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**MUTUAL MONITORING
IN A MULTI-PERIOD TEAM SETTING:
AN EXPERIMENTAL INVESTIGATION**

DISSERTATION

**Presented in Partial Fulfillment of the Requirements for
The Degree Doctor of Philosophy in the Graduate
School of The Ohio State University**

By

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ABSTRACT

This paper conducts an experiment to study a two-period team setting, in which the agents observe each others' actions after period one. The model which forms the basis for the experiment suggests that group incentives are more efficient than individual incentives. However, providing group incentives introduces potential behavioral issues which affect whether the principal's desired equilibrium will actually be reached. In particular, there are multiple subgame-perfect equilibria that create a potential conflict between risk and payoff dominant strategies, and also a potential coordination problem. In addition, the principal's preferred equilibrium requires that in the second period the managers play weakly dominated strategies. Also, the principal's preferred equilibrium strategy involves an implicit threat to punish by one manager in the second period, if the other manager shirks in the first period. The experiment manipulates pre-play communication, and several other factors, including penalty compared to bonus terminology, and commitment of second period strategies. The experimental results provide statistical support for the conjecture that the creation of self-enforcing, punishment strategies that make working in both periods a subgame-perfect equilibria help to increase the frequency of working in the first period. However, the results

suggest that a coordination problem might arise from the existence of multiple equilibria, and that communication allows the players to reduce uncertainty and facilitates coordination on the Pareto-dominant strategy. There is also evidence that the frequency of working is greater when the second period is framed in a penalty compared to a bonus context, although the difference is statistically insignificant. Finally, there is evidence that allowing commitment to second period strategies at the time first period actions are selected does not significantly increase the frequency of working in the first period, or facilitate coordination on the Pareto-dominant strategy.

Dedicated to my parents

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CHAPTER 1

INTRODUCTION

The use of teams and team-based incentives has become more popular among organizations. The use of teams can increase the productivity of an organization through the pooling of specialized skills and knowledge (Zimmerman, 2000). The increase in popularity of teams has also been accompanied by an increase in responsibilities delegated to teams as noted in the following quote from a recent article in Business Horizons (Gerwin, 1999).

"Team based organization is sweeping through North American business firms. With important stakeholders represented on a cross-functional team, the team can coordinate its own activities. By virtue of their almost continuous communication of information on the evolving product, team members are in the best position to make many business and technical decisions. A team makes decisions in certain areas during new product development: setting technical and business specifications; determining product and process design content ... and monitoring progress and evaluating performance."

However, in a team setting, incentive issues often arise because the individual inputs are not observable outside the team, and the team members have incentives to

shirk. In this paper, a team is two individuals that each provide an effort that determines a single output.¹ The measurement of individual performance and the incentive problems in a team setting can be facilitated through increased monitoring and the development of team loyalty, although this may be costly (Zimmerman, 2000). The individual incentives in a team setting can also be aligned through the development of incentive structures. This approach may be less costly, although other incentive issues arise due to the construction of a mechanism that creates many equilibria in the agents' subgame (Demski and Sappington [1984]; Arya, Fellingham and Glover [1997]; Amershi, Demski and Fellingham [1985]; Ma, Moore and Turnbull [1987] and Ma [1988]). The existence of multiple equilibria introduces a potential conflict between risk and payoff dominant strategies (Harsanyi and Selten, 1988), and whether individuals will coordinate on the principal's desired equilibrium (Ochs [1995], Van Huyck, Battalio and Beil [1990]). A strategy is risk dominant, for example if among two Nash equilibria in a 2 x 2 game, less stringent beliefs about a player's partner's actions are required to support an equilibrium (Harsanyi and Selten, 1988).

In their model, Arya et al. (1997) develop a mechanism that creates multiple equilibria in the second period subgame to make working hard in both periods the unique, Pareto-dominant, subgame-perfect equilibrium. The principal provides group incentives in the first period that ensure both managers working is preferred to both managers

¹ Marschak and Radner (1972) define a team as, "an organization the members of which have only common interests."

shirking. Individual incentives are provided in the second period that ensure working is preferred to shirking, *given the other manager is working*. Group incentives are less costly to the principal, provided both managers work.

The model developed by Arya et al. (1997) provides an experimental setting to examine these issues, and is of interest to accountants for several reasons. First, the development of incentive structures has important implications for management control in an organization. Also, the use of group incentives has potential benefits in a team setting, and can change the role of information. For example, the principal (owner) may design incentive contracts that use the private information that the agents (managers) may have about each others' actions together with financial reports on output to reduce the cost of contracting. Arya et al. (1997) note that in a team setting, the observable output is informative about the manager's unobservable effort and therefore provides incentive for each manager to work hard. Also, the output depends on the effort of both managers, therefore it provides incentive for one manager to monitor and a means to punish the other manager.

Whether it is efficient for the owner to provide group incentives to achieve incentive compatibility in the manner suggested by Arya et al. (1997) depends on the behavior of the managers. The question hinges upon whether the managers will play as predicted in the second of the contracting periods. It seems plausible that their behavior might not converge to the particular equilibrium in the subgame as anticipated by Arya et

al. (1997), because it requires the managers to play a weakly dominated strategy. The managers also use an implicit threat of punishment in the second period, which might be costly to them. In addition, there are multiple subgame-perfect equilibria including one where both managers shirk in the first period and work in the second period. Although the refinement of Pareto-dominance makes working in both periods the unique subgame-perfect equilibrium, there are other considerations including risk dominance and coordination of strategies.

I construct a game that mimics the subgame played by the managers which follows the various other characteristics of the contract. The model is used to determine whether individuals will play strategies that involve the implicit threat of punishment in the second period for shirking in the first period to foster coordination on Pareto-dominant equilibria. In addition the effects on the frequency of working, and the play of the Pareto-dominant outcome is examined with:

1. Penalty compared to bonus framing
2. Pre-play communication
3. Commitment of second period strategies

Although it does not affect the equilibrium strategies, prior research (Luft, 1994) has found that individuals prefer bonus to penalty terminology in contract settings. The use of a penalty frame might encourage individuals to play punishment strategies consistent with the theory, however it might also encourage the use of less forgiving

strategies that have been shown to reduce the utility of the players under certain circumstances (Kollock, 1993). Similarly, pre-play communication does not alter the equilibrium strategies, but might help individuals reduce uncertainty about their partner's strategy and facilitate coordination on payoff dominant compared to risk dominant strategies. The commitment to second period strategies before the first period output is realized might help facilitate coordination, if individuals do not believe players will follow through on punishment strategies.

The experimental results provide evidence that the frequency of working in the first period was significantly greater when there are group incentives in the first period and individual incentives in second period (GI game), than when there are group incentives in both periods (GG game). This provides some evidence that the existence of self-enforcing strategies in the second period that make working in both periods a subgame-perfect equilibrium increases the frequency of working in comparison to when there are no self-enforcing strategies, and working is not part of a Nash equilibrium in either period. In addition, individuals are more likely to play strategies in the second period consistent with punishment if their partner shirked in the first period than if their partner worked consistent with the theoretical results in all treatments, except when the second period is framed in a bonus context. However, coordination on the Pareto-dominant strategy is relatively low when the players do not have an opportunity to communicate before each period. Therefore, group incentives might not be beneficial

compared to individual incentives because the frequency of working with group incentives might be less compared to the two-fold repetition of the individual incentive game (II game). The results indicate that the frequency of working in each period, and the coordination on the Pareto-dominant strategy is significantly less in the GI than in the II game when the players do not have an opportunity to communicate before each period.

The results provide evidence that the addition of a pre-play communication stage before each period increases the ability of the players to coordinate on the payoff dominant strategy. In particular, the frequency of working in the first period and the coordination on the Pareto-dominant strategy, is insignificantly different in the GI than in the II game. The results of commitment indicate that although the frequency of the Pareto-dominant strategy is significantly greater than chance, the frequency of working in the first period is not significantly greater than when the second period action is selected after the first period output is revealed.

The rest of this study is developed as follows. Chapter two discusses the related literature, and chapter three discusses the model and develops the hypotheses. Chapter four discusses the experimental design, chapter 5 discusses the results and chapter 6 concludes.

CHAPTER 2

BACKGROUND AND LITERATURE REVIEW

The benefits of team incentives and the potential collusion or free rider problem has been noted in many studies (Demski and Sappington [1984]; Arya, Fellingham and Glover [1997]; Arya, Glover and Young [1996] and Ma [1988]). In multiple agent settings, a potential conflict arises between the principal's desired equilibrium and the agents' preferred strategies when there are multiple equilibria. In particular, many theoretical studies try to develop equilibrium strategies in the agents' subgame that are dominant or more stringent to ensure the agents will behave in the desired manner. For example, Arya, Glover and Young (1996) examine performance measures in a multi-agent capital budgeting setting. They show that the principal can reduce the cost of contracting with two risk-neutral agents in a correlated environment by using the information that the agents might have about each other through reports submitted by the agents. The principal uses relative performance evaluation that ranks projects according to the reports of the agents', and is able to make the desired equilibrium a dominant strategy at an arbitrarily small cost. In a principal-multi-agent setting with mutual monitoring, Ma

(1988) shows that it is possible to obtain the first-best outcome by offering the agents a lottery that depends reports submitted by the agents. However, each agent reports on the actions of the other agent, and therefore may require behavior that could potentially create conflict among the members of an organization.

The theory that motivates my experiment is the principal-multi-agent model developed by Arya et al. (1997). The principal uses mutual monitoring to provide a self-enforcing strategy for the managers to work hard. The unique, Pareto-dominant subgame-perfect strategy is for the managers to work in the first period, and work in the second period only if the other manager works in the first period. The Pareto-dominant strategy involves a type of tit-for-tat strategy, and an implicit threat of shirking in the second period if the other manager shirks in the first period. Although it occurs off the equilibrium path of play, this could be considered a type of punishment strategy, because if one player shirks in the second period it is costly for their partner.

In addition to the Pareto-dominant strategy, however, there are other subgame-perfect equilibria including both managers shirking in the first period and working in the second period. The existence of multiple equilibria introduces behavioral issues, and whether a particular equilibria will be reached (Harsanyi and Selten, 1988). The application of equilibrium refinements (Kreps, 1990) might help to reduce, or determine which equilibria are more likely to occur. However, the Nash equilibria are all subgame perfect, involving the use of weakly dominated strategies in the second period, and are

therefore not perfect. The beliefs of the players about their partner's strategy are an important element in equilibrium analysis. Therefore, if multiple equilibria exist one candidate for a focal point might be the Pareto-dominant equilibrium (Harsanyi and Selten, 1988). However, there are also other considerations including risk dominance. The Pareto-dominant strategy involves a type of punishment strategy. The opportunity for the players to punish each other is an important element in sustaining cooperation (Axelrod, 1984), and in an infinitely repeated game can sustain and expand the set of equilibria, the result of the Folk Theorem. However, the punishment occurs at the end of a non-repeated game, is potentially costly and might therefore be less credible. This study determines whether individuals will play strategies that involve punishment at the end of a non-repeated game to support coordination on the Pareto-dominant equilibrium.

The ability of players to coordinate on Pareto-dominant equilibria has been studied by Van Huyck et al. (1990) and Cooper et al. (1990). In Van Huyck et al. (1990) individuals selected actions, and were rewarded based on their actions relative to the minimum action of all players. Higher actions received higher rewards, however larger penalties were incurred the further a player's action was from the minimum. In their game, there were multiple equilibria that could be Pareto-ranked. Van Huyck et al. (1990) find that individuals do not coordinate on Pareto-dominant equilibria, and hypothesize that other considerations including risk might affect the ability of individuals to coordinate on more desirable strategies. Cooper et al. (1990) study the ability of individuals to

coordinate on Pareto-dominant equilibria in a one-shot setting with risk and uncertainty. Similar to Van Huyck et al. (1990), they find that risk and uncertainty may affect the ability of individuals to coordinate on payoff-dominant strategies.

The Pareto-dominant strategy in the model developed by Arya et al. (1997) might be characterized as risky, and also involves the use of weakly dominated strategies in the second period subgame. In particular, each player has a weak dominant strategy to shirk in the second period. Kreps (1990) raises suspicions about equilibria that involve the play of weakly dominated strategies. However, he also discusses circumstances under which it might not be unreasonable to believe that individuals will play weakly dominated strategies. In particular, it might not be unreasonable if both players can gain by playing weakly dominated strategies. Although the use of weakly dominated strategies occurs at the end of the game, and therefore there may be little incentive for the players to play a weakly dominated strategy (work) in the second period. However, each player receives less utility if both players shirk in the second period. Therefore, both players have an incentive to make their partner believe that they will work.

Prior studies have found that the language and terminology used in a contract setting can affect the behavior of the parties involved. In particular, Luft (1994) discusses the possible differences that may arise from bonus or penalty terminology in contracts including differences from prospect theory, and the difference in the perceived meaning of bonus and penalty terms. In addition, the use of bonus or penalty terminology might

affect the behavior of individuals by making strategies more salient. For example, penalty terminology might make penalty strategies more salient. This might facilitate the play of punishment strategies consistent with the Pareto-dominant strategy. However, motivation might be lower in comparison to when bonus terminology is used if players prefer bonus terminology. In addition, penalty terminology might make less forgiving strategies more salient. This might have undesirable effects, consistent with the findings of Kollock (1993) that more forgiving strategies perform better in tournament setting similar to Axelrod (1984) with noise. In my study, the effects of framing the second period in a bonus compared to a penalty context are examined. In this setting, the bonus and penalty are determined by the other manager instead of the owner.

The subgame-perfect equilibrium strategy in this study is one of several subgame-perfect equilibrium strategies in the two-period supergame. The existence of multiple equilibria introduces a potential coordination problem. Ochs (1995) notes that in games with multiple Pareto-ranked equilibria, individuals may not coordinate on the desired equilibria, or may fail to coordinate on any equilibria. Harsanyi and Selten (1988) discuss the potential for pre-play communication to reassure players, reduce uncertainty and allow them to potentially make a particular equilibrium focal through messages. Although pre-play communication is not binding, and therefore it does not affect the theoretical results it can potentially affect the coordination on a particular equilibrium. The ability of communication to facilitate coordination may depend on whether messages are potentially

self-committing as opposed to self-serving (Farrell and Rabin, 1996). A message is self-committing if the sender does not have an incentive to deviate, if the receiver plays the proposed strategy. Although an individual that proposes the play of the Pareto-dominant strategy would have an incentive to deviate in the first period, there is not an incentive to deviate in the two-period supergame because the punishment prescribed by the Pareto-dominant strategy is more costly than the gains from deviating in the first period.

Charness (2000) studies the ability of pre-play communication to facilitate coordination depending on whether messages are self-committing. He finds that in certain games -- for example the stag-hunt game -- messages are self-committing and help facilitate coordination. However, in other games, including the Prisoner's Dilemma -- where messages are not self-committing, the facilitating role of communication is reduced. Cooper et al. (1992) study the ability of pre-play communication to facilitate coordination on Pareto-dominant strategies. They find that two-way communication facilitates coordination in games that involve risk, although communication does not entirely eliminate the coordination problem. Similarly, Dickhaut et al. (1999) find that pre-play communication can help facilitate coordination in a repeated play of the Shapley game. In my study, the ability of pre-play communication to facilitate coordination on Pareto-dominant equilibria is determined by allowing players to signal their intentions through communication before each period.

The role of commitment in efficient contracts has been noted in many studies (Antle and Fellingham, 1995). The role of commitment can also alter the set of Nash equilibria, for example in bargaining settings. If players are not willing to play punishment strategies at the end of the game, then they may not believe that their partner will follow through on punishment strategies. The ability of players to commit to their second period strategies might alter the credibility of the threat of punishment in the second period for shirking in the first period. In particular, if players are committed to their second period strategy when their first period action is selected, punishment strategies might become more credible because the players do not have to follow through on punishments. Similarly, the commitment to second period strategies might facilitate coordination on the Pareto-dominant strategy because the Pareto-dominant strategy does not meet the refinement of renegotiation proofness. The Pareto-dominant strategy is not renegotiation proof because both players are better off in the second period if both players work. Therefore, if one player threatens to shirk in the first period the Pareto-dominant strategy is for the other player to threaten to shirk in the second period, and this strategy is not renegotiation proof. Therefore, coordination of the Pareto-dominant strategy might be facilitated if the players are committed to their second period strategy, because there is no opportunity to renegotiate and the threat of punishment in the second period for shirking in the first period might be more credible. In my study, the effects of

commitment are determined by moving the selection of the second period action to the first period.

CHAPTER 3

THEORY AND DEVELOPMENT OF HYPOTHESES

3.1 Theory

In the model developed by Arya et al. (1997), a risk neutral principal contracts with two risk and effort averse agents to provide an unobservable level of effort

$e^i \in \{e_L^i, e_H^i\}, i = \{1, 2\}$ in each period that determines a joint output $x_i, i \in \{L, H\}$. The managers have a disutility of effort with cost $c(e_L) < c(e_H)$, and reservation utility, $\bar{U}$.

The probability distribution over outcomes given the effort level of agents, $P(x | e^i, e^j)$ is assumed to satisfy first order stochastic dominance, or with binary outputs,

$P(x_H | e_L^i, e_L^j) < P(x_H | e_L^i, e_H^j) < P(x_H | e_H^i, e_H^j)$. The payment made to manager i by the principal is s^i .

The principal contracts with each manager at time zero to provide an unobservable level of effort over two periods. If only one manager accepts the contract, a flat wage is paid to the other manager that guarantees that the manager's utility will equal their

reservation utility. The sequence of events the subjects in the experiment followed is shown below.²

The managers accept or reject the contract	The managers provide a level of effort in the first period	The first period output is realized and the managers are compensated according to the contract	The managers provide a level of effort in the second period	The second period output is realized and the managers are compensated according to the contract
--	--	--	---	---

Figure 1: Timeline

The principal's objective is to minimize the cost of motivating the managers to provide a high level of effort. The usual treatment is that the principal treats the agents separately by applying the revelation mechanism that makes each agent working a best response to working (Myerson, 1979).³ This can be interpreted as providing individual incentives. To simplify the game for purposes of experimentation, I consider risk neutral agents but include bankruptcy constraints that require that the payment to the agents is

² The payments after the first period can also be delayed until after the second period with risk neutral or CARA utility representations.

³ A common issue in this setting is the existence of multiple equilibria in addition to the principal's desired equilibrium, one of which is preferred by the agents. This is outside of the scope of this paper.

nonnegative. Let $c_H^i = c(e_H^i)$, and $c_L^i = c(e_L^i)$. The principal's program under optimal individual incentives for manager i is:

Program INDIV:

$$\text{Min} \sum_{x \in X} P(x | e_H^i, e_H^j) s(x_i)$$

s.t.

$$P(x_L | e_H^i, e_H^j) s(x_L) + P(x_H | e_H^i, e_H^j) s(x_H) - c_H^i \geq \bar{U} \quad (IR - INDIV)$$

$$P(x_L | e_H^i, e_H^j) s(x_L) + P(x_H | e_H^i, e_H^j) s(x_H) - c_H^i \geq \quad (IC - INDIV)$$

$$P(x_L | e_L^i, e_H^j) s(x_L) + P(x_H | e_L^i, e_H^j) s(x_H) - c_L^i$$

$$i = \{1, 2\}$$

$$s(x) \geq 0 \quad (B - INDIV)$$

The last constraint, $s(x) \geq 0$ is the bankruptcy constraint. The parameters and payments under the optimal individual incentive contract presented to the subjects in my experiment are summarized in the following table.⁴

⁴ Please see Arya et al. (1997) for a more thorough discussion and formal proofs.

$P(x_H e_H^i, e_H^j)$	.80
$P(x_H e_H^i, e_L^j) = P(x_H e_L^i, e_H^j)$	.5749
$P(x_H e_L^i, e_L^j)$	.3507
c_H	50
c_L	5
$\bar{U}$	67.50
$s(x_H)$	199.91
$s(x_L)$	0

Table 1: Model parameters and payments (individual incentives)

The first result in Arya et al. (1997) is that with first order stochastic dominance of the probability distribution over output, the principal can reduce the cost of contracting by providing *group incentives* that ensure both members of the group working is preferred to both members of the group shirking. It turns out that group incentives is not subgame perfect. Under group incentives each manager's best response to the other working is to shirk. However, this problem will be addressed below. The principal's program under group incentives for manager i can be written as follows:

Program GROUP:

$$\text{Min} \sum_{x \in X} P(x | e_H^i, e_H^j) s(x_i)$$

s.t.

$$P(x_L | e_H^i, e_H^j) s(x_L) + P(x_H | e_H^i, e_H^j) s(x_H) - c_H^i \geq \bar{U} \quad (IR)$$

$$P(x_L | e_H^i, e_H^j) s(x_L) + P(x_H | e_H^i, e_H^j) s(x_H) - c_H^i \geq \quad (IC)$$

$$P(x_L | e_L^i, e_L^j) s(x_L) + P(x_H | e_L^i, e_L^j) s(x_H) - c_L^i$$

$$i = \{1, 2\}$$

$$s(x) \geq 0$$

The payments under the optimal group incentive contract for the parameters in

Table I are summarized in Table 2.

$s(x_H)$	146.88
$s(x_L)$	0

Table 2: The one period group incentive contract payments

It can be verified that the principal's cost of contracting is reduced under optimal group incentives compared to optimal individual incentives.⁵ The expected utility of each manager for the parameters and payments in Table 1 and 2 under group incentives are provided in Figures 2.⁶

	shirk	work
shirk	50 50	80 30
work	30 80	70 70

Figure 2: Managers' expected utility (group incentives)

The expected utility of the managers under individual incentives is given in Figure 3.

⁵ The expected payments under optimal individual incentives given the parameters in Table 1 are greater than the expected payments under optimal group incentives provided both managers work, and therefore the cost is greater under optimal individual incentives.

⁶ The expected payments are rounded for the purpose of experimentation.

	shirk	work
shirk	70 70	110 60
work	60 110	110 110

Figure 3: Managers' expected utility (individual incentives)

The game in Figure 2 is a Prisoner's Dilemma, with the unique Nash equilibrium of both players shirking. The principal would prefer to provide group incentives because the cost of contracting is lower than under individual incentives, however, each player has a dominant strategy to shirk.

Arya et al. (1997) show that one way for the principal to benefit from providing group incentives and make it incentive compatible for the managers to work is to have the managers repeat a task, and offer "individual incentives" in the second period (Figure 3).⁷ In both periods the game form is symmetric, therefore the strategies of the players are the same. From Figure 3, there are multiple Nash equilibria in the second period subgame including both players working and both players shirking. The existence of multiple equilibria in the later stages of a game makes it possible for strategies in earlier periods that are not equilibrium strategies in a one-shot setting to be part of an equilibrium

⁷ In this model, it is only important that the managers perform two tasks together, not that they repeat the same task.

strategy (Benoit and Krishna, 1985). In the optimal game, I next discuss how the players might solve the game.

The Nash equilibria in the GI game are summarized in Figure 4.

Strategy	Expected Cost of Compensation ⁴	Row Player's Expected Utility ³
(w, (s, w)), (w, (s, w)) ²	280	180
(s, (w, w)), (s, (w, w)) ²	215	160
(s, (w, w)), (s, (w, s)) ²	215	160
(s, (w, s)), (s, (w, w)) ²	215	160
(s, (w, s)), (s, (w, s)) ²	215	160
(s, (s, w)), (w, (w, w))	240 ⁴	190
(s, (s, w)), (w, (w, s))	240 ⁴	190
(w, (w, w)), (s, (s, w))	240	140
(w, (w, s)), (s, (s, w))	240	140
(s, (s, s)), (s, (s, s))	130	120

¹ The strategies are "s" = "shirk" and "w" = "work".

The strategy pair is the row player's followed by the column player's strategy. The strategy for a player is (1st pd. strategy, (2nd pd. strategy | partner selected s in the 1st pd., 2nd pd. strategy | partner selected w in the 1st pd.)).

² Indicates Nash equilibria if there is an option to reject the contract.

³ The expected compensation and expected utility is for the row player. The numbers are consistent with Figure 2 and 3.

⁴ The expected compensation is equal to the expected utility plus the disutility of effort of the manager. This is 245. However, the expected compensation should be the same as the strategy of (w, (w, w)), (s, (s, w)) which is 240. Therefore, 240 is used to be consistent.

Figure 4: Nash equilibria strategies (GI game)

All of the strategies in Figure 4 are also subgame-perfect. The strategy of working in the first period, and working in the second period only if the other manager worked in

the first period is Pareto-dominant if there is an option to reject the contract and Pareto-undominated if there is no option to reject the contract.⁸ If there is not an option to reject the contract, five additional subgame-perfect strategies exist. Four of the strategies involve one player shirking in the first period, and both players working in the second period. Although one player's utility is greater than if both players work in both periods, the other player's utility is strictly less and less than the utility from rejecting the contract.⁹ The other strategy involves both players shirking in both periods. The utility of both managers is less than their reservation utility if this strategy is played.

The Pareto-dominant strategy incorporates mutual monitoring, and involves a type of tit-for-tat strategy. In practice, people working in groups observe each others actions, while their supervisor may not. For example, the members of a team may be able to observe the contributions of the other members because of their proximity or regular interactions. An individual deviating from working in the second period could be construed as attempting to punish the other player, and in this study I say the Pareto-dominant strategy involves a "threat of punishment." It is a credible threat because it is part of a Nash equilibrium for one player to shirk. However, it is also costly for a player

⁸ It will be assumed that there is an option to reject the contract unless explicitly stated otherwise, and therefore the strategy of working in the first period and working in the second period only if the other manager works in the first period will be described as Pareto-dominant.

⁹ The reservation utility of the managers in each period in Table 1 is 67.5. The manager's reservation utility over two periods is, therefore less than the utility of 140 if they work in both periods, and their partner shirks in the first period and works in the second period. Therefore, the payment for rejecting the contract in the experiment was increased to 145 to ensure that this strategy is not an equilibrium when there is an option to reject the contract.

to punish and not renegotiation proof, because if one player is playing a strategy of shirking in the second period, the other player's best response is to shirk and both players receive a payoff of 70 instead of 110. The implicit threat of punishment in the second period for shirking in the first period makes working in both periods the unique Pareto-dominant, subgame-perfect equilibrium, because any gains from free riding in the first period are sufficiently reduced in the second period. For example, if a player shirks in first period they gain ten but lose forty in the second period. However, it might also be costly for a player to punish in the second period. There are also other subgame-perfect equilibrium strategies that involve one or one or both players randomizing in the first period.

3.2 Development of Hypotheses

In my experiment subjects are paired for two periods, and each takes on the role of a manager. In both periods, the players select one of two actions $a \in \{1, 2\}$ that determine their earnings for the period in accordance with the game forms in Figure 2 and 3.¹⁰ The outcomes were revealed the players at the end of each period.

In some sessions, the players were provided with the opportunity to accept or reject the contract at the beginning of each round, and received their reservation level of

¹⁰ In my experiments, the generic terms "One" and "Two" were used instead of "shirk" and "work", respectively.

utility over two periods if they rejected the contract. The option to reject the contract reduces the number of subgame-perfect equilibria, and might also have behavioral implications. Kohlberg and Mertens (1986) suggest that providing one player with the option to either receive a certain payment or play a coordination game can facilitate coordination on the Pareto-dominant strategy. This is consistent with the findings in Van Huyck, Battalio and Beil (1993).

The existence of multiple equilibria suggests that there might not be an obvious way to play (Van Huyck et al., 1993). For example, the maximin payoff for the strategy of working in the first period, and working in the second period if the other player works in the first period, and otherwise shirking is less than for other subgame perfect strategies. From figure 3, it is also a weak dominant strategy to shirk in the second period subgame.

Enforcement of the punishment also occurs at the end of the game, and therefore the players may be less willing to punish and less willing to believe that others will punish, especially if the punishment is costly to the punisher. To determine if adding a period which makes punishing in the second period for shirking in the first period a Nash equilibrium increases the frequency of working, the frequency of working in the first period in the GI game is compared to the GG game.

The unique Nash equilibrium in the two-fold repetition of the group incentive game is for both players to shirk in both periods, however when individual incentives are substituted in the second period a self-enforcing, subgame-perfect equilibrium strategy

exists that involves both players working in both periods. Therefore, the frequency of working in the first period should be greater when there are individual incentives in the second period. The following hypothesis is developed in alternate form:

H1a: The frequency of working in the 1st period will be greater in the GI game compared to the GG game.

If individuals are playing the strategy of working in the first period, and working in the second period only if the other player works in the first period, then the frequency of working in the second period should be greater if their partner worked in the first period compared to if their partner shirked in the first period. This strategy is Pareto-dominant in the treatment that includes an option to reject the contract, and Pareto-undominated in treatments without an option to reject the contract. In addition, if individuals are playing this strategy the occurrence of both players working in both periods should be greater than chance. The following two hypotheses are developed in alternate form.

H1b: Working will be more frequent in the 2nd period given a player worked in the 1st period if their partner worked in the 1st period compared to if their partner shirked in the 1st period in the GI game.

H1c: The subgame-perfect equilibrium strategy of both players working in both periods will be played significantly greater than chance in the GI game.

Group incentives reduce the cost of contracting to the principal compared to individual incentives if both players work. However, there are multiple equilibria in the GI supergame, and therefore the players may select strategies other than working in both periods. To determine if group incentives are beneficial to the principal given the strategies of the players, the frequency of working in the GI game is compared to the II game. The Nash equilibria in the II game are summarized in Figure 5.

Strategy	Expected Cost of Compensation ¹	Row Player's Expected Utility ¹
(w, (w, w)), (w, (w, w))	320	220
(w, (w, w)), (w, (s, w))	320	220
(w, (s, w)), (w, (w, w))	320	220
(w, (s, w)), (w, (s, w))	320	220
(s, (w, w)), (s, (w, w))	235	180
(s, (w, w)), (s, (w, s))	235	180
(s, (w, s)), (s, (w, w))	235	180
(s, (w, s)), (s, (w, s))	235	180
(w, (s, s)), (w, (s, s))	235	180
(s, (s, w)), (w, (w, w))	270 ⁴	220
(s, (s, w)), (w, (w, s))	270 ⁴	220
(w, (w, w)), (s, (s, w))	270	170
(w, (w, s)), (s, (s, w))	270	170
(s, (s, s)), (s, (s, s)) ²	150	140

- 1 The strategies are "s" = "shirk" and "w" = "work".
The strategy pair is the row player's followed by the column player's strategy. The strategy for a player is (1st pd. strategy, (2nd pd. strategy | partner selected s in the 1st pd., 2nd pd. strategy | partner selected w in the 1st pd.)).
- 2 Not a Nash equilibrium if there is an option to reject the contract.
- 3 The expected compensation and expected utility is for the row player. The numbers are consistent with Figure 3, and are rounded.
- 4 The expected compensation is equal to the expected utility plus the disutility of effort of the manager. This is 275. However, the expected compensation should be the same as the strategy of (w, (w, w)), (s, (s, w)) which is 270. Therefore, 270 is used to be consistent.

Figure 5: Nash equilibria strategies (II game)

The Nash equilibria in the II game are similar to the Nash equilibria in the GI game when there is not an option to reject the contract, and are all also subgame-perfect. However, there are four more equilibria, including three more strategies that achieve the outcome of both players working in both periods. In addition, only the equilibrium strategy of both players shirking in both periods is eliminated when an option to reject the contract is included.

Although there are also multiple subgame-perfect equilibria in the two-fold repetition of the individual incentive game, it may be easier for the players to coordinate strategies because working in both periods regardless of the outcome in the first period is a subgame-perfect equilibrium, and therefore the periods can be played individually. If working is more frequent when the principal provides individual incentives, then individual incentives might be preferred to group incentives. There are also more strategies available that achieve the outcome of both players working in both periods, which may facilitate coordinating on payoff dominant strategies because neither player has an incentive to deviate from working as long as both players work in both periods.

Although it may be easier to coordinate strategies in the repeated individual incentive game, it is Pareto-dominant in both games to work in both periods if there is an option to reject the contract, therefore it is not clear in which game, GI or II, working will be more frequent. The following two hypotheses are developed in null form to determine

if group incentives are less costly to the principal compared to individual incentives, given the strategies chosen by the players in my experiment.

H2a: The frequency of working in the 1st period will be the same in the GI game compared to the II game.

H2b: The frequency of working in the 2nd period will be the same in the GI game compared to the II game.

The first period was presented to the players in matrix form. However, in some sessions the second period was framed in either a penalty or bonus context.¹¹ In the penalty frame the players were informed that they would each receive 110 points, and that they would both have the opportunity to deduct points from their partner. If only one player deducted points, 50 points were deducted from their partner. If both players deducted points, 40 points were deducted from both players and if neither player deducted points, no points were deducted from either player. The bonus frame was similar, except each player received 70 points and could add points to their partner.

Prior literature suggests that individuals prefer contracts framed in bonus terminology that provide lower expected utility than penalty contracts. Although individuals may prefer bonus terms, and therefore may be more motivated to earn a bonus they also dislike receiving penalties more than not receiving a bonus (Luft, 1994).

However, it is not clear whether individuals are more likely to coordinate on the Pareto-

dominant strategy in the bonus or penalty frame. To determine if the performance of the players is affected depending on whether the second period is framed as a bonus or penalty, the following hypotheses are developed in alternate form.

H3a: The frequency of working in the 1st period when the 2nd period is framed in a bonus compared to a penalty context in the GI game will be the same.

H3b: The frequency of working in the 2nd period when the 2nd period is framed in a bonus compared to a penalty context in the GI game will be the same.

The existence of multiple subgame-perfect equilibria creates a potential coordination problem (Cooper et al. [1990], Dickhaut et al. [1992]). If the players interests are closely aligned, the addition of a pre-play communication period might help to facilitate coordination. A pre-play communication stage is added before each period to determine if allowing the players an opportunity to reduce uncertainty, and develop trust facilitates the ability to coordinate on the Pareto-dominant equilibrium. The following hypotheses are developed in alternate form.

H4a: The frequency of working in the 1st period will be greater when there is a pre-play communication stage before each period in the GI game.

H4b: The frequency of working in the 2nd period will be greater when there is a pre-play communication stage before each period in the GI game.

¹¹ Please see Appendix C for a sample of the screen display.

The addition of a pre-play communication stage might facilitate coordination by allowing players to signal their strategies, and therefore reduce uncertainty. However, the ability of messages to develop focal points depends on which equilibria are signaled. Therefore, the ability of players to coordinate on payoff dominant equilibria should depend on the content of the messages. For example, if both players signal an intent to work in both periods, coordination on the Pareto-dominant equilibrium should be more frequent than if one player signals an intent to work in both periods, but the other player signals an intent to shirk in one or both periods, or sends a neutral message. The following hypothesis is developed in alternate form.

H5: The frequency of working in the 1st and 2nd period will be greater in the GI game with a pre-play communication stage when players signal an intent to work.

The Pareto-dominant strategy in the GI games involves an implicit threat to shirk in the second period if the other player shirks in the first period. However, the second period is the end of the game, and therefore it may be less credible to believe that a player will punish especially if it is costly. If it is less credible that individuals will follow through on punishment strategies, if players are committed to their second period actions the frequency of working in the first period should increase compared to if the players

select their second period action after the first period output is realized. The following hypothesis is developed in alternate form.

H6: The frequency of working in the 1st period will be greater if the players are committed to their 2nd period action before the 1st period outcome is realized in the GI game.

CHAPTER 4

EXPERIMENTAL DESIGN

A 3 x 3 x 2 x 2 x 2 between-subjects fractional factorial design with 82 participants was used to examine the hypotheses.¹² The five factors are frame (none, penalty or bonus), two-period supergame (GI, GG or II), pre-play communication, option to reject and commitment. Individuals participated in one of eight sessions, the design and the number of subjects in each session is summarized in Figure 6.

¹² **Participants were students enrolled in undergraduate business courses at Ohio State University.**

Frame	Two-Period Supergame ^{1,2}	Commun - ication	Option to Reject Contract	Commit - ment	No. Subjects
N/A	GG	No	No	No	8
N/A	GI	No	No	No	10
Penalty	GI	No	Yes	No	12
Penalty	GI	Yes	Yes	No	10
Penalty	GI	No	Yes	Yes	10
Penalty	II	No	Yes	No	16
Penalty	II	Yes	Yes	No	8 ³
Bonus	GI	No	Yes	No	8

¹ G = Group incentives, I = Individual incentives.

² 1st period game - 2nd period game (for example, in the GI treatment the 1st period game is group incentives and the 2nd period game is individual incentives.

³ There were 10 subjects for 11 rounds. One subject had to leave early after round 11, and one subject after round 12 due to time constraints.

Figure 6: Summary of treatments

The participants interacted over a computerized network. After they read the instructions, they were provided with a brief explanation of the game. The participants then played three practice rounds against a pre-programmed computerized strategy to familiarize them with the screen, and answered a short quiz on the payoff structure.¹³ In each session, the participants then played twenty rounds of one of the two-period games for experimental points.¹⁴ The players were randomly paired with another player at the

¹³ Please refer to Figure 15 in Appendix C for a sample screen display.

¹⁴ The subjects only played 11 rounds in the II game without communication because of time

beginning of each round to simulate a non-repeated setting, and received points according to the schedules in Figures 2 and 3.¹⁵ At the end of each round, the total points earned in all rounds by a player was revealed.¹⁶ At the end of the 20th round, each participant completed a voluntary, post-experimental questionnaire, and was paid according to the number of points they earned.¹⁷

In the basic treatment, the players did not have an option to reject the contract and the game was presented in matrix form. The basic treatment included one GI and one GG treatment. The players were presented with the payoff matrices in Figures 2 and 3 and earned points according the strategies they selected and the strategies of their partner. Figures 2 and 3 also represent the certain equivalents of each player, therefore the players earned points deterministically based on their strategies according to their certain equivalents. After the players simultaneously selected their first period strategy, the first period outcome was revealed. Therefore, each player knew their partner's strategy in the first period (mutual monitoring). The players then simultaneously selected their second period strategy, and the second period outcome was revealed.

constraints. The sessions lasted between 1 and 2 1/2 hours. Each point was worth \$.0056 in all of the treatments except the II treatment, where each point was worth \$.0045. The average compensation was between \$10 and \$25 per subject.

¹⁵ In the sessions with an option to reject the contract, the players were paired after they decided to play.

¹⁶ In the sessions with an option to reject the contract, both the history of a player and their partner's earnings during each round was also displayed.

¹⁷ The questionnaire was designed to determine the prior experience the participants had in experimental studies, and what type of strategies they were using. A sample of the questionnaire is provided in Appendix B.

The remaining six treatments included an option to reject the contract at the beginning of each game. The players decided whether they wanted to play or not play the two period game.¹⁸ If either player decided to not play, both players received 145 points and did not play the two-period game during the round. If both players decided to play, they played the two-period game and earned points according to the schedules in Figures 2 and 3.

In the penalty and bonus frames, the first period was presented to the players in matrix form according to the schedules in Figures 2 and 3. In the penalty frame, the players each received 110 points in the second period, and they were told that they could each deduct 50 points from their partner. There was no cost for deducting points, however if both players deducted points only 40 points were deducted from each player. Therefore, the framing was equivalent in utility to the individual incentive structure in Figure 3 where the strategy of deducting points was equivalent to shirking, and not deducting points equivalent to working. In the bonus frame, each player received 70 points in the second period and could add 40 points to their partner. There was no cost for adding points, unless only one player added points. If only one player added points, 40 points was added to their partner and 10 points was deducted from them. The frame was also equivalent in utility to the individual incentive structure in Figure 3, where not

¹⁸ The generic terms “Play” and “Don’t Play” were used instead of “accept” and “reject”, respectively. Although the reservation utility over two periods from Table I is 135, the reservation utility must be greater than 140 to make working in both periods Pareto-dominant. If the payment for rejecting the contract is not greater than 140, then working in both periods is only Pareto-undominated (please refer to footnote 9).

adding points was equivalent to shirking and adding points equivalent to working.

In the communication treatments, the players were allowed to send and receive an unlimited number of messages before both the first and second periods. The messages were entered in text, and were not restricted in length or content.¹⁹

In the game with commitment, the players selected both their first and second period strategies at the same time. Second period strategies were selected for both of the possible strategies of their partner in the first period. Therefore, the players selected a second period strategy contingent on their partner shirking in the first period, and a second period strategy contingent on their partner working in the first period. Both the first and second period strategies of a player were private information.

¹⁹

The subjects were asked not to identify themselves through messages.

CHAPTER 5

ANALYSIS OF RESULTS AND DISCUSSION

5.1 Overview

In all of the eight treatments, the participants interacted in a non-repeated play setting over several rounds. Figure 7 summarizes the proportion of strategies in the first period in all treatments.

Proportion of working in the 1st period by round

Figure 7: Proportion of working in the 1st period by round

The average frequency of working in the first period across all rounds in the eight treatments is greater in the II game with communication than in the II game without communication and GI game with communication. The frequency of working in these games is greater than in the four GI, and GG games without communication. The average frequency of working in the 1st period across all rounds is summarized in Table 3 below.

<u>Treatment</u>	<u>Average Frequency of Working</u>
II Penalty w/ communication	94.79%
II Penalty	76.70%
GI Penalty w/ communication	73.75%
GI Penalty	36.83%
GI Bonus	32.50%
GI No Frame (no history, no option)	27.00%
GI Penalty w/ commitment	26.25%
GG No Frame (no history, no option)	14.38%

Table 3: Average proportion of working in the 1st period

The proportion of strategies in the second period is summarized in Figure 8.

Proportion of working in the 2nd period by round

Figure 8: Proportion of working in the 2nd period by round

Similar to the first period, the frequency of working in the II supergame with communication is greater than the other treatments. The frequency of working in the II supergame without communication is about the same as in the GI supergame with communication, and is greater than the GI supergame without communication in the penalty, bonus, no frame and commitment treatments. The average frequency of working in the second period across all rounds in the eight treatments is summarized in Table 4.

<u>Treatment</u>	<u>Average Frequency of Working</u>
II Penalty w/ communication	88.13%
II Penalty	65.91%
GI Penalty w/ communication	61.13%
GI Penalty	27.50%
GI No Frame (no history, no option)	23.00%
GI Bonus	21.00%
GI Penalty w/ commitment	20.21%
GG No Frame (no history, no option)	10.00%

Table 4: Average proportion of working in the 2nd period

The relatively lower frequency of working in the GI supergames without communication may be a result of the play of punishment strategies in the second period that result from the lower frequency of both players working in the first period. The frequency of working is also decreasing in the GG and GI supergames without communication, and starts at about 50% in the first round. The pattern over time in these games shows that the willingness of participants to work breaks down, suggesting that the participants that shirk drive out the participants that work instead of participants learning to coordinate on working over time. The frequency of working remains relatively constant in the GI game with communication, and the II games. The results of the hypotheses are discussed in the following sections.

5.1.1 Implicit, Self-Enforcing Punishment Strategies

Hypothesis one examines whether individuals will play strategies to foster coordination in a team setting. In the supergame with group incentives in both periods, shirking is the unique Nash equilibrium in both periods. If the existence of a self-enforcing strategy fosters coordination, then the frequency of working in the first period in the GI game should be greater compared to the GG game. The theory predicts that individuals will work in both periods, and therefore shirking in the second period if the other player shirks in the first period is an off-equilibrium event. Although shirking should not be observed, prior experimental evidence suggests that individual do not always behave in a manner consistent with game theoretic predictions. Therefore, the GG game is used as a benchmark for determining the effects of the existence of punishment strategies in the GI game on the strategies of the players.

In Figure 7, the frequency of working in the first period in the GI game without an option to reject the contract or frame is greater than in the GG game. The average frequency of each player's average frequency of working in the first period across all rounds in the GI and GG treatments is 27% and 14.38%, respectively. A Mann-Whitney test comparing the average frequency of working across all rounds by player indicates that the difference is significant at the .0485 level. The results indicate that the existence of a self-enforcing strategy that could be used to punish increases the frequency of

working. This is consistent with the theoretical result in Arya et al. (1997), and provides support for Hypothesis 1a. However, the frequency of working is relatively low. One possible explanation is that individuals are uncertain about the strategy of their partners. The possibility that multiple equilibrium create a coordination problem is examined through communication in section 5.1.4. It is also possible that individuals do not believe their partners will follow through on punishment strategies in the second period. This might also create coordination problems if individuals are not willing to work because it is riskier than other strategies. However, it also might have a direct effect if the credibility of punishment in the second period is reduced. In addition, the credibility of working in the second period might be reduced because it is a weakly dominant strategy to shirk in the second period subgame. The use of a punishment strategy, and working in the second period might become more credible if individuals select their first and second period strategies at the same time, and specify second period strategies contingent on each of the partner's first period strategies. This is examined through commitment in section 5.1.5.

It is credible, and a unique Pareto-dominant, or Pareto-undominated subgame-perfect equilibrium for each player to shirk in the second period if their partner shirks in the first period in the GI supergame. Therefore, if a player works in the first period, they should play the shirk strategy more frequently in the second period if in this unique Pareto-dominant equilibrium their partner shirked in the first period in comparison to if their partner worked. The results provide evidence that the players condition their

strategy in the second period on their partner's strategy in the first period consistent with the Pareto-dominant (when there is an option to reject), or Pareto-undominated strategy (no option to reject). Figure 9 summarizes the distribution of the players strategies in the second period conditional on their partners strategy in the first period for the players that worked in the first period in all games.²⁰

²⁰

In the GI commitment game, individuals selected their strategies in the second period when they selected their strategies in the first period, and selected a second period strategy for both of their partner's possible strategies in the first period. The frequency of working in this game is calculated from the actual strategies, instead of the outcomes.

Proportion of working in the 2nd period given a player worked in the 1st period, conditional on their partner's strategy in the 1st period

Figure 9: Proportion of working in the 2nd pd. contingent on partner's 1st pd. strategy

Figure 9 indicates that in all games except the GG treatment, if a player worked in the first period, the frequency of shirking in the second period is greater if their partner shirked in the first period than if their partner worked in the first period. In the GI games, this is consistent with the theory, and Hypothesis 1b. To determine if the difference is significant, the frequency of working across all instances that a player worked in the first period is calculated for both contingencies depending on their partner's action in the first period. A Wilcoxon rank sum test is used to determine if the frequency

of working in the second period if a player's partner worked in the first period is greater than the Hodges - Lehman point estimate of the frequency of working in the second period if a player's partner shirked in the first period.

The results indicate that the frequency of working in the second period is significantly greater in all of the GI games at the .05 level except in the bonus frame ($\alpha = .078$). The average frequency of working of all players are summarized in Table 5 and provide support for Hypothesis 1b in four of the five GI games.

Treatment	Wilcoxon rank sum test statistic	Alpha	Partner's 1 st Period Strategy	2 nd Period Strategy ¹		
				<u>"shirk"</u>	<u>"work"</u>	<u>Total</u>
GI No Frame	36	.004	"shirk"	8 (.80)	26 (.20)	34
			"work"	<u>6 (.25)</u>	<u>14 (.75)</u>	<u>20</u>
				14	40	54
GI Penalty	21	.016	"shirk"	38 (.94)	5 (.06)	43
			"work"	<u>4 (.15)</u>	<u>14 (.85)</u>	<u>18</u>
				42	19	61
GI Bonus	23	.078	"shirk"	21 (.81)	7 (.19)	28
			"work"	<u>10 (.59)</u>	<u>8 (.41)</u>	<u>18</u>
				31	15	46
GI Penalty (w/ communication)	55	.001	"shirk"	19 (.74)	10 (.26)	29
			"work"	<u>11 (.12)</u>	<u>91 (.88)</u>	<u>102</u>
				30	101	131
GI Penalty (w/ commitment) ²	45	.002	"shirk"	31 (.87)	5 (.13)	36
			"work"	<u>0 (0)</u>	<u>36 (1)</u>	<u>36</u>
				31	41	72

¹ The frequencies represent the total of all players in each representative cell. The percentages in parentheses represent the average of the average frequency of working of each player in the representative cell.

² Actual strategies.

Table 5: Proportion of working in the 2nd period contingent on partner's strategy in the 1st period.

Hypothesis 1c examines whether the Pareto-undominated subgame-perfect strategy of working in both periods was played significantly greater than chance. The average frequency of the outcome of working in both periods across all games played for

each player was compared to chance to calculate the Wilcoxon Rank Sum statistic. The average frequency of both players working in both periods across all games played by all players is greater than chance in only the penalty frame with and without communication, and the penalty frame with commitment in the GI games. The results of the Wilcoxon test indicate that the frequency by player is greater than chance at the .05 level in only the penalty frames with communication and commitment. The results are summarized in Table 6 and provide support for Hypothesis 1c in two of the five games.

	GI No Frame (no option, no commun.)	GI Penalty (option, no commun.)	Treatment ¹ GI Bonus (option, no commun.)	GI Penalty (option, commun.)	GI Penalty (option, no commun., commit- ment)
Frequency of Both Players Working in Both Periods	5.00%	7.23%	4.62%	46.07%	24.22%
Number of games	200	166	130	178	128
Wilcoxon Rank Sum test stat.	15	33	8	55	45
alpha	> .5	> .5	> .5	.001	.042

The frequency of both players working in both periods is the total outcomes of both players working in both periods in all games that both players decided to play. The average frequency of the outcome of both players working in both periods by player over all games played by the player is compared to chance to calculate the Wilcoxon rank sum statistic in all treatments except the commitment game. In the commitment treatment, the frequency of each player selecting the strategy of working in the 1st period, and shirking in the 2nd period if their partner shirks in the 1st period and working in the 2nd period if their partner works in the 1st period is compared to chance.

Table 6: Frequency of both players working in both periods (GI games)

An explanation for these results is similar to the explanation provided for Hypothesis 1a. This is that the existence of multiple equilibria create a coordination problem. In addition, individuals might not believe that it is credible for a player to shirk in the second period for shirking in the first period.

In summary, the results of hypothesis one provide evidence that individuals will play punishment strategies conditional on their partner's strategy in the first period consistent with the theoretical result, although there is little evidence that the implicit threat of shirking in the second period fosters a high level of coordination when the players are not allowed to communicate. Although the play of the Pareto-dominant strategy when the players are allowed to communicate, or are committed to their second period action increases, the frequency of working is relatively low with commitment indicating that it is more likely that the existence of multiple equilibria and uncertainty creates a coordination problem. Although commitment might help reduce coordination problems, a coordination problem might still exist because the players do not know which strategy their partner has committed to.

5.1.2 Group Compared to Individual Incentives

The first and second period payoffs correspond to group and individual incentives. Hypothesis Two examines the benefit of group incentives compared to individual incentives. Group incentives are less costly if both players work, therefore the benefit of group incentives may depend on the strategies of the players. To determine if group incentives are beneficial, the strategies in the GI game are compared with those in the II game, with and without communication.

The proportion of strategies in the first period in the GI and II games from Figure 5 indicates that the frequency of working in the II compared to GI games with and without communication is greater. The average frequency of each player working across all periods is used as one observation in each treatment to determine if the differences are significant.²¹ The results indicate that the frequency of working in the GI supergame with communication is not significantly different at the .05 level than the II supergame with communication, however the frequency of working is significantly lower at the .05 level in the GI supergame without communication compared to the II supergame without communication.²²

The results indicate that the frequency of working is significantly less in the GI supergame compared to the II supergame without communication. This is inconsistent with the theoretical predictions, Hypothesis 2a and provides evidence that group incentives might not be beneficial to the principal because the managers work less frequently. Evans, Hoffman and Rau (1994) find that individuals will choose incentive contracts that provide them with lower levels of utility to reduce the possibility of being taken advantage of. Therefore, individuals in the GI supergame may have selected safer

²¹ The results of the GI supergame with the bonus frame are similar to the GI supergame in the penalty treatment without communication, and therefore are not presented. The second period of the II supergame is also framed in a penalty context. There is also no II game without a frame.

²² A binary logit regression was also used to determine if the strategies of the players in the first period were dependent on the strategies of their partner in the first period of the three previous games. There were no significant dependencies in any of the eight games, except in the GI games with and without communication in the penalty treatment, and the II supergame with communication. In these treatments, the coefficient on a player's partner's strategy in the first period of the previous game is significant at the .05 level.

strategies. For example, strategies that involve shirking in the first period and working in the second period may be safer, because they involve less stringent beliefs about the strategies that their partner. The results are summarized in Table 7.

<u>GI compared to II (penalty frames)¹</u>		
	No Communication in both treatments	Communication in both treatments
Mann-Whitney test		
Test statistic	290.50	73.5
p-value (adjusted for ties)	.0062	.0590

¹ The number of observations in the GI and II supergame with and without communication, and in the II supergame without communication was 12, 10 and 16, respectively. In the II supergame with communication there were 10 observations for 11 games, 9 observations for 1 game and 8 observations for 8 games.

Table 7: Results of frequency of working in the 1st period (GI compared to II games)

A Mann-Whitney test comparing the average frequency of working of each player across all rounds in the second period indicates that the frequency of working is significantly different at the .05 level in the II supergame with communication and GI supergame with communication, and in the II supergame without communication and GI supergame without communication. The results are summarized in Table 9, and do not

provide support for Hypothesis 2b. The results provide support only for Hypothesis 2a in the treatments with communication. The implications of the results are that there might be a trade-off between providing group or individual incentives. In particular, group incentives are less costly if both manager work. Although the unique Pareto-dominant strategy in the GI game is for the manager to work hard in both periods, the results provide evidence that the frequency of working is less compared to the II game. Therefore, the principal might incur a cost if group incentives are provided because it is assumed to be optimal to motivate both managers to work hard.

<u>GI compared to II (penalty frames)¹</u>		
	No Communication in both treatments	Communication in both treatments
Mann-Whitney test		
Test statistic	119.5	72.5
p-value (adjusted for ties)	.0117	.0489

¹ The number of observations in the GI and II supergame with and without communication, and in the II supergame without communication was 12, 10 and 16, respectively. In the II supergame with communication there were 10 observations for 11 games, 9 observations for 1 game and 8 observations for 8 games.

Table 8: Results of frequency of working in the 2nd period (GI compared to II games)

Figure 10 summarizes the percentage of strategies across both periods in all treatments without commitment.

Figure 10: Proportion of outcomes

From Figure 10, the distribution of outcomes in the GG, GI and II games have a similar pattern, except for a larger proportion of outcomes in GI and II that involved both players working in both periods in the games with communication, and the II game without communication. This is consistent with a coordination problem arising because of the existence of multiple equilibria. Although there are multiple equilibria in the II game, the loss to a player from working instead of shirking if their partner shirks is only 10, and the periods can be played individually. Therefore, coordination might be easier, because it is less risky for a player to work in each period. The increase in the frequency of working in the GI game with communication is consistent with opportunity to reduce

uncertainty through pre-play communication being an important factor to consider in the design of incentive contracts.

5.1.3 Penalty Compared to Bonus Frame

In addition to allowing the players to deduct points from their partner, a bonus treatment was framed to allow the players to add points to their partner's earnings in the second period. The frequency of working in the first and second period in the penalty and bonus treatments in Figures 7 and 9 is similar.

A Mann-Whitney test comparing the frequency of working of each player across all rounds indicates that the difference is not significant at the .05 level in either period. The results indicate that although individuals may prefer bonus to penalty terms, and the bonus or penalty is determined by the other manager instead of by the owner, their ability to coordinate on Pareto-dominant strategies is not statistically different. The results support Hypotheses 3a and 3b, and are summarized in Table 9.

	<u>GI Penalty compared to GI bonus¹</u>	
	1 st Period	2 nd Period
Mann-Whitney test		
Test statistic	90	101
p-value (adjusted for ties)	.6702	.2013

¹ The number of observations in the GI penalty and bonus supergame was 12 and 8, respectively.

Table 9: Results of the frequency of working in the bonus compared to penalty frame (GI game)

The results of Hypothesis 1b indicated that the difference in the players second period strategies contingent on their partner's strategy in the first period is significant at the .05 level in the penalty frame but not in the bonus frame.

5.1.4 Pre-play Communication

The existence of multiple subgame-perfect equilibria in the GI supergame creates an uncertainty about which strategy a player might select, and therefore a coordination problem might result. To determine whether the addition of a pre-play communication stage before each period increases the ability of the players to coordinate on the Pareto-dominant strategy, the frequency of working in the first and second period of the GI penalty game with and without communication are compared.

Figures 7 and 9 indicate that the frequency of working is greater with communication in both periods. A Mann-Whitney test comparing the frequency of working of each player over all rounds indicates that the difference is significant at the .05 level in both periods. The results support Hypotheses 4a and 4b and provide evidence that although cheap-talk communication is generally not included in most theoretical models, it might be an important factor to consider in the design of contracts. The results are summarized in Table 10.

	<u>1st Period</u>	<u>2nd Period</u>
Mann-Whitney test ¹		
Test statistic	151.5	153.5
p-value (adjusted for ties)	.0171	.0121

¹ The number of observations in the GI supergame with and without communication was 12 and 10,

Table 10: Results of pre-play communication (GI game)

The facilitating role of communication might also depend on the content of the messages sent by the players. In particular, coordination should be more frequent if the messages signal an intent to work, and if both players signal an intent to work instead of one or no player signaling an intent to work. The proportion of messages in the first and second period that signal an intent to work, shirk or neither work or shirk (neutral)

conditional on their partner's message, and the correspondent proportion of strategies work or shirk selected in the GI game are summarized in Figure 11.

<u>Message</u>			<u>Proportion of Total</u>	<u>Proportion of Strategies (work)</u>
Message	Partner's message	#		
1st Period				
Work	Work	80	53.33%	92.50%
Work	Neutral	11	7.33%	81.82%
Neutral	Work	11	7.33%	36.36%
Neutral	Neutral	44	29.33%	50.00%
Neutral	Shirk	1	.67%	0.00%
Shirk	Neutral	1	.67%	0.00%
Shirk	Shirk	2	1.33%	0.00%
2nd Period				
Work	Work	60	40.00%	88.33%
Work	Neutral	10	6.67%	80.00%
Neutral	Work	10	6.67%	60.00%
Neutral	Neutral	66	44.00%	34.85%
Neutral	Shirk	2	1.33%	0.00%
Shirk	Neutral	2	1.33%	0.00%

Figure 11: Proportion of messages (work, shirk or neutral) conditional on partner's message (work, shirk or neutral), and strategies (work) in the 1st and 2nd period (GI game).

The proportion of messages from Figure 11 that signal an intent to work, shirk or neither work or shirk is 60.67% (work - work plus work - neutral), 2% (shirk – neutral

plus shirk – shirk) and 37.33% (neutral – work plus neutral – neutral) in the first period, respectively. The proportion of messages work, shirk or neutral in the second period are 46.67%, 1.33% and 52%, respectively. Therefore, messages are more likely to signal an intent to work in the first period, and slightly less likely to signal an intent to work in the second period. This is consistent with players trying to make the payoff dominant strategy more focal. The messages sent are also fairly credible. For example, the frequency of a player working after both players signal an intent to work is 92.50 % and 88.33% in the first and second period, respectively. After both players signal a neutral message, the frequency of a player working is 50.00% and 34.85% in the first and second period, respectively. If either player signaled an intent to shirk, both players always shirked in both periods.

If pre-play communication facilitates coordination by allowing the players to reduce uncertainty, coordination on payoff dominant strategies should be greater if both players communicate an intention to work. A Mann-Whitney test that compares the average frequency of working by player when both, one or neither player sends signals an intent to work indicates that the frequency of working in the first and second period is significantly greater at the .05 level when both players signal an intent to work compared to when both players send neutral messages. The frequency of working in the first and second period when both players signal an intent to work is not significantly greater

compared to when one players signals an intent to work, and one player sends a neutral message.

Also, the frequency of working in the first and second period when one player signals an intent to work and one player sends a neutral message is not significantly greater than when both players end a neutral message. The results are summarized in Table 11, and provide some support for Hypothesis 5.

	<u>1st Period¹</u>	<u>2nd Period¹</u>
Both work v.s. one work, one neutral		
Mann-Whitney test		
Test statistic	100	95.5
p-value (adjusted for ties)	.0867	.0766
Both work v.s. both neutral		
Mann-Whitney test		
Test statistic	117	119
p-value (adjusted for ties)	.012	.0082
One work, one neutral v.s. both neutral		
Mann-Whitney test		
Test statistic	96.5	81
p-value (adjusted for ties)	.3049	.3377

¹ The messages from rounds 1 - 3 are not available. There were not a sufficient number of observations when the message signaled an intent to shirk for a statistical analysis.

Table 11: Results of pre-play communication contingent on message content (GI game)

Although the results provide evidence that one-way communication might be sufficient for coordination on Pareto-dominant strategies, Figure 11 indicates that when one player signals an intent to work and their partner sends a neutral message the frequency of working in the first period is not much less than when their partner signals

an intent to work (81.82% compared to 92.50%). Therefore, the frequency of working in the first period when one player signals an intent to work and their partner sends a neutral message is more a result that the players that signal an intent to work have a relatively high frequency of working regardless of whether their partner signaled an intent to work, or sent a neutral message. Also, a player is more likely to shirk after sending a neutral message in the first period if their partner signaled an intent to work than when their partner sent a neutral message (36.36% compared to 50.00%). Therefore, there is some evidence that individuals will take advantage of their partner.

A more relevant indicator of the interdependency on the ability of players to coordinate conditional on the content of message might be the frequency of coordinating on the Pareto-dominant strategy. If both players signaled an intent to work in both periods, coordination on the Pareto-dominant strategy was 80%, and if both players signaled an intent to work in only the first period, coordination on the Pareto-dominant strategy was 72.50%. If one player signaled an intent to work and the other player sent a neutral message, coordination on the Pareto-dominant strategy did not occur unless both players signaled an intent to work in the second period. The players then always coordinated on the Pareto-dominant strategy, but there were only two pairs for which this occurred. In general, coordination on the Pareto-dominant strategy was much lower when both players did not signal an intent to work. Therefore, the ability of

communication to reduce uncertainty might depend on the messages of both players, consistent with the results of Cooper et al. (1992).

5.1.5 Commitment

In the GI game, the Pareto-dominant or Pareto-undominated strategy involves a threat of punishment in the second period for shirking in the first period. However, the second period is the end of the game, and therefore it may be less credible that an individual will play a punishment strategy given that it may be costly. Although both players working or both players shirking are Nash equilibria in the second period subgame, it is more credible that a player will follow through on a punishment if they are committed to their strategy. In the game with commitment, the players select both their first period strategy and a second period strategy if their partner shirks, and if their partner works in the first period. The proportion of the ten strategies across all games is summarized in Figure 12.

¹ Strategies are (1st pd. Stg, 2nd pd. Stg. | partner shirked in 1st pd., 2nd pd. Stg. | partner worked in 1st pd).

Figure 12: Proportion of strategies (GI game with commitment)

In Figure 12, a large proportion of strategies are to shirk in both periods regardless of first period strategies (38.50%), and to play the Pareto-dominant strategy (15.50%). The results of Hypotheses 1b and 1c found that players are more likely to work in the second period if their partner worked in the first period, and that the Pareto-dominant strategy is played significantly greater than chance. This is consistent with the results for the GI treatment without communication or commitment, except the outcome of both players working in both periods occurred significantly less than chance.

To determine if the commitment to second period strategies in the first period contingent on a player's partner's first period strategy makes punishment and working in

the second period more credible, the frequency of working in the first period of the GI game when the first and second period strategy are selected at the same time is compared to the GI game when the second period strategy is selected after the first period output has been realized. A Mann-Whitney test was used to compare the average frequency of working in the 1st period by player in both of the GI games. The results indicate that the frequency of working in the first period is not significantly greater when the players are committed to their second period strategy, and therefore do not support Hypothesis 5.

GI commitment to no commitment (no frame, no communication) ¹	
Mann-Whitney test	
Test statistic	120
p-value (adjusted for ties)	.3827

¹ The number of observations in the G – I commitment and no commitment games was 10 and 12, respectively.

Table 12: Frequency of working in the 1st period (GI commitment compared to GI no commitment)

The results support that the ability of the players to reduce uncertainty created by multiple equilibria through communication results in greater working and facilitates more coordination on Pareto-dominant strategies compared to commitment. This is supported by the results of Hypothesis 1b, which found that individuals will play

strategies in the second period contingent on their partner's strategy in the first period consistent with the theoretical results. Therefore, commitment to second period strategies does not eliminate the coordination problem created by multiple equilibria, and this might be a more important factor in coordination on the Pareto-dominant strategy in this setting

5.2 Summary and Discussion

There is some evidence that providing a self-enforcing punishment strategy by creating multiple equilibria in the managers' second period subgame facilitates coordination on more payoff dominant equilibria. The main results of this study are:

1. The frequency of working in the first period is significantly greater in the GI game than in the GG game, which provides evidence that the inclusion of self-enforcing punishment strategies has the desired effect of increasing coordination on Pareto-dominant equilibria.
2. Participants will play punishment strategies in the second period, and in general condition their strategies in the second period on their partner's strategy in the first period consistent with supporting coordination on the Pareto-dominant equilibria, and the theoretical prediction of Arya et al. (1997).
3. The coordination on the Pareto-dominant strategy is relatively low. This implies that group incentives might not be beneficial to the principal, and that the behavior of the members of the team might be an important factor to consider in the design of incentive contracts.
4. The ability of the players to communicate before each period facilitates the coordination on the Pareto-dominant equilibrium.

In the experiment, communication facilitated coordination on the Pareto-dominant equilibrium. In particular, the frequency of working is significantly greater in both periods compared to when the players are not provided with an opportunity to communicate, and the frequency of working did not decrease over time. This provides evidence that the uncertainty might create a coordination problem due to the existence of multiple equilibria. In this setting, providing individuals with an opportunity to communicate facilitates coordination on more desirable equilibria from the principal's perspective, and might be an important factor to consider in organizational and contractual design.

CHAPTER 6

SUMMARY AND CONCLUSIONS

6.1 Implications

The use of teams can help to enhance the productivity of organizations through the pooling of specialized skills and knowledge. Organizations may design incentive structures that incorporate the “soft” information that individuals might have about each other to reduce the costs of contracting in a team setting. The use of mutual monitoring has important implications, and may change the role of more traditional, “hard” including accounting information by providing incentives for team members to monitor and a means to punish each other. This paper determines whether individuals will play punishment strategies to support coordination on Pareto-dominant equilibria in a two-period, non-repeated mutual monitoring setting, in the model developed by Arya et al. (1997).

In this experiment, providing incentives that incorporate mutual monitoring enables the principal to reduce the cost of contracting. In this setting, individuals condition their strategies in the second period on their partner’s first period strategy, and

the frequency of working increases consistent with the theoretical result of Arya et al. (1997). However, a coordination problem might still exist due to the existence of multiple equilibrium which is not consistent with the theoretical prediction, and whether group incentives are beneficial given the behavior of the managers. The existence of multiple equilibria introduces a potential role for communication, and in particular the results provide evidence that the ability of players to reduce uncertainty through communication facilitates coordination on the Pareto-dominant equilibrium. The use of teams in organizations has become more common, and the benefits that can be gained from teams has important implications for the incentive structures and organizational characteristics that facilitate coordination among the members of the organization. In this setting, communication might be an important factor.

6.2 Future Research

The use of mutual monitoring in incentive structures to align individual incentives in a team setting can reduce the cost of contracting, and has important implications for accounting. There are important theoretical and behavioral subtleties in the design of incentive structures. For example, the opportunity for individuals to interact in multiple stages in the model in this study provided an opportunity for individuals to punish each other, and was an important element in sustaining a self-enforcing equilibrium. However,

in other settings it might not be desirable from a behavioral perspective to provide individuals with an opportunity to act at multiple stages. It may also be interesting to examine self-enforcing mechanisms and mutual monitoring contracts in other organizational forms including partnerships.

The ability of communication to facilitate coordination in other settings might also help provide insights. In particular, it may be worthwhile to further determine the contexts that communication plays a facilitating role.

Appendix A

Sample Instructions (GI penalty, no communication)

Thank you for participating in this research study. During the study, we ask that you do not speak with any of the other participants about any aspects of the study.

You will have the opportunity to earn a substantial amount of money depending on the decisions you make. You will accumulate points during each period, and at the end of the study you will be paid according to the number of points you have earned at the following rate.

1 point ~ ____ cents

During the study, you will have the option to play (Play) or not play (Don't Play) a two period game at the beginning of each game. If you decide to play, you will have a choice between one of two actions, One or Two in the first period. In the second period, you will receive a fixed number of points and have the option to deduct a fixed number of points from the person you are paired with. The person you are paired with may also deduct a fixed number from points you. If you decide not to play, you will

receive a fixed number of points for the current game (two periods), and will not play during the current game.

If you decide to play, you will be randomly paired with one other person for two periods, and will earn points according to the actions that you and the person you are paired with select. The two period game will be repeated a total of 20 times, including the option to play or not play at the beginning of each game.

If you decide to play the current game, the points you earn in any given period will depend on the action that you and the person you are paired with select. Before each period, you will be provided with a schedule that specifies the points you will earn if you decide not to play, and the points for each of the possible combinations of actions selected by you and the person you are paired with. At the end of each period, the points you and the person you are paired with earned during the current period, and the points you and the other players you have been paired with in each game will also be revealed.

The following is an example of the schedule of possible earnings for each of the possible action combinations that will be provided to you for the first period, and the second period choice you will have to deduct points from the person you are paired with. You will always appear as the row player in the first period.

First Period

You	Other Player	
	One	Two
One	50 50	80 30
Two	30 80	70 70

Second Period

You and the person you are paired with will receive 110 points.
You may deduct points from the person you are paired with, and the person you are paired with may deduct points from you.

If you deduct points from the person you are paired with and the person you are paired with does not deduct points from you, 50 points will be deducted from the person you are paired with and 0 points will be deducted from you. If the person you are paired with deducts points from you and you do not deduct points from the person you are paired with, 50 points will be deducted from you and 0 points will be deducted from the person you are paired with.

If you deduct points from the person you are paired with and the person you are paired with deducts points from you, 40 points will be deducted from both of you.

Deduct points

Do not deduct points

Figure 13: Sample game (group incentives)

In the first period schedule above, the upper left (lower right) corner in each cell represents the points you (the person you are paired with) will receive for all possible combinations of action choices. Although the action you select in the 1st period will not

directly affect the points you receive in the 2nd period, it is possible to play strategies in the second period contingent on the outcome in the 1st period. Following are some examples (the points received for not playing are 145):

1. If the person you are paired with selects Two in the 1st period and Do Not Deduct points in the second period regardless of what you select in the 1st period.

If you select Two in the 1st period and Do Not Deduct points in the 2nd period regardless of the outcome in the 1st period, you will receive 70 points in the 1st period (lower right box) and 110 points in the 2nd period. The person you are paired with will also receive 70 points in the 1st period and 110 points in the 2nd period. Therefore, you will receive 180 points and the person you are paired with will receive 180 points for both periods.

2. If the person you are paired with selects Two in the 1st period and Deduct points in the 2nd period if you select One in 1st period and Do Not Deduct points in the 2nd period if you select Two in the 1st period.

If you select Two in the 1st period and Deduct points in the 2nd period if the person you are paired with selects One in the 1st period, and Do Not Deduct points in the second period if the person you are paired with selects Two in the 1st period, you will receive 180 points and the person you are paired with will receive 180 points for both periods (70 points in the 1st period and 110 points in the 2nd period).

If you select One in the 1st period and Do Not Deduct points in the 2nd period regardless of the outcome in the 1st period, you will receive 140 points (80 in the 1st period and 60 in the 2nd period) and the person you are paired with will receive 140 points (30 in the 1st period and 110 in the 2nd period).

3. If the person you are paired with selects One in the 1st period and Do Not Deduct points in the 2nd period regardless of what you selected in the 1st period.

If you select One in the 1st period and Do Not Deduct points in the second period regardless of the outcome in the 1st period, you will receive 160 points and the person you are paired with will receive 160 points (50 in the 1st period and 110 in the 2nd period).

If you select Two in the 1st period and Do Not Deduct points in the 2nd period regardless of the outcome in the 1st period, you will receive 140 points (30 in the 1st period and 110 in the 2nd period) and the person you are paired with will receive 190 points (80 in the 1st period and 110 in the 2nd period).

4. If the person you are paired with selects One in the 1st period and Deduct points in the 2nd period regardless of what you selected in the 1st period.

If you select One in the 1st period and Deduct points in the 2nd period regardless of the outcome in the 1st period, you will receive 120 points and the person you are paired with will receive 120 points (50 in the 1st period and 70 in the 2nd period).

If you select Two in the 1st period and Deduct points in the 2nd period if the other player selects One in the 1st period and Do Not Deduct points in the 2nd period if the other player selects Two in the 1st period, you will receive 100 points (30 in the 1st period and 70 in the 2nd period), and the person you are paired with will receive 150 points (80 in the 1st period and 70 in the 2nd period).

5. If you decide not to play the current game, you will receive 145 points and the person you are paired with will receive 145 points for both periods.

After you have read the instructions, the instructions will be read verbally and any questions you have will be answered. There will then be a practice period against a pre-programmed strategy for three periods to familiarize you with the screen. The programmed strategy will play the following in each period:

Game	1st Period	2nd Period	
		If you play One in the 1st period	If you play Two in the 1st period
1	2	Do Not Deduct	Do Not Deduct
2	2	Deduct	Do Not Deduct
3	1	Do Not Deduct	Do Not Deduct

Figure 14: Pre-programmed strategy

After the practice period, there will be a short quiz. If any of the questions on the quiz are incorrect, the quiz will prompt you to reanswer the questions that are not correct. The answers to any incorrect questions will then be displayed. After the quiz, the first game for points will begin. There will be 20 games (20 repetitions of the two-period game) for points. After, there will be a questionnaire (optional). After the questionnaire you will be paid according to the number of points you earned during the 20 games.

Thank you again. Your participation is greatly appreciated.

Appendix B

Sample Questionnaire (GI penalty, no communication)

1. Please indicate your sex

Male	Female
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2. Have you ever participated in an experimental economics or similar study, and if so how many times?

0	1	2	3	More than 3
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3. How well did you feel that you understood the instructions?

1	2	3	4	5
Not at all	Not very well	Somewhat	Well	Very Well

4. In the periods that involved the compensation schedules above, how important was the strategy of your partner in the 1st period in the selection of your 2nd period action.

1	2	3	4	5
Not at all	Not very well	Somewhat	Well	Very Well

5. In the periods that involved the compensation schedules above, how important were the strategies of your partner in determining your strategy in the 1st period.

1	2	3	4	5
Not at all	Not very well	Somewhat	Well	Very Well

6. Are there any other particular strategies that you had, or any other comments you would like to make about the study?

Appendix C

Sample Screen Display (GI penalty, no communication)

Please indicate if you would like to play the current game and click (Y/N).

PLAY points earned will be deducted by the next one party.

WANT PLAY (you will receive 100 points)

Current Game

By Pt. You Other Party

Not Played

Score Point

History

Other is the player you are paired with during the game.

Game	Result	Result	Result
	You	Other	You
1			
2			
3			
4			
5			
6			
7			
8			
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13			
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99			
100			

You will receive 100 points in the 2nd period. You may deduct points from the person you are paired with and the person you are paired with may deduct points from you.

If you deduct points from the person you are paired with and the person you are paired with does not deduct points from you, 20 points will be deducted from the person you are paired with.

If the person you are paired with deducts points from you and you do not deduct points from the person you are paired with, 20 points will be deducted from you.

If you deduct points from the person you are paired with and the person you are paired with deducts points from you, 40 points will be deducted from both of you.

Figure 15: Sample screen display (GI game)

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