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THE TIES THAT BOND:  
PERSONAL TIES, INTER-FIRM RELATIONS, AND ECONOMIC  
DEVELOPMENT\*

BENJAMIN E. HERMALIN,<sup>†</sup> LARRY LI,<sup>‡</sup> AND TONY NAUGHTON<sup>§</sup>

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ABSTRACT

This paper explores the consequences of an improving legal system on an economy that has heretofore relied on relational (informal) contracting. We show such improvement can be welfare enhancing or welfare reducing. In the latter case, we show that often a mediocre legal system is worse than either a bad legal system or an excellent system, with the second often being superior to relational contracting. If the quality of the legal system is positively correlated with development, then this paper offers explanations for why efforts to enhance relational contracting, including promoting personal ties, are critical in early stages of development, but why developed economies will tend, instead, to rely on formal contracting and be suspicious of personal ties. In some cases, it pays to use both informal and formal contracting, with formal contracting serving to enhance relational contracting.

*Keywords:* formal and relational contracting, economic development, personal ties.

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<sup>†</sup>University of California • Berkeley, CA, USA • email: hermalin@berkeley.edu.

<sup>‡</sup>School of Economics, Finance, & Marketing • RMIT University • Melbourne, VIC, Australia • email: larry.li@rmit.edu.au.

<sup>§</sup>School of Economics, Finance, & Marketing • RMIT University • Melbourne, VIC, Australia • email: tony.naughton@rmit.edu.au.

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## 1 INTRODUCTION

Firms conduct business with each other through contracting. These contracts can be formal, relying on the capacity and reliability of the legal system, or relational in the sense that the strength of ongoing ties forms the basis of enforcement. Relational contracting can be observed to be particularly strong in economies where contract law and its enforcement are inadequate. It is, therefore, reasonable to assume that relationship contracting is particularly evident in emerging or transition economies. At the same time, Macaulay (1963) suggests that strong ties between firms can strengthen formal contracting. Hence, even well-developed economies, such as Japan, can be observed to have extensive relationships at the core of business-to-business contracting.

On the other hand, economic theory (*e.g.*, Schmidt and Schnitzer, 1995) has suggested that the more parties can rely on formal contracts, the less they can rely on relational contracting. The better is formal contracting, the less dire the consequences of a relationship collapse, and, hence, the harder it is to maintain a relationship.<sup>1</sup>

In this paper, we attempt to reconcile these views, with an emphasis on the implications for economic development. We show, *inter alia*, that the conclusions of both Macaulay and Schmidt and Schnitzer are arguably incomplete. Although a stronger legal system can undermine relational contracting, we show that conclusion could be dependent on assuming that relational and formal contracting is an either-or proposition. If we allow the parties to use both simultaneously, then we find, as somewhat the reverse of Macaulay, that stronger formal contracting can strengthen relational contracting.<sup>2</sup>

Historically, trading parties' ability to appeal to the legal system if there was a problem with trade was limited. Relational or ongoing dealings between traders substituted for a formal legal system (see, *e.g.*, Greif, 1993, and Kranton, 1996). In contrast, in developed economies, the parties can rely on the legal system. This raises questions about what path welfare took as the legal system improved.<sup>3</sup> We show, under a number of different assumptions, that an

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<sup>1</sup>Specifically, Schmidt and Schnitzer assume formal contracting can achieve the same outcomes as informal contracting, but the use of formal contracts means incurring costs absent with informal contracting. So, in their model, "better formal contracting" means a reduction in those costs. In contrast, we restrict attention to situations in which outcomes supportable with informal contracts simply cannot be supported with formal contracts if the legal system is sufficiently poor, but the set of outcomes supportable by formal contracts expands as formal contracting becomes better (the legal system improves). As an abstraction, we assume the costs of the two kinds of contracting are the same.

<sup>2</sup>Baker et al. (1994) and Kvaløy and Olsen (2009) also investigate what happens if formal and informal contracting are used simultaneously. Their models differ from ours in a number of important ways, as discussed below.

<sup>3</sup>Kranton and Swamy (1999) show, in the case of British India, that improvements in the court system had pluses and minuses with respect to farm lending. Johnson et al. (2002), and Djankov et al. (2003), *inter alia*, consider empirically some of the issues associated with evolving legal systems. In particular, they document that different legal systems vary in quality and that more-developed economies tend to have higher quality legal systems. Johnson et al. find evidence that changes in the quality of the legal system have bearing on inter-firm

improved legal system could have undermined relational contracting faster than it became an adequate substitute, so welfare initially fell as the legal system improved.

It is possible that welfare fell less in those societies that stressed personal ties or otherwise fostered relational contracting. Hence, this, for instance, could be a rationale for the government-*chaebol* cooperation seen in Korea, especially in her early stages of development in the 1960s. Similarly, the Chinese form of personal business relationships referred to as *guanxi* became the norm during the period of rapid economic growth in China.

Even if welfare dips as the legal system improves, we show that eventually, if the legal system becomes good enough, it will prove superior to relational contracting alone (unless the latter achieves the first best). Hence, the success of the developed world is consistent with the analysis we set forth below. This could help to explain why *chaebol* and *keiretsu* are not held in as high esteem today as they were at earlier stages of development.

Although relationships can be maintained by firms, often they are at the personal level. We, therefore, also allow for the possibility of personal ties among firms' managers. The literature has suggested such ties can be a two-edged sword. Tsang (1998) argues that *guanxi* creates a sustainable competitive advantage for firms. Lovett et al. (1999) argue that the *guanxi*-based system is more reliable than formal contracting when economic progress is coupled with uncertainty. In contrast, Fan (2002) cites the ethical problems created, noting that *guanxi* has the potential to bring benefits to individuals at the expense of firms and, at a broader level, is detrimental to society. In China, *guanxi*-based relationships are closely related to corruption, nepotism, bribery, and fraud (Yang, 1994).<sup>4</sup> Our results below reflect this duality. When managers have strong personal ties, firms would do better to actually encourage their managers to emphasize their personal ties over firm profits. When ties are weaker (*i.e.*, pass below a certain threshold), then firms do better to discourage those ties and to encourage greater direct emphasis on profits. If, as we assume in Section 6, managerial favor exchange comes at their employers' expense, then these conclusions are tempered, but not reversed. In particular, we show that owners could still wish to encourage favor exchange even though it is a direct expense. Only when the legal system is sufficiently high quality, can we be sure that owners will want to clamp down on favor exchange.

Our paper builds on the literature on relational contracting (see, *e.g.*, MacLeod, 2007, for a survey). Baker et al. consider a principal-agent relationship in which the parties observe both the agent's actual performance and

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interactions consistent with the theoretical predictions we set forth here.

<sup>4</sup>Cultivating personal business relationships is not a unique phenomenon of a particular country or region. It can be observed almost everywhere around the world. In Russia, *blat* (personal business relationships) have been an important component in the development of the corporate sector. For example, Puffer et al. (1998) report that foreign companies are more likely to choose partners who have influence with the national or local business community and governments. See also Johnson et al. In Vietnam, good business relationships can help firms to extend their trade credit limits (McMillan and Woodruff, 1999).

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a signal correlated with it. Critically, only the latter is verifiable. When the correlation between signal and actual performance is sufficiently good, it is no longer feasible for the parties to also employ a relational contract based on actual performance. Hence, as in Schmidt and Schnitzer, the ability to contract formally can eliminate informal contracting. If one interpreted stronger correlation as a more accurate court, then Baker et al. can be seen as reaching a result opposite to our result that, when both relational and formal contracts can be used, formal contracting can help support informal contracting. The difference arises because, in this interpretation of their model, what is at issue is how good the court is at observing what happened; in contrast, we assume the court can observe that breach occurred, but it may err in assigning blame, or reach a judgment after much delay, or is, in some other way, unable to guarantee the injured party receives its full compensation.<sup>5</sup> Given that a number of authors have suggested that it is not the ability of the court to see what happened, but rather its ability to enforce contracts, that should be at issue, our model could be a valuable addition to the literature.<sup>6</sup>

Attention should also be paid to Kvaløy and Olsen. Like us, they allow the parties to write formal contracts but rely on the ongoing relation to ensure compliance. In their model, the cost of formal contracting is endogenous. The more one party, the principal, expends on formal contracting, the better that contracting is in the sense that it will yield greater gross surplus in equilibrium. This should be contrasted with Schmidt and Schnitzer's model, in which the cost of formal contracting is independent of the quality of the formal contracts. An ongoing relationship permits spending less on the formal aspects of the contract than one would in a one-shot game. This threat of having to pay more should there be a breakdown in trust helps support the reputational relationship. Consistent with Schmidt and Schnitzer's finding, should the *marginal* cost of formal contracting shift down, then relational contracting is undermined. If one interprets the fall in marginal cost as arising from an improved legal system, then Kvaløy and Olsen's results capture one of the two effects we find: Like us (and Schmidt and Schnitzer), they find that the better formal contracting is as a substitute for informal contracting, the less effective informal contracting will be. But there is also an opposite effect: We show that, because better formal contracting also raises the immediate penalty for breach, better formal contracting can help to support relational contracting.

The remainder of the paper has the following organization. The next section introduces our model. Firms seek to cooperate with each other. Such cooperation is variable and will depend on the contracts (relational, formal, or both) in place. We model the legal system as an imperfect enforcer of contracts, where

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<sup>5</sup>Djankov et al. note that the principal way in which courts are "low quality" is the delay with which they reach judgments.

<sup>6</sup>Hermalin (2008) observes that if the parties can renegotiate prior to a court case, then the court's accuracy in judging *what* happened could be largely immaterial. See also the surveys by Hermalin et al. (2007) and MacLeod for more on the broader issue of the relevance of the observable-verifiable distinction.

the quality of the legal system is proxied by the reliability and speed with which courts enforce contracts. Section 3 details what the first-best solution would be and what would happen if the firms interacted only once. The focus of Section 4 is on the situation in which the firms themselves can maintain a relationship (*i.e.*, ignoring managers' personal ties). Much of the analysis is spent analyzing how welfare is affected as the quality of the legal system improves. As noted above, the analysis depends, in part, on whether formal and relational contracting is an either-or proposition or both can be utilized simultaneously. In the latter case, there are circumstances in which welfare is strictly increasing in the quality of the legal system. In the former case, a non-monotonic relation between quality of the legal system and welfare will exist; initially, improvements in the legal system will reduce welfare, but ultimately welfare will begin to improve with the quality of the legal system. For sufficient improvement and assuming relational contracting does not achieve the first best, welfare will be greater than it could be under relational contracting. Section 5 explores the interaction between managers' seeking to maintain personal ties and their firms' relational contracting outcomes. Section 6 considers the broader agency issues associated with managers' maintaining personal ties. We conclude in Section 7. Proofs not given in the text are in Appendix A. Table A.1 lists the notation employed.

## 2 MODEL

### 2.1 BASIC ASSUMPTIONS

There are two firms. Within each period, the timing is as follows:

1. An agreement on a contract (relational, formal, or both) for that period is reached.
2. Each firm (its manager) chooses the amount of cooperation,  $q \in \mathbb{R}_+$ , it will supply that period.
3. Payoffs are realized.

Let the payoff to firm  $i$  be  $\beta(q_1, q_2) - c(q_i)$ , where  $\beta : \mathbb{R}_+^2 \rightarrow \mathbb{R}$  and  $c : \mathbb{R}_+ \rightarrow \mathbb{R}_+$ . Assume the functions are twice continuously differentiable in all their arguments. We further assume:

- Cost and marginal cost are both increasing in  $q$ ; that is,  $c(\cdot)$  is increasing and strictly convex. To ensure interior maxima, we assume  $c'(0) = 0$ .
- The benefit of no cooperation is normalized to zero; that is,  $\beta(0, 0) = 0$ .
- The benefit function is symmetric; that is, for any  $q$  and  $q'$ ,  $\beta(q, q') = \beta(q', q)$ .
- At least on some margins, benefit increases in cooperation. Specifically,  $\partial\beta(q_i, q_j)/\partial q_i > 0$  whenever  $q_i \leq q_j$ ; at some points in the analysis, we assume the more stringent condition:

**Strong Increase:** For all  $q_i$  and  $q_j$ ,  $\partial\beta(q_i, q_j)/\partial q_i > 0$ .

- For a given sum of  $q_1$  and  $q_2$ , output is at least weakly greater if the  $q$ s are more equal rather than less equal. Formally, we assume that the function  $\beta$  is Schur concave.<sup>7</sup>

Among the functions that would satisfy these assumption are those in the class:

$$\beta(q_1, q_2) = f(q_1) + f(q_2),$$

where  $f(\cdot)$  is concave. Another example is

$$\beta(q_1, q_2) = (q_1 + q_2)^{3/2} + \exp(-(q_1 - q_2)^2).$$

Note that, although the latter example is a Schur-concave function, it is not a concave function.

Although we recognize real-life relations could be asymmetric, assuming  $\beta$  is a symmetric function greatly simplifies the analysis insofar as we don't continually need to develop parallel conditions for two kinds of firms. A further advantage is it allows us to further assume  $\beta$  is Schur concave (a necessary condition for Schur concavity is symmetry). Schur concavity, in turn, essentially serves to guarantee symmetric equilibria, which again avoids the complications of having to develop parallel conditions and possible multiplicity of equilibria. It also seems a reasonable assumption in and of itself because it strikes us that in many relationships getting the partner supplying less effort to increase his or her effort improves the outcome by more than would an equal increase in effort by the partner supplying more effort (this is essentially what Schur concavity entails).

We also assume there exists a positive and finite value  $q_M$  such that

$$2\frac{\partial\beta(q, q)}{\partial q} - c'(q) < 0 \tag{1}$$

for all  $q > q_M$ . As will be seen, this ensures that the managers always wish to choose a finite level of cooperation.

We assume that the two firms are the “only game in town” insofar as neither has the opportunity to trade with a third firm. This assumption means that a breakdown in relational contracting is *not* punished by terminating the relationship, but by use of formal contracts. We recognize that, in certain situations, firms could terminate their relationship and search for new partners. If, however, it is relatively easy to find new partners, then it will be difficult

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<sup>7</sup>Schur concavity means that if  $(q_1, q_2)$  majorizes  $(q'_1, q'_2)$ , then  $\beta(q_1, q_2) \leq \beta(q'_1, q'_2)$ . In our context, majorization can be defined as  $(q_1, q_2)$  majorizes  $(q'_1, q'_2)$  if  $|q_1 - q_2| > |q'_1 - q'_2|$  and  $q_1 + q_2 = q'_1 + q'_2$ . More generally, majorization is defined as follows. Consider two vectors of dimension  $N$ ,  $\mathbf{x}$  and  $\mathbf{y}$ . The vector  $\mathbf{x}$  majorizes  $\mathbf{y}$  if, when the elements of each vector are ordered largest to smallest,  $\sum_{n=1}^k x_n \geq \sum_{n=1}^k y_n$  for all  $k < N$  and  $\sum_{n=1}^N x_n = \sum_{n=1}^N y_n$ . Note the similarity between the concepts of majorization and second-order stochastic dominance.

to maintain relational contracts in the first place because the outside option is presumably as good or close to as good as the current relationship. (This assumes reputations cannot be carried by word of mouth.) Consequently, relational contracting could be most prevalent among firms that find each other the only game in town. Alternatively, if reputation could be carried by word of mouth, so a firm that breached its relational contract could be blackballed by its former partner; or if a newly partnerless firm is mistrusted, then such a firm could find itself limited to formal contracts with new partners only. In this interpretation, the continuation payoffs considered below that a breaching-firm gets from formal contracting are simply the payoffs from contracts it signs with a new partner (or new partners). In this way, the analysis below can be extended to situations in which firms have potentially multiple partners.

## 2.2 THE LEGAL SYSTEM

The firms may wish to enter into a formal contract that specifies the levels of  $q_1$  and  $q_2$ . Consider a specific contract  $\langle \bar{q}_1, \bar{q}_2 \rangle$ . In what follows, there is no loss of generality in considering firm 1 to be the contract breacher and firm 2 to be the injured party. Imagine that firm 1 breaches by choosing  $q_1 < \bar{q}_1$ .<sup>8</sup> We assume that the court is imperfect. Specifically, in the event of contract breach it awards damages to the non-breaching firm (here, firm 2) with probability  $\theta \in [0, 1)$ . Note  $\theta = 0$  could be viewed as equivalent to no court system. The parameter  $\theta$  is common knowledge at the time the parties contract. The parameter  $\theta$  can be thought of as a measure of the quality of the legal system. We discuss its interpretation at greater length at the end of this subsection.

We assume, in keeping with the law's abhorrence of penalties in private contracts (see *e.g.*, Hermalin et al., 2007, §5.3), that there are limits on the amount of damages  $D$ . In particular, and consistent with practice in many courts, we limit damages so as not to exceed the actual loss suffered. In legal terms, we are focusing on expectation damages; that is,

$$D \leq \beta(\bar{q}_1, \bar{q}_2) - \beta(q_1, \bar{q}_2).$$

Damage claims greater than this will be dismissed as punitive by the courts (consistent with common practice). Beyond its realism, limiting attention to expectation damages facilitates the analysis. That said, we note that our basic conclusions would still apply if there were no court-imposed limits on penalties, but firms could go bankrupt. For low enough court quality, it would still be the case that relational contracting would dominate legal contracting, which is what is essential for our analysis.

In equilibrium, the firms will honor the contract. Hence, on the equilibrium path, penalties aren't paid. It is, therefore, without loss of generality to assume

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<sup>8</sup>A "breach" in which firm 1 chooses  $q_1 > \bar{q}_1$  is of no interest given that firm 2 would not be harmed by such a deviation and would, thus, have no grounds on which to sue firm 1. Moreover, in equilibrium, the firms would never agree to a contract in which firm 1 had incentives to cooperate more than called for by the contract.



the parties set the maximum penalty in their contract so as to achieve the maximum deterrence effect. Hence, they utilize expectation damages. The expected payoffs to the breaching firm (here, 1) and the payoff to the injured firm (here, 2) are, respectively,

$$\begin{aligned}\Pi_1 &= (\theta + 1)\beta(q_1, \bar{q}_2) - \theta\beta(\bar{q}_1, \bar{q}_2) - c(q_1) \quad \text{and} \\ \Pi_2 &= (1 - \theta)\beta(q_1, \bar{q}_2) + \theta\beta(\bar{q}_1, \bar{q}_2) - c(\bar{q}_2).\end{aligned}\tag{2}$$

Our model of the legal system has a number of interpretations. One is that the court always reaches the correct verdict, but there is uncertainty over whether the court will hear the case or be able to enforce its judgment or both. An alternative, but related, interpretation is that the court accurately assigns guilt, but is subject to delays, so the plaintiff only recovers damages with a lag (*i.e.*, in this interpretation  $\theta$  is the relevant discount factor). A third interpretation is that only the plaintiff can receive damages (similar to the system in the United States), but there is uncertainty as to whether the court will arrive at the correct verdict. A final interpretation, although one that requires a change in variables, is that the court always arrives at a verdict, but there is uncertainty as to whether the court will arrive at the correct verdict. Whichever party it judges to be responsible for breach must pay the other party damages (hence, sometimes, the plaintiff must pay the defendant, a possibility allowed for in some legal systems). If one adopts this last interpretation and  $\xi$  is the probability that the court rules for the injured party (firm 2), then identical conclusions to those obtained below will be reached by making the transformation  $\xi = \frac{1}{2}(1 + \theta)$  (note, this restricts,  $\xi \in [1/2, 1)$ ; the injured party is at least as likely to receive damages as the breaching party).<sup>9</sup>

### 2.3 PERSONAL TIES

In addition to the relationship they enjoy through their firms, the managers of the firm may enjoy a personal relationship. In any given period, one of two states arises. In one state, the manager of firm 1 seeks a favor from the manager of firm 2; in the other state, it is the manager of firm 2 that seeks a favor. Assume the two states are equally likely to occur.<sup>10</sup>

<sup>9</sup>Another way of modeling legal-system quality, not pursued here, would be in terms of how corrupt the legal system is. In an article that looks at consumers' incentives to invest in learning about firms' reputations prior to purchase to avoid low-quality goods versus relying on being able to sue a firm that cheats them, Dhillon and Rigolini (2011) endogenize, to an extent, court quality by looking at the incentives of firms to bribe the court when they are sued by consumers for selling low quality goods. In that article, court quality varies in equilibrium with how costly it is for firms to provide high quality.

<sup>10</sup>It would complicate the analysis to allow simultaneous requests for favors or to allow periods with no requests. The results, however, would not be substantively changed. In particular, what follows could already be interpreted to allow for periods without requests; simply interpret actual benefits and costs as expected benefits and costs. Simultaneous requests would not affect the analysis if we assumed that the managers decided simultaneously and independently within a period whether to grant each others' requests.

We assume that the managers cannot contract on favors, nor can one manager pay the other directly. The latter assumption is primarily for convenience: Given the absence of contracts, any promised payment would be discretionary and, hence, essentially equivalent to the promise to repay the favor with a favor.

Assume a favor granted yields the grantee a gain of  $\gamma$  and imposes a cost (loss) on the grantor of  $\lambda$ . Assume  $\gamma > \lambda > 0$ . Note we can readily think of  $\gamma$  as an expected value of the gain from a favor (as long as the minimum possible gain exceeds  $\lambda$ ); for reasons that will become clear shortly,  $\lambda$  needs to be interpreted as a fixed value. We leave extensions of the model in which the cost of granting a favor is stochastic or non-stationary to future work. Prior to the start of a period, neither manager knows whether he will be the favor giver or receiver; hence, the expected value of favor exchange is

$$\frac{1}{2}\gamma - \frac{1}{2}\lambda \equiv \Delta.$$

To keep the analysis straightforward, we assume simply that a manager assigns weight  $\phi$ ,  $0 < \phi < 1$ , to his benefits from his personal ties and weight  $1 - \phi$  to his firm's profit (payoff). That is, the expected per-period utility of manager is

$$\phi\Delta + (1 - \phi)\Pi,$$

where  $\Pi$  is his firm's profit. We discuss this assumption at length in Section 6, where we consider how  $\phi$  could arise endogenously from owners' providing the managers explicit incentives.

### 3 FIRST BEST AND THE ONE-SHOT GAME

We begin our analysis by determining what the first-best outcome would be and what would, instead, result were the interaction between firms and their managers single shot.

Because the gain from receiving a favor,  $\gamma$ , exceeds the loss,  $\lambda$ , from granting it, favors should be given in the first best. Were, however, the managers to play once, there would be no favors granted. With no hope of repayment, the manager of whom the favor has been requested has no incentive to grant it.

We now focus on the level of firm cooperation (*i.e.*, the choices of  $q_1$  and  $q_2$ ). To that end, the following lemma will prove useful.

**Lemma 1.** *Under the above assumptions about the benefit function,  $\beta : \mathbb{R}_+^2 \rightarrow \mathbb{R}$ , the following are true with regard to the expression*

$$\zeta\beta(q_1, q_2) - c(q_1) - c(q_2), \tag{3}$$

$\zeta \in (0, 2]$ :

- (i) *If  $(q'_1, q'_2)$  has the same sum as  $(q''_1, q''_2)$ , but is more disperse (*i.e.*,  $(q'_1, q'_2)$  majorizes  $(q''_1, q''_2)$ —see footnote 7 *supra*), then (3) is greater given  $(q'_1, q'_2)$  than given  $(q''_1, q''_2)$ .*

- (ii) *There exists a finite level of cooperation,  $q^*(\zeta)$ , such that (3) is maximized if each firm chooses  $q^*(\zeta)$ .*
- (iii)  *$\zeta > \zeta'$  implies  $q^*(\zeta) > q^*(\zeta')$ .*
- (iv) *Holding one firm's level of cooperation fixed, there exists a finite level of cooperation for the other firm that maximizes (3).*
- (v) *That level of cooperation in part (iv) is increasing in  $\zeta$ .*

Joint profits are

$$\beta(q_1, q_2) - c(q_1) + \beta(q_1, q_2) - c(q_2) = 2\beta(q_1, q_2) - c(q_1) - c(q_2). \quad (4)$$

From the lemma, there exists a finite  $q^*(2)$  that, if both firms choose it, maximizes their joint profits.

Individual firm profit is, however,

$$\beta(q_1, q_2) - c(q_i), \quad (5)$$

$i = 1$  or  $2$ . By definition, it must be that  $q^*(2)$  is the solution to

$$\max_q 2\beta(q, q^*(2)) - c(q).$$

From parts (iv) and (v) of the lemma, there exists a level of cooperation less than  $q^*(2)$  that maximizes firm  $i$ 's individual profit when the other firm chooses  $q^*(2)$  (it is as if  $\zeta$  went from 2 to 1). In other words, maximizing their individual profits, the firms will not choose, in equilibrium, the level of cooperation that maximizes their joint profits. This establishes:

**Proposition 1.** *Were the firms to interact once, they would not choose a level of cooperation that maximized their joint profits.*

Proposition 1 is the familiar result that team members (here, the firms) undersupply effort relative to the first best because each team member bears 100% of the cost of his effort, but reaps only a fraction of the total benefit his effort produces (see, *e.g.*, Holmström, 1982). This problem is sometimes referred to as free-riding; ultimately it is a reflection of the well-known result that parties expend too little effort, from a welfare perspective, on activities that generate positive externalities.

For future reference, define

$$q^{\text{BR}}(q, \zeta) = \operatorname{argmax}_x \zeta \beta(x, q) - c(x). \quad (6)$$

Observe  $q^{\text{BR}}(q, 1)$  is a manager's best response to his fellow manager's choosing  $q$  assuming that he wishes to maximize a single period's profits only (assuming no contract).

**Lemma 2.**  $q^{\text{BR}}(q^*(\zeta), \zeta) = q^*(\zeta)$ .

Lemma 2 implies that a Nash equilibrium of the game played once, absent any contract, is for both managers to choose  $q^*(1)$ .

Consider the one-shot game with contracts, as outlined in Section 2.2. For firm  $i$ 's manager to honor a contract calling for the firms to play  $\langle \bar{q}_i, \bar{q}_j \rangle$  it must be that

$$\beta(\bar{q}_i, \bar{q}_j) - c(\bar{q}_i) \geq \max_q (\theta + 1)\beta(q, \bar{q}_j) - \theta\beta(\bar{q}_i, \bar{q}_j) - c(q), \quad (7)$$

where the right-hand side follows from (2). We can rearrange (7) to reëxpress the condition as

$$(\theta + 1)\beta(\bar{q}_i, \bar{q}_j) - c(\bar{q}_i) \geq \max_q (\theta + 1)\beta(q, \bar{q}_j) - c(q). \quad (8)$$

The following is immediate:

**Lemma 3.** *A contract  $\langle \bar{q}_i, \bar{q}_j \rangle$  will be honored in equilibrium only if  $\bar{q}_i = q^{BR}(\bar{q}_j, \theta + 1)$  and  $\bar{q}_j = q^{BR}(\bar{q}_i, \theta + 1)$ .*

Although it is not essential for the subsequent analysis, it facilitates that analysis if we restrict attention to situations in which  $q^*(\zeta)$  is unique for all  $\zeta \in [1, 2]$ . To this end, we assume

**Assumption 1.** *The univariate function  $\mathbb{R}_+ \rightarrow \mathbb{R}$  defined by  $q \mapsto \zeta\beta(q, q) - 2c(q)$  is a strictly concave function (of  $q$ ) for all  $\zeta \in [1, 2]$ .*

We can now establish:

**Proposition 2.** *If the quality of the legal system is  $\theta$ ,  $\theta \in [0, 1)$ , then the only formal contract that will be honored as a pure-strategy equilibrium is the one that calls on each firm to choose level of cooperation  $q^*(\theta + 1)$ .*

Proposition 2 has a few implications. First, given Lemma 1(v), it implies that the equilibrium level of cooperation in a one-shot game is greater the more accurate is the court (the better is the legal system). Second, if the court is never accurate or non-existent,  $\theta = 0$ , then the outcome is identical to the outcome were no contract in force. Third, if the court is perfect,  $\theta = 1$ , then the outcome given a contract is the first-best outcome. Finally, given Assumption 1, the function  $\beta(q, q) - c(q)$  is strictly concave, so the closer  $q^*(\theta + 1)$  is to  $q^*(2)$ , the greater is welfare; in other words, the better the legal system (*i.e.*, the greater is  $\theta$ ), the greater is welfare.

#### 4 THE REPEATED GAME I: COOPERATION AND PERSONAL TIES CONSIDERED SEPARATELY

We now consider an infinitely repeated game. With respect to favor granting, if the managers play repeatedly, then a favor in one period will be, in expectation, repaid in some later period. For convenience, assume the managers' discount factor is the same as the firms', namely  $\delta$ . The rationale for a manager to grant a favor today is the threat of what would happen were he to refuse.

Assume, in this section, that refusal to grant a favor (non-cooperation) results in reversion to infinite repetition of the one-shot equilibrium of the favor-granting game only. Should reversion occur, favors are never again granted. Hence, in deciding whether to grant a favor, a manager weighs his immediate loss,  $\lambda$ , against the present discounted value of his expected benefit,  $\Delta\delta/(1-\delta)$ .

We say that the managers have *strong* ties if

$$-\lambda + \frac{\delta}{1-\delta}\Delta \geq 0. \quad (9)$$

Expression (9) states that a manager finds it in his self interest to grant a favor today in exchange for the flow of future expected favors starting in the next period. We say that the managers have *weak* ties if

$$-\lambda + \frac{\delta}{1-\delta}\Delta < 0. \quad (10)$$

If (10) holds, then, absent other considerations, the managers will not exchange favors in equilibrium.

With respect to cooperation between the firms, we begin by ignoring the possibility of favor exchange. An issue is whether we view relational and formal contracts as an either-or proposition or whether we allow for both to be used simultaneously. That is, can the firms have a relational and formal contract in force simultaneously or, alternatively, can they have only one or the other in force?

It might seem that the either-or case is the less empirically relevant case. This could well be true, but one can imagine an extension of our model in which there are fixed costs of writing formal contracts or using the courts. Hence, it is worth knowing how well the parties could do relying solely on relational contracts. Moreover, doing so permits us to highlight how allowing the parties to use both yields results that differ from earlier analyses that took an either-or approach.

Suppose, first, that it is an either-or proposition. So, if the parties are operating under a relational contract, there can be no formal contract. The parties can, however, revert to using formal contracts should their relational contract collapse. In a world of either-or contracting, a level of cooperation  $\hat{q}$  can be sustained in equilibrium if

$$\begin{aligned} (\beta(\hat{q}, \hat{q}) - c(\hat{q})) \frac{1}{1-\delta} &\geq \left( \max_q \beta(q, \hat{q}) - c(q) \right) \\ &+ \frac{\delta}{1-\delta} \underbrace{\left( \beta(q^*(\theta+1), q^*(\theta+1)) - c(q^*(\theta+1)) \right)}_{\pi_{\text{CON}}(\theta)}; \end{aligned}$$

or, rearranging, if

$$\beta(\hat{q}, \hat{q}) - c(\hat{q}) \geq (1-\delta) \left( \max_q \beta(q, \hat{q}) - c(q) \right) + \delta \pi_{\text{CON}}(\theta). \quad (11)$$

Ideally, the firms wish to sustain the first-best level of cooperation,  $q^*(2)$ . Because there is a finite maximum to the optimization program embedded in (11), it follows, by taking the limit of (11) as  $\delta \rightarrow 1$ , that there exists, for each  $\theta < 1$ , some discount factor such that the first best is supportable via relational contracts.

The following result follows readily from (11):

**Proposition 3.** *Assume the use of formal and relational contracts is either-or. For any quality of the legal system,  $\theta \in [0, 1)$ , there exists a cutoff,  $\delta^*(\theta) < 1$ , such that first best is supportable for all discount factors,  $\delta$ , such that  $\delta \geq \delta^*(\theta)$  and unsupported for all  $\delta < \delta^*(\theta)$ . The function  $\delta^*(\cdot)$  is increasing and  $\lim_{\theta \rightarrow 1} \delta^*(\theta) = 1$ .*

In words, the better is the legal system, the higher the discount factor must be to sustain the first-best level of cooperation under relational contracting.

What if the discount factor is below the cutoff necessary to sustain the first best (*i.e.*, what if  $\delta < \delta^*(\theta)$ )? It can still be possible to support some cooperation greater than  $q^*(\theta + 1)$  (the fallback level). To see this, suppose that  $\delta$  is just a bit less than  $\delta^*(\theta)$ . Suppose  $\hat{q}$  in (11) is reduced slightly from  $q^*(2)$ . By the envelope theorem and assuming the strong increase condition,

$$\frac{\partial}{\partial \hat{q}} \left( \max_q \beta(q, \hat{q}) - c(q) \right) = \frac{\partial \beta(q, \hat{q})}{\partial \hat{q}} > 0.$$

Because  $q^*(2)$  maximizes  $2\beta(q, q) - 2c(q)$  and, thus,  $\beta(q, q) - c(q)$ , we have

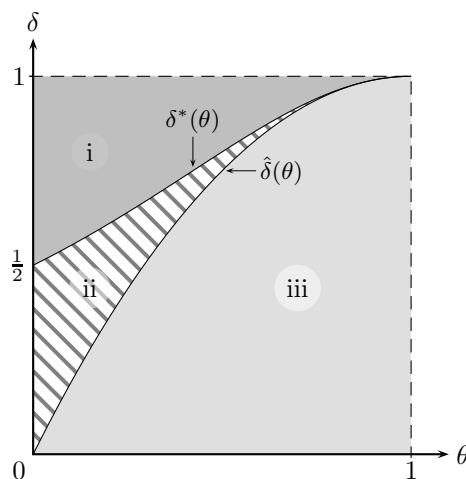
$$\frac{\partial}{\partial \hat{q}} (\beta(\hat{q}, \hat{q}) - c(\hat{q})) \approx 0$$

for  $\hat{q}$  near  $q^*(2)$ . It thus follows that reducing  $\hat{q}$  from  $q^*(2)$  leaves the left-hand side of (11) basically unchanged, but lowers the right-hand side of (11); hence, if (11) just failed to hold at  $\hat{q} = q^*(2)$ , it should hold for some  $\hat{q} < q^*(2)$  but “close.” More formally, we have

**Lemma 4.** *Assume the use of formal and relational contracts is either-or. Assume too that the “Strong Increase” condition holds. For any quality of the legal system,  $\theta \in [0, 1)$ , there exists a cutoff,  $\hat{\delta}(\theta) < 1$ , such that a level of cooperation greater than that supportable by a formal contract is supportable via a relational contract for all  $\delta \geq \hat{\delta}(\theta)$ ; however, no level of cooperation greater than that supportable by a formal contract is supportable via a relational contract if  $\delta < \hat{\delta}(\theta)$ . The function  $\hat{\delta}(\cdot)$  is increasing and  $\lim_{\theta \rightarrow 1} \hat{\delta}(\theta) = 1$ .*

Proposition 3 and Lemma 4 imply that  $\theta$ - $\delta$  space can be divided into three regions (see Figure 1): (i) a region in which the first best can be achieved; (ii) a region in which the first best cannot be achieved, but relational contracting is superior to formal contracting; and (iii) a region in which the equilibrium is characterized by formal contracting alone.

The existence of region (ii) offers one explanation for how, when the legal system is weak, relational contracting is superior to formal contracting, but how

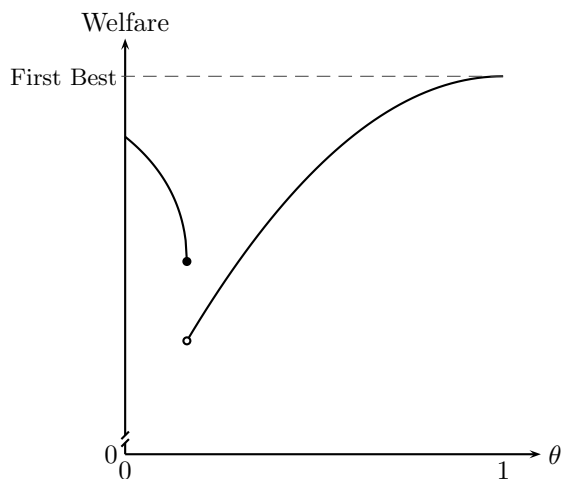


**Figure 1:** Equilibria by Region: (i) first best can be achieved; (ii) first best cannot be achieved, but relational superior to formal contracting; and (iii) formal contracting only. Figure drawn assuming  $\beta(q_1, q_2) = q_1 + q_2$  and  $c(q) = q^2/2$ .

a vastly improved legal system can outperform relational contracting. Specifically, with regard to Figure 1, suppose  $\delta \in (0, 1/2)$ . When the legal system is at a minimum (*i.e.*,  $\theta = 0$ ), relational contracting is better than formal contracting. However, the welfare associated with relational contracting is less than the first-best level and will be so regardless of the quality of the legal system. When the legal system, however, becomes high quality ( $\theta \rightarrow 1$ ), then welfare under formal contracting approaches the first best.

Figure 2 plots the equilibrium level of welfare as a function of the quality of the legal system under the same functional assumptions as Figure 1 with  $\delta$  set equal to  $3/10$ . For low  $\theta$  (to the left of the discontinuity), a relational contract is used in equilibrium. For  $\theta$  high enough (to the right of the discontinuity), a formal contract is used in equilibrium. In turn, the relation between welfare and quality of the legal system is non-monotonic: Improving a low-quality legal system can reduce welfare, while improving a moderate-quality legal system can raise welfare.<sup>11</sup>

<sup>11</sup>Note that Figure 2 (and Figure 3 *infra*) are comparative static results. In particular, they are thus different than an analysis that assumed the firms were aware the legal system was improving. Were that the case, then, being forward looking, anticipated future improvements and their consequent effects on relational contracting would be taken into account in the present, which could change the relational contracts agreed to in the present. That noted, if—as seems reasonable—the firms couldn't anticipate when improvements would occur and if the average rate of improvement were sufficiently low, then the effect on the relational contracts signed would be fairly minimal and these figures would fairly accurately reflect the time path of welfare even with forward-thinking firms. A complete analysis of such a



**Figure 2:** Equilibrium Welfare as a Function of the Quality of Legal System. Same functional assumptions as Figure 1.  $\delta = 3/10$ . Scales of horizontal and vertical axes are not the same.

What if the use of relational and formal contracting is not either-or? In particular, even if a formal contract *alone* cannot induce the desired level of cooperation, it can serve to reinforce the relational contract by reducing the benefit of renegeing on the promised level of cooperation by imposing damage payments. Using (2), the condition for the firms to cooperate at a level  $\hat{q}$  given that failure to do so results in both the breaching firm having to pay, with probability  $\theta$ , expectations damages *and* the end of relational contracting is

$$\begin{aligned} (\beta(\hat{q}, \hat{q}) - c(\hat{q})) \frac{1}{1-\delta} \geq & \left( \max_q (\theta + 1) \beta(q, \hat{q}) - \theta \beta(\hat{q}, \hat{q}) - c(q) \right) \\ & + \frac{\delta}{1-\delta} \left( \beta(q^*(\theta + 1), q^*(\theta + 1)) - c(q^*(\theta + 1)) \right); \end{aligned}$$

or, rearranging, the condition for cooperation can be written as

$$\beta(\hat{q}, \hat{q}) - c(\hat{q}) \geq (1 - \delta) \left( \max_q (\theta + 1) \beta(q, \hat{q}) - \theta \beta(\hat{q}, \hat{q}) - c(q) \right) + \delta \pi_{\text{CON}}(\theta). \quad (12)$$

Expression (12) is similar to (11) and identical if  $\theta = 0$  (*i.e.*, for the lowest quality legal system). Consistent with the intuition given earlier, we can show the following.

**Lemma 5.** *Suppose a level of cooperation  $\hat{q}$ ,  $q^*(\theta + 1) < \hat{q} \leq q^*(2)$ , can be supported by a relational contract for a given discount factor and quality of*

*non-stationary model is beyond the scope of this paper.*



the legal system,  $\theta$ , when the use of relational contracts and formal contracts is either-or. Then that level of cooperation can be supported by a relational contract “backed up” by a formal contract for the same discount factor and the same quality of the legal system.

A corresponding result to Proposition 3 when both relational and formal contracting can be employed is

**Lemma 6.** *Assume that formal and relational contracts can be used simultaneously (i.e., the former “backs up” the latter). For any quality of the legal system,  $\theta \in [0, 1]$ , there exists a cutoff,  $\delta^{**}(\theta) < 1$ , such that the first best is supportable for all  $\delta \geq \delta^{**}(\theta)$  and unsupported for all  $\delta < \delta^{**}(\theta)$ . Furthermore,  $\delta^{**}(0) = \delta^*(0)$  and  $\delta^{**}(\theta) < \delta^*(\theta)$  for all  $\theta \in (0, 1)$ .*

The astute reader will note an important difference between Proposition 3 and Lemma 6: We make no claim that  $\delta^{**}(\cdot)$  is increasing. In fact, it need not be, as summarized by the following result:

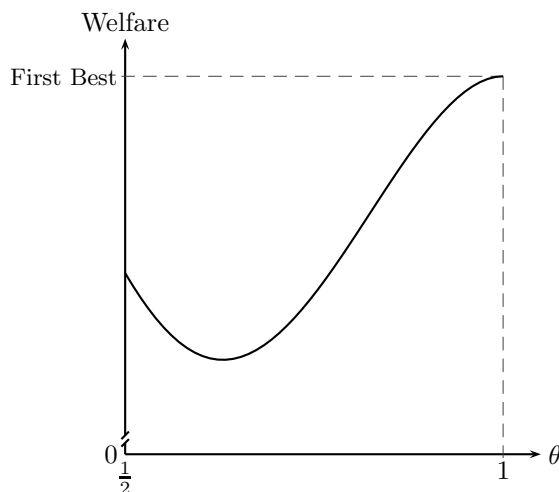
**Proposition 4.** *Suppose that formal contracts can be used to back up relational contracts. An improvement in the legal system can reduce, leave unchanged, or increase the space of parameters such that full efficiency can be achieved. As examples, suppose the cost of cooperation function is  $c(q) = q^2/2$ . The discount-factor cutoff,  $\delta^{**}(\theta)$ , for which full efficiency can be supported is*

- (i) *increasing in the quality of the legal system if  $\beta(q_1, q_2) = \log(q_1 + q_2 + 1)$ ;*
- (ii) *constant with respect to the legal system if  $\beta(q_1, q_2) = q_1 + q_2$ ; and*
- (iii) *decreasing in the quality of the legal system if  $\beta(q_1, q_2) = q_1 + q_2 - (q_1 - q_2)^2$ .*

Parts (ii) and (iii) of Proposition 4 shows that the prediction of Figure 2, namely that improvements in the quality of the legal system reduce welfare, at least in a neighborhood of minimum quality, could be an artifice of the assumption, underlying those figures, that the use of relational contracting and formal contracting is either-or. If formal contracts can be used to back up relational contracting, then welfare can be unaffected by improvements in the legal system (case ii) or benefitted directly (case iii). On the other hand, there is no guarantee that welfare is not reduced by an improvement of the legal system even outside the either-or context.

From Lemma 4, when formal and relational contracting is either-or, there exists a discount-factor cutoff,  $\hat{\delta}(\theta)$ , such that relational contracting is employed if and only if  $\delta \geq \hat{\delta}(\theta)$ ; recall Figure 1. When, instead, formal contracts can be used to back up relational contracts, relational contracting will be employed in equilibrium for all positive discount factors:

**Proposition 5.** *Suppose that formal contracts can be used to back up relational contracts. In equilibrium, the parties will always employ a relational contract backed-up by a formal contract rather than just a formal contract provided the discount factor is positive.*



**Figure 3:** Welfare can still be non-monotonic in the quality of the legal system even when formal contracts back up relational contracts. Figure drawn assuming  $\beta(q_1, q_2) = q_1 + q_2 - (q_1 - q_2)^2$ ,  $c(q) = q^2/2$ , and  $\delta = 3/10$ . Scales of horizontal and vertical axes are not the same.

Given, from Proposition 5, that formal contracts will always be used to back up relational contracts, it follows that improving the legal system has two, conflicting, effects on welfare: (i) it makes formal contracts a better backup, thus increasing welfare; but (ii), as in the either-or case, it also makes the alternative to relational contracting better, which reduces welfare. Hence, a non-monotonic relation between the quality of the legal system and welfare can still exist—see Figure 3. The one consequence, though, of using formal contracts as backups is that there is no longer a discontinuity in welfare as a function of the quality of the legal system (*i.e.*, compare Figures 2 and 3).

## 5 THE REPEATED GAME II: INTERACTION BETWEEN COOPERATION AND PERSONAL TIES

If the managers compartmentalize their personal exchanges and their firms' cooperation—that is treat the two as separate—then the situation is as analyzed in the previous section. If personal ties are strong and cooperation achieves the first best (*i.e.*,  $q_1 = q_2 = q^*(2)$ ), then there is no need for further analysis beyond that of the previous section. Hence, the situations of interest arise when (i) the managers do not compartmentalize their personal exchanges and their firms' cooperation and (ii) the situation is one of weak personal ties, a failure to achieve the first-best level of cooperation, or both.

## 5.1 STRONG PERSONAL TIES

Suppose the managers have strong personal ties (*i.e.*, expression (9) holds), but the parameters of the model are such that, when considered independently, the first-best level of cooperation cannot be sustained. Suppose, further, that the managers do not compartmentalize personal favor exchange and inter-firm cooperation; specifically, assume that a failure to abide by the cooperative agreement on either dimension ends all future cooperation on both dimensions (*i.e.*, leads to reversion to the one-shot equilibria of the favor-exchange and cooperation games).

Define

$$P(\theta, \delta, \hat{q}) = \delta\pi_{\text{CON}}(\theta) + (1-\delta) \times \begin{cases} \max_q \beta(q, \hat{q}) - c(q), & \text{if either-or case} \\ \max_q (\theta + 1)\beta(q, \hat{q}) - \theta\beta(\hat{q}, \hat{q}) - c(q), & \text{otherwise} \end{cases}.$$

Recall a manager assigns weight  $\phi \in (0, 1)$  to the benefits from his personal ties and weight  $1 - \phi$  to his firm's profit. A manager will maintain personal ties and cooperate at level  $\hat{q}$  if

$$\beta(\hat{q}, \hat{q}) - c(\hat{q}) \geq \frac{\phi}{1-\phi} ((1-\delta)\lambda - \delta\Delta) + P(\theta, \delta, \hat{q}). \quad (13)$$

An immediate implication of (13) is

**Proposition 6.** *The level of cooperation and, thus, firm profits that can be supported in equilibrium is non-decreasing in the strength of personal ties (*i.e.*, the greater is  $\delta\Delta - (1-\delta)\lambda$ ). Furthermore, if personal ties are strictly strong (*i.e.*, (9) is a strict inequality), then the level of cooperation and, thus, firm profits that can be supported in equilibrium is non-increasing in the weight a manager places on his company's profits.*

The second half of Proposition 6 might, at first, seem counter-intuitive, namely that the firm can do better the less its manager cares about its profit. The explanation is that the more the manager cares about his personal ties, the less tempted he is to breach his informal agreement with his fellow manager simply for the purpose of raising his firm's profit in the short term. Strengthening personal ties can be a way to induce greater commitment to the relational contract between the firms with respect to their level of cooperation.

Proposition 6 can be strengthened as follows:

**Proposition 7.** *Suppose that some level of cooperation is sustainable by a relational contract (*i.e.*, suppose there exists a  $\hat{q}$  that satisfies (13)). Let  $\bar{q}$  be the largest such level of cooperation and suppose that  $q^*(\theta + 1) < \bar{q} < q^*(2)$ . Finally, suppose that personal ties are strictly strong (*i.e.*, (9) is a strict inequality). Then an increase in the strength of personal ties or a decrease in the importance managers place on their firms' profits increases the maximum level of cooperation sustainable in equilibrium.*

## 5.2 WEAK PERSONAL TIES

Suppose, now, that the managers' personal ties are weak (*i.e.*, expression (10) holds). Continue to assume, however, that the managers do not compartmentalize personal favor exchange and inter-firm cooperation; specifically, assume that a failure to abide by the cooperative agreement on either dimension ends all future cooperation on both dimensions (*i.e.*, leads to reversion to the one-shot equilibria of the favor-exchange and cooperation games).

The same analysis used in the previous subsection for Propositions 6 and 7 yields the similar conclusion with respect to the value of personal ties:

**Corollary 1.** *The level of cooperation and, thus, firm profits that can be supported in equilibrium is non-decreasing in the strength of personal ties (*i.e.*, the greater is  $\delta\Delta - (1 - \delta)\lambda$ ). Furthermore, if  $\bar{q}$  is the largest level of cooperation sustainable via relational contracting and  $q^*(\theta+1) < \bar{q} < q^*(2)$ , then an increase in the strength of personal ties increases the maximum level of cooperation sustainable in equilibrium.*

On the other hand, the reverse result now applies with respect to the weight the managers place on their firm profits: Specifically, whereas less weight on firm profits raised profits when personal ties are strong, less weight on firm profits *reduces* profits when personal ties are weak. Formally, we have:

**Corollary 2.** *Suppose personal ties are weak. The level of cooperation and, thus, firm profits that can be supported in equilibrium is non-decreasing in the weight a manager places on his company's profits. Furthermore, if  $\bar{q}$  is the largest level of cooperation sustainable via relational contracting and  $q^*(\theta+1) < \bar{q} < q^*(2)$ , then a decrease in the weight managers attach to firm profits reduces the level of cooperation and, thus, firm profits that can be supported in equilibrium.*

Summarizing this second corollary and Propositions 6 and 7, we see that having managers place more weight on firm profits is bad for profits when their personal ties are strong, but good for profits when their personal ties are weak.

## 6 AGENCY ISSUES

We have, so far, not explicitly modeled agency costs in our analysis. In particular, we have assumed that the cost of favors is borne by the manager and not his employer. In reality, we might expect that the firm bears some of the cost incurred when its manager grants the other manager a favor. For instance, hiring the other manager's less-than-qualified nephew imposes direct costs on the firm.

To study the agency issue, suppose that the cost of a favor,  $\lambda$ , is borne solely by the firm of the manager who grants the favor. A manager's expected per-period utility is, therefore,

$$\frac{\phi}{2}\gamma + (1 - \phi) \left( \Pi - \frac{1}{2}\lambda \right) = \phi \left( \frac{1}{2}\gamma - \frac{1}{2} \left( \frac{1 - \phi}{\phi} \lambda \right) \right) + (1 - \phi)\Pi.$$

If we define  $\Lambda = \frac{1-\phi}{\phi}\lambda$ , then the analysis is similar to above, except with  $\Lambda$  in place of  $\lambda$ .

From (13), the condition for the manager to cooperate at both the personal and firm level is, therefore,

$$\beta(\hat{q}, \hat{q}) - c(\hat{q}) \geq \left(1 - \frac{\delta}{2}\right) \lambda - \frac{1}{2} \delta \frac{\phi}{1-\phi} \gamma + P(\theta, \delta, \hat{q}), \quad (14)$$

where  $P$  is as defined in the previous section. An immediate consequence of (14) is

**Lemma 7.** *The level of cooperation and, thus, firm profits that can be supported in equilibrium is non-increasing in the weight a manager places on his company's profits.*

In other words, conditional on favor exchange and cooperation sustained by relational contracting, the firms can generate greater cooperation by encouraging their managers to emphasize personal ties.

On the other hand, unlike the analysis of Propositions 6 and 7, now that the firm bears the cost of the personal ties, it is possible that the firms do better eliminating favor exchange all together. This would mean inducing the managers to put all weight on firm profit (*i.e.*, make  $\phi = 0$ ). In practice this is no doubt easier said than done. Presumably, the firms' owners will need to use incentive contracts, direct monitoring, or other means to ensure no favor exchange. Nevertheless, the additional analysis necessary to introduce incentive contracts or monitoring into the current model would add to the length of the paper without necessarily providing significant additional insights. Hence, we assume, as an abstraction, that the the owners can simply induce the managers to behave as if  $\phi = 0$ .<sup>12</sup>

If the owners can set  $\phi$ , it follows that, for  $\lambda$  small enough or a bad enough legal system, they would select  $\phi = 1$ . From (14) this would permit first-best cooperation in equilibrium.<sup>13</sup> A firm's expected profit per period would be

$$\beta(q^*(2), q^*(2)) - c(q^*(2)) - \frac{\lambda}{2}. \quad (15)$$

If the owners set  $\phi = 0$ , then the analysis is identical to that in Section 4. Let  $\hat{q}(\theta)$  denote the second-best equilibrium level of cooperation given the quality of the legal system is  $\theta$  (*i.e.*,  $\hat{q}(\theta)$  maximizes  $\beta(\hat{q}, \hat{q}) - c(\hat{q})$  subject to (11) in an

<sup>12</sup>We also abstract from the various complications that can arise in models of game-playing agents. See, *e.g.*, Katz (1991) for a discussion.

<sup>13</sup>A possible objection to this conclusion is that, if  $\phi = 1$ , then the managers are completely indifferent to what the firms do. Because, however,

$$P(\theta, \delta, q^*(2)) - \left(\beta(q^*(2), q^*(2)) - c(q^*(2))\right) - \left(1 - \frac{\delta}{2}\right) \lambda$$

is finite, there must exist a  $\bar{\phi} \in (0, 1)$  such that (14) holds for  $\hat{q} = q^*(2)$  and  $\phi \geq \bar{\phi}$ . Writing the owners select  $\phi = 1$  can be considered short hand for stating they select a  $\phi \in [\bar{\phi}, 1)$ .

either-or regime or subject to (12) when formal contracts can backup relational contracts). A firm's per-period profit is, therefore,

$$\Pi^0(\theta) \equiv \max \left\{ \beta(\hat{q}(\theta), \hat{q}(\theta)) - c(\hat{q}(\theta)), \beta(q^*(\theta+1), q^*(\theta+1)) - c(q^*(\theta+1)) \right\}. \quad (16)$$

The following result is immediate:

**Proposition 8.** *Suppose the cost of managerial favor granting is borne by his firm. Suppose the owners can select the weight the manager places on his personal ties and his firm's profit. Suppose the cost of favor granting is small enough and the legal system sufficiently poor that (15) exceeds (16). Then the owners wish to strongly encourage favor exchange (personal ties). As the legal system approaches maximum quality, there comes a point at which the owners will switch from encouraging favor exchange to eliminating it.*

The last part of Proposition 8 follows because

$$\lim_{\theta \rightarrow 1} \Pi^0(\theta) = \beta(q^*(2), q^*(2)) - c(q^*(2)).$$

Although, in the limit, a better legal system must lead to firms' seeking to clamp down on favor exchange, the relation between the quality of the legal system and owners' attitudes toward favor exchange need not be monotonic. Following Figures 2 and 3, it is possible that when the legal system is poor, owners clamp down on favor exchange because the quality of relational contracting is sufficiently great that they do not wish to incur the cost of favor exchange. An improved legal system sufficiently undermines relational contracting, that the owners are now willing to incur that cost. Finally, as noted, when the legal system is sufficiently good, the owners again wish to clamp down.

As we observed earlier, our analysis is incomplete insofar as we do not fully model the agency game. No doubt issues around favor exchange require closer scrutiny. In particular, absent any checks, favors have a strong potential to involve the extraction from the firm of considerable private benefits by the managers. Moreover, to the extent the favors are of the form of mutual kick-backs or other under-the-table actions, they could well be unobservable. The perfect clamping down on favor exchange considered above could well constitute a theoretical ideal rather than a practical goal. As such, this issue can be viewed as a subset of the broader agency problems in corporate settings. What our analysis indicates is that the optimal solution to these agency problems is likely intertwined with issues of inter-firm relations and with the overall state of the legal system.

Enriching the model is not simply a matter of incorporating additional contracting costs. In particular, monitoring potentially affects the range of decisions and actions of managers considered in this paper. For instance, a manager may avoid establishing a relationship with another firm if that relationship might arouse suspicion. That is, monitoring, to curtail the granting of favors, potentially undermines the willingness of managers to enter into relational contracting. These are challenging issues that will enrich the analysis, but ones that are the work of future research.

## 7 CONCLUSION

In this paper, we have presented a model in which firms' choices between relational cooperation and formal contracting, or the decision to use both, is influenced by the strength of managers' personal ties and the quality of the legal system.

When the legal system is poor, firms need to rely on relational contracting to facilitate cooperation. Similar to the findings of Baker et al. (1994) and Schmidt and Schnitzer (1995), a better legal system can erode the effectiveness of relational contracting when the use of relational contracting or formal contracts is an either-or proposition. That is, improving the legal system can be welfare reducing. The either-or assumption could, however, be suspect in some settings. Hence, this paper explores what happens when formal contracts can serve to backup relational contracts—the parties always write formal contracts but adherence to them is essentially a function of repeated play, not the threat of legal sanctions. The same erosion as seen in the either-or case may still occur, but whether it does depends on the details of how cooperation affects firm payoffs. Also, unlike earlier literature, this paper shows that when relational contracting cannot achieve the first best, there comes a point when improving the legal system is welfare enhancing.

When the firms' managers' personal ties are incorporated, we observe that the stronger the ties and the more a manager values them, the less tempted he is to breach an informal contract with the other firm. We show that an increase in personal ties, or a decrease in care for firm profits, increases the level of firm cooperation provided the managers' ties are *strong*. Hence, even if the favor exchange between the firms' managers is directly costly to the firms, the firms' owners may nevertheless wish to encourage the managers' personal ties. On the other hand, if the managers have *weak* personal ties, these ties are not beneficial to the firm and the firms' owners will, therefore, wish to discourage them.

In terms of policy implications, this paper suggests that a prescription of a better legal system and a crackdown on "corruption" (favor exchange among firms' managers) need not always lead to better economic performance, at least in the short run. It also suggests that developing economies with a strong tradition of personal ties could outperform those with a weak tradition or those in which such ties are discouraged. The analysis further indicates that a quantum improvement in the legal system could be preferable to incremental improvements. Of course, speeding the improvement in the legal system would naturally seem a good thing, but beyond the obvious benefit of speeding up when the returns of an improved legal system are enjoyed, a fast change reduces the period of time over which economic performance actually decreases. Moreover, to the extent reduced economic performance could undermine support for legal reforms or limit the funding for such reforms, a quantum leap may be necessary from a political-economy perspective. Future work may wish to explore in greater detail such political-economy issues; in particular, could incremental change "stall," leading to permanent economic under performance?

Empirically, the paper suggests that measures of legal system effectiveness

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could have a U-shaped relation to economic performance. It also suggests that economies with strong traditions of personal ties or strong personal-ties networks could outperform those without, at least in early stages of development. As hinted earlier, the paper could offer some insights into why *chaebols* and *keiretsus* were initially seen as positive factors in Korean and Japanese development, but have more recently been viewed with suspicion. Of course, we recognize that the real world is far messier than any model, and hence any empirical analysis must take into account many important factors left out of our model. Hence, we view our paper as shedding light on some aspects of a complex reality, not as the definitive explanation for all of it.

In terms of the modeling itself, we recognize more could be done. For instance, in our analysis, we limited attention to supporting symmetric levels of cooperation (*i.e.*,  $q_1 = q_2$ ) between the firms. When, however, personal ties are involved, if the managers can make their levels of cooperation contingent on which manager owes which a favor in a given period, then the managers may seek to induce unequal levels of cooperation. Our preliminary exploration of this possibility indicates that the analysis can be quite involved, but it could offer additional insights into the tradeoffs between personal ties and inter-firm cooperation.

In our comparative statics analysis, we have effectively treated the players as naïve about there being an improving legal system (see footnote 11 *supra*). The modeling benefit of assuming such naïveté is the repeated games can be treated as stationary, which greatly facilitates their analysis. Assuming less naïve players could lead to a more interesting dynamic analysis, although we suspect that, as long as the players cannot anticipate the timing of legal-system improvements, substantively similar conclusions would be reached. If the timing were anticipated, then—at least when the use of formal and relational contracts is an either-or proposition—an announcement of future reform could cause the immediate collapse of relational contracting. In this case, the analysis would be similar to that illustrated by Figure 2 except that the drop in welfare would occur immediately and welfare would be a function solely of the quality of the legal system.

In our modeling, we treat the legal system as somewhat of a black box; an improved legal system is simply taken to be one that is more likely to reach and enforce the correct decision.<sup>14</sup> How a legal system improves in this manner is not formally modeled. One possibility is that access to the legal system is rationed, so that the parameter  $\theta$  has to do with the probability of a case being heard. Rationing could also occur through delays; that is, all cases are heard, but many with great delay. In this case, as noted earlier, the parameter  $\theta$  could be interpreted as a discount factor on damage payments. Another way in which a legal system could improve is by becoming less corrupt. Although one could twist the model here to accommodate that form of improvement (*e.g.*,

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<sup>14</sup>A further issue is that, even restricting attention to formal contracting only, a more accurate legal system need not always be welfare improving; see Hermalin (2008). We abstract from the issues raised there.



because of corruption, the contract breacher can reach a settlement with the injured party for less than the full damages, with the reduction being greater the more corrupt the legal system), it is more natural to see corruption as a cost of contracting—somewhat along the lines of Schmidt and Schnitzer (1995). This would change the modeling in some ways, but not, we believe, the substantive conclusions reached.

We are confident, therefore, that, while the modeling extensions and complications discussed in this section are important and will have implications for the details of the model and its predictions, the broader insights would be robust to these issues.

## APPENDIX A: PROOFS AND ADDITIONAL MATERIAL

Some of the analysis in this paper relies on the following well-known revealed-preference result, which is worth stating once, at a general level, for the sake of completeness and to avoid unnecessary repetition. In what follows, the convention of using subscripts to denote partial derivatives is employed.

**Lemma A.1.** *Let  $f(\cdot, \cdot) : \mathbb{R}^2 \rightarrow \mathbb{R}$  be a twice differentiable function. Suppose that  $f_{12}(\cdot, \cdot)$  has a constant sign. Let  $\hat{x}$  maximize  $f(x, z)$  and let  $\hat{x}'$  maximize  $f(x, z')$ , where  $z > z'$ . Then  $\hat{x} \geq \hat{x}'$  if  $f_{12}(\cdot, \cdot) > 0$  and  $\hat{x} \leq \hat{x}'$  if  $f_{12}(\cdot, \cdot) < 0$ . The inequalities are strict if either  $\hat{x}$  or  $\hat{x}'$  (or both) are interior maxima.*

**Proof:** By the definition of an optimum (revealed preference):

$$f(\hat{x}, z) \geq f(\hat{x}', z) \text{ and} \quad (17)$$

$$f(\hat{x}', z') \geq f(\hat{x}, z'). \quad (18)$$

Expressions (17) and (18) imply

$$\begin{aligned} 0 &\leq (f(\hat{x}, z) - f(\hat{x}', z)) - (f(\hat{x}, z') - f(\hat{x}', z')) \\ &= \int_{\hat{x}'}^{\hat{x}} (f_1(x, z) - f_1(x, z')) dx = \int_{\hat{x}'}^{\hat{x}} \left( \int_{z'}^z f_{12}(x, y) dy \right) dx, \end{aligned}$$

where the integrals follow from the fundamental theorem of calculus. Because the direction of integration is left to right, the inner integral in the rightmost term is positive if  $f_{12}(\cdot, \cdot) > 0$  and negative if  $f_{12}(\cdot, \cdot) < 0$ . It follows that the direction of integration in the outer integral must be weakly left to right (*i.e.*,  $\hat{x}' \leq \hat{x}$ ) if the inner integral is positive and it must be weakly right to left (*i.e.*,  $\hat{x}' \geq \hat{x}$ ) if the inner integral is negative. This establishes the first part of the lemma.

To establish the second part, because  $f(\cdot, y)$  is a differentiable function for all  $y$ , if  $\tilde{x}$  is an interior maximum, then it must satisfy the first-order condition

$$0 = f_1(\tilde{x}, y).$$

Because  $f_1(\tilde{x}, \cdot)$  is strictly monotone,  $f_1(\tilde{x}, y) \neq f_1(\tilde{x}, y')$ ,  $y \neq y'$ . Hence,  $\tilde{x}$  does not satisfy the necessary first-order condition to maximize  $f(\cdot, y')$ . Therefore,

$\hat{x}' \neq \hat{x}$ ; that is, the inequalities are strict. ■

**Proof of Lemma 1:** The expression  $-c(q_1) - c(q_2)$  is Schur concave in  $q_1$  and  $q_2$  given that  $c(\cdot)$  is convex (see, *e.g.*, Marshall and Olkin, 1979, p. 64). The set of Schur concave functions is closed under addition and positive scalar multiplication, so

$$\zeta\beta(q_1, q_2) - c(q_1) - c(q_2)$$

is Schur concave in  $q_1$  and  $q_2$ . Result (i) then follows from the definition of Schur concavity.

Given (i), we know that if  $(q_1, q_2)$  maximizes (3), then  $q_1 = q_2$ . To prove (ii) observe that  $(0, 0)$  is not a solution to the program of maximizing (3) with respect to  $q_1$  and  $q_2$  given that its gradient evaluated at  $(0, 0)$  is

$$\zeta \times \left( \frac{\partial\beta(0, 0)}{\partial q_1}, \frac{\partial\beta(0, 0)}{\partial q_2} \right) > (0, 0)$$

(recall  $c'(0) = 0$ ). Consider the program

$$\max_{\{q_1, q_2\}} 2\beta(q_1, q_2) - c(q_1) - c(q_2).$$

In light of part (i), this program is equivalent to

$$\max_q 2\beta(q, q) - 2c(q). \quad (19)$$

Evaluated at  $q = 0$ , that expression is zero. Expression (19) is smaller for any  $q > q_M$  than when evaluated at  $q_M$  by condition (1). Hence, there is no loss of generality in restricting attention to  $q \in [0, q_M]$ . Given that domain is compact and (19) is continuous and bounded on  $[0, q_M]$ , a maximum must exist by a theorem of Weierstrass's. As shown that maximum is finite, but not zero. This maximum can be labeled  $q^*(2)$ . From Lemma A.1 for any  $q > q^*(2)$  we have

$$\zeta\beta(q, q) - 2c(q) < \zeta\beta(q^*(2), q^*(2)) - 2c(q^*(2)). \quad (20)$$

Hence, there is no loss of generality in maximizing the left-hand side of (20) on the interval  $[0, q^*(2)]$ . Invoking Weierstrass's theorem again, a maximum must exist on that interval. This is  $q^*(\zeta)$ .

Result (iii) and (v) follow immediately from Lemma A.1.

Consider (iv). Without loss of generality, hold  $q_2$  fixed. Suppose (iv) were false, then there would exist a  $\zeta$  and  $q_2$  such that the set

$$\left\{ q_1 \mid \zeta \frac{\partial\beta(q_1, q_2)}{\partial q_1} - c'(q_1) > 0 \right\}$$

is unbounded above. So for any  $\bar{q}_1$ , there exists a  $q_1 > \bar{q}_1$  such that

$$\zeta \frac{\partial\beta(q_1, q_2)}{\partial q_1} - c'(q_1) > 0. \quad (21)$$

Consider a  $q_1 > \max\{q_M, q_2\}$  that satisfies (21). A function  $\beta$  is Schur concave if and only if

$$(x_1 - x_2) \left( \frac{\partial \beta(x_1, x_2)}{\partial x_1} - \frac{\partial \beta(x_1, x_2)}{\partial x_2} \right) \leq 0$$

(see Marshall and Olkin, 1979, Theorem A.4, p. 57). Hence, since  $c(\cdot)$  is strictly convex, it follows from (21) that, for all  $q < q_1$ ,

$$\zeta \frac{\partial \beta(q_1, q)}{\partial q_2} - c'(q) > 0.$$

By continuity, letting  $q \rightarrow q_1$ , we have

$$\zeta \frac{\partial \beta(q_1, q_1)}{\partial q_2} - c'(q_1) \geq 0.$$

Given symmetry, this, in turn, implies

$$0 \leq 2 \frac{\partial \beta(q_1, q_1)}{\partial q_1} - c'(q_1). \quad (22)$$

Given that  $q_1 > q_M$ , expression (22) contradicts condition (1). The result follows *reductio ad absurdum*. ■

**Proof of Lemma 2:** By definition of an optimum:

$$\zeta \beta(q^{\text{BR}}(q^*(\zeta), \zeta), q^*(\zeta)) - c(q^{\text{BR}}(q^*(\zeta), \zeta)) \geq \zeta \beta(q, q^*(\zeta)) - c(q)$$

for all  $q$ ; hence,

$$\zeta \beta(q^{\text{BR}}(q^*(\zeta), \zeta), q^*(\zeta)) - c(q^{\text{BR}}(q^*(\zeta), \zeta)) \geq \zeta \beta(q^*(\zeta), q^*(\zeta)) - c(q^*(\zeta)).$$

Subtracting  $c(q^*(\zeta))$  from both sides yields

$$\begin{aligned} \zeta \beta(q^{\text{BR}}(q^*(\zeta), \zeta), q^*(\zeta)) - c(q^{\text{BR}}(q^*(\zeta), \zeta)) - c(q^*(\zeta)) \\ \geq \zeta \beta(q^*(\zeta), q^*(\zeta)) - c(q^*(\zeta)) - c(q^*(\zeta)). \end{aligned} \quad (23)$$

But, by definition,  $q^*(\zeta)$  maximizes (3) and moreover, by Schur concavity, no pair  $(q, q^*(\zeta))$ ,  $q \neq q^*(\zeta)$  can; hence, (23) can hold only if  $q^{\text{BR}}(q^*(\zeta), \zeta) = q^*(\zeta)$ . ■

**Proof of Proposition 2:** Lemmas 2 and 3 imply that both firms will honor the contract  $\langle q^*(\theta + 1), q^*(\theta + 1) \rangle$  in equilibrium.

To show this is the only such contract, we first establish that no contract  $\langle \bar{q}_1, \bar{q}_2 \rangle$  will be honored in equilibrium if  $\bar{q}_1 \neq \bar{q}_2$ . Without loss of generality, take  $\bar{q}_2 > \bar{q}_1$ . The function  $\beta$  is Schur concave if and only if

$$(\bar{q}_2 - \bar{q}_1) \left( \frac{\partial \beta(\bar{q}_1, \bar{q}_2)}{\partial q_2} - \frac{\partial \beta(\bar{q}_1, \bar{q}_2)}{\partial q_1} \right) \leq 0$$

(see Marshall and Olkin, 1979, Theorem A.4, p. 57). Hence,

$$\frac{\partial\beta(\bar{q}_1, \bar{q}_2)}{\partial q_2} \leq \frac{\partial\beta(\bar{q}_1, \bar{q}_2)}{\partial q_1}. \quad (24)$$

Suppose it were the case that  $\langle \bar{q}_1, \bar{q}_2 \rangle$  would be honored in equilibrium, then they must be best responses and, so, solve the first-order conditions

$$(\theta + 1) \frac{\partial\beta(\bar{q}_1, \bar{q}_2)}{\partial q_1} - c'(\bar{q}_1) = 0 \quad \text{and} \quad (25)$$

$$(\theta + 1) \frac{\partial\beta(\bar{q}_1, \bar{q}_2)}{\partial q_2} - c'(\bar{q}_2) = 0. \quad (26)$$

Combining expressions (24)–(26) yields

$$c'(\bar{q}_1) = (\theta + 1) \frac{\partial\beta(\bar{q}_1, \bar{q}_2)}{\partial q_1} \geq (\theta + 1) \frac{\partial\beta(\bar{q}_1, \bar{q}_2)}{\partial q_2} = c'(\bar{q}_2) > c'(\bar{q}_1),$$

where the last inequality follows because  $c(\cdot)$  is strictly convex. But this implies the contradiction  $c'(\bar{q}_1) > c'(\bar{q}_1)$ . *Reductio ad absurdum*, no contract will be honored in equilibrium if  $\bar{q}_1 \neq \bar{q}_2$ .

Observe, we have so far not required Assumption 1.

Finally, we wish to rule out the firms honoring a contract  $\langle \bar{q}, \bar{q} \rangle$ ,  $\bar{q} \neq q^*(\theta + 1)$ . Suppose, to the contrary, that there were such a contract. Then, from (25) and (26), it would be a local maximum of

$$(\theta + 1)\beta(q, q) - 2c(q).$$

But because that univariate function is strictly concave by Assumption 1, the function has only one maximum, which implies  $\bar{q} = q^*(\theta + 1)$ . ■

**Proof of Proposition 3:** Let

$$\pi^* = \beta(q^*(2), q^*(2)) - c(q^*(2)) \quad \text{and} \quad \pi_{\text{DEV}} = \max_q \beta(q, q^*(2)) - c(q).$$

By Proposition 1 (revealed preference, really),  $\pi_{\text{DEV}} > \pi^*$ . By Proposition 2,  $\pi^* > \pi_{\text{CON}}(\theta)$ . By continuity, there exists a  $\delta$  such that

$$\pi^* = \delta\pi_{\text{CON}}(\theta) + (1 - \delta)\pi_{\text{DEV}}. \quad (27)$$

Because  $\pi_{\text{DEV}} > \pi_{\text{CON}}(\theta)$  the right-hand side of (27) is decreasing in  $\delta$ , so the solution is unique. Call the solution  $\delta^*(\theta)$ . Because  $\pi_{\text{CON}}(\theta) < \pi^*$ ,  $\delta^*(\theta) < 1$ . If  $\delta \geq \delta^*(\theta)$ , then the left-hand side of (27) is greater, so (11) holds. Similarly, if  $\delta < \delta^*(\theta)$ , then (11) fails. Because, given Assumption 1,  $\pi_{\text{CON}}(\cdot)$  is an increasing function, it follows that, to maintain equality in (27),  $\delta$  must increase; that is,  $\delta^*(\cdot)$  is increasing. The limit result follows because  $\pi_{\text{CON}}(1) = \pi^*$ . ■

**Proof of Lemma 4:** Understanding the proof is facilitated by considering Figure 4. Rewrite (11) as

$$\beta(\hat{q}, \hat{q}) - c(\hat{q}) - (1 - \delta) \left( \max_q \beta(q, \hat{q}) - c(q) \right) \geq \delta \pi_{\text{CON}}(\theta). \quad (11')$$

Let  $\hat{q}(\delta)$  maximize the left-hand side of (11') (to establish a maximum exists, one can apply the argument used in the proof of Lemma 1(iv)). By the implicit function theorem,  $\hat{q}(\cdot)$  is continuous. By Lemma A.1,  $\hat{q}(\cdot)$  is increasing in  $\delta$ .

Observe  $\hat{q}(1) = q^*(2)$ , from which it follows that the left-hand side of (11') is strictly greater than the right-hand side if  $\delta = 1$ . Suppose  $\delta = 0$ , revealed preference implies the left-hand side of (11') is non-positive. It can be made to equal zero if  $\hat{q} = q^*(1)$ . Hence, the left-hand side and right-hand sides of (11') are equal at  $\delta = 0$ .

The derivative of the right-hand side of (11') with respect to  $\delta$  is  $\pi_{\text{CON}}(\theta)$ . Except if  $\theta = 0$ , this exceeds the derivative of left-hand side with respect to  $\delta$  evaluated at  $\delta = 0$ , which is

$$\beta(q^*(1), q^*(1)) - c(q^*(1)) = \pi_{\text{CON}}(0).$$

Hence, increasing  $\delta$  from 0 to some arbitrarily small  $\varepsilon > 0$  means causing the right-hand side of (11') to exceed the left. As noted, however, for  $\delta$  large enough the left-hand side exceeds the right-hand side. In other words, we have established that, for  $\theta > 0$ , the left-hand side of (11') as a function of  $\delta$  must cross the right-hand side as a function of  $\delta$  at least once at some  $\delta \in (0, 1)$ .

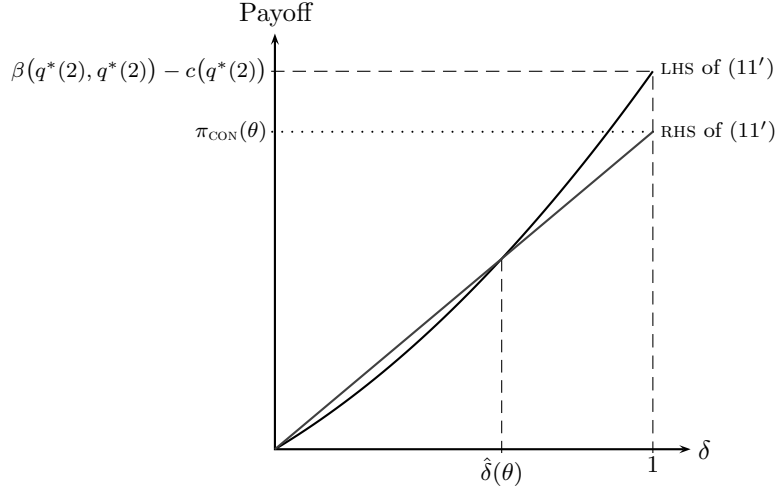
We wish to show that there is only one such crossing. Given the analysis above, we know, at the first such crossing, that the left-hand side crosses the right-hand side from below; hence, the slope of the left-hand side must exceed that of the right-hand side. There can, thus, be only one such crossing if we can show that the slope of the left-hand side remains greater than the slope of the right-hand side for all to the right of their point of crossing. Using the envelope theorem, the derivative of the slope of the left-hand side is

$$\frac{\partial}{\partial \hat{q}} \left( \max_q \beta(q, \hat{q}) - c(q) \right) \hat{q}'(\delta) = \frac{\partial \beta(q, \hat{q})}{\partial \hat{q}} \hat{q}'(\delta) \geq 0.$$

In other words, the slope of the left-hand side is non-decreasing in  $\delta$ . Since the slope of the right-hand side is a constant,  $\pi_{\text{CON}}(\theta)$ , it follows that the two sides cross once and only once at a  $\delta > 0$  provided  $\theta > 0$ . Define  $\hat{\delta}(\theta)$  as the value of  $\delta > 0$  at which they cross. See Figure 4.

For  $\delta < \hat{\delta}(\theta)$ , the right-hand side of (11') is greater than the maximum possible value of the left-hand side, hence no  $q > q^*(\theta + 1)$  can be sustained via a relational contract. For  $\delta \geq \hat{\delta}(\theta)$ ,  $\hat{q}(\delta)$ , at least, can be sustained via a relational contract. If  $\hat{q}(\delta) \leq q^*(\theta + 1)$ , then the left-hand side would necessarily be less than the right-hand side. Hence, for  $\delta > \hat{\delta}(\theta)$ ,  $\hat{q}(\delta) > q^*(\theta + 1)$ .

Finally, to see that  $\hat{\delta}(\cdot)$  is increasing consider Figure 4. If  $\theta$  increases, the line labeled RHS of (11') rotates counter-clockwise about the origin. It hence



**Figure 4:** Illustration for the Proof of Lemma 4. Figure valid for  $\theta \in (0, 1)$ . LHS and RHS denote left and right-hand sides, respectively.

intersects the curve labeled LHS of (11') at a point to the right of the one illustrated. That  $\lim_{\theta \rightarrow 1} \hat{\delta}(\theta) = 1$  can also be seen from the figure given that  $\pi_{\text{CON}}(1) = \beta(q^*(2), q^*(2)) - c(q^*(2))$  and the curves cross once for  $\delta > 0$ . ■

**Proof of Lemma 5:** The proof requires five steps.

**Step 1:** We first establish that any solution to

$$\max_q (\theta + 1)\beta(q, \hat{q}) - c(q) \quad (28)$$

is less than  $\hat{q}$ . By the assumptions of the lemma and the implicit function theorem, there exists a  $\hat{\theta} > \theta$  such that  $\hat{q} = q^*(\hat{\theta} + 1)$ . By Lemmas 2 and 3,  $\hat{q}$  therefore maximizes

$$\max_q (\hat{\theta} + 1)\beta(q, \hat{q}) - c(q). \quad (29)$$

By Lemma A.1, the solution to (28) is less than the solution to (29). Let  $\tilde{q}$  denote the solution to (28).

**Step 2:** Because  $\partial\beta(q, \hat{q})/\partial q > 0$  for  $q \leq \hat{q}$ ,  $\beta(\tilde{q}, \hat{q}) < \beta(\hat{q}, \hat{q})$ .

**Step 3:** Using the envelope theorem,

$$\begin{aligned} \frac{\partial}{\partial \theta} \left( \max_q (\theta + 1)\beta(q, \hat{q}) - \theta\beta(\hat{q}, \hat{q}) - c(q) \right) \\ = \beta(\tilde{q}, \hat{q}) - \beta(\hat{q}, \hat{q}) < 0. \end{aligned} \quad (30)$$

**Step 4:** It follows, therefore, that

$$(1 - \delta) \left( \max_q (\theta + 1) \beta(q, \hat{q}) - \theta \beta(\hat{q}, \hat{q}) - c(q) \right) < (1 - \delta) \left( \max_q \beta(q, \hat{q}) - c(q) \right), \quad (31)$$

given that the right-hand side of (31) is the left-hand side evaluated at  $\theta = 0$ .

**Step 5:** Given (11) is assumed to hold and the right-hand side of (11) is greater than the right-hand side of (12) by (31), it follows that (12) must hold as well. ■

**Proof of Lemma 6:** The proof is effectively the same as the proof of Proposition 3. Let  $\pi^*$  have the same value as there. Now define

$$\pi_{\text{DEV}}(\theta) = \max_q (\theta + 1) \beta(q, q^*(2)) - \theta \beta(q^*(2), q^*(2)) - c(q).$$

For the same reasons given in the proof of Proposition 3,  $\pi_{\text{DEV}}(\theta) > \pi^* > \pi_{\text{CON}}(\theta)$ . Hence, a  $\delta$  exists that solves (27) given this new definition of  $\pi_{\text{DEV}}(\theta)$ . The existence of the cutoff value  $\delta^{**}(\theta)$  follows the logic given in that earlier proof.

We turn now to proving the “furthermore” sentence. Observe  $\pi_{\text{DEV}}(\theta)$  is the same as in the proof of Proposition 3 if  $\theta = 0$ . Hence,  $\delta^{**}(0) = \delta^*(0)$ . Finally, from Step 3 of the proof of Lemma 5,  $\pi_{\text{DEV}}(\theta)$  is here decreasing in  $\theta$ ; hence, the value of  $\pi_{\text{DEV}}(\theta)$  here is less than corresponding value in the proof of Proposition 3, from which it follows that the  $\delta$  that solves (27) is less here than in Proposition 3 for  $\theta \in (0, 1)$ . ■

**Proof of Proposition 4:** The proof is by construction. Let  $\pi_{\text{DEV}}(\theta)$  be the same as in the proof of Lemma 6. Observe  $\delta^{**}(\theta)$  is the solution to

$$\beta(q^*(2), q^*(2)) - c(q^*(2)) = \delta \pi_{\text{CON}}(\theta) + (1 - \delta) \pi_{\text{DEV}}(\theta).$$

Hence,

$$\delta^{**}(\theta) = \frac{\beta(q^*(2), q^*(2)) - c(q^*(2)) - \pi_{\text{DEV}}(\theta)}{\pi_{\text{CON}}(\theta) - \pi_{\text{DEV}}(\theta)}.$$

It follows that

$$\begin{aligned} \text{sign}(\delta^{**'}(\theta)) = \text{sign} & \left( \left( \beta(q^*(2), q^*(2)) - c(q^*(2)) \right) (\pi'_{\text{DEV}}(\theta) - \pi'_{\text{CON}}(\theta)) \right. \\ & \left. - \pi_{\text{CON}}(\theta) \pi'_{\text{DEV}}(\theta) + \pi'_{\text{CON}}(\theta) \pi_{\text{DEV}}(\theta) \right). \quad (32) \end{aligned}$$

For case (i), (32) is positive.<sup>15</sup> For case (ii), calculations (available upon request) reveal that  $\delta^{**}(\theta) \equiv 1/2$ , which is constant. Finally, for case (iii), calculations (available upon request) reveal that

$$\delta^{**'}(\theta) = \frac{-1}{(2+\theta)^2} < 0.$$

■

**Proof of Proposition 5:** Define

$$\pi_{\text{DEV}}(\theta, \hat{q}) \equiv \max_q (\theta + 1)\beta(q, \hat{q}) - \theta\beta(\hat{q}, \hat{q}) - c(q).$$

From Lemma 2,

$$\begin{aligned} \pi_{\text{DEV}}(\theta, q^*(\theta + 1)) &= \beta(q^*(\theta + 1), q^*(\theta + 1)) - c(q^*(\theta + 1)) \\ &= \pi_{\text{CON}}(\theta). \end{aligned}$$

Hence, (12) is an equality for all  $\theta$  and  $\delta$  if  $\hat{q} = q^*(\theta)$ . The result follows, therefore, if we can show the left-hand side of

$$\beta(\hat{q}, \hat{q}) - c(\hat{q}) = \delta\pi_{\text{CON}}(\theta) + (1 - \delta)\pi_{\text{DEV}}(\theta, \hat{q}) \quad (33)$$

is increasing in  $\hat{q}$  faster than the right-hand side of that expression starting from  $\hat{q} = q^*(\theta + 1)$ . The derivative of the left-hand side of (33) evaluated at  $\hat{q} = q^*(\theta + 1)$  is

$$\begin{aligned} \frac{\partial\beta(q^*(\theta + 1), q^*(\theta + 1))}{\partial q_1} + \frac{\partial\beta(q^*(\theta + 1), q^*(\theta + 1))}{\partial q_2} - c'(q^*(\theta + 1)) \\ = 2 \frac{\partial\beta(q^*(\theta + 1), q^*(\theta + 1))}{\partial q} - c'(q^*(\theta + 1)) \quad (34) \end{aligned}$$

$$= (1 - \theta) \frac{\partial\beta(q^*(\theta + 1), q^*(\theta + 1))}{\partial q}, \quad (35)$$

where (34) follows from symmetry and (35) follows from Proposition 2 (*i.e.*, that  $q^*(\theta + 1)$  satisfies the first-order condition for a firm's optimal response to the other firm choosing  $q^*(\theta + 1)$  under a formal contract). The derivative of the right-hand side of (33) reduces, using the envelope theorem and evaluated at  $\hat{q} = q^*(\theta + 1)$ , to

$$(1 - \theta)(1 - \delta) \frac{\partial\beta(q^*(\theta + 1), q^*(\theta + 1))}{\partial q}. \quad (36)$$

Because  $\delta > 0$ , (35) exceeds (36), as was to be shown. ■

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<sup>15</sup>The Mathematica program that verifies this is available from the authors upon request.



**Proof of Proposition 7:** Let

$$Z = \frac{\phi}{1-\phi}((1-\delta)\lambda - \delta\Delta) \quad \text{and} \quad \Omega(q) \equiv \beta(q, q) - c(q) - P(\theta, \delta, q).$$

Note  $Z < 0$ . Because all functions are continuous and  $\bar{q} \in (q^*(\theta + 1), q^*(2))$ , it must be, from (13), that

$$\Omega(\bar{q}) = Z. \tag{37}$$

Let either personal ties strengthen or the weight put on firm profits lessen and let  $Z'$  be the corresponding new value of  $Z$ . Observe  $Z' < Z$ . Because  $\Omega(\cdot)$  is continuous, there exists an  $\eta > 0$  such that

$$\Omega(\bar{q}) - \Omega(q) < Z - Z'$$

for all  $q \in (\bar{q}, \bar{q} + \eta)$ . It follows, then, from (37) that

$$\Omega(q) > Z'$$

for all  $q \in (\bar{q}, \bar{q} + \eta)$ . Letting  $\hat{q}$  be an element of  $(\bar{q}, \bar{q} + \eta)$ , it follows that (13) holds for  $\hat{q}$ . ■

**Table A.1:** Summary Table of Notation

$\beta(q_1, q_2)$ : a symmetric function, is the gross benefit a firm receives as a function of the two firms' level of cooperation.

$c(q)$ : is the cost of cooperation.

$D$ : damages paid the prevailing side if the firms go to court

$\delta$ : discount factor;  $\delta^*(\theta)$  is the cutoff value for the first-best outcome to be possible under relational contracting in either-or case;  $\delta^{**}(\theta)$  is the cutoff value for the first-best outcome to be possible under relational contracting when simultaneous use of both contract types are feasible;  $\hat{\delta}(\theta)$  is the cutoff level for a level of cooperation greater than that supportable by formal contracting alone to be feasible.

$\Delta$ : expected value of a future period's favor exchange

$\phi$ : weight manager places on favors;  $1 - \phi$  is weight he places on his firm's profit.

$\gamma$ : expected value of a favor received by a manager

$\lambda$ : a manager's cost of granting a favor

$\pi_{\text{CON}}(\theta)$ : one-period profit using formal contracts only when quality of legal system is  $\theta$

$\Pi$ : firm profit

$q$ : amount of cooperation;  $q^*(\zeta)$  maximizes expression (3);  $q^*(2)$  is first-best level of cooperation.  $q^{\text{BR}}(q, \zeta)$  is a firm's best-response to the other firm choosing  $q$  given effective weight  $\zeta$ .

$\theta$ :  $\theta \in [0, 1)$  is the quality of the legal system; it is the probability the court rules correctly should a dispute occur.

$\zeta$ :  $\zeta \in (0, 2]$  is the effective weight placed on a firm's benefit,  $\beta$ .

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