disagreement point (usually entailing enforcement of an outstanding contract) determine the outcome. We use the same technique, but we apply it in a setting of *recurrent negotiation*. We model renegotiation between the agents, which occurs in each period, using an explicit cooperative bargaining game. All of the agents' joint decisions, including contracted transfers, whether or not to approach the intermediary, whether to sever the relationship, and the selection of equilibrium, are determined by the bargaining solution. Our model emits a unique equilibrium, in contrast to standard reputation-based formulations in which the "folk theorem" allows punishments to be constructed by arbitrarily linking equilibrium selections to agents' past actions.[6]

[5] A representative sample of this large literature includes Williamson (1979), Grout (1984), Grossman and Hart (1986), and Hart and Moore (1990).

[6] Because of the agents' ability to hold up the relationship in each period, schemes that are "renegotiation proof" in the sense of Bernheim and Ray (1989) and Farrell and Maskin (1989) cannot be supported. The theory of Pearce (1987), Abreu and Pearce (1991), and Abreu, Pearce, and Stacchetti (1993) takes a step

This paper builds on our previous work aimed at examining various facets of ongoing contractual relations. Ramey and Watson (1999) provide a general theory of why agents condition their decisions on the status of their relationship as defined by an external social institution, as opposed to attempting to enforce contracts on their own. The essence of this general theory is captured by the notion of a *uniformly best* equilibrium presented here. Ramey and Watson (1997) and den Haan, Ramey, and Watson (1999a,c) analyze employment relationships using a variant of the model considered here. These papers focus on compensation policies and conditions under which relationships will be "fragile," i.e., subject to separations that reduce joint surplus. Den Haan, Ramey and Watson (1999b) extend these ideas to credit market relationships that are subject to limited liquidity. These papers abstract from the consideration of dispute resolution by assuming that contractual violations result in severance. The current paper can be viewed as providing a theoretical foundation for dispute-induced severance.

Other relevant work includes the literature on litigation processes, in particular discovery.[7] Our modelling exercise also speaks to the alternative dispute resolution (ADR) movement, which has focussed on the design of dispute resolution systems that foster better information gathering, lower dispute resolution costs, and preservation of relationships.[8] Our

toward incorporating bargaining power into repeated games. Note that our theory explicitly models recurrent negotiation and ties enforcement to intermediaries.

[7] Theoretical work on litigation is surveyed by Cooter and Rubinfeld (1989). Discovery processes have been modelled by Sobel (1985), Shavell (1989) and Cooter and Rubinfeld (1994). Studies of discovery generally emphasize asymmetries of information between the contracting parties, while we focus on differences between what the parties jointly observe and what they can verify to the enforcement authority. Further, we do not model incentives in the discovery process, but instead assume that all verifiable information is automatically made known to the intermediary.

[8] The ADR literature is quite large and varied. Henry and Lieberman (1985) and Goldberg, Sander and Rogers (1992) provide good introductions and surveys of this literature. See Shavell (1995) for a recent evaluation in the law-and-economics vein.

paper provides a theoretical framework for assessing the trade-offs involved in designing an ADR system. By emphasizing a few salient roles of intermediaries, we are able to generate insights on how contract enforcement is achieved. However, it is important to recognize the limits of our analysis, which stem from our confined focus on complete information and rationality, as well as our narrow definition of dispute (contractual breach). Many other roles of intermediaries deserve study.[9] We view our model as a useful first step in understanding the broad functioning of intermediaries in contract enforcement.

Section 2 introduces our model of contractual relationships and enforcement institutions, and Section 3 develops three benchmark cases of enforcement that differ with respect to verifiability of information and constraints on contractible transfers. Optimal enforcement systems are considered in Section 4, implications for the holdup problem are discussed in Section 5, and Section 6 concludes.

2. Contracting Model

2.1. Contractual Relationship. We suppose there are two agents, denoted by $i = 1, 2$, who interact in discrete periods, numbered $t = 1, 2, ...$ Each period consists of three phases. First, there is a *negotiation phase*, where the agents make *joint* decisions concerning their relationship. Next follows an *enforcement phase*, in which the agents can seek external enforcement of their contract. Finally, there occurs a *production phase*, where the agents make *private* decisions. The relationship can in principle continue indefinitely, but agents also have the option of permanently severing the relationship in the negotiation phase of any

[9] For example, here are three roles that we do not address. The first, widely attributed to Schelling (1960), views third-party mediation as a coordination institution that helps agents communicate (by authenticating messages) and select a specific equilibrium from within a set of possibilities; see also Dixit and Nalebuff (1993). Second, as Milgrom, North and Weingast (1990) study, an intermediary can facilitate cooperation in one-shot relationships by disseminating information about agents' past disputes and their resolution. Discussions from outside of the economics literature emphasize a third role: that intermediaries can serve to facilitate rational discussion and decision-making by cooling agents' emotions in the heat of disputes.

period.

Formal contracting between the agents takes the form of an agreement to make externally enforced monetary transfers m_1 and m_2, where m_i denotes the payment received or made by agent i, and $m_1 + m_2 = 0$.[10] Transfers may be conditioned on relevant state variables, as discussed below. Each agent wishes to maximize the discounted sum of his payoff stream, where the payoff within a period is given by the sum of net monetary transfers and payoffs obtained in the production phase.

We now give more detailed descriptions of the three phases, in reverse order.

Production Phase. In the production phase, the agents make simultaneous private decisions which determine their productive outcome in the period. To keep the model simple, we allow for just two possible choices for each agent — "high" (H) or "low" (L) — and we assume the payoffs take the form of a prisoners' dilemma. The production decisions may be broadly construed to include a range of possible behaviors, including timely delivery of goods or services, quality or effort levels, adherence to verification arrangements, theft, and abuses of authority in agency relationships, such as assignment to unpleasant tasks. Agent i obtains a within-period payoff of z_i when both agents choose H in a given period. However, if agent j exerts high effort, then agent i can obtain a payoff of x_i by choosing L, in which case agent j receives y_j. If both agents select L, then each obtains a payoff of zero. Production choices and payoffs are illustrated in the table below. The agents observe each other's actions at the end of the production phase.

[10] In principle, agents could negotiate "inefficient" contracts that set $m_i + m_j < 0$, and also contracted payments could vary over time. Such contracts would not arise in equilibrium, however, because agents would always prefer to rewrite them prior to external enforcement. Thus, for simplicity we will not consider them explicitly.

1\2	H	L
H	z_1, z_2	y_1, x_2
L	x_1, y_2	$0, 0$

We assume $z_i > 0$, $x_i > z_i$, and $y_i < 0$ for each i. We also assume $x_i + y_j < 0$ in order to rule out inessential special cases. If the relationship is severed, then agent i obtains the value w_i from the start of the next period, representing opportunities outside of the relationship. Assume $w_i > 0$ for $i = 1, 2$. We suppose further that, in the absence of external enforcement, the value of high effort is sufficiently great to dissuade each agent from unilaterally exerting low effort and then exercising the severance option at the start of the next period. A necessary condition for this is:

$$\frac{z}{1-\delta} > x + \delta w, \tag{1}$$

where $x = x_1 + x_2$, $w = w_1 + w_2$, and δ gives the discount factor.[11]

Enforcement Phase and Intermediation. Enforcement of the formal contract, and resolution of disputes arising under the contract, is vested in a third party called the *intermediary*, who intervenes in the relationship during the enforcement phase. The intermediary maintains an ongoing record of the current status, or *state*, of the relationship, reflecting information about the relationship that can be used by the intermediary for purposes of contract enforcement. The intermediary can also make changes in the state during the enforcement and production phases, and possibly impose costs on the agents. Importantly, intervention by the intermediary is triggered only at the request of the contracting agents.

[11]Future punishments cannot drive agent i's payoff below w_i, else agent i would unilaterally sever the relationship in the negotiation phase, as described below. Accordingly, at least one of the agents would have the incentive to choose low effort — and cooperation would be unsustainable — if inequality (1) were reversed.

Throughout the paper, we focus on contracts in which the agents seek to implement the desirable (H, H) outcome in each period's production phase. The set of possible states recorded by the intermediary is defined relative to this outcome. The relationship remains in the *cooperative* state, referred to as state C, as long as the agents maintain the choices (H, H). On the other hand, if either agent chooses L then a *dispute* state is triggered. We allow for multiple dispute states, denoted by D_k.

We also assume that formal disputes can be triggered by spurious events, unrelated to any misbehavior by the agents; these are called *nuisance disputes*. When the relationship ends a period in state C, a nuisance dispute may occur with probability γ. The random draw that determines whether a nuisance dispute occurs takes place at the end of a period, following the production phase. The occurrence of a nuisance dispute causes the state to be switched to one of the dispute states D_k (to be specified below), which is then in effect at the beginning of the next period. Assume γ is positive but sufficiently small to give

$$\frac{z + \gamma\delta w}{1 - (1 - \gamma)\delta} > x + \delta w, \tag{2}$$

which is analogous to (1), but includes the possibility that nuisance disputes lead to severance of the relationship. Nuisance disputes can be interpreted as actual disputes triggered by misunderstandings between the agents or by one-time dealings with outside parties, or as mistakes by the intermediary.

There are two aspects to intervention by the intermediary. First, the intermediary can enforce the contracted transfers m_1 and m_2 based on the current state. For simplicity, we assume that the intermediary does not impose costs on the agents for enforcing transfers. Second, when the relationship starts the enforcement phase in state D_k, the intermediary may carry out a *dispute resolution process*, which proceeds in the following way. The agents each pay a cost $c/2$ at the outset of the enforcement phase. Then, with probability $1-p$, the intermediary officially resolves the dispute by switching the state to C, and the relationship

continues to the production phase in the current period. With probability p, the intermediary fails to resolve the dispute. In this case, the state is not changed, the agents miss the opportunity to produce in the current period (the production phase is skipped), and the dispute resolution process is automatically invoked again at the start of the next period. Further, contracted transfers are not enforced again in the following period. Probability p represents delay in the attainment of formal dispute resolution. Litigation may impose such delays, for example.

We now provide further details concerning the transitions between states. The relationship begins the initial period in state C, which is maintained until one of the following two events occurs: (i) One or both agents choose L in the production phase; in this case a dispute breaks out, and the state is immediately switched to one of the dispute states D_k. (ii) The relationship ends the production phase in state C, but a nuisance dispute occurs, leading to the designated nuisance dispute state. Once the relationship is in state D_k, it remains there until successful dispute resolution switches the state back to C, or else the relationship is severed.

Changes in the state from C to D_k that are induced by the agents' productive choices correspond to events that can be verified by the intermediary. Verification arrangements can take two forms. First, the intermediary could observe the relationship in each production phase on an ongoing basis, taking note of the production outcome and modifying the state accordingly. Alternatively, the intermediary might observe production outcomes only when intervention is requested by one of the agents. The intermediary then ascertains the correct state only at the point of intervention, by examining records of past production phases. In this case, verifiability of actions refers to what can be discovered on the basis of the historical record. Our model applies equivalently to either of these two cases; the essential point is that the state records the information that will be used by the intermediary when contract enforcement is requested.

Negotiation Phase. In the negotiation phase, the agents jointly decide whether and how to continue their relationship in the short run by selecting among: (Q) quit, (R) resolve, and (G) go on. If Q is chosen, then the relationship is severed and the agents receive their outside option values w_1 and w_2. In the event of Q, either agent can appeal to the intermediary in the ensuing enforcement phase to enforce contracted transfers, after which the relationship ceases. The choice of R means the agents decide to appeal to the intermediary for dispute resolution; in the ensuing enforcement phase, the intermediary enforces the contracted transfers and initiates the dispute resolution process. G means the agents continue their relationship without appealing to the intermediary; in this case, the agents skip directly to the production phase. As noted above, the agents have no joint decision to make if they enter a period in the dispute resolution process; the process continues until the dispute is formally resolved.[12]

During the negotiation phase, the agents can also agree to change their formal contract by re-specifying the functions m_1 and m_2. In addition, they can make spot monetary transfers between themselves during the negotiation phase, and they can engage in meta-level negotiation over the equilibrium selection, as described below.

2.2. Equilibrium. We use a generalized notion of strategy, called a *regime*, to investigate behavior in this setting. Let the set of states be denoted by S. A regime consists of four functions θ, n, m and σ defined for each $s \in S$. The function θ maps elements s to the joint decision Q, R or G made in the negotiation phase. Spot transfers to be made in the negotiation phase are indicated by $n = (n_1, n_2)$, where $n_1(s) + n_2(s) = 0$. The function m maps s to contracted transfers m_1 and m_2 that are enforceable by the intermediary. Under the assumptions of joint optimality made below, and since $m_1(s) + m_2(s) = 0$, we can

[12] As a fourth decision, the agents could request the intermediary to enforce contracted transfers without initiating the dispute resolution process. This decision is equivalent to G, however, in that contracted transfers are made implicitly as part of bargaining in the negotiation phase; see below.

presume that the agents will not revise their specification of m; thus, we focus on a single m for the life of the relationship. Finally, σ maps s to the productive choices made by the agents in the ensuing production phase.[13]

Given a regime, we can define the agents' continuation values as functions of the state. Let $g_i(s)$ denote agent i's continuation value from the start of a period in state s. This is the discounted sum of agent i's payoffs, conditional on the state s, with future behavior specified by the regime. We define $g(s) = g_1(s) + g_2(s)$ to be the corresponding joint continuation value of the relationship. Observe that $g(s)$ does not depend on n, since the latter merely indicates how the continuation value is divided between the agents through spot transfers in the negotiation phase. In fact, given the other components of the regime, g_i is implied by n_i and vice versa. Thus, we will not need to refer directly to n, and a regime can be described by θ, m, σ, and the agents' continuation values.

Let $g(s|Q)$, $g(s|R)$ and $g(s|G)$ denote the joint continuation values conditional on Q, R and G being chosen in the negotiation phase, with future behavior specified according to the regime. Clearly $g(s|Q) = w$, while based on the dispute resolution procedure, we have

$$g(s|R) = (1-p)g(C|G) + p\delta g(s|R) - c. \tag{3}$$

The term $g(C|G)$ appears here because, since agents will not throw money away, the continuation payoff conditional on successful dispute resolution is exactly the same as the value of choosing G in state C. We also have

$$g(s|G) = u' + (1-\gamma)\delta g(s') + \gamma\delta g(D_K), \tag{4}$$

[13]For simplicity, we have restricted θ, n, m and σ to be functions of s, rather than of the full set of histories of play. As shown in Ramey and Watson (1999), however, our results are not altered by allowing the players to condition their behavior on the full set of histories in addition to the state recorded by the intermediary, given an appropriate extension of our equilibrium selection criterion. The issue of the conditioning set is discussed further in the Conclusion.

where D_K is the dispute state triggered by a nuisance dispute, u' gives the joint payoff in the production phase implied by the choices $\sigma(s)$, and s' is the state that obtains following the production phase, based on the current state s and the choices $\sigma(s)$.

In equilibrium, the mappings θ, m, and g_i are chosen to satisfy a bargaining solution, while σ is determined according to the usual subgame perfection requirement. The agents' joint decision in the negotiation phase may be represented as a standard Nash bargaining problem, with joint surplus determined by continuation values and a disagreement point. The possible continuation values are given by w, $g(s|R)$, or $g(s|G)$, while disagreement in the negotiation phase implies the decision Q, which we assume can be unilaterally imposed by either agent. Bargaining weights are given by nonnegative constants π_1 and π_2, with $\pi_1 + \pi_2 = 1$; these determine how surplus is divided in the negotiation phase. For this well-defined bargaining problem, we employ the generalized Nash solution. This solution captures the idea that each agent can hold up the relationship in the negotiation phase, using the threat to terminate the relationship.

Our definition of equilibrium is summarized as follows.

Definition 1. *A regime is a* ***negotiation equilibrium*** *if the following two conditions hold for every $s \in S$.*

1. *Joint decisions are resolved according to the Nash bargaining solution; that is,*

$$g(s) = \max\{w, g(s|R), g(s|G)\}, \tag{5}$$

and for $i = 1, 2$,

$$g_i(s) = w_i + m_i(s) + \pi_i[g(s) - w]. \tag{6}$$

2. *Private choices $\sigma(s)$ are optimal for each agent, given the choice specified for the other agent and the continuation values $g(s')$ implied by the current state s and the production phase choices.*

Observe that the value of the outside option in (6), $w_i + m_i(s)$, derives from agents' ability to unilaterally induce the decision Q with enforcement of the contracted transfers. The bargaining solution gives agent i proportion π_i of the joint surplus $g(s) - w$, where spot transfers n_1 and n_2 are used to achieve the necessary split.[14]

Since multiple negotiation equilibria may exist, we assume the agents select their preferred equilibrium in the negotiation phase. This meta-level negotiation is modeled using the following simple concept.

Definition 2. *A negotiation equilibrium is called* ***uniformly best*** *if, for every state $s \in S$, it yields the highest joint continuation value among all negotiation equilibria.*

To understand this definition, suppose g is the joint value function of a given negotiation equilibrium. Then this equilibrium is uniformly best if $g(s) \geq g'(s)$ for every state $s \in S$ and every g', where g' is the value function of another negotiation equilibrium. Note that "best" is measured by joint continuation value. In fact, since the agents share the continuation value in fixed proportions (due to Nash bargaining in the negotiation phase), they fully agree on the rankings over negotiation equilibria. When a uniformly best equilibrium exists, the agents prefer this same equilibrium in every state. Thus, the equilibrium selection is not renegotiated over time.[15]

[14] We have thus far abstracted from considering how the agents select m and divide joint surplus in the initial period. Assume that there is no outstanding formal contract at the beginning of the negotiation phase in period 1. Thus, given that m can be chosen to implement the cooperative outcome, the agents use spot transfers in the period 1 negotiation phase to effect a division of joint surplus giving payoff $w_i + \pi_i[g(C) - w]$ to agent i, i.e. $g_i(C) + n_i' = w_i + \pi_i[g(C) - w]$, where $g_i(C)$ is given by (6) and n_i' denotes the period 1 spot transfer.

[15] See Ramey and Watson (1999) for a generalization of the uniform best notion.

3. Benchmark Cases of Enforcement

The method of contract enforcement used by the agents hinges on (i) the amount of information that is verifiable to the intermediary, (ii) the costs of dispute resolution, and (iii) the allowable size of contracted penalties. In this section, we consider three benchmark cases that differ with respect to verifiability of information and constraints on enforceable transfers. The analysis will make use of the following lemma, which characterizes the joint continuation value in a dispute state for any negotiation equilibrium.

Lemma. *In any negotiation equilibrium, for all D_k, we have*

$$g(D_k) = \max\left\{w, \frac{(1-p)g(C) - c}{1 - p\delta}\right\}. \tag{7}$$

Proof. Suppose the current state is D_k entering the negotiation phase, and the agents select G. Then irrespective of what choices are made in the ensuing production phase, agent i's continuation value entering the following period will be $g_i(D_k)$. It follows from the prisoners' dilemma structure of the production phase payoffs that each agent will select L. Thus, G cannot be an equilibrium choice in state D_k, or else the continuation payoff would be zero ((L, L) played over and over again), whereas the agents could obtain $w > 0$ by selecting Q. Either Q or R will be chosen. Using (3), we find that (7) indicates the maximized value obtained. *Q.E.D.*

The Lemma indicates that the agents will not select G once a dispute has broken out, since incentives to choose high effort in the production phase are undermined given that the state has been switched to D_k. The agents must either sever their relationship or seek dispute resolution from the intermediary. This underscores the importance of dispute resolution systems in contractual relationships. A dispute resolution system formally defines the occurrence of a dispute and whether it is resolved. By conditioning on these distinctions, agents are able to sustain cooperation only under the C state.

3.1. Full Verifiability with Unconstrained Transfers. In our first benchmark case, the complete history of agents' past behavior can be verified to the intermediary. In other words, the intermediary can observe whether individual agents selected H or L in earlier periods. Further, it is assumed that there are no restrictions on the range of contracted transfers that can be enforced. In this contracting environment, the agents can easily sustain cooperation, using external enforcement to directly punish a party who cheats.

For sustaining cooperation in the full verifiability case, it suffices to allow for three dispute states, D_1, D_2 and D_B, where D_i for $i = 1, 2$ means that agent i unilaterally initiated a dispute by being the first to play L subsequent to the most recent resolved dispute, while D_B means the agents simultaneously initiated the dispute by selecting L simultaneously. For convenience, we assume that nuisance disputes trigger the dispute state D_B. We obtain the following proposition.

Proposition 1. *In the case of full verifiability with unconstrained transfers, regardless of the values c and p, there is a uniformly best negotiation equilibrium. Cooperation is sustained in this equilibrium, yielding*

$$g(C) = \frac{z + \gamma\delta g(D_B)}{1 - (1-\gamma)\delta}, \tag{8}$$

with $g(D_B)$ defined by (7).

Proof: We shall construct a regime that is uniformly best and specifies high effort in the cooperative state C. According to the Lemma, we set $\theta(D_k)$ equal to Q or R, depending on which decision maximizes the right-hand side of (7). We also prescribe $\theta(C) = G$ and $\sigma(C) = (H, H)$, so that $g(C)$ is given by (8). Further, we set $m(C) = m(D_B) = (0, 0)$. The continuation values for individual agents are given by $g_i(C) = w_i + \pi_i[g(C) - w]$, according to (6).

Consider incentives in the production phase. In order for (H, H) to be sustained in state C, it must be that the choice H maximizes agent i's payoff stream, given that agent j

chooses H, and that agent i induces state C or D_i in the following period by choosing H or L, respectively. Thus, a necessary and sufficient condition for payoff maximization is given by

$$z_i + (1-\gamma)\delta g_i(C) + \gamma\delta g_i(D_B) \geq x_i + \delta g_i(D_i).$$

Using (6) to substitute for g_i, and simplifying, yields

$$\delta\pi_i[(1-\gamma)g(C) + \gamma g(D_B) - g(D_i)] + z_i - x_i \geq \delta m_i(D_i). \tag{9}$$

The specifications above determine $g(C)$, $g(D_B)$, and $g(D_i)$. We can specify $m(D_1)$ and $m(D_2)$ so that $m_i(D_i)$ is sufficiently small to satisfy (9). In other words, the agents' written contract prescribes a large transfer from agent i to his partner conditional on i initiating a dispute. By construction, we have a negotiation equilibrium.

To see why this equilibrium is uniformly best, recall that equation (7) holds in any negotiation equilibrium. Thus, the continuation values of being in the various dispute states are increasing functions of the continuation value in state C. Obviously, (8) gives the highest possible continuation value for the relationship. Since the equilibrium we constructed attains this value in the cooperative state, it must be uniformly best. *Q.E.D.*

In the proof of the proposition, cooperative equilibria are constructed by imposing large negative payments m_i in states D_i that indicate disputes initiated by agent i. The key to enforcing such contracts is that the intermediary has the ability to verify which agent initiates a dispute and to impose unrestricted contractual penalties on that agent. Note that cooperation can be sustained in this case for any values of the dispute resolution costs c and p.

3.2. Limited Verifiability. Constraints on what can be verified by a third party can limit the scope for external enforcement. As our second benchmark case, we consider *limited verifiability*, in which the intermediary can verify only whether or not the (H, H) outcome has obtained in previous periods, and not the particular form of any deviation from (H, H).

For example, consider a trade of grain between two dealers, where the quality of the grain is maintained only if both dealers exercise due care.[16] After the trade, it may be possible for a third party to verify whether the quality of the grain has been compromised, but it cannot be determined whether it was the buyer or the seller that failed in his charge. We also allow for unlimited transfers in the limited verifiability case.

To capture limited verifiability, we now allow for a single dispute state D, meaning that at least one agent has selected L since the last time the intermediary had recorded state C. Nuisance disputes also trigger state D. The following proposition characterizes the uniformly best outcomes.

Proposition 2. *In the case of limited verifiability, regardless of the values c and p, there is a uniformly best negotiation equilibrium. Cooperation is sustained if and only if the following condition holds:*

$$x - z \leq (1-\gamma)\delta(c + px). \tag{10}$$

If the condition holds, then the continuation values $g(C)$ and $g(D)$ are determined by (7) and

$$g(C) = \frac{z + \gamma\delta g(D)}{1 - (1-\gamma)\delta}. \tag{11}$$

Otherwise, the values are $g(C) = g(D) = w$ and the relationship is severed immediately.

Proof: We start by demonstrating that (10) is a necessary condition for cooperation to be sustained. Note that agent i, expecting agent j to select H, has an incentive to choose H in state C only if

$$z_i + (1-\gamma)\delta g_i(C) + \gamma\delta g_i(D) \geq x_i + \delta g_i(D), \tag{12}$$

[16] Perhaps the seller is responsible for transporting the grain, while the buyer is responsible for storing it after it is delivered. Either party may destroy the quality by failing to protect the merchandise from the elements.

where it should be noted that agent i induces a transition to state D if he chooses L. Summing the conditions (12) over the two agents and combining terms, we have the following necessary condition:

$$(1-\gamma)\delta[g(C)-g(D)] \geq x-z. \tag{13}$$

If the agents select G in state C, and if $\sigma(C)=(H,H)$, then $g(C)$ is given by (11), while $g(D)$ is given by (7). Solving the system (7) and (11) for $g(C)$ and $g(D)$, substituting these values into (13), and rearranging yields (10). This proves the "only if" part of the proposition. Further, given that cooperation cannot be sustained, the agents would select Q in the initial period, since the payoff w dominates the payoff of zero that obtains from the (L,L) outcome.

Sufficiency is proved by observing that, when (10) holds, $m(C)$ and $m(D)$ can be chosen so that (12) holds for $i=1,2$. To be specific, we can set $m(C)=(0,0)$, which defines $g_i(C)$ using condition (6). Then we can find $m(D)$ so that, with $g_i(D)$ given by (6), the inequalities (12) hold. *Q.E.D.*

Comparing Propositions 1 and 2, it follows that limited verifiability imposes additional restrictions on the ability to sustain cooperation, in the form of the constraint (10), which reflect the fact that the intermediary is unable to impose penalties on particular agents. In view of our maintained hypothesis $x>z$, (10) implies that cooperation can be sustained only if dispute resolution costs c and p are sufficiently large. High dispute resolution costs serve as an implicit bond on the relationship, by creating a wedge between $g(C)$ and $g(D)$: once agents are in the D state, they can salvage cooperation only by approaching the intermediary and incurring the dispute resolution costs, thereby restoring the C state. Maintaining state C becomes valuable precisely because agents know they will choose to incur the dispute resolution costs, or else sever their relationship, should a dispute break out. It follows that cheating is deterred if the costs are sufficiently high. By the same token, (10) fails to hold, and cooperation becomes unsustainable, when c and p are too small. Thus, high dispute

resolution costs are both necessary and sufficient for cooperation under limited verifiability.

This result demonstrates that the intermediary's ability to officially *certify* the resolution of disputes is valuable for the agents. This function, which is ubiquitous among enforcement institutions, turns out to play an important role in maintaining incentives for cooperation. The key idea is that agents do not have total freedom to manipulate the official status of their relationship, but rather they must incur costs to induce desired changes in that status. The standard reputation mechanism, in contrast, is undermined by agents' ability to freely reinterpret the history of play: for a given history, it costs them nothing to switch from a "dispute" designation, which would trigger punishments, to a "cooperate" designation that would restore the cooperative equilibrium. Since such a switch is always in the agents' interests, incentives for cooperation are undermined.[17]

By similar reasoning, it follows that the agents cannot replicate the dispute resolution costs internally by agreeing to burn money (or pay money to a third party) if one or both agents selects L; once an infraction occurs, it is jointly optimal for the agents to avoid following through with the agreement.[18] Likewise, it is impossible for them to self-enforce a contract having an agent who cheats pay the other in the following period. Once an agent cheats, he can hold up the relationship to avoid paying the penalty. These conclusions arise naturally as a product of joint optimization in the negotiation phase, as characterized by the Nash bargaining solution, which underscores the importance of explicitly modeling recurrent negotiation in ongoing relationships.

[17]In other words, the usual reputation-based cooperative equilibrium — as studied by Klein and Leffler (1981), Shapiro (1983), Allen (1984), Bull (1987), and many others — does not satisfy the "uniformly best" criterion when states are interpreted as the usual supergame histories. Ramey and Watson (1999) develop a related, weaker criterion and show that cooperation cannot be sustained in a general setting under the usual reputation mechanism.

[18]Standard bonding arrangements of this sort have been considered by Kennan (1979) and Williamson (1983), among others.

3.3. Transfer Constraints. External enforcement may be subject to limits on the size of transfers that the agents can contractually impose on one another, as is frequently observed in practice. These constraints may inhibit agents' ability to enforce cooperative outcomes, even under full verifiability.[19] Suppose the intermediary is unable to enforce transfers in excess of $\overline{b}$; i.e., contracted transfers must satisfy $m_i \leq \overline{b}$ for $i = 1, 2$. This may be due, perhaps, to limits on the award of compensatory damages, or to liquidity constraints. For this case we have the following proposition.

Proposition 3. *Consider the case of full verifiability with constrained transfers, and suppose*

$$\overline{b} < \frac{x - z}{2\delta}. \tag{14}$$

Then cooperation cannot be sustained if c and p are sufficiently close to zero.

Proof. Here we can use some of the analysis of Subsection 3.1. Given the transitions in the state induced by his choice, agent i has an incentive to select H, given that agent j chooses H, only if (9) holds. Suppose there is a regime in which the agents sustain cooperation in state C, with $c = p = 0$. We demonstrate that this contradicts (14). Note that, with $c = p = 0$, (7) implies $g(C) = g(D_B) = g(D_i)$. Thus, (9) simplifies to

$$z_i + (1 - \gamma)\delta g_i(C) + \gamma\delta g_i(D_B) \geq x_i + \delta g_i(D_i).$$

Using (6) to substitute for g_i, and simplifying, yields

$$x_i - z_i \leq -\delta m_i(D_i). \tag{15}$$

Adding the inequalities (15) for $i = 1, 2$ and rearranging gives

$$-m_1(D_1) - m_2(D_2) \geq \frac{x - z}{\delta}. \tag{16}$$

[19] Sappington (1983) and Dickens, et al (1989), among others, have analyzed the effects of transfer constraints in one-shot principal-agent settings, while den Haan, Ramey and Watson (1999a,b) consider transfer constraints in models related to the present one.

Since $-m_i(D_i) \leq \overline{b}$, it follows that (16) cannot hold when (14) is imposed. The result extends immediately to nonzero, but sufficiently small, c and p. *Q.E.D.*

Proposition 3 demonstrates that full verifiability is not sufficient for sustaining cooperation when the intermediary is prevented from imposing large contractual penalties. Irrespective of any constraints on transfers, however, it is possible to support cooperation by imposing high enough dispute resolution costs, as may be shown by directly applying the argument of Proposition 2. In general, costly dispute resolution can operate to enforce cooperative agreements in long-term relationships where constraints on information or transfers, or other reasons, rule out the use of complete contracts. For the remainder of the paper, we assume there are no limits on transfers.

4. Optimal Enforcement Systems

4.1. Dispute Resolution Costs and Preservation of Relationships. Optimal contract enforcement systems are those that maximize the agents' ex ante joint value $g(C)$, as determined in Propositions 1 and 2 for the cases of full and limited verifiability, respectively. Note that the optimal selections of dispute resolution costs c and p depend on the amount of verifiable information; full verifiability favors zero costs, while with limited verifiability positive costs are essential to maintaining cooperation. In addition, c and p will be selected in a manner that ensures relationships will be preserved when a dispute arises; i.e., agents choose to resolve disputes rather than sever their relationship. These findings are formalized in the following proposition.

Proposition 4. *Under full verifiability, the optimal enforcement system satisfies $c = p = 0$; under limited verifiability, c and p are chosen so that (10) holds with equality. In either case, the optimal system satisfies $g(D_k) > w$.*

Proof. The claim concerning the choice of c and p in the full verifiability case follows at once from (7) and (8), while the fact that $g(D_k) > w$ under full verifiability is implied by (2). As for the case of limited verifiability, we utilize expressions from the proof of Proposition

2. Take any c and p such that, solving (7) and (11), one obtains $g(D) = w$. It must be that at least one of c and p is strictly positive. Substituting $g(D) = w$ and

$$g(C) = \frac{z + \gamma\delta w}{1 - (1-\gamma)\delta}$$

into the agents' pooled incentive constraint (13), we obtain

$$\frac{z + \gamma\delta w}{1 - (1-\gamma)\delta} \geq x + \delta w.$$

This does not bind, given (2). Therefore, we can lower p and c (whichever is not equal to zero) until the incentive constraint (10) binds. Note that $g(C)$ and $g(D)$ (again found by solving (7) and (11)) rise in the process and that $g(D) > w$. Values p and c cannot be lowered further without thwarting incentives. *Q.E.D.*

Preservation of relationships is optimal due to the fact that severance imposes the worst punishment that agents can face when a dispute arises. Thus, designing an enforcement system that induces the agents to request dispute resolution, rather than sever their relationship, can only reduce the costs of disputes and raise the value of the objective. Under full verifiability, it is optimal to resolve disputes at zero cost and enforce cooperation through contracted transfers. Under limited verifiability, the optimal enforcement system must impose positive dispute resolution costs, but never so large that the agents would prefer severance to dispute resolution.[20]

4.2. Information Costs. Although full verifiability allows the agents to sustain cooperation with zero dispute resolution costs, the need to communicate information to the intermediary on an ongoing basis, to monitor actions constantly, or to maintain careful

[20]Our result strongly supports the emphasis placed by the ADR movement on preservation of relationships. As Bernstein (1996) notes of the NGFA dispute resolution system, "[the arbitration system] and its adjudicative approach are designed to enable companies to submit disputes to arbitration while minimizing the disruption to their relationship" (footnote 124).

records imposes additional information costs relative to the case of limited verifiability. The optimality of full versus limited verifiability then hinges on the level of these information costs.

Let d denote the additional per period information costs imposed on the agents by full verifiability, relative to limited verifiability. Clearly, if d is equal to zero, then full verifiability is optimal, since cooperation could be sustained without any dispute resolution or information costs. With positive information costs, however, the attractiveness of full verifiability depends on whether or not limited verifiability would entail large dispute resolution costs due to nuisance disputes. This trade-off is formalized in the following proposition.

Proposition 5. *Suppose d is strictly positive. If γ is sufficiently small, then the optimal enforcement system is characterized by limited verifiability.*

Proof. The optimal enforcement system with full verifiability sets $p = c = 0$, and the value of the relationship, net of information costs, is $(z - d)/(1 - \delta)$. From (11), however, it may be seen that the value of the optimal enforcement system with limited verifiability $z/(1 - \delta)$ as γ converges to zero, and it follows that limited verifiability yields a strictly greater value than when γ is sufficiently small. *Q.E.D.*

Although full verifiability makes it possible to enforce the contract with zero dispute resolution costs, the presence of information costs makes limited verifiability more attractive in situations where nuisance disputes arise infrequently. The key idea is that high ex post dispute resolution costs do not correspond to high ex ante costs when disputes can be avoided. As long as there are few nuisance disputes, or the enforcement system can screen them out prior to the dispute resolution process, limited verifiability will maximize the agents' welfare by making detailed communication or documentation of actions unnecessary.[21] In other

[21]To the extent that nuisance disputes arise from misunderstandings between the agents as to whether cheating has occurred, it may be possible at relatively low cost for agents to screen out nuisance disputes through better communication. Further, agents will have an incentive to engage in such screening in order

words, enforcement systems might usefully focus on ascertaining whether a given dispute constitutes a genuine breakdown of cooperation, rather than whether the breakdown was caused by agent 1 or agent 2.

4.3. General and Specific Systems. An enforcement system that is used by a wide variety of contractual relationships is called a *general enforcement system*. The most basic example of a contracting institution is the system of public courts, administered by lawyers and judges who serve as intermediaries. General systems have the advantage of vesting dispute resolution in a single institution, but there may be agents who find the system poorly suited to their particular circumstances. Groups of agents may be motivated to set up *specific enforcement systems* whose parameters are better tailored to their needs. One example is the NGFA's private legal system, which supplants U.S. law and courts for transactions between members of the association. A wide range of contractual relationships, such as labor relationships, utilize mediation or arbitration agreements, whereby agents commit to bypass public courts. Indeed, any form of alternative dispute resolution can be interpreted as a specific system. Of course, the disadvantage of a specific system is that the agents must incur added costs by duplicating to some extent the general system.

The trade-offs between general and specific systems can be illustrated using our model. Suppose the agents can choose at the start of their relationship whether to enforce their contract using a predetermined general system, involving a particular degree of verifiability and dispute resolution costs c and p, or else to establish their own specific system. The specific system, which imposes an added overhead cost of h^* per period, allows the agents to select a degree of verifiability and dispute resolution costs c^* and p^* that are optimal for their own relationship.

Suppose first that the general system entails limited verifiability, and information costs

to avoid costly dispute resolution with the intermediary. This may work to increase the salience of the low γ case in practice.

are such that the agents' optimal specific system also involves limited verifiability. The comparison of general and specific systems turns on the relationship between their relative costs. Suppose first that c and p are very large relative to the optimal choices c^* and p^*; that is, dispute resolution costs under the general system are high relative to the agents' preferred levels. As long as h^* is not too great, the agents would choose the specific system in this case. Next, if c and p are approximately equivalent to c^* and p^*, in the sense that the implied values of $g(D)$ are about the same, then the agents would make use of the general system in order to avoid the added overhead costs. Finally, if c and p are very low, then cooperation becomes unsustainable under the general system, and a specific system is the agents' only feasible option. We summarize with the following proposition.

Proposition 6. *Suppose the general and optimal specific systems involve limited verifiability. If h^* is not too great, then the optimal specific system will be preferred to the general system if c and p are both either very high or very low. The general system will be best for a middle region of c and p.*

The proposition establishes that the relationship between the agents' preferred system and the costs of the general system is not monotone. Instances of excessive costs in general enforcement systems, including high fees, delays and severance of relationships, have received much attention from practitioners. Our analysis, however, also uncovers the possibility that dispute resolution costs can be too *low* to sustain cooperation. In this case, optimal specific systems must introduce added costs of dispute resolution, even as they work to preserve relationships in the event of disputes.[22]

Another common criticism of general systems is that they make poor use of information that is specialized to the agents' relationship. This issue can be considered by measuring

[22]Taking an ex post view of dispute resolution, the ADR literature emphasizes the benefits of lowering dispute resolution costs. Our result indicates the importance of taking an ex ante perspective, where one observes that costly dispute resolution can deter disputes from occurring.

the use of information in terms of information costs. Let d and d^* denote the values of information costs under the general and specific systems, respectively. Under the general system, the intermediary may know little about the agents' productive activity, and extensive documentation may be required to communicate the history of actions; the information cost d is relatively large in this case. With the specific system, in contrast, the intermediary would presumably be more skilled in examining the agents' actions, so that d^* would be lower. The following proposition links the agents' choice of system to the information and overhead costs.

Proposition 7. *A necessary and sufficient condition for use of a specific system with full verifiability to be preferred to the general system with full verifiability is* $h^* + d^* \leq d$.

Proof. From the proof of Proposition 6, we have that the value of the relationship under the general system with full discovery is $(z-d)/(1-\delta)$, whereas the value under the specific system with full discovery is easily seen to be $(z-h^*-d^*)/(1-\delta)$. *Q.E.D.*

As the proposition demonstrates, it may be worthwhile to incur added overhead costs if a specific system makes possible a large enough reduction in information costs.

5. Contract Enforcement and Noncontractible Long-Term Investment

We have emphasized that costly dispute resolution processes can secure incentives for cooperation when agents are unable to impose direct contractual punishments. In this section we show that costly dispute resolution can also play a role in providing incentives to make long-term, relation-specific investments. As discussed by Williamson (1979) and Grout (1984), agents will tend to underinvest in relationships when investments are noncontractible, since their partners can hold them up for part of the ex post returns. A properly designed enforcement system can overcome the holdup problem by providing offsetting incentives to invest, based on the manner in which investment interacts with incentives to cooperate.

To introduce long-term investment, we modify the benchmark limited verifiability setup as follows. At the beginning of period 1, before the initial negotiation phase, agent 1 makes

an investment, denoted by α. We assume that, regardless of agent 1's investment, the relationship begins in the C state. That is, the investment choice cannot trigger the dispute state; in this way, investment is nonverifiable. The joint payoff from the choices (H, H) is given by $z(\alpha)$, which is taken to be an increasing and strictly concave function of α. The value of outside opportunities w is assumed to be unaffected by α, however, so that investment is specific to the relationship. We simplify further by taking x to be independent of α and by setting $\gamma = 0$.

Assume that (1) holds at $z = z(0)$, and that $z'(0)$ is large enough to ensure that agent 1 will select a strictly positive investment level. The efficient investment level, assuming that cooperation will be sustained, solves the following problem:

$$\max_{\alpha}\{g(C;\alpha) - \alpha\},$$

where $g(C;\alpha) = z(\alpha)/(1-\delta)$. Let α^E denote the efficient investment level. Finally, given c and p, let $g(D;\alpha)$ denote the value of the D state when the investment level is α:

$$g(D;\alpha) = \max\left\{w, \frac{(1-p)g(C;\alpha) - c}{1-p\delta}\right\}.$$

The following proposition verifies that the usual underinvestment result holds in this setting when agent 1 cannot appropriate all of the joint surplus, as long as prospects for sustaining cooperation are unaffected by agent 1's investment choice.

Proposition 8. *Suppose $\pi_1 < 1$. If c and p are sufficiently large, then in equilibrium agent 1 chooses $\alpha < \alpha^E$.*

Proof. Suppose that dispute resolution costs are so high that cooperation is sustained at every investment level; i.e., we have

$$g(C;0) \geq x + \delta g(D;0). \tag{17}$$

It is evident that as α rises, $g(C;\alpha)$ increases at a faster rate than does $\delta g(D;\alpha)$. This implies that the necessary and sufficient condition for cooperation, given by (13), will be

satisfied for all α when (17) holds. It follows that the payoff-maximizing investment level for agent 1 solves

$$\max_{\alpha}\{\pi_1[g(C;\alpha) - w] + w_1 - \alpha\}.$$

Clearly, agent 1 prefers an investment level less that α^E, since he can realize only proportion $\pi_1 < 1$ of the returns. *Q.E.D.*

For large values of c and p, cooperation is sustainable even when $\alpha = 0$, so that agent 1 anticipates that cooperation will obtain irrespective of his choice of α. If dispute resolution costs are smaller, however, then the choice of α can affect whether cooperation is sustainable, and agent 1 can be induced to select a higher investment level. The following proposition demonstrates that the efficient investment level can be implemented in this manner.

Proposition 9. *Suppose π_1 is sufficiently large to give*

$$\pi_1[g(C;\alpha^E) - w] \geq \alpha^E. \tag{18}$$

Then there exist values of c and p such that in equilibrium, cooperation is sustained and agent 1 chooses the efficient investment level.[23]

Proof. We may obtain $g(C;\alpha^E) > x+\delta g(D;\alpha^E)$ by choosing c and p large enough to make $g(D;\alpha^E) = w$, based on the assumption that (1) holds at $\alpha = 0$. Further, choosing c and p equal to zero gives $g(D;\alpha^E) = g(C;\alpha^E)$, in which case we have $g(C;\alpha^E) < x + \delta g(D;\alpha^E)$, using the fact that $z < x$. Thus, by continuity, there must be intermediate values satisfying

$$g(C;\alpha^E) = x + \delta g(D;\alpha^E).$$

For this specification of the dispute resolution costs, agent 1 will be unwilling to choose any $\alpha < \alpha^E$, since then $g(C;\alpha)$ will lie strictly below $x + \delta g(D;\alpha)$ and the relationship would

[23] If $\pi_1[g(C;\alpha^E) - w] < \alpha^E$, then the dispute resolution system cannot induce efficient investment, but it can operate to move agent 1's investment choice closer to the efficient level.

immediately collapse. Only by choosing $\alpha \geq \alpha^E$ can agent 1 ensure that cooperation is sustainable and the return is positive, and clearly agent 1's most preferred selection among these investment levels is α^E. It follows that agent 1 will choose α^E as long as his net payoff is nonnegative, and (18) is a sufficient condition for this. *Q.E.D.*

Dispute resolution processes can alter incentives to invest by exploiting the effect of investment on incentives to cooperate: as investment rises, cooperation becomes more valuable, and the agents become more willing to avoid disputes. Thus, when dispute resolution costs are reduced, agents must increase investment in order to preserve cooperation, and the dispute resolution system can be designed to take advantage of this trade-off.[24] From another perspective, specific investment can be viewed as a substitute for costly dispute resolution, as cooperation may be sustained through either high investment or costly dispute resolution. For example, when nuisance disputes occur frequently, the optimal arrangement may combine large amounts of up-front investment with speedy and inexpensive dispute resolution.

6. Conclusion

We have developed a new model of contract enforcement emphasizing the roles played by third party intermediaries. Intermediaries create value by compelling contracted transfers, recording when relationships are in dispute, and resolving disputes when called upon by the contracting parties. We have demonstrated that the nature of contract enforcement depends on the amount of information that is verifiable to the intermediary and the costs of dispute resolution. With full verifiability, dispute resolution costs are optimally zero and

[24]We are not the first to demonstrate how the process of dispute resolution affects ex ante incentives. Hart and Moore (1988), Aghion, Dewatripont, and Rey (1994), Che and Hausch (1999), and others examine whether the hold up problem can be averted by manipulating aspects of ex post negotiation (such as bargaining power, default options, and the use of verifiable messages). Edlin and Reichelstein (1996) focus on forms of enforcement specifying breach remedies. Our work contributes by recognizing that costly dispute resolution (not present in the above models) may counteract holdup in long-term relationships.

cooperation can be sustained by directly punishing a party who breaches a contract. In the case of limited verifiability, parties voluntarily submit to a costly dispute resolution process, which serves to implicitly bond their relationship against misbehavior. Our theory suggests that, to sustain cooperation in some settings, standard reputation and third-party bonding mechanisms may be less important than the nature of dispute resolution processes.

Our results have important implications for the design of dispute resolution systems. Such systems can trade off ex post dispute resolution costs against ex ante information costs in sustaining cooperative incentives, and in many cases the optimal system entails costly dispute resolution with limited information. Efficient institutional design also facilitates preservation of relationships. Further, agents may be best served by establishing specific enforcement systems tailored to their needs, rather than relying on general systems such as courts. A range of institutional structures, including alternative dispute resolution systems and firms, can be understood in terms of their functioning as specific systems.

Our theory is founded on the principle that contract enforcement is in the hands of intermediaries. Accordingly, we advocate a new perspective from which to study ongoing contractual relations — a perspective that highlights contract enforcement on the basis of disputes and dispute resolution. As argued above, contracting agents are ill-suited to duplicate such an enforcement system on their own, due to their ability to freely reinterpret history and alter their internal designation of the relationship's status. For example, suppose the agents agree to condition their behavior on some imaginary system of states, including a dispute state that is triggered when one or both parties select L. Suppose as well that the agents agree to play (L, L) forever, once the dispute state is reached, as a punishment. Then if the dispute state is *actually* reached, the agents would have the joint incentive to revise their state system and re-start cooperation; that is, they would effect a costless switch from the dispute state back to the cooperative state. In addition, agents cannot credibly commit to tying future transfers to the history of interaction, since both can hold up the relationship in each period. The prospect of cooperation is therefore undermined. On the other hand,

by conditioning their behavior on the external contracting institution, the agents can avoid such renegotiation problems.

Theoretically, the issue of what agents condition their decisions on is a matter of meta-level negotiation over equilibria. The argument for conditioning on the intermediary's state is captured by our uniform best criterion, which evaluates whether agents can gain (in any state) from switching their equilibrium. A complete analysis of conditioning institutions, including a selection criterion that weakens the uniform best notion, appears in Ramey and Watson (1999); there we focus on the case in which transfers cannot be compelled by a third party.

Although we have not pursued it here, our theory may be useful in evaluating the relative effectiveness of different modes of community and bilateral enforcement. Several authors, including Bendor and Mookherjee (1990), Greif (1993), Greif, Milgrom, and Weingast (1994), and Woodruff (1996), have stressed that, under some conditions, multilateral sanctions improve a society's ability to sustain cooperation, relative to bilateral sanctions. In this literature, sanctions involve switching to a low-level equilibrium which, as some of these authors have pointed out, may not survive renegotiation. Our theory demonstrates that the parameters of the dispute resolution process are fundamental to enforcement of contracts. Since agents have the joint incentive to renegotiate away from punishing each other, certification by third parties has value. Thus, in the context of community interaction, it is important to identify the relevant third party for the purposes of obtaining official certification, e.g. certain members of the community may function as intermediaries. The role of intermediaries in disseminating information about dispute resolution becomes especially important in such contexts.

A further issue for community enforcement is whether third parties have the incentive to do their part in maintaining the system, as they may be called upon to forgo productive interaction with members of the community who have cheated others. They may, however, prefer to renegotiate with new partners to avoid such sanctions. Clearly, to understand

whether community enforcement is possible, one must take full account of the technology of information transmission and the costs of bringing subsets of agents together for negotiation and dispute resolution. Research along this line is underway.

More broadly, our model may shed some light on how institutions evolve as costs of administering contract enforcement change over time. An economy at its early stage of economic development may be characterized by inefficient public institutions that impose very high certification costs. In these circumstances, agents are driven to form relatively small trade groups, such as guilds, or narrow political units that define a specific system. As public institutions improve, the costs of the general system fall, and the use of public contract enforcement supplants small group enforcement. At the final stage, dispute resolution through the general system becomes so cheap that specific institutions again become widespread, including in particular the use of large integrated organizations.

Finally, our analysis of specific dispute resolution systems yields insights into the internal structure of firms, in particular regarding alternative management regimes. On one hand, we may observe managers who continuously gather information about their subordinates and settle disputes in a timely manner, promoting full verifiability. On the other hand, in some settings managers intervene only occasionally, with little information, and settle disputes slowly, extracting rents in the process; this is captured by the limited verifiability model with positive dispute resolution costs. The latter system, with its relatively distant, uninformed and feared managers evoking the comic strip *Dilbert*, will be the optimal one in many circumstances. In general, firms may be structured to achieve a desired framework within which disputes between employees are resolved; this may involve manager-intermediaries as well as an ex ante investment in monitoring technology.[25]

[25] In his analysis of generic forms of economic organization, Williamson (1991) discusses how internal organization is distinguished in terms of contract law. Regarding disputes that arise between individuals in a firm, there are barriers to the use of courts which support the firm's specific system. As Williamson states, forbearance of courts confirms hierarchy as "its own court of ultimate appeal."

References

[1] Abreu, D. and D. Pearce (1991), "A Perspective on Renegotiation in Repeated Games," in R, Selten (ed.), *Game Equilibrium Models*, v2, Springer-Verlag.

[2] Abreu, D., D. Pearce, and E. Stacchetti (1993), "Renegotiation and Symmetry in Repeated Games," *Journal of Economic Theory* 60: 217-240.

[3] Aghion, P., M. Dewatripont, and P. Rey (1994), "Renegotiation Design with Unverifiable Information," *Econometrica* 62: 257-282.

[4] Allen, F. (1984), "Reputation and Product Quality," *Rand Journal of Economics* 15: 311-327.

[5] Bendor, J. and D. Mookherjee (1990), "Norms, Third Party Sanctions, and Cooperation," *Journal of Law, Economics, and Organization* 6: 33-63.

[6] Bernheim, B. D. and D. Ray (1989), "Collective Dynamic Consistency in Repeated Games," *Games and Economic Behavior* 1: 295-326.

[7] Bernstein, L. (1996), "Merchant Law in a Merchant Court: Rethinking the Code's Search for Immanent Business Norms," *University of Pennsylvania Law Review* 144: 1765.

[8] Blume, A. (1994), "Interplay Communication in Repeated Games," *Games and Economic Behavior* 6: 181-211.

[9] Bull, C. (1987), "The Existence of Self-Enforcing Implicit Contracts," *Quarterly Journal of Economics* 102: 147-159.

[10] Che, Y.-K. and D.B. Hausch (1999), "Cooperative Investments and the Value of Contracting," *American Economic Review* 89: 125-147.

[11] Cooter, R.D., and D.L. Rubinfeld (1989), "Economic Analysis of Legal Disputes and Their Resolution," *Journal of Economic Literature* 27: 1067-1097.

[12] Cooter, R.D., and D.L. Rubinfeld (1994), "An Economic Model of Legal Discovery," *Journal of Legal Studies* 23: 435-463.

[13] den Haan, W.J., G. Ramey, and J. Watson (1999a), "Contract-Theoretic Approaches to Wages and Displacement," *Federal Reserve Bank of St. Louis Review* 81(3).

[14] den Haan, W.J., G. Ramey, and J. Watson (1999b), "Liquidity Flows and Fragility of Business Enterprises," Discussion Paper No. 99-07, UCSD, March.

[15] den Haan, W.J., G. Ramey, and J. Watson (1999c), "Job Destruction and the Experiences of Displaced Workers," *Carnegie-Rochester Conference Series on Public Policy*, forthcoming.

[16] Dickens, W.T., L.F. Katz, K. Lang, and L.H. Summers (1989), "Employee Crime and the Monitoring Puzzle," *Journal of Labor Economics* 7: 331-347.

[17] Dixit, A. and B. Nalebuff (1993), "Making Strategies Credible," in R. Zechhauser (ed.), *Strategy and Choice*, MIT Press.

[18] Edlin, A.S. and S. Reichelstein (1996), "Holdups, Standard Breach Remedies, and Optimal Investment," *American Economic Review* 86: 478-501.

[19] Ellickson, R., *Order without Law: How Neighbors Settle Disputes*, Cambridge: Harvard University Press, 1991.

[20] Farrell, J. and E. Maskin (1989), "Renegotiation in Repeated Games," *Games and Economic Behavior* 1: 327-360.

[21] Goldberg, S. B., F. E. A. Sander, and N. H. Rogers (1992), *Dispute Resolution: Negotiation, Mediation, and other Processes*, 2nd ed., Boston: Little, Brown, and Company.

[22] Green, J. and J.-J. Laffont (1994), "Non-Verifiability, Costly Renegotiation, and Efficiency," *Annales D'Economie Et De Statistique* 36: 81-95.

[23] Greif, A. (1993), "Contract Enforceability and Economic Institutions in Early Trade: The Maghribi Traders' Coalition," *American Economic Review* 83: 525-548.

[24] Greif, A., P. Milgrom, and B. R. Weingast (1994), "Coordination, Commitment, and Enforcement: The Case of the Merchant Guild," *Journal of Political Economy* 102: 745-776.

[25] Grossman, S. and O. Hart (1986), "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration," *Journal of Political Economy* 94: 691-719.

[26] Grout, P. (1984), "Investment and Wages in the Absence of Binding Contracts: A Nash Bargaining Approach," *Econometrica* 52: 449-460.

[27] Hart, O. and J. Moore (1988), "Incomplete Contracts and Renegotiation," *Econometrica* 56: 755-785.

[28] Hart, O. and J. Moore (1990), "Property Rights and the Nature of the Firm," *Journal of Political Economy* 98: 1119-1158.

[29] Henry, J. F. and J. K. Lieberman (1985), *The Manager's Guide to Resolving Legal Disputes: Better Results without Litigation*, New York: Harper and Row.

[30] Kandori, M. (1992), "Social Norms and Community Enforcement." *Review of Economic Studies* 59: 63-80.

[31] Kennan, J. (1979), "Bonding and the Enforcement of Labor Contracts," *Economics Letters* 3: 61-66.

[32] Klein, B. and K. Leffler (1981), "The Role of Market Forces in Assuring Contractual Performance," *Journal of Political Economy* 89: 615-641.

[33] McCutcheon, B. (1997), "Do Meetings in Smoke-Filled Rooms Facilitate Collusion?" *Journal of Political Economy* 105: 330-550.

[34] Milgrom, P. R., D. C. North, and B. R. Weingast (1990), "The Role of Institutions in the Revival of Trade: The Law Merchant, Private Judges, and the Champagne Fairs," *Economics and Politics* 2: 1-23.

[35] North, D. (1991), *Institutions, Institutional Change and Economic Performance*, Cambridge: Cambridge University Press.

[36] Pearce, D. (1987), "Renegotiation-Proof Equilibria: Collective Rationality and Intertemporal Cooperation," Cowles Foundation Discussion Paper 855, Yale University.

[37] Ramey, G. and J. Watson (1997), "Contractual Fragility, Job Destruction, and Business Cycles," *Quarterly Journal of Economics* 112: 873-911.

[38] Ramey, G. and J. Watson (1999), "Conditioning Institutions and Renegotiation," Discussion Paper No. 99-09, UCSD, April.

[39] Sappington, D. (1983), "Limited Liability Contracts Between Principal and Agent," *Journal of Economic Theory* 29:1-21.

[40] Schelling, T. (1960), *The Strategy of Conflict*, Cambridge: Harvard University Press.

[41] Shapiro, C. (1983), "Premiums for High Quality Products as Returns to Reputations," *Quarterly Journal of Economics* 98: 659-679.

[42] Shavell, S. (1989), "Sharing of Information Prior to Settlement or Litigation," *RAND Journal of Economics* 20: 183-195.

[43] Shavell, S. (1995), "Alternative Dispute Resolution: An Economic Analysis," *Journal of Legal Studies* 24: 1-28.

[44] Sobel, J. (1985), "Disclosure of Evidence and Resolution of Disputes: Who Should Bear the Burden of Disputes?" in A.E. Roth, ed., *Game-Theoretic Models of Bargaining*, Cambridge: Cambridge University Press.

[45] Williamson, O. (1979), "Transactions-Costs Economics: The Governance of Contractual Relations," *Journal of Law and Economics* 22: 233-261.

[46] Williamson, O. (1983), "Credible Commitments: Using Hostages to Support Exchange," *American Economic Review* 73: 519-540.

[47] Williamson, O. (1991), "Comparative Economic Organization: The Analysis of Discrete Structural Alternatives," *Administrative Science Quarterly* 36: 269-296.

[48] Woodruff, C. (1996), "Getting Institutions Right: Contract Enforcement and Coalitions in Closed and Open Economies," manuscript, University of California, San Diego.

[49] Woodruff, C. (1997), "Trade Associations and Coalitional Bargaining with Incomplete Contracts," manuscript in preparation, University of California, San Diego.