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Control in a Teamwork Environment—The Impact of Social Ties on the Effectiveness of Mutual Monitoring Contracts

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ABSTRACT: This study examines control in a teamwork setting, experimentally investigating two financial incentive systems that have been proposed in the agency-theory-based analytic literature. Both systems rely on mutual monitoring—the ability of team members to observe each other's actions. However, the systems differ on whether team members report observations of their peers' efforts to management (vertical incentive system) or directly control the actions of each other (horizontal incentive system). Findings suggest that the effectiveness of these systems depends on the level of team identity. Specifically, a strong team identity leads to greater coordination. The result is that the effectiveness of a vertical incentive system is degraded by a strong team identity. On the other hand, a horizontal incentive system becomes more effective in the presence of a strong team identity. The results of this study suggest that when the team has achieved a high level of identity, the most effective way to use this information is likely horizontal in nature, delegating responsibility for control to self-managed teams, rather than extracting the information through reporting mechanisms. This study thus helps explain why firms have more readily embraced horizontal incentive systems than vertical incentive systems.

Keywords: *control systems; teams; mutual monitoring; incentives; social identity.*

Data Availability: *The experimental data are available for purposes of replication. Please contact the author.*

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I. INTRODUCTION

The use of teams in the workplace has increased dramatically over the last several years (Cohen and Bailey 1997). Firms report a number of benefits of teams, including greater participation and involvement, increased attention to process improvements, and improved employee satisfaction (Wellins et al. 1994). However, from a measurement and contracting perspective, the teamwork setting presents a challenge. When accurate and verifiable measures of individual contributions are not available, incentive contracting may not be useful for encouraging employees to direct their efforts toward management's goals. Instead, the use of team incentives can result in free-riding. Therefore, researchers have begun to design incentive systems tailored to the teamwork setting.

This study investigates two incentive systems. Both systems rely on mutual monitoring, the ability of team members to observe each other's actions. Peer observations are "soft" in the sense that they are not directly verifiable and do not meet the stringent measurement requirements to be included in the accounting library (Demski 1997).[1] Nevertheless, incentive contracting schemes can incorporate peer observations, and analytic researchers have identified two general approaches for doing so. The approaches differ on whether team members report observations of their peers' efforts to management (vertical incentive system) or directly control the actions of each other (horizontal incentive system). The premise of this study is that the effectiveness of each system depends on the degree to which team members have established a strong psychological attachment, or *team identity*. Specifically, I show that team identity *interacts* with the incentive system, such that as the level of identity increases, the horizontal approach becomes more effective relative to the vertical approach.

This interaction occurs because of key assumptions underlying the two types of incentive systems. A key feature of agency models using the vertical approach is the assumption that the agents will choose their strategies independently, rather than engaging in coordinated behavior. Specifically, a vertical incentive system reduces a worker's incentive to shirk, because of the threat that his/her behavior will be observed and reported by a teammate. This threat can be eliminated if all agents agree to "cover for each other," consistently making favorable reports regardless of the effort levels observed. Horizontal systems, on the other hand, rely on the agents' coordination. That is, the principal creates an incentive system that induces the agents to agree (among themselves) to the high effort levels desired by the principal and to enforce these agreements through the use of formal sanctions, peer pressure, or enforceable side-contracting. I demonstrate that team identity increases the level of coordination among team members, thereby decreasing the effectiveness of the vertical system, while increasing the effectiveness of the horizontal system.

This research is important to managers wishing to maximize the effectiveness of work teams and to managerial accountants and assurance providers who design and evaluate managerial control systems. A considerable body of analytic modeling research has focused on the use of incentives to motivate desired behavior by employees. Milgrom and Roberts (1992, 413) point out, however, that:

> Almost all of the formal theory emphasizes incentives for individuals on the grounds that it is individuals who must be motivated to work. Yet the most common explicit incentive contracts are applied across groups of individuals.

[1] Compensation contracts frequently allow for the use of soft data, generally through subjective performance evaluations (Fisher et al. 2003) or discretionary bonuses (Baiman and Rajan 1995).

Thus, more recent analytic work has focused on incentive systems specifically designed for the teamwork environment. This research contributes to this stream of literature by investigating the use of an unconventional measure (peer observation) in incentive contracting. Further, this study provides evidence that the incentive system cannot be considered in a vacuum. While the analytic literature tends to view a team as a collection of individuals, united only by interdependent tasks or incentives, this paper shows that social psychological factors—specifically, the strength of team identity—play an important role in determining the effectiveness of incentive systems. In doing so, this paper answers recent calls for research that melds theory from both economics and psychology to provide insights into accounting issues (Haynes and Kachelmeier 1998; Moser 1998; Waller 1995, 2001).

Graduate business students participated in an experiment with a 2 × 2 (Incentive System × Team Identity) between-subjects factorial design.[2] Each experimental session involved eight participants, randomly assigned to four two-person teams. Team members assumed the roles of two division managers working for the same company, with compensation dependent upon their decisions. Each person's primary responsibility was to choose the level of effort (or more broadly, the level of resources) his/her division would commit to the production process. The first manipulated factor is the incentive system, capturing the two models of interest (vertical versus horizontal). The second factor is team identity, manipulated by varying the salience of intra-team relationships.

The primary dependent variable is the level of costly effort chosen. I find a significant interaction between the incentive system and the level of team identity. Specifically, under the horizontal approach, a strong team identity leads to increased effort levels. However, under the vertical approach, a strong team identity leads to decreased effort levels. Further tests provide evidence that this effect is a result of both a cognitive change, leading team members to focus on joint versus individual outcomes, and an increase in communication. Moreover, the incentive systems themselves differentially reinforce team identity in that, after repeated interaction, the level of team identity becomes higher for teams using the horizontal incentive system than for those using the vertical incentive system.

The remainder of this paper is organized as follows. The following section reviews the relevant literature and introduces a model of the team setting that is used to motivate the hypotheses. Section III describes the methodology. Section IV provides data analysis, and the final section summarizes and concludes the paper.

II. THEORY AND HYPOTHESES

The Use of Teams in the Workplace

Modern organizations increasingly use a team-based approach (Cohen and Bailey 1997). For example, based on their 1995 research on salary growth, Hewitt Associates (1995) report that 65 percent of surveyed companies use teams in some capacity. Similarly, in its *1999 Practice Analysis*, the Institute of Management Accountants (IMA 1999) reports that 73 percent of survey respondents work at companies where management accountants are involved in cross-functional teams. Many young companies (e.g., Southwest Airlines [Kelley 2000], Whole Foods [Fishman 1996], Cisco Systems [Gillmor 2000]) use teams as a central organizing principle, but even older, more established companies herald the benefits of teamwork. For example, General Mills, Inc. has reported that productivity is as

[2] The experiment was repeated 20 times, and thus period number is a third (within-subjects) factor. However, the primary hypotheses do not involve period-by-period analysis.

much as 40 percent higher in factories using a team-based approach as compared to a traditional approach (Dumaine 1990).

Agency Theory in a Teamwork Environment

The analytic literature on contracting has begun to explore the implications of team settings. Most of the models are based on the principal-agent paradigm, with the basic model (Holmstrom 1979) modified to include multiple agents. While the literature has identified several ways in which the principal can improve his/her contracting position in the multiagent setting, this study focuses on mutual monitoring.[3] That is, while the principal cannot observe the agents' actions, the agents may be able to observe each other. The principal can benefit by designing incentive schemes that exploit this capability.

In this section, I introduce two incentives systems that rely on mutual monitoring. For simplicity, I describe these incentive structures using the parameters from the actual experiment. (For a more technical discussion, including the constraints on parameter choices, see the Appendix.) I define a team as two individuals (agents) engaged in some type of joint production. The principal cannot directly observe the agents, and there is no conventional measure of individual performance, but the two agents can mutually monitor each other's actions. Each agent selects an effort level (shirk or work), and joint output is a stochastic function of these effort choices.[4]

I assume that the two agents are risk-neutral and effort-averse. The analytic papers (Arya et al. 1997; Ma 1988) used as a basis for this model assume risk aversion. In fact, if the agents were risk-neutral (with no bankruptcy constraints), there would be a trivial solution to the problem (selling the firm to the agents). In this experimental setting, however, the agents' risk preferences are not related to the hypothesized effects, and therefore, I assume risk neutrality for ease of exposition and operationalization.[5] In the laboratory, I control for risk preferences by basing experimental payments on the expected values of the stochastic distributions. To operationalize the concept of effort aversion, participants who work are charged 10 points, and participants who shirk are not charged any points.

Next, I will explore the use of two types of incentive systems to induce the agents to work in this setting. As will be explained, a key difference between horizontal and vertical incentive systems is the degree to which agents are assumed to coordinate their strategies. In the "Hypothesis" section, I will argue that teams with strong team identities tend to coordinate their strategies, which works in favor of the horizontal incentive system.

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[3] These improvements include the use of relative performance evaluations (Arya and Glover 1996a; Frederickson 1992; Gibbons and Murphy 1990; Holmstrom 1982; Mookherjee 1984), improved risk-sharing (Ramakrishnan and Thakor 1991; Villadsen 1995), and gains from synergy and cooperation (Itoh 1991; Tirole 1988; Villadsen 1995).

[4] A key feature absent in this experimental setting is synergy. Real-world teams engaged in joint production are likely to experience gains from synergy. However, the use of mutual monitoring is not affected by whether such gains exist. Further, I am not aware of a theory that would suggest an interaction between the degree of synergy and either of the independent variables in this study. Therefore, to simplify the experimental setting, the conditional probability distribution used here is linear and additive in effort, incorporating no synergies into the production process.

[5] From a strictly economic perspective, if the agents were risk-averse, then the principal would prefer the vertical system, as it imposes no risk on the agents. Thus, in this setting with risk-neutral agents, I avoid making any generalizations regarding the relative desirability of the two systems. Instead, my focus is on the impact of social identity on incentive effectiveness. I am not aware of a theory that would suggest an interaction between risk preferences and social identity, and therefore, inducing risk neutrality should not affect the generalizability of the results.

Vertical Incentive System

Agency theorists have developed an extensive literature on incentive contracts that rely on vertical communication (agent to principal) in a multiagent setting (Arya and Glover 1996b; Demski and Sappington 1984; Demski et al. 1988; Fischer and Hughes 1997; Ma 1988; Ma et al. 1988). While the assumptions and forms of these vertical incentive contracts vary, the general model is one in which each agent observes the other agent's action and truthfully reports it to the principal.[6] Each agent's compensation is then based on the report filed by his/her teammate. The agents are essentially whistle-blowers, who pass along to the principal any information they gather about their coworkers. The vertical approach relies on the assumption that the agents will choose strategies independently, because coordination among them can undermine the reliability of their reports.[7]

Peer evaluations are commonly used for career development purposes. For example, many firms have adopted "360 evaluation" systems, in which each worker evaluates the performance of superiors, subordinates, and peers (Edwards and Ewen 1996). However, there has been a reluctance to report these evaluations upwardly or to tie compensation to them (Antonioni and Park 2001; Jackson and Greller 1998; Thatcher 1996; Wells 1999).[8] In fact, several authorities (e.g., W. Edwards Deming, Peter Drucker, and Tom Peters) warn expressly against doing so (Coates 1998). Thus, the use of vertical reports of peer observations for incentive contracting purposes, as conceptualized in economic theory, is not common in practice.

The vertical incentive system in this study is based loosely on the model proposed by Ma (1988) (hereafter Ma). Under this scheme, each agent's wages have two additive components—*effort pay* and a *reporting bonus/penalty*. An agent's effort pay depends entirely on the report filed by his/her teammate, and equals 20 (0) points if the teammate reports that the agent worked (shirked). Thus, assuming that the teammate reports truthfully, the agent is better off working than shirking. Working will net the agent 10 points (20 points of effort pay minus a 10-point deduction for effort aversion). Shirking will net the agent 0 points (0 points of effort pay with no deduction for effort aversion).

This incentive system depends crucially on truthful reporting, and the reporting bonus/penalty provides the incentive for each agent to tell the truth. Specifically, if an agent reports that his/her teammate shirked, and that report is truthful, then the agent receives a reporting bonus of 10 points. However, if that report turns out to be false, then the reporting agent is penalized 20 points. The principal cannot directly observe the actions of the agents. Therefore, one might ask how the principal can verify the veracity of the agents' reports, paying bonuses to accusing agents only if their accusations are proved truthful. One method (similar to that proposed by Ma) is the use of lotteries. Specifically, in accusing another agent of shirking, the accusing agent is required to accept an output-based lottery that is valuable only if the other agent did in fact shirk. Another alternative is for the firm to employ an auditor. The auditor is called only if one agent accuses the other of shirking.

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[6] A number of the papers in this category describe a setting of correlated private information rather than unobservable action. This setting is conceptually similar to a setting in which each agent imperfectly observes the other's action.

[7] The defining feature of all vertical systems is that the principal uses the agents' truthful reports to extract rents from the agents. If the agents collude in their reports, then they keep these rents, reducing the principal's wealth and rendering the incentive system ineffective.

[8] Recently, several consulting firms have begun to market their peer evaluation systems for compensation purposes, and businesses have explored tying pay to peer reports. It is unclear, however, whether these implementations will be successful (Edwards and Ewen 1996), and this remains a subject of controversy among Human Resources professionals.

The accusing agent is then rewarded (penalized) if the auditor determines that the accusation is truthful (false). In this study, I do not specify a method for ensuring truthful reporting, but instead generalize this aspect of the model by having the experimenter verify the reports.

An important feature of the vertical incentive system is that verification only occurs when one agent accuses the other of shirking. Verification processes are costly, and so the principal would not want to verify all reports.[9] From the principal's perspective, the optimal approach is to verify only negative reports, because under this approach, the costly verification only occurs off-equilibrium. Therefore, the principal uses the agents' ability to mutually monitor one another to achieve a first-best solution.

The vertical incentive scheme is summarized in normal form in Exhibit 1, Panel A. To make economic predictions using this form, one must first recall the sequential nature of the system. That is, the vertical system involves a two-stage game, with agents making effort choices in stage 1 and reporting choices in stage 2. At the beginning of stage 2, each agent has perfect knowledge of the effort choices made in stage 1. In choosing their reporting strategies, the agents therefore play one of four subgames, depending on what effort levels were selected in stage 1. For example, if Agent 1 works and Agent 2 shirks, then the agents will play the stage 2 subgame represented by the four bottom left squares of the matrix. The unique Nash Equilibrium of each of these stage 2 subgames involves truthful reporting. (The equilibria of the four subgames are highlighted.) Through backward induction, the stage 1 game economically reduces to a choice among these four equilibria. This reduced stage 1 game is summarized in Exhibit 1, Panel B. The unique Nash Equilibrium of this game is for both agents to work. As demonstrated by this backward induction process, the anticipation of truthful reporting in stage 2 (the dominant strategy) assures that both agents work in stage 1.

Economic theory predicts the unique subgame perfect Nash Equilibrium that agents facing this incentive system will choose to work and to report truthfully. However, an examination of Exhibit 1 reveals that this equilibrium is not Pareto optimal to the agents. Both agents are better off if they coordinate their actions, each shirking and then falsely reporting that the other has worked. This collusive outcome is not a Nash Equilibrium, because both agents have strict incentives to report truthfully.[10] However, under some circumstances agents may be able to achieve that outcome. This idea will be explored shortly, but first I will introduce the second type of incentive system—the horizontal incentive system.

Horizontal Incentive System

A second way in which the principal can take advantage of the opportunity for mutual monitoring is through the use of a horizontal incentive system, relying on team self-management and peer-based control (e.g., Arya et al. 1997; Barron and Gjerde 1997; Itoh 1993; Kandel and Lazear 1992; Prendergast 1999; Radner 1986; Ramakrishnan and Thakor 1991; Tirole 1988; Varian 1990; Villadsen 1995). In contrast to the vertical approach, the horizontal incentive system does not involve reporting to the principal. Instead, the principal assumes that the agents will explicitly or implicitly coordinate their actions. Therefore, the principal creates an incentive system that induces the agents to agree (among themselves) to the actions desired by the principal and to enforce these agreements through the use of

[9] In fact, if the principal were willing to incur the cost of verifying all reports, then peer monitoring would be of no value.

[10] The term "collusion" is defined as coordination among the agents that is not in the principal's best interest.

EXHIBIT 1
The Vertical Incentive System

Panel A: Normal Form Representation of Vertical Incentive System[a]

	Agent 2			
Agent 1	*s,s*	*s,w*	*w,s*	*w,w*
*s,s**	10, 10**	30, 0	−20, 0	0, −10
s,w	0, 30	20, 20	0, 20	20, 10
w,s	0, −20	20, 0	−30, −30	−10, −10
w,w	−10, 0	10, 20	−10, −10	10, 10

* Represents the effort choice (made in stage 1) and reporting choice (made in stage 2), respectively (*s* = shirk, *w* = work). Note that in stage 2, each agent reports on *the other agent's* stage 1 choice.
** Represents the payoff to Agent 1 and Agent 2, respectively.

Panel B: Normal Form Representation of Reduced Stage 1 Game[b]

	Agent 2	
Agent 1	*s*	*w*
*s**	10, 10**	0, 20
w	20, 0	10, 10

* Represents the effort choice (made in stage 1) and reporting choice (made in stage 2), respectively (*s* = shirk, *w* = work).
** Represents the payoff to Agent 1 and Agent 2, respectively.
[a] Note that the vertical incentive system involves a two-stage game, with agents choosing effort levels in stage 1 and reporting in stage 2. The shaded cells represent the unique Nash Equilibria of the four stage 2 subgames. For example, if both agents shirk, then the agents play the stage 2 subgame represented in the top left four cells of the matrix. The unique Nash Equilibrium of this subgame is for each agent to report that the other agent shirked. That is, given that both agents have shirked, the dominant strategy for each agent is to report truthfully. Truthful reporting is the unique Nash Equilibrium for all four stage 2 subgames, as represented in the shading above.
[b] The game implied by the vertical incentive systems is solved through backward induction. The stage 1 game is reduced to a choice among the Nash Equilibria of the four stage 2 subgames. Thus, each cell in Panel B represents one of the shaded cells in Panel A. The unique Nash Equilibrium in this reduced stage 1 game is for each agent to work. That is, given that each agent will report truthfully in stage 2, each agent's dominant strategy is to work in stage 1.

formal sanctions, peer pressure, or enforceable side-contracting (either explicit or implicit).[11]

Unlike the vertical approach, the horizontal approach corresponds to a practice commonly observed in the real world. The popular press has discussed the role of peer pressure and social norms in helping Japanese companies achieve success (Nahavandi and Aranda 1994). Likewise, North American firms have shifted control from supervisors to self-managing teams (Dumaine 1990), often using team-based compensation (DeMatteo et al. 1998) and lateral control regimes (Lazega 2000).

[11] While the enforcement mechanism differs across models, the defining characteristic of all horizontal incentive systems is that the principal's preferred outcome requires coordination among the agents. Therefore, as the level of coordination increases, the incentive system becomes more effective.

The horizontal incentive system presented here is based on that of Arya et al. (1997) (hereafter AFG). AFG's approach is to have the principal tie each agent's pay to the team output. A fundamental issue with team-output-based pay is the opportunity for social loafing (the withholding of effort as individual effort becomes less identifiable) (Kidwell and Bennett 1993). To prevent social loafing, AFG rely on the ability of the agents to monitor each other's efforts and to punish each other for shirking. This threat of punishment is a type of peer pressure, as conceptualized by Kandel and Lazear (1992). Punishment may take on many forms, ranging from informal social sanctions to more formalized disciplinary procedures. It also can be represented analytically. In AFG's two-period model, the threat to punish takes the form of a "tit-for-tat" strategy. Each agent works in the first period and then works in the second period only if the other agent worked in the first period. Nikias (2001) provides experimental evidence that under certain conditions, participants play punishment strategies when faced with the AFG incentive scheme.

The principal provides output-based *team incentives* in period 1, meaning that each agent's compensation is increasing in team output and that each agent prefers both agents working to both shirking. Recall that I control for risk preferences by basing experimental payments on the expected values of the stochastic distributions. Thus, the stochastic element of output is removed, and the requirement that each agent's compensation is increasing in team output is equivalent to the requirement that each agent's compensation is increasing in total team effort. Under the horizontal system, if both agents work, then each agent receives 20 points from the principal, resulting in a net profit of 10 points after deducting the 10-point cost of effort. If only one agent works, then each agent receives 14 points, but only one incurs the 10-point cost of effort. If both agents shirk, then each agent receives 8 points. As represented in Exhibit 2, Panel A, this incentive structure is essentially a prisoner's dilemma game, in that each agent's dominant strategy is to shirk even though both could do better by working. Thus, in the one-period (or finitely repeated) version of the game, the unique subgame perfect Nash Equilibrium has both agents shirking. However, the principal can potentially induce the agents to work in period 1 by changing the incentive structure in period 2.

In period 2, summarized in Exhibit 2, Panel B, the principal creates an opportunity for the agents to punish each other. In this period, if both agents work, then each agent receives 20 points. If only one agent works, then each receives 10 points. If both agents shirk, then each receives 0 points. Thus, each agent is indifferent to working or shirking. (The individual agent's gain in compensation from working exactly offsets the 10-point deduction for effort aversion.) However, each agent strongly prefers that the other agent work. Each agent can therefore threaten to punish his/her teammate for shirking in period 1 by shirking in period 2. All four cells of the period 2 subgame represent Nash Equilibria, so either agent can credibly threaten to move from the work-work equilibrium to punish deviant behavior in period 1. Thus, the punishment strategy is a Nash Equilibrium in the two-period game. Further, it is a Nash Equilibrium in the n-period game formed by repeating the two-period game $n/2$ times.[12] Note that the behavioral outcome of this equilibrium is that both agents will work each period. Therefore, if both agents use the punishment strategy, they will each net 20 points over the two-period game. An agent who shirks in period 1 will only net 14 points over the two-period game (14 points in period 1 and 0 points in period 2, when s/he is punished by the other agent).

[12] The punishment strategy could be sustained as a Nash Equilibrium in an n-period game by using the individual (punishment phase) incentives only in period n. However, to increase the salience of the opportunity for punishment, I use the individual incentives in all even-numbered periods.

EXHIBIT 2
Horizontal Incentive System

Panel A: Normal Form Representation of the Horizontal Incentive System—Period 1[a]

	Agent 2	
Agent 1	*s*	*w*
*s**	8, 8**	14, 4
w	4, 14	10, 10

Panel B: Normal Form Representation of the Horizontal Incentive System—Period 2[b]

	Agent 2	
Agent 1	*s*	*w*
*s**	0, 0**	10, 0
w	0, 10	10, 10

* Represents effort choice (*s* = shirk, *w* = work).
** Represents the payoff to Agent 1 and Agent 2, respectively.
[a] Period 1 of the Horizontal Incentive System is essentially a prisoner's dilemma, in that the unique Nash Equilibrium is for each agent to shirk, but the Pareto optimal outcome is for each agent to work.
[b] In period 2, all four cells represent Nash Equilibria, because each agent is indifferent to his/her own actions. For example, if Agent 1 shirks, Agent 2 earns 0 points regardless of whether s/he shirks or works. Likewise, if Agent 1 works, Agent 2 earns 10 points regardless of whether s/he shirks or works. Therefore, period 2 can be used as a punishment period, which sustains a tit-for-tat strategy in the two-period game. The Pareto optimal equilibrium in the two-period game is for each agent to work in period 1 and then to work in period 2 only if the other agent worked in period 1.

A natural question arises at this point: Why doesn't the principal use the period 2 (individual) incentives in all periods? The principal could use these incentives in all periods and induce working as equilibrium behavior. The reason the principal would not want to do this in a conventional principal-agent setting is related to risk aversion. The individual incentives of period 2 impose greater risk on the agents than do the team incentives of period 1. While I have assumed risk-neutrality for simplification, real-world agents would likely be risk-averse, requiring greater pay under higher-risk incentives. Therefore, the principal would want to use the higher-risk individual incentives only as needed to provide for a punishment opportunity.

While the outcome of each agent playing the tit-for-tat or some other punishment strategy is a Nash Equilibrium, it is not unique. Therefore, it does not rule out the possibility that the agents will play some other equilibrium that is not in the principal's best interest. For example, the undesirable outcome in which both agents shirk each period is also an equilibrium. (If one agent's strategy is to always shirk, then the other agent's best response is to always shirk.) However, the punishment equilibrium Pareto dominates all other Nash Equilibria, and so agents who coordinate their actions are more likely to achieve the punishment equilibrium. What determines whether the agents will coordinate their actions and thus achieve the desirable result of working each period? One answer to this question may be related to the relationship between the two agents, as developed in the next section.

Team Identity

As described earlier, a key difference between the horizontal and vertical systems relates to assumptions about side contracting. The vertical system assumes that team members

choose their strategies independently, with no coordination or side contracting between the agents. In contrast, the horizontal incentive system relies on the assumption that the agents will cooperate, coordinating their actions through implicit or explicit side contracts. Therefore, to predict the effectiveness of either system in eliciting high levels of effort, one must understand the likelihood of coordinated behavior among the agents. The analytic models treat the level of coordination as an exogenous factor, and do not delve into the processes through which such coordination emerges. Social psychology research, on the other hand, provides a theory for predicting when team members will coordinate their actions. In this section, I introduce Social Identity Theory, and describe how it can be applied to make specific predictions regarding the effectiveness of vertical and horizontal incentive systems.

Social Identity Theory describes the psychological processes that occur when a person self-identifies as a group member. A social identity results from a *self-categorization* process, through which an individual cognitively groups himself/herself with others, based on perceived similarities (Turner 1987a; Hogg 1987). Tajfel and Turner (1986) describe this process as a transition, through which a person stops thinking like a unique individual and instead begins to think like a representative of a group. As described by Brewer and Schneider (1990, 170), there is "a fundamental depersonalization of the self-concept."

The adoption of a social identity affects how information is interpreted and how decisions are made (Lembke and Wilson 1998). For example, King (2002) demonstrates that a sense of social identity among auditors mitigates their tendency to over-rely on clients' nonbinding communication. In a team setting, the shift from an individual to a team perspective will change team members' beliefs about how their actions affect outcomes (Wech et al. 1998). In a highly identified team, team members are likely to believe that they can influence outcomes through collective versus individual actions. Thus, they will coordinate their actions and focus on joint rather than individual outcomes (Brewer 1979).

Several studies have investigated the effect of social identity on contributions to public goods, finding that such contributions increase when participants categorize themselves into a group with other participants (Brewer and Kramer 1986; De Cremer and van Vugt 1998; Kramer and Brewer 1984). Similarly, Wit and Wilke (1992) report that individuals who self-categorize themselves as group members achieve greater cooperation in several types of social dilemmas.[13] These social dilemma experiments are particularly relevant for the current study, because both the horizontal and vertical incentive systems of interest have features that relate to social dilemmas. Specifically, in a social dilemma, it is individually rational for each person to defect (behave opportunistically), but each person is better off if all choose to cooperate than if all choose to defect (Dawes 1980). The horizontal and vertical incentive systems demonstrate a similar tension between individual rationality and social welfare.[14]

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[13] The settings for these studies vary in several important ways from the current study. Most notably, while the current study focuses specifically on incentive systems based on mutual monitoring, the prior studies do not allow participants to observe each other's actions or to communicate with each other. Further, prior investigations of social identity in social dilemma settings have restricted interaction, including opportunities for communication. A team setting generally creates significant opportunities for communication and, thus, in the current study, participants are allowed to communicate in writing.

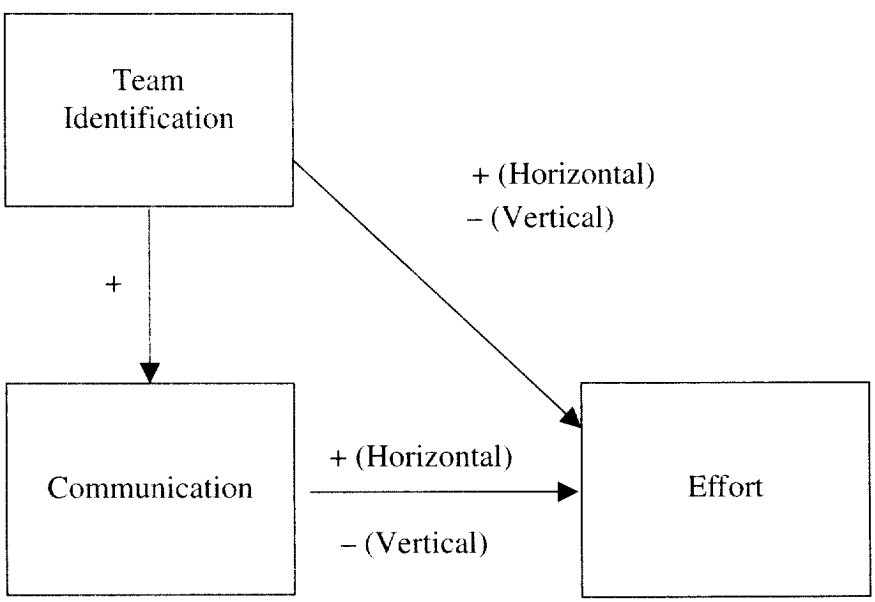
[14] The horizontal incentive system is not a social dilemma, per se. As described earlier, a social dilemma is characterized by a situation where the unique Nash Equilibrium is not Pareto optimal. This is not the case in the horizontal system, as the outcome that has each person playing a "tit-for-tat" strategy is both a Nash Equilibrium and a Pareto optimal outcome. However, this solution depends entirely on the multiperiod nature of the game, with "enforcement periods" used to sustain cooperation in earlier periods. These earlier periods, standing alone, are essentially risky prisoner's dilemmas. The enforcement periods create an interesting twist.
(*continued on next page*)

Hypotheses

This study's primary prediction is an interaction between the incentive system and the level of team identity, such that the effectiveness of an incentive system is either enhanced or degraded by a strong team identity. This prediction is hypothesized formally in H1, following a description of the process resulting in this interaction. Figure 1 illustrates the process.

The reasoning depends on a self-categorization process, by which members of highly identified teams cognitively group themselves with their teammates. As a result, the team, rather than the individual, becomes the primary cognitive unit of analysis. In considering strategy choices, the team members become more attuned to the interrelatedness of their actions, focusing on the ways in which they can jointly affect outcomes. This change in cognitive focus will lead them to choose strategies that are mutually beneficial (or cooperative) in nature. Thus, the cognitive change that defines team identity will have a *direct effect* on the level of cooperation achieved. In other words, highly identified teams are more likely than other teams to reach Pareto optimal outcomes. Team identity also operates through an *indirect effect*, resulting from the efforts of highly identified teams to actively coordinate their strategies. Coordination is enhanced by communication (Cooper et al.

FIGURE 1
The Hypothesized Effects of Team Identity on Effort
(Direct and Indirect Effects)



Footnote 14, continued

While these enforcement periods serve the specific purpose of increasing cooperative behavior, by creating opportunities for retribution, there is some possibility that their usefulness will be undermined by social identity. That is, if a strong team identity reduces participants' willingness to punish one another for not cooperating, it may have the indirect effect of reducing cooperative behavior, a result opposite of that found in prior research on social identity in social dilemmas.

1992), so it follows that highly identified teams will engage in greater communication, leading to an increased probability of arriving at cooperative (Pareto optimal) outcomes.

Thus, I predict that team identity, operating through both direct (cognitive) and indirect (communication-mediated) effects, will lead to greater cooperation. However, cooperation means different things under the two incentive systems. Recall that under the vertical incentive system, pay is based on reported effort. This opens the possibility for collusion between the two agents—they can each shirk and report that the other worked. This collusive outcome is not a Nash Equilibrium, because each agent has strict incentives to report truthfully. However, the collusive outcome is Pareto superior (from the agents' point of view) to the principal's preferred outcome of working and truthful reporting. Under the vertical incentive system, therefore, agents who collude are likely to choose *lower* effort levels than those who choose their strategies independently.

The horizontal incentive system, on the other hand, bases pay on team output and offers no opportunities for collusion. Indeed, under this system, the principal assumes that the agents will side contract to the principal's advantage. There are a number of equilibria (e.g., both agents shirk each period) in the multiple-period game, but the cooperative (Pareto optimal) outcome is the one preferred by the principal. In this equilibrium, each agent plays a punishment strategy, with the result that each agent works each period. Under the horizontal incentive system, therefore, agents who cooperate are likely to choose *higher* effort levels than those who choose their strategies independently.

In summary, team identity should lead to greater cooperation, which can have either a positive or negative effect on effort, depending on the incentive system in place. This is the primary hypothesis, stated in the alternate form.

H1: The incentive system will interact with team identity, such that the effectiveness (in terms of the level of effort elicited) of the horizontal incentive system will be enhanced by a strong team identity, while the effectiveness of the vertical incentive system will be degraded by a strong team identity.

The second hypothesis focuses on the *process* resulting in the predicted interaction between team identity and the incentive system. Specifically, H2 tests the two paths through which team identity is expected to influence the effectiveness of the incentive system—the direct, or cognitive, path, and the indirect, or communication-mediated, path.

H2: Team identity will have both a direct and an indirect, communication-mediated, effect on the effectiveness of the incentive system.

In the discussion to this point, the incentive system and the level of team identity have been considered independent and exogenous factors, reflecting the experimental manipulations. However, *after repeated interaction*, an endogenous relationship can arise between these two constructs. Specifically, the type of incentive system is likely to affect the level of identity that a team achieves, because the two incentive systems emphasize different aspects of the agents' relationship. The horizontal system is geared toward a team mentality. That is, the principal remains unaware of individual contributions and each person's compensation is based on the team's total output. The vertical system, on the other hand, eschews the cooperative spirit of a team. Instead, team members tattle on one another. Individual compensation is based on peer reports, and team members receive bonuses for making unfavorable reports on their peers. For these reasons, the type of incentive system

is expected to affect the team members' feelings about one another, and thus the level of team identity. This leads to the final hypothesis.

H3: After repeated interaction, individuals compensated according to the horizontal incentive system will experience a higher level of team identity than will individuals compensated according to the vertical incentive system.

III. METHOD

This experiment uses a 2 × 2 (Incentive System × Team Identity) between-subjects factorial design. Sixteen experimental sessions each involved eight participants recruited from graduate business classes at a large university (i.e., 128 participants in total). As participants arrived, they were randomly assigned to two groups of four, with each group identified by a different color. For the instructional phase, each participant was seated with members of his/her color group.

Color groups were used to manipulate team identity. The wording of the instructions, along with seating assigned by color and the use of colored props, increased the salience of the color groups, facilitating the participants' self-categorizations into these groups. The presence of two color groups in each session promoted this process, as prior research has shown that a team identity may be clarified by in-group/out-group comparisons (Abrams and Hogg 1990). Teams of two were required for the actual experimental task. In the high-identity condition, each team was formed by pairing two members from the *same* color group, whereas in the low-identity condition, each team was formed by pairing two members from *different* color groups.[15] For a real-world analogue to this manipulation, suppose that the color groups represent functional roles (accounting, engineering, etc.). The low-identity teams then represent cross-functional teams, while the high-identity teams represent uni-functional teams.

While seated with their color groups, participants read a scenario, in which they were instructed to assume the roles of two division managers making effort (or more generally, resource allocation) decisions. The scenario described the incentive system, manipulated to represent the two systems of interest. Participants were informed that they would be compensated in cash at a rate of 10 points per dollar, based on the decisions made and the incentive system in place. Because risk preferences were not relevant to this study, the stochastic element was eliminated, and each incentive system was presented in expected value terms.

After the instructions were read and reviewed, the members of each team were seated at opposite ends of a table, where they completed the experimental task. The task was for each participant to choose the level of resources that his/her division would provide. Participants were asked to choose high or low resources, rather than to choose work or shirk, because of the concern that the latter labels might invoke a value judgment and response.[16] The two members of each team made these decisions simultaneously, circling high or low on Resource Decision Forms. The experimenter then showed each participant the form completed by his/her teammate, capturing the notion of mutual monitoring. Participants were informed that in addition to circling "high" or "low" on their Resource Decision

[15] While it may seem improbable that *ad hoc* assignments to color groups would engender a sense of group identity, psychology studies on this "minimal group paradigm" are quite robust. Favoritism for in-groups over out-groups, even for explicitly random groups, has been demonstrated in numerous studies. For a review, see Turner (1987b).

[16] From this point forward, the terms "work" and "shirk" are used interchangeably with choosing high and low resources.

Forms, they could write whatever else they would like.[17] Because these forms were shown to their teammates, this allowed for intra-team communication. In the vertical incentive system, each participant also submitted a Report Form, revealing (either truthfully or not) the level of effort selected by his/her teammate. Each session consisted of 20 periods, following which participants completed a post-experimental questionnaire of demographic and process-related questions.[18]

IV. RESULTS

Hypothesis 1

Hypothesis 1 predicts an interaction between the level of team identity and the incentive system.[19] The dependent variable is the effectiveness of the incentive system. This construct is operationalized as "total effort," the cumulative number of times team members chose to work over the course of the experiment. Because under the horizontal incentive system, the even periods are essentially enforcement periods, aimed at eliciting high effort in odd periods, this analysis considers only odd periods.[20] Therefore, this variable can take on any value between 0 and 20, with 20 representing a team for which each member chooses to work all 10 odd periods. Table 1 presents descriptive statistics, and Table 2 presents the results of the 2 × 2 ANOVA.

The hypothesized interaction between team identity and the incentive system is highly significant ($F = 9.38$, $p < 0.01$). Furthermore, simple effects analysis (in Panel B of Table 2) reveals that under the vertical incentive system, high identity teams chose *lower* levels of effort than low identity teams ($F = 3.52$, $p < 0.04$ one-tailed), but that under the horizontal incentive system, high identity teams chose *higher* levels of effort than low identity teams ($F = 6.03$, $p < 0.01$ one-tailed). Thus, the effectiveness of the vertical incentive system is degraded by a strong team identity, while the effectiveness of the horizontal incentive system is enhanced by a strong team identity, supporting H1. This result provides a possible explanation for the observation that the horizontal approach is more common in practice than the vertical approach. Firms using teams often do so to capture gains from cooperation, information-sharing, and productive synergies. A number of consulting firms (e. g., Teambuilding, Inc. and Team Builders Plus) specialize in training aimed at creating a sense of "oneness" among team members. Paradoxically, the results presented here show that the team spirit many companies try to instill actually undermines the incentive effects of the vertical approach. Thus, these firms are likely to design their incentive systems using a horizontal approach, which becomes more effective in the presence of a strong team identity.

Supplemental Analysis on Hypothesis 1

While the primary analysis for H1 focuses on the effort levels, supplemental analysis can provide insight into the social processes through which these effort levels were

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[17] This instruction was provided verbally. The administrator was unaware of the experimental condition at the time of providing this instruction in order to eliminate the potential for experimenter bias.

[18] For the vertical system, this entailed 20 replications of the one-period game, while for the horizontal system, it entailed 10 replications of the two-period game.

[19] A post-experimental question served as a manipulation check for the team identity variable. When asked what their feelings had been at the beginning of the experiment, participants in the high-identity condition reported that they considered the person with whom they were paired to be a "teammate" to a greater extent than did participants in the low-identity condition ($F = 7.69$, $p < 0.01$).

[20] If all periods are used for both systems, then the results are inferentially identical. Further, if only odd periods are used for the horizontal system while all periods (divided by 2 for scaling) are used for the vertical system, then the results are inferentially identical. Finally, results are inferentially identical for analysis using only the first ten periods or only the last ten periods.

TABLE 1
Descriptive Statistics

	Incentive System			
	Horizontal		Vertical	
	Identity		Identity	
	Low	High	Low	High
Mean (Std. Dev.)				
Total Effort[a]	27.20 (7.95)	35.19 (6.34)	22.88 (13.21)	13.25 (15.54)
Total Effort in Odd Periods Only[b]	10.31 (5.51)	15.88 (5.02)	11.38 (6.78)	7.13 (7.92)
Communication[c]	18.19 (52.40)	68.94 (99.28)	13.88 (38.06)	51.19 (74.87)
Points Earned[d]	352.25 (34.21)	384.75 (24.70)	465.63 (184.53)	613.13 (159.90)
Ending Level of Team Identity[e]	5.56 (1.25)	6.06 (1.42)	4.41 (2.32)	6.00 (1.52)
Proportion of Shirking in period after:[f]				
Teammate Shirks	0.27	0.10		
Teammate Works	0.06	0.03		
Proportion of Truthful Reports after:[g]				
Teammate Shirks			0.32	0.20
Teammate Works			0.93	0.99

[a] Total Effort is defined as the cumulative number of times teammates worked in all periods. For each period, the variable is valued at 0, 1, or 2, depending on if neither, one, or both team members choose to work. Each session included 20 periods. Therefore, this variable can range from 0 to 40.

[b] Total Effort in Odd Periods Only can range from 0 to 20.

[c] Communication is the total number of words written on all forms passed between team members during the session.

[d] Points earned equals the total number of points earned by both members of the team over the 20 periods.

[e] Ending Team Identity is measured via the Likert-scale response to the post-experimental question, "At the end of the session, to what extent did you perceive yourself to be a teammate of the person you were paired with?" The responses are averaged for each pair.

[f] These proportions are calculated for the horizontal system only. The denominator is the total number of times either teammate shirked (worked) in odd periods. The numerator is equal to the number of times a team member shirked in the even period immediately following a period in which his/her teammate shirked (worked).

[g] These proportions are calculated for the vertical system only. The denominator is the total number of times either teammate shirked (worked) in all periods. The numerator is equal to the number of times a team member filed a truthful report in the period in which his/her teammate shirked (worked).

achieved. For example, a corollary to H1 is that under the vertical incentive system, members of high-identity teams will report less honestly than will members of low-identity teams. This difference occurs because high-identity teams are more likely to coordinate their strategies, and coordination under the vertical incentive system involves "covering" for a shirking teammate. As detailed in Table 1, both high- and low-identity team members showed willingness to cover for their teammates, with only 32 percent (20 percent) of shirking choices truthfully reported by low-identity (high-identity) teams. This proportion is calculated for each team, and the Wilcoxon signed ranks test confirms that high-identity team members were less likely to truthfully report a shirking teammate than were low-identity team members ($p < 0.01$).

TABLE 2
H1 Results—ANOVA on Effort[a]

Panel A: Main Effects

Factor	dof	Mean Square	F	p-value
Team Identity[b]	1	6.89	0.17	<0.69**
Incentive System[c]	1	236.39	5.76	<0.02**
Incentive System × Team Identity	1	385.14	9.38	< 0.01*
Error	60	41.08		

Panel B: Simple Effects for Each Incentive System

Effect of Team Identity under *Vertical* Incentive System	1	144.50	3.52	<0.04*
Effect of Team Identity under *Horizontal* Incentive System	1	247.53	6.03	<0.01*

* The p-values for the incentive system × team identity interaction and both simple effects are reported on a one-tailed basis, given the directional predictions for these effects.

** The p-values for the team identity and incentive system main effects are reported on a two-tailed basis, because no directional predictions are made for these effects.

[a] Effort is defined as the cumulative number of times teammates worked in odd periods. For each period the variable is valued at 0, 1, or 2, depending on if neither, one, or both team members choose to work. Each session included 20 periods (10 odd periods). Therefore, this variable can range from 0 to 20, and each team is considered one independent observation.

[b] Team Identity is manipulated between subjects at two levels. High-identity teams were formed from two members of the same color group. Low-identity teams were formed from one member of each color group.

[c] Incentive System is manipulated consistent with the two incentive schemes being studied. Participants accumulated points based on the incentive system formulas. The points were converted to cash at the conclusion of the session.

Supplemental analysis for the horizontal incentive system investigates the propensity of team members to punish each other. Recall that under this system, the Pareto optimal outcome is for both agents to work each period and to enforce the agreement through a tit-for-tat-type strategy. While I predict and find that effort levels are higher in high-identity teams, it is difficult to make a prediction regarding the level of punishment in high- versus low-identity teams. This difficulty arises because a team that is playing the coordinated tit-for-tat strategy will never actually engage in punishment; the mere threat of punishment will be sufficient to ensure that both agents work in all periods. Table 1 shows that high-identity team members were less likely to punish shirking teammates (by shirking in the subsequent period) than were low-identity team members. However, when this proportion is calculated for each team, the Wilcoxon signed ranks test finds that this difference is not statistically significant ($p > 0.80$).[21] Therefore, there is no statistical evidence of a difference in the propensity for punishment in high- versus low-identity teams. Despite this fact, high-identity teams achieved greater cooperation. This paradoxical result suggests an important implication for firms using teams. Specifically, social factors may sometimes play a more important role than formal sanctioning and control systems in eliciting cooperative behavior among team members. For example, for firms using self-managing teams, a focus on team

[21] For both high- and low-identity teams, the distribution of this proportion is bimodal, with most teams either always or never punishing shirkers.

building may provide greater benefits to the firm than an emphasis on the team members' control over such things as compensation, promotions, and workload distribution.

Hypothesis 2

Hypothesis 2 is aimed at unraveling the process by which team identity influences the effectiveness of incentive systems, suggesting that the relationship occurs through both direct (cognitive) and indirect (communication) effects. This model is tested using path analysis.[22] Under this structural equations approach, a single covariance matrix is created and used to simultaneously estimate all the links in the model (Kline 1998).[23] The primary measure of fit is a Chi-squared statistic, which tests the null hypothesis that the proposed model is a good fit for the data. This statistic is not statistically significant ($\chi^2 = 0.15$, $p > 0.69$), indicating that the model is a good fit.[24]

The independent and dependent variables for this analysis are the same as those used in the ANOVA for H1. However, an additional mediating variable, the level of communication, is added to the analysis. Recall that participants were allowed to share written communication with their teammates. The level of communication is captured by counting the number of words written by each team.[25]

The standardized path coefficients for this model are presented in Figure 2. The model confirms a significant direct relationship between team identity and effort. That is, there is a team identity × incentive system interaction ($\chi^2 = 6.06$, $p < 0.02$). Note that this result is fundamentally different from that presented for H1. While H1 tested for an interaction between team identity and the incentive system, that test was aimed at identifying only the total effect, not its direct and indirect components. The path analysis is aimed at unraveling these two components. Thus, the significant interaction here suggests a moderating influence of the incentive system on the *direct* effect of team identity on effort. Under the horizontal incentive system, a strong team identity increases the level of effort ($t = 2.80$, $p < 0.01$ one-tailed), whereas under the vertical incentive system, the direct effect of team identity is not statistically significant ($t = -1.08$, $p < 0.15$ one-tailed). However, there is weak evidence of a direct effect, even under the vertical system. Recall that the level of effort is assessed for odd periods only. If all 20 periods of data are used instead, then this direct effect is marginally significant ($t = -1.30$, $p < 0.10$ one-tailed).

I now address the indirect (communication) effect of team identity on effort. As hypothesized, high team identity leads to significant increases in communication ($t = 2.55$, $p < 0.01$ one-tailed). There is also a marginal communication × incentive system interaction ($\chi^2 = 3.16$, $p < 0.08$), meaning that the effect of communication on effort depends on the incentive system in place. Under the vertical incentive system, communication is negatively associated with effort ($t = -1.82$, $p < 0.04$ one-tailed), suggesting that team members used communication to collude with one another, leading them to reduce their

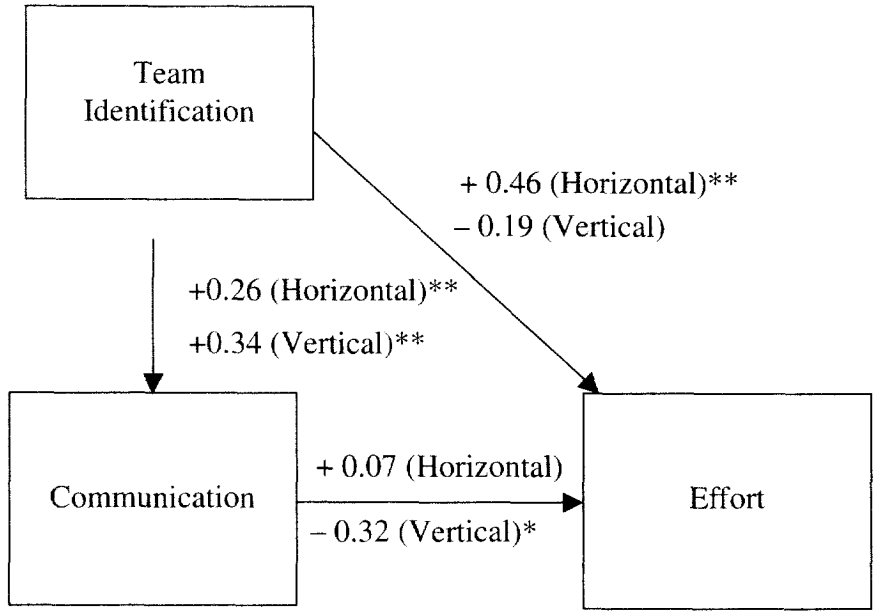
[22] Path analysis is the general term for structural equations modeling when no latent variables are included.

[23] Because of the predicted interactions, the simpler method of mediation analysis proposed by Baron and Kenny (1986) is not appropriate. Instead, I use a multisample approach with nested model comparisons. (For a detailed explanation of this procedure, see Rigdon et al. 1998.)

[24] This evidence is corroborated by the Tucker-Lewis Index, also known as the Non-Normed Fit Index. This value indicates the proportion of improvement of the model over a null model. The value of 1.30, indicating a 130 percent increase over the null model, is well above the generally accepted cut-off value of 90 percent (Kline 1998, 131).

[25] While I did not conduct a formal content analysis of the communication transcripts, casual observation of the content suggests no differences among the experimental conditions. The vast majority of communication was aimed at problem solving and coordination.

FIGURE 2
H2 Results—The Effects of Team Identity on Effort[a]
(Direct and Indirect Effects)



*, ** Significant at < .05 and < .01, respectively.
[a] Overall Goodness of Fit: $\chi^2 = 0.15$, $p > 0.69$ (tests the null that the model is a good fit).

effort levels. Under the horizontal incentive system, however, communication has no significant relationship with effort ($t = 0.45$, $p > 0.65$). One possible explanation for this lack of association is the relative simplicity of the horizontal system. Results from the post-experimental survey show that participants found the horizontal system less complex than the vertical incentive system ($t = 1.40$, $p < 0.09$ one-tailed).

Alternatively, one might argue that the importance of communication for determining the level of cooperation lies not in the *amount* of communication but in whether communication occurs at all. That is, an important determinant of the amount of communication may be related to individual differences, as some people are direct and "to the point," whereas others are more verbose. Thus, communication might alternately be operationalized as a dichotomous (yes/no) variable, instead of as the number of words. To test this alternate model specification, I conducted a logistic regression, using the level of identity (0 = low, 1 = high) as the independent variable, and a dichotomous communication variable as the dependent variable. This regression finds a significant relationship between the level of identity and whether communication occurred ($\chi^2 = 9.22$, $p < 0.01$). Further, a two-way ANOVA finds that this dichotomous communication variable interacts with the incentive system to affect effort ($F = 16.97$, $p < 0.01$). Specifically, the presence of communication (regardless of the amount of communication) increases effort under the horizontal system ($F = 3.19$, $p < 0.04$ one-tailed), but decreases effort under the vertical system ($F = 16.32$, $p < 0.01$ one-tailed). Thus, the findings using a dichotomous communication variable

support an indirect (communication-mediated) effect of team identity on effort for both the horizontal and vertical incentive systems. However, it should be noted that structural equations-based path analysis cannot be legitimately performed on a dichotomous measure. Therefore, the analysis using the dichotomous measure does not simultaneously estimate all the paths of the model, and should be interpreted with caution.

In summary, the model predicted in H2 is fully supported under the vertical incentive system. Specifically, under the vertical incentive system, the effort-reducing effect of team identity has both a direct and an indirect (communication-mediated) component. Under the horizontal incentive system, the effort increasing effect of team identity also appears to have direct and indirect components. Under this condition, while high identity did lead to increased communication, the effect of communication on effort was driven by the mere presence of communication and not by the amount of communication.

Hypothesis 3

While the analysis to this point views team identity and the incentive system as two exogenous and independent constructs, H3 predicts that *after repeated interaction,* individuals compensated according to the horizontal incentive system will experience a higher level of team identity than will individuals compensated according to the vertical incentive system (i.e., team identity has an endogenous component in addition to its exogenous manipulation). The dependent variable for this test is ending team identity, measured through the post-experimental survey. Each participant was asked, "At the end of the session, to what extent did you perceive yourself to be a teammate of the person you were paired with?" The Likert scale response to this question is averaged for each pair.

Table 3 reports a two-way (team identity × incentive system) ANOVA. Team identity (representing the *manipulated* high- or low-identity condition) is included because this manipulation is expected to have a lasting effect. That is, a team that begins the process with a high team identity is likely to maintain a relatively high level of identity, regardless of the incentive system in place. Indeed this is the case, as teams in the high-identity

TABLE 3
H3 Results—ANOVA on Ending Team Identity[a]

Factor	dof	Mean Square	F	p-value
Team Identity (as manipulated)[b]	1	17.54	6.23	<0.01*
Incentive System[c]	1	5.94	2.11	<0.08*
Incentive System × Team Identity	1	4.79	1.70	0.20**
Error	60	2.82		

* The p-values for the team identity and incentive system main effects are reported on a one-tailed basis, given the directional predictions for these effects.

** The p-value for the incentive system × team identity interaction is reported on a two-tailed basis, because no directional prediction is made for this effect.

[a] Ending Team Identity is measured via the Likert-scale response to the post-experimental question, "At the end of the session, to what extent did you perceive yourself to be a teammate of the person you were paired with?" The responses are averaged for each pair, and so each team is considered one independent observation.

[b] Team Identity is manipulated between subjects at two levels. High-identity teams were formed from two members of the same color group. Low-identity teams were formed from one member of each color group. The main effect observed indicates that the manipulation of team identity was still in effect at the end of the experiment.

[c] Incentive System is manipulated consistent with the two incentive schemes being studied. Participants accumulated points based on the incentive system formulas. The points were converted to cash at the conclusion of the session.

condition self-reported higher ending levels of team identity than teams in the low-identity condition ($F = 6.23$, $p < 0.01$ one-tailed). This result is essentially a manipulation check. A marginally significant main effect for the incentive system ($F = 2.11$, $p < 0.08$ one-tailed) also exists, suggesting that after repeated interaction, teams operating under the horizontal incentive system experienced higher levels of team identity than did teams operating under the vertical incentive system. Therefore, H3 is marginally supported.

While the incentive system $\times$ team identity interaction term for this ANOVA is not significant ($F = 1.70$, $p > 0.19$), it is nonetheless important to point out that the incentive system main effect is driven by the vertical system.[26] The small difference in ending team identity between the two systems in the high-identity condition (6.06—horizontal, 6.00—vertical) is likely due to a ceiling effect. That is, even in the low-identity condition, participants under the horizontal system reported relatively high levels of ending team identity (5.56 out of a possible 7.00). Thus, there is little room for an incremental level of ending team identity in the high identity condition.

V. SUMMARY AND CONCLUSIONS

This study presents evidence that the effectiveness of a financial incentive system can be enhanced or degraded by a sense of team identity, depending on specific characteristics of the incentive system. A strong team identity increases the level of coordination among the agents. This degrades the effectiveness of a vertical incentive system, in which the agents report observations of their teammates' efforts to the principal. Coordination undermines the incentive system, as individuals collude against the principal, choosing low levels of effort and reporting falsely. Conversely, the effectiveness of a horizontal incentive system, based on peer-enacted control, is enhanced by a strong team identity. Because no collusive opportunities exist under this incentive system, a strong team identity serves to help teams to reach a cooperative solution, as desired by the principal. The evidence presented here suggests that under both incentive systems, the effect of team identity on cooperation has both direct (based on a change of cognitive focus) and indirect (communication-mediated) components.

Finally, evidence suggests that team identity is partially endogenous, in that it is affected by the incentive system in place. After repeated interaction, the horizontal system, with its focus on team outcomes rather than individual contributions, leads to higher levels of team identity than does the vertical incentive system, where individuals act as whistle-blowers for the principal.

This research provides useful insights for both theory and practice. From a practical standpoint, this study provides evidence on the usefulness of mutual monitoring as an alternative to traditional methods of measuring individual production inputs. In many joint production settings, workers hold high-quality information on coworkers' inputs, and firms can benefit by understanding how to use this knowledge base to make informed decisions in such areas as resource allocation, compensation, and promotion. The results of this study suggest that when the team has achieved a high level of identity, the most effective way to use this information is likely horizontal in nature, delegating responsibility for control to self-managed teams, rather than extracting the information through reporting mechanisms.

[26] Simple effects analysis demonstrates that in the low-identity condition, ending team identity was significantly higher in the horizontal incentive system than in the vertical incentive system ($F = 3.79$, $p < 0.03$ one-tailed). In the high-identity condition, the level of ending team identity was not significantly different under the two incentive systems ($F = 0.01$, $p < 0.93$).

This study thus helps explain why firms have more readily embraced horizontal incentive systems than vertical incentive systems.

Further, this study provides evidence on the types of incentive systems that are most likely to be effective for different types of teams. For example, Scott (1997) demonstrates that permanent teams tend to develop higher levels of identity than do part-time or temporary teams. One inference from the results presented here is that the horizontal approach is particularly appropriate for work teams involved in manufacturing or other permanent production-related tasks. Thus, by focusing on the consequences of team identification, this study aids in understanding the causal linkages among team characteristics, incentives, and performance.

From a theoretical standpoint, this study draws from both economics and psychology, demonstrating that concepts from psychology may be useful in understanding the economic incentives addressed by agency theory. The study therefore adds to an expanding body of literature examining variables that interact with financial incentives to influence performance (Bonner et al. 2000; Bonner and Sprinkle 2002; Drake et al. 1999; Sprinkle 2000). The paper contributes more specifically to the relatively undeveloped literature on the effect of incentives in a team environment (Drake et al. 1999; Fisher et al. 2002; Rankin and Sayre 2000; Rankin 2003).

Certain factors limit the study's generalizability. For example, one may view these results as implying that firms should *always* use the horizontal system, because it performs better than the vertical incentive system when the team identity is high and no worse when the team identity is low. However, this study was not designed to directly compare these two systems, and any such comparisons should be interpreted with caution, due to the study's suppression of risk preferences. That is, to simplify the laboratory experiment, the stochastic element was removed, and the incentive systems were presented to participants in expected value terms. Such an abstraction is appropriate, because risk preferences are not relevant to the hypotheses investigated in this study. However, risk preferences are an outside factor that may affect the relative desirability of the two systems.

I also make the simplifying assumption that effort is discrete and perfectly observable, an attribute almost certainly not characteristic of real-world settings. While team members may observe the amount of time a coworker spends on a particular task, it is considerably more difficult to observe the intensity or creativity with which s/he works.[27] This study compares two analytic approaches to incentive contracting, and these simplifying assumptions help to enhance comparability of results across the two incentive systems. However, it is unclear how the results would change if effort were imperfectly observable. For example, in their experimental investigation of several budget-based group incentive plans, Sprinkle et al. (2003) demonstrate different effects on effort duration, which is easily observed, and effort intensity, which is less easily observed. This limitation offers an opportunity for future research, and a body of psychology literature may prove helpful. Social Comparison Theory (Kunda 1999, 494) provides a rich theory for understanding the more subtle aspects of mutual monitoring. Thus, future work in this area may follow the approach used here of melding insights from both economics and psychology to understand complex managerial accounting issues.

[27] These dimensions of effort are not only unobservable, but are also likely immeasurable. This leads to difficulty in meeting another assumption—common knowledge of the probability distribution of outcomes given effort.

APPENDIX
TECHNICAL DETAILS

In this appendix, I introduce a model of team production, including the opportunity for mutual monitoring. I then demonstrate how each type of incentive system (vertical versus horizontal) may be used in this setting. Consider two risk-neutral and effort-averse agents (*a* and *b*) engaged in joint production over *n* periods. Each agent *i* selects an effort level $e_i \in \{shirk, work\}$ and output $x \in \{high, low\}$ is a function of these effort choices. Specifically, $x = f(e_a, e_b, \theta)$, where θ is a random variable representing uncertainty in the production process. As reflected in θ, output is stochastically related to the agents' effort levels, resulting in the conditional probability distribution depicted in Exhibit 3. For the remainder of this appendix, I suppress θ and focus on the resultant conditional probability distribution, $p(x_j | e_a, e_b)$, the probability that output is *j*, given the levels of effort selected by the two agents.

Each agent *i* maximizes expected utility $u_i = g(e_i, m_i)$, which is increasing in monetary wages (m_i) and decreasing in effort (e_i). This function is additively separable in its two operands. As is common in many experimental studies, I make the simplifying assumption that utility can be measured in dollars. Therefore, the utility function may be represented as $u_i = m_i - c(e_i)$, where $c(e_i)$ is a function converting effort levels to costs. Assume that the principal prefers each agent to work (w) rather than shirk (s).[28] However, $c(w) > c(s)$ due to effort aversion, so *ceteris paribus*, the agents will both prefer shirking. Next, I will explore the use of two types of incentive systems to induce the agents to work in this setting.

Vertical Incentive System

Under the vertical system, agent *i*'s wages m_i have two additive components—effort pay and reporting pay. Formally, $m_i = E_i + R_i$, where:

$$E_i \text{ (effort pay)} = \begin{cases} \hat{u}_i + c(w) & \text{if } r_i = \text{work} \\ \hat{u}_i + c(s) - \delta & \text{if } r_i = \text{shirk} \end{cases} \quad (1)$$

$$R_i \text{ (reporting pay)} = \begin{cases} \beta & \text{if } r_j = \text{shirk and } e_j = \text{shirk} \\ \gamma & \text{if } r_j = \text{shirk and } e_j = \text{work} \\ 0 & \text{otherwise (i.e., if } r_j = \text{work)} \end{cases} \quad (2)$$

$r_i \in \{shirk, work\}$ is agent *i*'s effort, as reported by agent *j*
$\hat{u}_i$ = agent *i*'s reservation utility
$\delta \geq \beta > 0$;[29] $\gamma < 0$; $i \neq j$

Intuitively, effort pay represents wages for effort as reported by the other agent, and each agent will be paid his/her reservation utility (plus an amount equal to the disutility of effort) if the report indicates that s/he has worked.[30] If the report indicates that s/he

[28] I treat the principal and the incentive system exogenously, with all analysis directed to the agents' subgame.

[29] The requirement that $\delta \geq \beta$ is not a technical requirement, but rather a practical one. If $\beta > \delta$, then a collusive opportunity exists for the agents to increase their payoffs by agreeing to shirk and report truthfully. This collusive outcome (not a Nash Equilibrium) is easily avoided by adding this constraint.

[30] In Ma's original model, the incentive scheme is asymmetric, with one agent reporting and the other agent verifying the first agent's report. Further, Ma assumes that each unique pair of actions by the two agents leads to a unique probability distribution of outputs, an assumption not met in the simplified setting used in this experiment.

EXHIBIT 3
Conditional Probability Distribution

Effort Levels	Probabilities of Output Levels: Low	High
Both Shirk	75%	25%
Agent 1 Shirks/Agent 2 Works	50%	50%
Agent 1 Works/Agent 2 Shirks	50%	50%
Both Work	25%	75%

Three assumptions are made regarding this conditional distribution:

1) First-order stochastic dominance.
2) Non-moving support (the stipulation that the support of x (output) is the same for any combination of efforts by the two agents (Holmstrom 1979)).
3) Symmetry—this assumption is not required, but is made for simplicity.

shirked, then a penalty of δ is subtracted. Reporting pay is the wage component that induces truthful reporting, because it pays a bonus (penalty) to the agent who accuses his/her teammate of shirking, if that report is truthful (false). In this study, the following specific parameters are used, resulting in the normal form game tree found in Exhibit 1.

$$\hat{u}_i = \$10.00^{31}$$
$$c(s) = \$0.00, \qquad c(w) = \$10.00$$
$$\beta = \$10.00$$
$$\delta = \$10.00$$
$$\gamma = -\$20.00.$$

This game can be solved by backward induction, resulting in the unique subgame perfect Nash Equilibrium in which each agent works and each agent reports truthfully. Further, if this game is repeated finitely, the unique subgame perfect Nash Equilibrium in the n-period game will have the agents working and reporting truthfully in each period (Gibbons 1992, 84).

Horizontal Incentive System

As detailed in Exhibit 2, Panel A, the principal provides output-based *team incentives* in period 1, meaning that each agent's compensation is increasing in team output and that each agent prefers both agents working to both shirking. Precisely,

$$m_i = \begin{cases} \hat{u}_i + c(w) + \lambda_1 & \text{if } x = \text{high} \\ \hat{u}_i + c(w) + \lambda_1 - \dfrac{\lambda_1}{p(low|w,w)} & \text{if } x = \text{low} \end{cases} \tag{3}$$

[31] It is not necessary that the participants' reservation utilities exactly equal \$10.00. In the laboratory, it is only important that the reward structure achieve Smith's (1982) dominance precept, meaning that it must dominate any subjective, nonmonetary costs or values that the subjects hold for participating in the experiment.

where:

$$\lambda_1 = \frac{[c(w) - c(s)][p(low|w,w)]}{p(low|s,s) - p(low|w,w)} + \varepsilon, \text{ and}$$

ε = an arbitrarily small positive increment.

The subscript on λ refers to the period. This scheme is designed to ensure that each agent earns exactly his/her reservation wage in expectation when both agents work. The conditional probability distributions and the definitions and values of $\hat{u}_i$, $c(s)$, and $c(w)$ are the same as presented earlier for the vertical incentive system. The constraint on λ_1 assures that each agent prefers both agents working to both shirking, and requires that λ_1 = \$5.00 + ε. I set ε = \$1.00. Using these parameters, if output is high (low), each agent receives compensation of \$26.00 (\$2.00).

This single-period game is a prisoner's dilemma, in that the unique Nash Equilibrium is for each agent to shirk, while a Pareto optimal outcome is for each agent to work. If this game were repeated finitely, the unique Nash Equilibrium for the multiple-period game would have both agents shirking in each period, because each agent could use backward induction to "unravel" the problem. However, the principal can induce the agents to work in period 1 by changing the incentive structure in period 2 (Arya et al. 1997).

In period 2, the principal uses *individual incentives* rather than team incentives, such that each agent at least weakly prefers working, given that the other agent is working. In doing so, the principal creates multiple equilibria in the period 2 subgame. In at least one of these equilibria, agent i is worse off than in the other equilibria. Agent j can therefore threaten to punish agent i for not working in period 1 by playing this "bad equilibrium" in period 2. The threat is credible, because punishing behavior in period 2 is part of an equilibrium. Because each agent has the ability to punish within an equilibrium, the problem no longer unravels due to backward induction. Thus, a punishment strategy can be maintained in a Nash Equilibrium, using the following parameters in the second period:

$$m_i = \begin{cases} \hat{u}_i + c(w) + \lambda_2 & \text{if } x = \text{high} \\ \hat{u}_i + c(w) + \lambda_2 - \dfrac{\lambda_2}{p(low|w,w)} & \text{if } x = \text{low} \end{cases} \tag{4}$$

where:

$$\lambda_2 = \frac{[c(w) - c(s)][p(low|w,w)]}{p(low|w,s) - p(low|w,w)}.$$

Using the values defined earlier, λ_2 = \$10.00, resulting in the normal form game represented in Exhibit 2, Panel B.

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Editorial Data

The following table contains information about turnaround time for manuscripts (including revisions) on which editorial decisions were made in the 12-month period ended May 31, 2003. Turnaround time is the number of days between the date that the manuscript was received *and the date of the editor's letter to the author(s)*:

	Number of Manuscripts	Cumulative Number	Cumulative Percent
0 ≤ Days ≤ 30	60	60	15.42
31 ≤ Days ≤ 60	143	203	52.19
61 ≤ Days ≤ 90	136	339	87.15
91 ≤ Days ≤ 120	38	377	96.92
121 ≤ Days	12	389	100.00

The mean review time was 57.9 days; the median review time was 57 days.